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Paris Metropolitain Railway—Mtg. 251
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Yorkshire Electric Power—Rpt. 733, Mtg. 815
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THE ELECTRICIAN:

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NOTES.

THE necessity of closing the debate on measuring instruments at the Institution of Electrical Engineers last week in sufficient time to allow Mr. FIELD to read his Paper on eddy currents in cable sheaths, resulted in some amusing incidents in the discussion. There being many speakers, Mr. GAVEY (who occupied the chair in Mr. GRAY'S absence) insisted firmly upon an observance of the 10-minutes rule. The tone of each speaker's voice towards the end of his remarks betrayed anxiety lest he should be cut short before he had said all he wanted to, and one speaker in particular, while delivering himself of what he had to say in rapid sentences, systematically connected these together with links of inarticulate noises in order that the Chairman should be unable to cut him short during a pause. Mr. GAVEY has set a good example, however, which we trust some of the long-winded speakers at the Institution will take note of. Taking even last week's debate, although the speeches were on the whole commendably brief and to the point, there was not a single speaker who should not have been able to say what he wanted to say well within 10 minutes; in most cases five or six minutes would have sufficed. Many members of the Institution have still to learn that conciseness of expression is one of the chief desiderata for the best style in oratory.

COMING to the subject matter of the discussion, the chief point that was raised was standardisation in moving coil instruments. It is certainly desirable that each instrument maker should have his instruments and the shunts and series resistances of his ammeters and voltmeters standardised in such a manner that either the instruments themselves or the shunt (or resistance) can be replaced without the necessity of replacing both. But to desire each instrument maker to construct his instruments for a stated number of milli-volts or milliamperes laid down by an outside authority, as Major CROMPTON apparently desires, would be going very far in this direction, and it is doubtful whether all the instrument makers would agree to this proposal, except in so far as the standard adopted happened to agree with their own practice.

ON the whole, however, instrument users rather than instrument makers should derive most profit from the discussion and from the Paper. They have been told clearly what accuracy to expect from the instruments, and, moreover, they have been reminded of a source of serious error which is too often disregarded—viz., parallax. As Mr. VIGNOLES pointed out, this is especially troublesome with the now fashionable "edgewise" instruments, in which the angle between the direction of the observer's vision and the instrument scale differs enormously for different readings. It is, in fact, only on account of the parallax error that "set up" or "open scale" instruments are more accurate than those with equally-divided scales, for the percentage accuracy of the instrument itself is the same in the two cases if the instruments are otherwise similar. The unreliability of some wattmeters, emphasised by one or two speakers, was also a point upon which it did no harm to remind central station men, for although some may consider a switchboard instrument merely as an indicator, others base calculations and quantitative records upon the absolute readings. Prof. AYRTON'S remarks as to the stray field due to the 'bus bars should also be borne in mind. Some switchboards are designed in such a way that the instruments could not possibly be accurate unless they were calibrated in position, and even on the best-designed continuous-current switchboard there are magnetic fields, dependent on the current through the 'bus bars, which may be troublesome if the instruments are not sufficiently well shielded. Moreover, Mr. NALDER pointed to an error that could arise from the screening iron case itself. The subject is certainly one to which a little more attention might well be directed.

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WE have more than once hinted that the practice of municipalities of letting tenders for electrical plant before the Local Government Board sanction to the necessary loans has been obtained is undesirable. This is emphasised by recent circumstances at Stourbridge, recorded in another column. Briefly, the history is as follows:—In 1898 the Stourbridge District Council obtained an electric lighting order. At the expiration of three years no progress had been made with the works, but a two years' extension was granted by the Board, and very shortly afterwards a resident engineer was appointed—viz., Mr. J. B. CLARKE. Two schemes were put before the local authority, the larger of which, involving an outlay of £15,674, was accepted. A refuse destructor was to be erected and worked in conjunction with the electric lighting plant, and for this portion of the scheme a loan of £5,500 has already been obtained. In October last application was made to the Local Government Board for a loan of £16,000 in order to carry out the remainder of the undertaking, but it was only on Thursday last week that the inquiry was held. Tenders for the dynamos, engines, boilers, &c., were let about a fortnight before the inquiry, however, subject of course to the loan being granted. But now there is a likelihood that sanction to borrow this money will be refused, as the Inspector, Mr. F. H. TULLOCH, apparently leaned towards the views of a large number of ratepayers that the current should be taken "in bulk" from the Midland Electric Corporation for Power Distribution. Should this happen, it will, we believe, be the first case in which sanction to a loan has been refused by the Local Government Board after the tenders for plant had been let. It will be a warning to tendering firms that it may sometimes be desirable to examine the circumstances of the case closely when they accept contracts in advance, and also an incentive to the Local Government Board to avoid these serious delays in holding its inquiries.

PROF. BRAUN'S article, appearing in this issue, on certain devices of his for use in wireless telegraphy, sets forth very clearly the development on scientific lines of the important conception originally due to him. This conception may be described in a few words as proposing the creation in the air-wire of energetic, regular and prolonged electrical vibrations by acting upon it—by direct connection or merely inductively—by the comparatively undamped oscillations in a vigorously excited closed circuit. In this process the transmitter becomes a compound apparatus, consisting of a closed circuit called the oscillator circuit, and an open circuit which is the actual radiator. The purpose of the combination is clear, for by drawing upon the kinetic energy stored in the oscillator-circuit, more energy can be radiated in each effort of the air-wire system than could possibly be given to it alone, except by the use of impracticable potentials. Moreover, the vibration cycle of the radiator is, theoretically, greatly prolonged, and thus a great step is made towards that consummation so necessary for syntonic wireless telegraphy—a long train of regular waves.

UNFORTUNATELY, it seems to be the case that the amount of energy which can be stored in a simple oscillator circuit of an ordinary frequency is still small, unless, again, high potentials are employed. But high potentials inevitably involve wasteful spark-gaps. Prof. BRAUN, therefore, took up the problem of making an oscillator circuit of the required frequency which would behave as a large storehouse of energy, but which would yet permit of economical potentials. We now have before us the results of his labours. A perusal of the article shows that the problem was not an easy one, and the ingenuity of the solution will excite admiration. It is worthy of remark that Mr. MARCONI pushed forward to the same end—namely, the energetic excitation of the air-wire system,—by the use of extremely high potentials and by ignoring the losses at the spark-gaps. An indication of the extent of this waste has, by the way, been placed on record by Dr. FLEMING in his remarks on the blinding intensity of the sparks at the Poldhu station.

AN English patent, relating to improvements in the commutation and power-factor of single-phase motors, has been granted to Dr. G. FINZI and Signor E. KORRODI, and is reproduced elsewhere in this issue. The patentees attain the desired result by stiffening the field through tapering the field magnets towards the armature. It may be that these investigators are the first to apply this device to commutating motors of the single-phase type, but it is well to point out that the same means has already been suggested for bettering the commutating properties of continuous-current machines. It is mentioned, for instance, in Prof. S. P. THOMPSON'S book on "Dynamo-electric Machinery."

IN our Parliamentary columns this week will be found a short report of the debate which took place in the House of Commons on Friday last week in connection with the Weights and Measures Bill introduced by Mr. BOUSFIELD. It will be observed that the measure included a section relating to the use of the metric system which was eventually withdrawn owing to the opposition of the House. It would appear that it only proposed, under Part IV., a modified adoption of the metric system—viz., for the purposes for which the Troy and Apothecaries' measures are now employed—and in no way dealt with the question in a complete manner. The inference might be drawn that all legislation concerning the metric system is now "dead" for this session, but we would point out that the Bill which was introduced into the House of Lords on February 23rd by Lord BELHAVEN is still under consideration by the Select Committee of the House to which it was referred. Apparently the reason why Mr. BOUSFIELD included the section referred to in his Bill was his conviction that no Government would be likely to propose such a reform as the adoption of the metric system *en bloc*, but that a cautious step might be made in this direction. There might possibly be some advantage in giving the change-over a trial at the hands of one section of the community; but on the other hand, the special and limited applications of Troy weight and Apothecaries' weight cover so limited a field that no gauge could be drawn in this manner as to the balance of advantages and disadvantages which would accrue from a general super session of our present system of weights and measures by the Continental system. In any case, however, the matter is of sufficient importance for a Government Bill, and should not be dealt with in a private measure.

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IT appears that the law relating to the electrical industry is very similar in America to that of England—that is to say, the actual statutes are similar, but the effect produced is by no means the same. In an interesting article in the *Electrical World* of New York, Mr. W. VALENTINE BALL, barrister-at-law, calls attention to the fact that this is largely due to the great number of precedents which have been established in this country as compared with the extreme diversity of the decisions which have been given in American courts of law. Hence, while the English law has assumed tangible principles upon which future judgments may be based, that of the United States does not present any definite grounds beyond the mere Acts of Congress. For instance, it is now useless for an electricity supply undertaking to plead exemption from liability for nuisance under its Act or Provisional Order, as it is held that no such Act or Order can sanction interference with the rights and privileges of ordinary citizenship. But in America, although the statutes aim at the same end, it is well-nigh impossible to succeed in an action against a statutory electrical undertaking for nuisance or annoyance. On the other hand, American juries award substantial damages for negligence on very small pretext. And it is for this reason that a considerable number of claims are settled out of court. English tramway companies, in particular, ought to be grateful for the absence of what is known in America as the "ambulance lawyer"—mostly a broken-down or dishonest solicitor—who watches keenly for opportunities to attack tramway companies on behalf of "clients" who have received more or less imaginary injuries. This species of shark is the outcome of impressionable juries and the unstable condition of American law, which is different for nearly every one of the Union States.

N-Rays.—Mr. Leslie Miller informs us that, in addition to muscle-ray effects, he is now able to show that a coiled-up clock spring will decidedly brighten up a calcium sulphide screen through two thicknesses of cardboard and several inches of air.

Obituary.—The death took place on Tuesday of Sir Clement Le Neve Foster, D.Sc., F.R.S. Sir Clement Foster was, until recently, one of His Majesty's Inspectors of Mines, and he was one of the mining men who took part in the discussion on the subject of Electricity in Mines at the Institution of Electrical Engineers in 1901.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Cayenne—Pinheiros	Aug. 18, 1902 ..	—
Beissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
New York—Hayti	Apr. 18, 1903 ..	April 15, 1904
Tourane—Amoy	Nov. 10, 1903 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Dakar—Conakry	April 11, 1904 ..	—

Electricity in Mining.—A blue book has now been issued by the Home Office giving the reports of the evidence which was given before the Departmental Committee which considered the question of the application of electricity in mines. The Committee's report and proposed regulations were given in *The Electrician*, Vol. LII., pp. 608, 650 and 689, and some comments on them will be found in the same volume on pp. 652, 763, 788 and 856. Our own report of the evidence given before the Committee will also be found in Vol. L., pp. 652, 819 and 937, and Vol. LI., pp. 78, 125 and 168.

Forthcoming Papers at the Institution of Electrical Engineers.—At the meeting of the Institution of Electrical Engineers on Thursday last week, Mr. J. Gavey, who was in the chair, announced that the following two Papers would be read before the end of the present session:—"Power Station Design," by C. H. Merz and W. McLellan; "The Steam Turbine as applied to Electrical Engineering," by Messrs. C. A. Parsons, G. Stoney and C. P. Martin. The Paper by Messrs. Merz and McLellan is down for reading next week.

The McMillan Memorial Fund.—This fund at present amounts to £1,320. 11s. The Council feels that a sum of at least £2,000 will be needed if the fund is to meet the object for which it was started. It appears that many subscribers have wrongly assumed that the sums named in the circular are the maximum sums expected and the Council is therefore inviting any subscribers, who may desire to do, to augment their subscriptions in case the amounts chosen by them in the first instance were fixed under this misapprehension. We trust that this further appeal will have the desired effect, and also that members who have not already contributed will take early opportunity of showing their appreciation of the zealous and self-denying services rendered to the Institution by its late secretary.

A New Electric Cut-out for Alternating Currents.—In the English patent No. 15,500, of 1903, Messrs. Brown, Boveri & Co. describe a new cut-out, the chief advantages of which are claimed to be that it has an adjustable time constant and that it may be easily regulated for different currents. Its principle is this: A metal disc is free to rotate between the poles of an electromagnet which is fed from the alternating-current circuit. The tendency of this disc to move is opposed by a weight which is hung from a string, this being slung around the axle of the disc. As soon as the alternating current exceeds a certain value, depending on the weight attached to the string, the torque set up in the disc will cause this to rotate against the pull of the weight. The weight is wound up and, upon arriving at a given height, it closes an auxiliary circuit by which the switch mechanism is operated. Altering the length of the string obviously alters the time constant of the cut-out.

The Chancellorship of the Glasgow University.—At the meeting of the Institution of Electrical Engineers on Thursday last week, Mr. J. Gavey, who was in the chair, referred to the appointment of Lord Kelvin as Chancellor of the Glasgow University. He said that they all knew Lord Kelvin, and nothing he could say could raise him further in the esteem of the members, but there was one point in which he thought everyone would feel considerable interest. It had been the practice very much in the past to give this high honorary office to people who had made a name in the political world, and it was gratifying to find that this office had now been given to one who had made the highest name possible in the scientific and engineering world. With the permission of the members it was proposed, on behalf of the Institution, to write a letter congratulating Lord Kelvin on the honour that had been conferred upon him. The meeting cordially acquiesced in this proposal.

Running Powers on Municipal Tramways.—A conference of representatives of municipal corporations owning and working tramways was held at London on Tuesday, to consider the recent decision of a Committee of the House of Lords in which compulsory running powers over the Newcastle Corporation tramways were granted to the Tyneside Tramways and Tramroads Co. (see *The Electrician* for March 25th, p. 916, and April 1st, p. 931). Baillie E. Paton, chairman of the Glasgow Tramways committee, presided. On the motion of Ald. Bell (Birmingham), seconded by Councillor Boyle (Manchester), it was resolved that the granting by Parliament of compulsory running powers and compulsory traffic facilities over municipal tramways would be fraught with grave and undesirable consequences and prove detrimental to the working of large tramway systems. It was also decided that a committee, consisting of representatives of the corporations of Birmingham, Liverpool, Manchester, Leeds, Cardiff, Sheffield and Newcastle-on-Tyne, and the London County Council, with

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power to add to their number, be appointed to take such steps as it might deem necessary in relation to the matter.

Submarine Boats and Mines.—According to a Reuter telegram from St. Petersburg, one of the five new submarine boats which are being constructed in the St. Petersburg Iron and Steel Works is being dispatched to Port Arthur. It is stated that the vessel will carry an improved apparatus for firing torpedoes by an electrical contrivance, and also that the submarine is propelled by electricity.——The *Standard's* naval expert states that the class of mine employed by the Japanese at the mouth of Port Arthur appears to have been what is known as the "electro-mechanical." In the British service, our contemporary says, mines of this class consist of cylindrical iron cases, having in the bottom an explosive charge of about 75lb. of wet gun-cotton—though sometimes much more is used—with a primer tin inserted in the upper surface, over which is a pedestal supporting a mercurial circuit closer. This appliance is a cylinder filled with re-distilled mercury, so arranged that when it is tilted over at a particular angle—generally 70deg.—the mercury completes an electric circuit, thereby firing the detonators and the mine. One advantage of mines of this class is said to be that they can be laid easily and rapidly, being arranged for submersion at the proper depth of 10ft. or 15ft. All that is necessary to explode the mine is for a ship to bump against the cylinder, thereby causing the mercury to complete the electric circuit.

Incorporated Municipal Electrical Association.—The ninth annual meeting of this Association will take place at Derby, Nottingham and Sheffield, from June 29th to July 2nd. The following is the programme of the proceedings, which may, however, be modified if it is found necessary to change any of the present arrangements.

Derby, Wednesday, June 29th.

Morning.—Reception by the Mayor. Presidential Address. Paper by Mr. C. E. Shawfield (Wolverhampton) on "The Commercial Practicability of Electric Traction by Surface Contacts."

Afternoon.—Excursion to Chatsworth and Haddon, by invitation of the Mayor and Corporation.

Nottingham, Thursday, June 30th.

Morning.—Reception of members by the Mayor. Papers by Messrs. S. L. Pearce (Manchester) "Polyphase Sub-stations, their Equipment and Working"; H. Faraday Proctor (Bristol) "Some Notes on the Bristol Electricity Works Fire"; and R. S. Downe (Southport) "Boiler House Economies."

Afternoon.—Visit to electricity works and other works.

Evening.—Members' annual dinner.

Sheffield, Friday, July 1st.

Morning.—Reception of the members by the Lord Mayor. Papers by Councillor Blakeway (Southampton): "The Financial Position of Municipal Electrical Undertakings," and Mr. A. J. Cridge (Sheffield): "The Organisation and Management of the Meter Department."

Afternoon.—Visit to electricity works and other works.

Derby, Saturday, July 2nd.

Morning.—Annual general business meeting (members only).

We are glad to learn that so many technical subjects are to be dealt with in the Papers. It may be anticipated that the discussion and the results of the meeting generally will be of exceptional merit from the engineer's point of view.

Radium Ore.—In a Paper read before the Canadian Mining Institute at Toronto, Mr. J. Obalski, an inspector of mines, states that about 10 years ago he found a remarkable specimen in a white mica mine then operated by the Canadian Mica Co.; this specimen he identified as cleveite. It had a specific gravity of 8·43, and weighed 375 grammes. It was well crystallised, in dodecahedron form, thus deriving from an isometric system. No complete analysis had yet been made, but it had been ascertained that it carried 70·71 per cent. uranium oxide. Mr. Obalski experimented with this crystal and found that it affected photograph plates strongly. The specimen had also a well-marked action on the electroscope. He came to the conclusion that it contained radium, and in order to have his opinion confirmed, he showed it to Prof. Rutherford, of McGill University, who stated that its radio-activity was equal to four or five, and that it contained one-tenth of a milligramme of radium. This made it comparable with the best pitch-blende so far tested for the production of radium. The author admitted that the crystal might be an accidental one, but he had found other small specimens of the same mineral in this vein. He also found in the same dyke a carbonaceous material, burning quite easily and leaving a large proportion of ash containing uranium oxide. He was not able to state what was the relation between the two specimens, but proposed to make further investigations next summer. The white mica vein from which these specimens were taken is situated near Lake Pieddes-Monts, which is about 18 miles back from Murray Bay, in the county of Charlevoix, on the north shore of the St. Lawrence. Specimens of the carbonaceous material were tested by Mr. M. L. Hersey, of Montreal, and it was found that the sample had a fibrous, irregular structure and contained a small amount of mica; it proved to be a non-coking bituminous coal, yielding considerable gas, which burned with a bright yellow flame. The volatile matter (including volatile combustible matter and a small quantity of moisture) was 40·185 per cent; fixed carbon 52·59 per cent; ash, 7·225 per cent.; total, 100 per cent. The ash itself was analysed and found to contain 2·5 per cent. uranium, based on the coal, which was equal to 35·43 per cent of uranium in the ash itself. The colour of the ash was olive green, owing to the presence of uranium oxide. In another test the coal was not burned, but was finely pulverised, and the powdered coal treated with boiling nitric acid to dissolve the uranium compounds.

Uniformity in the Use of Symbols.—At a recent meeting of the Elektrotechnischer Verein in Berlin, Herr K. Strecker submitted the report of the committee entrusted with the consideration of the question as to how far uniformity in the symbols used in pure and applied science might be possible, and as to how an understanding between the various bodies interested in the matter might be arrived at. The opinions of individuals and technical and scientific societies had been solicited, and a considerable number of replies had been received. Only a few of the correspondents agreed with the original proposals of the Elektrotechnischer Verein, which were based on the resolutions passed in Chicago and which were themselves founded on a system expounded by M. Hospitalier. Most writers were of the opinion that any code that might be devised ought to follow as closely as possible existing practice, and they also agreed that, if possible, an international understanding on the question ought to be sought. It was estimated that a fairly complete list of scientific and practical dimensions would include between 200 and 300 such dimensions, and, since the number of symbols at our disposal is limited, it would be necessary to use a symbol occasionally for more than one purpose. Confusion from this course was not, however, generally anticipated, because the symbols would be made to represent such diverse dimensions as were not likely to occur simultaneously in any formula or expression. The symbols proposed by the committee numbered 124, and were chosen from the Latin, Greek and German alphabet, but many correspondents were opposed to the use of the latter alphabet, chiefly on the ground that it was not sufficiently well known to foreigners. Besides these three alphabets it had also been suggested to make use of script letters (Rundschrift) and block letters. In addition, there are one or two arbitrary signs, such as $\sim$, which it is proposed to call "per," and a new sign, ↻ intended to represent the number of "revolutions," and to be termed "tur." Of the symbols for which the assent of the majority of the correspondents was obtained there were 12 coinciding with those contained in a list of symbols tabulated by the German Physical Society in 1903. These 12 dimensions and their symbols are: Length l, mass m, time t, radius r, acceleration due to gravity g, pressure p, work A, magnetic permeability μ, magnetic susceptibility χ, electromotive force E, current J, capacity C.

The Faraday Society.—An ordinary meeting of the Faraday Society was held on Wednesday, April 13th, at the Institution of Electrical Engineers. Mr. J. Swinburne, vice-president, was in the chair. Mr. Arthur J. Hiorns read an abstract of his Paper on "Alloys of Copper and Arsenic," illustrating his remarks by a series of interesting and beautiful lantern slides. The object of the author's investigations was to ascertain the exact relation between copper and arsenic in binary alloys, and the limit of proportion of arsenic that can be retained in copper in the cold solid state. The Paper also contained a detailed description of the various alloys, fully illustrated by excellent

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photo-micrographs. Mr. E. G. P. Bousfield then read the Paper on "Experiments with a New Primary Cell," published in our last issue. In the discussion that ensued, Mr. W. R. Cooper referred to the disadvantages of both nitric acid and caustic soda as electrolytes. The high E.M.F. of the cell was only apparent because it rapidly fell to a working value of 1·8 or 1·9 He would have liked to see comparative tests made, say, with a bichromate cell. Mr. J. Swinburne mentioned a suggestion made by Dr. Swan, that the cell would be improved if it were converted into a three-fluid cell, with a neutral electrolyte (*e.g.*, $NaNO_3$) in the mid compartment. Mr. Bousfield also contributed a "Note on Determining Accurately the Percentage of Ozone in Gases not Dissociated by Moderate Heat." Difficulty was found in determining accurately the quantities of ozone formed in different electrolytic reactions. The potassium iodide test, he said, was sufficiently accurate for most purposes, but for very accurate work it was not satisfactory, as an error of 5 per cent. or more was often obtained with a slightly alkaline solution, and an error of as much as 1 or 2 per cent. with an acid solution. Estimating the ozone by weight, using glass globes for that purpose, was also found to be somewhat uncertain, due to the condensation of moisture on the glass. The method recommended by the author was a measurement by volume. A certain quantity of gas containing ozone is measured. This gas is then passed over some substance, such as heated platinised asbestos, which is capable of converting ozone into ordinary oxygen. On again measuring the gases, an increase of volume due to the breaking down of "O_3" molecules into "O_2" molecules is found. From this increase of volume the quantity and percentage of ozone originally present is readily calculated. A description of the simple apparatus required for the measurements was given in the Paper.

Electric Railway Tests at St. Louis.—Among the most valuable technical features of the St. Louis Exhibition will be the elaborate series of electric railway tests which will be conducted under the auspices of a special commission appointed by the exhibition authorities. The members of the Electric Railway Test Commission are Messrs. J. G. White (chairman), H. H. Vreeland, W. J. Wilgus, James H. McGraw and George F. McCulloch. The *Electrical World* of New York states that special tracks, having an almost level grade and well ballasted, will be provided in the exhibition grounds for the operation and testing of railway car and locomotive equipments. These special tracks consist of one section 1,400ft. in length and one section 2,000ft. in length, the two sections being parallel. It is proposed to carry on operating, acceleration, braking, coasting and motor-heating tests, as well as tests to determine car and train friction. In addition, the commission will carry on a number of tests in the electricity building, all of which will be supervised by some engineer of national reputation, to be selected later, and all instruments and appliances used in connection with them will be calibrated by the National Bureau of Standards. The bureau will erect in the Palace of Electricity a laboratory for this purpose, equipped with all appliances needed for the accurate standardisation of all the instruments, meters, &c., required. Before deciding upon the detailed tests to be made, the Test Commission appointed four engineering committees to draw up a series of recommendations of the various tests which, in their opinion, would cover the main branches of electric railway work as at present developed. A large number of American electric railway engineers constituted the committees, and the following are the tests which have been recommended by the committee on City and Suburban Equipments and that on Inter-urban Equipments :—

In Electricity Building.—Tests of various kinds of electric railway motor equipments under constant load, regulated by brake, to determine rate of heating (*a*) of the armature, (*b*) of the field coils; on electric railway motor equipments of the various kinds, to determine the motor efficiency under different fixed conditions of operation, including varying number of stops per mile; on motor equipments, to determine their torque curves and accelerating power; on electric railway motor equipments under constant loads, to determine the rheostatic losses corresponding to various lengths of time consumed in application of full-current strength; on electric railway motor equipments, to determine at what loads, speeds and frequency of stops it becomes economical to adopt automatic control in place of hand control for single cars; on hand, automatic and multiple-control systems, to determine their relative economy, certainty and regularity of starting motor car equipments under fixed conditions of load and track; on electric railway motor equipments, to determine safe load during continuous operation, as compared with rated capacity of motors.

On the Experimental Track.—Tests to determine the relative values of two-motor and four-motor car equipments (*a*) as to power consumption with fixed loads and with varying loads and (*b*) as to acceleration with both fixed and varying loads; to determine the proper method of mounting a two-motor equipment on an eight-wheel two-truck car—viz., on which two of the four axles the motors shall be mounted—acceleration tests on single cars and on motor cars and trailer, showing rate of acceleration and power used with both hand and automatic control; comparative tests on different types of power brakes, both electric and mechanical, in respect to efficiency and economy; braking tests on single car and on motor car with trailer, under varying conditions, with both hand and power brakes; on single-car equipments to determine motor and truck friction at different speeds. For tests on storage battery cars the following are recommended :—Tests to determine the efficiency of batteries under maximum, average and varying loads; also to determine life of batteries under average and adverse conditions of service.

The tests on apparatus to be conducted in the electricity building for inter-urban equipment are practically the same as those recommended for the city equipment. For the experimental tracks the committee has recommended a series of tests with various classes of cars and equipments, provided time will permit. If only one type of equipment is tested the committee suggests a car body weighing 16 tons to 20 tons, exclusive of trucks and motors, with a pair of trucks weighing 8 tons to 12 tons per pair, and a standard four-motor equipment of 75 H.P. motors, equipped with different types of controlling apparatus. The three points to which effort will chiefly be directed, in case facilities for conducting high-speed tests are available, are as follows :—

The relation between the average electrical losses in the motors and the rise in temperature attained under various conditions of high-speed service. The train resistance (or power required to propel a car or train at uniform speed) at very high speeds. The performance of cars equipped with controllers so arranged that the acceleration is automatic, as compared with the performance under similar conditions, where the rate of acceleration depends upon the handling of the controller by the motorman. In the test on electrical losses an effort will be made to determine the average losses at different schedule speeds with a given rise in temperature and with different periods of stops and lay-overs. The train resistance tests recommended are with single cars, and also with trains made up of different numbers of cars at various speeds, from 40 miles per hour upwards, and measured in different ways—viz., by direct measurement of instantaneous power input when running at uniform speed, and by the coasting method. In the test of control systems it is proposed to investigate not only the efficiency of different systems of control, but the effect of automatic acceleration on the power consumption, &c.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, April 22nd.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:30 p.m. Meeting at the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Annual General Meeting for the election of Council for the ensuing year.

TUESDAY, April 26th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Annual General Meeting for the election of Council, &c., for the ensuing year.

WEDNESDAY, April 27th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Meeting at 92, Victoria-street, Westminster. Paper to be read: "Insulation and Insulators." By H. D. Symons.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

2:30 p.m. Visit to the generating station of the Metropolitan Railway Co. at Neasden. Train 2:8 p.m. from Baker-street.

THURSDAY, April 28th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "Power Station Design." By C. H. Merz and W. McLellan.

FRIDAY, April 29th.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

11 a.m. Visit to the Holborn—Strand Improvement Works. Assemble outside Holborn Restaurant.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER STUDENTS' SECTION.

7:30 p.m. Meeting in the School of Technology. Paper to be read: "The Equipment and Maintenance of Electric Street Cars," C. W. Crosbie.

SATURDAY, April 30th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

10 a.m. Visit to the works of the Western Electric Co., North Woolwich.

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THEORETICAL BASIS FOR THE EXPERIMENTAL PRE-DETERMINATION OF THE REGULATION OF ALTERNATORS.

BY DR. THEO. TORDA-HEYMANN.

Mr. B. A. Behrend, in his interesting article on "The Experimental Basis for the Theory of the Regulation of Alternators," published in *The Electrician* of January 1st, refers to the Behn-Eschenburg method and to the Rothert method for determining experimentally the regulation of

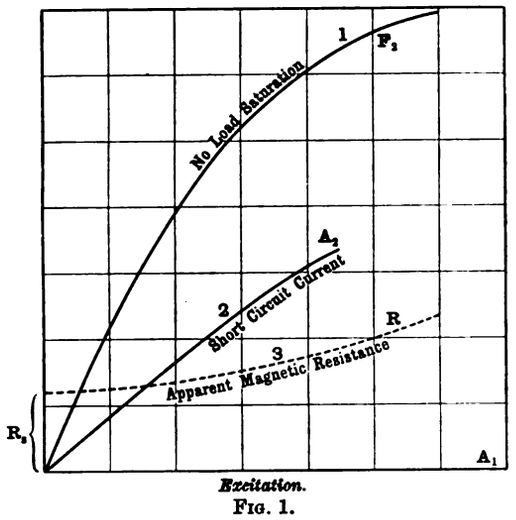

FIG. 1.

alternators, and he shows that neither of them gives exact results. This is due to the fact that neither the one nor the other takes into consideration more than a part of the causes which determine the drop in voltage, and the aim of the present article is to describe a method which will more nearly coincide with actual facts.

According to the practice of engineers in this country, the regulation is defined as the drop in voltage which occurs when full load is put on the machine, excitation and speed remaining constant.

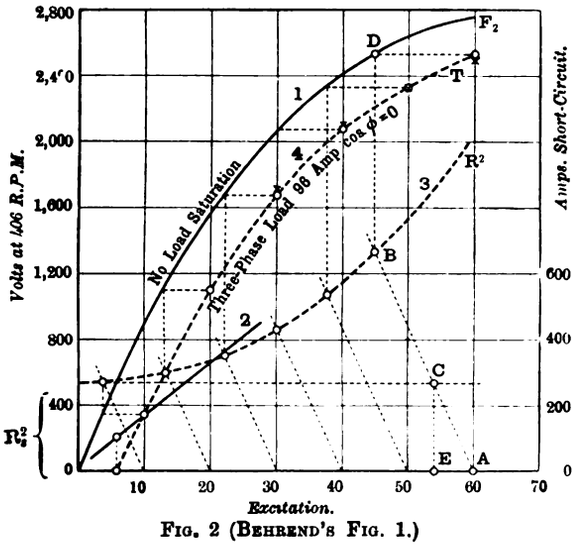

FIG. 2 (BEHREND'S FIG. 1.)

Before discussing the theoretical basis for the experimental pre-determination of the regulation, I propose to apply the method to some of Mr. Behrend's own examples in order to show the striking accuracy of my method. Curve 1 in Fig. 1 represents the no-load saturation and curve 2 the short-circuit curve, the abscissæ being in both cases in terms of the field-ampere turns, and the ordinates representing the E.M.F. at the armature terminals and the current in the short-circuited armature respectively. Curve 3 stands for the apparent magnetic resistance of the alternator, expressed in terms of the field ampere-turns, this apparent magnetic resistance being defined as the ratio of field ampere-turns to the E.M.F. of the generator. By means of these three characteristic curves the voltage drop on inductive load with power-factor zero may most accurately be obtained. For other power-factors, then, the regulation is easily determined by the method referred to by Behrend (*The Electrician*, Vol. LII., p. 413) or by one of the other methods suggested for this purpose.

For the first example let us take Behrend's 500kw. three-phase induction generator, the curves of which were represented in Fig. 1 on p. 410 of *The Electrician* of January 1st. The saturation curves of this machine for no-load and 96 amperes are again represented in Fig. 2. Curve 3 of Fig. 2 represents the square of the apparent magnetic resistance in terms of the field ampere-turns. In order to arrive at the regulation of this generator, when loaded with 96 amperes, proceed as follows:—From the short-circuit characteristic take the field ampere-turns corresponding to 96 amperes and deduct the value so found from the field ampere-turns corresponding to the particular field excitation for which the regulation is required.

In the case of Fig. 2, where the excitation is given in amperes and not in ampere-turns, take the exciting amperes corresponding to 96 amperes on the short-circuit characteristic. They will be found to be about six in this concrete case, and deduct this from the field current. For the same reason the magnetic resistance will be expressed in terms of amperes instead of in ampere-turns, the turns of the field not being given.

Erect at this point, E, a perpendicular and mark on it the point with the ordinate R_a^2. Draw the line AC until it cuts the R^2 curve in B. Draw through B a perpendicular until it intersects the no-load saturation curve at D, and the voltage thus indicated is the voltage of the generator loaded with 96 amperes and at a power-factor zero. In Fig. 2 the operations just described have been carried out, first of all, for an exciting current of 60 amperes, and then for the other field currents also. By applying this method, most satisfactory results are obtained, as will be seen from Table I.

Table I.

Excitation amperes.	Terminal voltage with 96-ampere load.		Voltage drop per cent. with 96-ampere load.	
	Actual.	New method.	Actual.	New method.
10	360	360	59·0	59·0
20	1,110	1,110	29·3	29·3
30	1,700	1,675	19·4	20·5
40	2,100	2,070	14·2	15·5
50	2,330	2,330	12·0	12·0
60	2,460	2,490	10·9	9·9

The method as applied to the 500kw. three-phase generator of Behrend's Fig. 4 (p. 411 of Vol. LII.) gives the results shown in Fig. 3 and Table II.

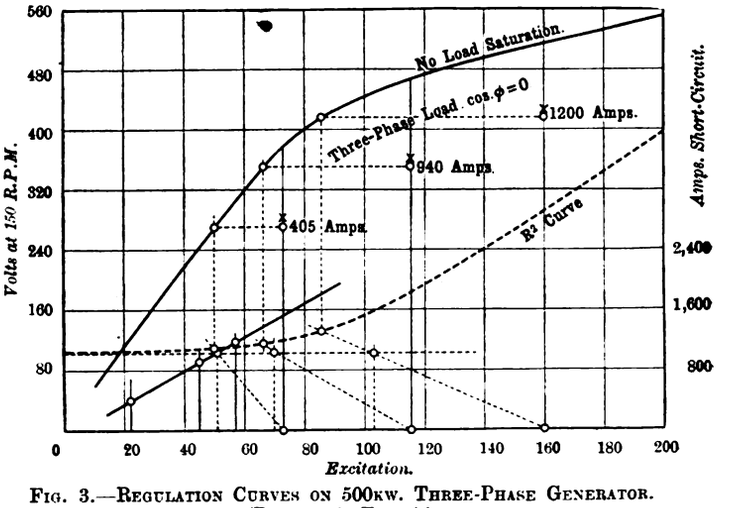

FIG. 3.—REGULATION CURVES ON 500KW. THREE-PHASE GENERATOR. (BEHREND'S FIG. 4.)

Table II.

Excitation amperes.	Terminal voltage.		Voltage drop per cent.	
	Actual.	New method.	Actual.	New method.
115	360	350	22·5	24·7
160	420	414	18·0	19·0

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The following diagrams and tables relate to other machines referred to in Mr. Behrend's article:—

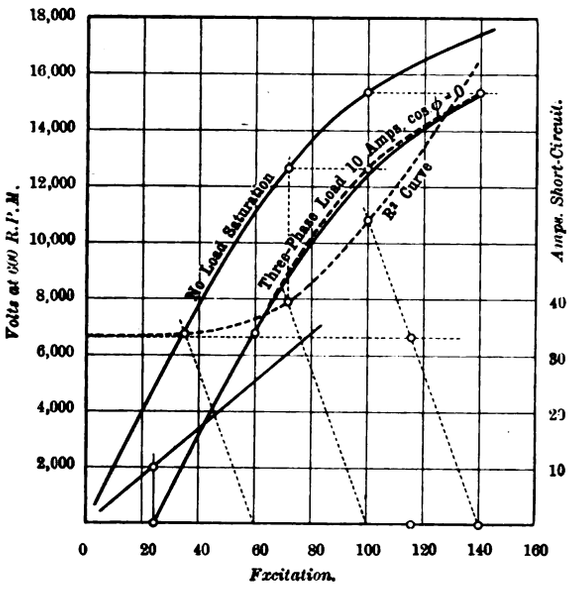

FIG. 4.—REGULATION CURVE ON 200KW. THREE-PHASE GENERATOR. (BEHREND'S FIG. 7.)

Table III.

Excitation amperes.	Terminal voltage.		Voltage drop per cent.	
	Actual.	New method.	Actual.	New method.
60	6,750	6,750	38·5	38·5
100	12,300	12,500	20·0	18·5
140	15,370	15,370	10·8	10·8

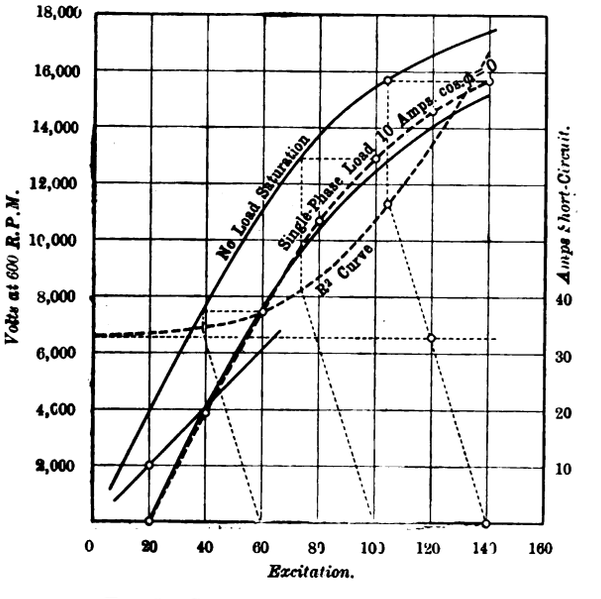

FIG. 5.—SINGLE-PHASE REGULATION CURVES. (BEHREND'S FIG. 8.)

Table IV.

Excitation amperes.	Terminal voltage.		Voltage drop per cent.	
	Actual.	New method.	Actual.	New method.
60	7,390	7,390	33·0	33·0
100	12,400	12,730	19·2	17·2
140	15,000	15,500	13·0	10·0

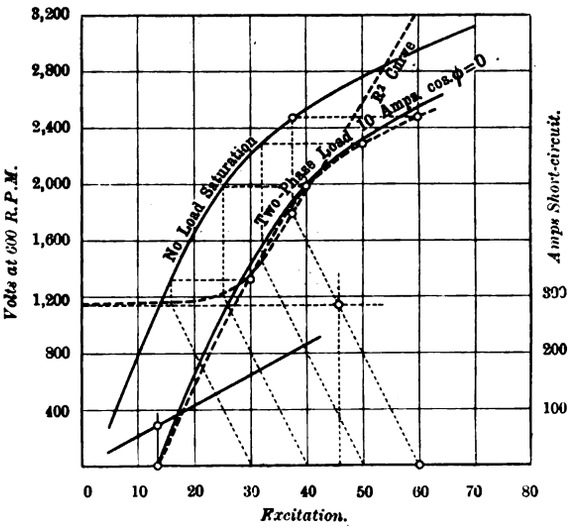

FIG. 6.—REGULATION CURVE OF A 350KW. TWO-PHASE GENERATOR. (BEHREND'S FIG. 13.)

Table V.

Excitation amperes.	Terminal voltage.		Voltage drop per cent.	
	Actual.	New method.	Actual.	New method.
20	640	570	62·4	66·0
40	2,030	2,030	20·5	20·5
60	2,600	2,530	12·2	14·5

As shown by the examples, the method gives practically exact results when applied either to polyphase or single-phase generators.

Turning now to the theoretical basis of the method, let us first tabulate the items which contribute to the voltage drop. They are: (1) Ohmic loss in the armature. (2) Drop in voltage due to hysteresis and eddy currents; since both are small, they will not be considered in the discussion in order to simplify matters. (3) Leakage of the exciting field. (4) Leakage of the armature field. (5) The demagnetising effect of the armature ampere-turns.

The influence of these different items is most readily realised by reference to the diagrammatic representation of the magnetic circuit in Fig. 8. In this, A_1 represents the magnetomotive force of the exciting field; r_1 = magnetic resistance of the field system; F_1 = flux in the field system; r_1' = magnetic resistance of the field leakage path; F_1' = flux in the field leakage path; r_0 = magnetic resistance of the air-gap; F_0 = flux in the air-gap; r_2 = magnetic resistance of the armature system; F_2 = flux in the armature system; r_2' = magnetic resistance of the armature leakage path; F_2' = flux through the armature leakage path; and A_2 = magnetomotive force of the armature ampere-turns.

Applying the Kirchhoff rules to the circuits, we get

$$A_1 = F_1 r_1 + F_1' r_1'. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$
$$F_1 = F_1' + F_0. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$
$$F_0 r_0 + F_2' r_2' - F_1' r_1' = 0. \quad . \quad . \quad . \quad . \quad . \quad (3)$$
$$F_0 = F_2 + F_2'. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$
$$-A_2 = F_2 r_2 + F_2' r_2'. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

After some simple transformations, the following equation is arrived at:

$$A_1 = R \times F_2 + C \times A_2, \quad . \quad . \quad . \quad . \quad . \quad (I.)$$

wherein

$$R = \frac{(r_0+r_2')r_1r_2 + (r_0+r_1')r_1r_2' + (r_0+r_1)r_1'r_2 + (r_0+r_2)r_1'r_2'}{r_1'r_2'}$$

and

$$C = \frac{(r_0+r_2')r_1 + (r_0+r_1)r_1' + r_1'r_2'}{r_1'r_2'}.$$

R may be termed the apparent magnetic resistance of the circuit. It varies with the state of magnetic saturation of the different parts of the entire magnetic system. C varies with the magnetic saturation of the field system only.

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If the armature circuit is open, $A_2 = 0$, and substituting this value in (I.) we get

$$A_1 = RF_2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (II.)$$

This equation represents the open circuit characteristic of the generator, and the apparent magnetic resistance of the machine is in this case $R = A_1/F_2$. R is given in Fig. 1 (curve 3) in terms of A_1.

For the short-circuited armature, on the other hand, the E.M.F. is very small—*i.e.*, F_s is nearly zero, always neglecting ohmic resistance and iron losses. In this case we derive from equation (I.),

$$A_1 = C_s \times A_2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (III.)$$

As tests have shown, the short-circuit characteristic is a straight line within practical limits of the field excitation. C_s varies with r_1—*i.e.*, with the magnetic saturation of the field system only, the magnetic resistances r_0, r_1', and r_2' being constant.

In the following the plain letters refer to open circuit data, the letters with an index "*s*" apply to short-circuit phenomena and those with a bar correspond to the terminal voltages.

For an inductive load on the generator, equation (I.) takes the form

$$A_1 = \overline{R}\overline{F}_2 + \overline{C}A_2. \quad . \quad . \quad . \quad . \quad . \quad . \quad (IV.)$$

in which $\overline{F}_2$ represents the terminal voltage of the loaded generator in terms of the field excitation ($\overline{F}_2$ represents, therefore, the load-saturation curve, such as curve 4 in Fig. 2). The ordinate difference $F_2 - \overline{F}_2$ represents the inductive voltage drop for a certain armature current.

Substituting $\overline{F}_2 \times \overline{R}$ of equation (IV.) by the respective ampere-turns, we obtain: $A_1 = \overline{A}_1 + \overline{C}A_2$ (for an external inductive load) and $A_{1s} = C_s A_2$ (in case of a short-circuit), the armature current being the same in both cases. The equation

$$A_1 = \overline{A}_1 + \frac{\overline{C}}{C_s} A_{1s} \quad . \quad . \quad . \quad . \quad . \quad . \quad (V.)$$

gives the terminal voltage in terms of A_1 (curve 4, Fig. 2) for a given armature current.

Rothert's method, called by Mr. Behrend the "optimistic" method, is based on the equation $A_1 = \overline{A}_1 + A_{1s}$, and it is obvious that the drop in voltage arrived at from this equation falls short of the actual drop, because the neglected factor $\overline{C}/C_s$ is larger than unity. For standard modern designs $\overline{C}/C_s$ may have a value of 1·3 or more, as Mr. Behrend's examples show. C_s can be actually determined, not, however, $\overline{C}$. But we are justified, as will be shown below, in substituting $(R/R_s)^2$ for this quotient. This has been done in Fig. 2 and in the other applications.

In the modern alternator the fractions r_1/r_1', r_0/r_1', r_2/r_1', r_1/r_2', r_0/r_2' and r_2/r_2' are very small, and the squared values or the product of any two of them are negligible compared with unity. As result of some simple but lengthy transformations we get for the apparent magnetic resistance the value $R = [C(r_2/r_2' + 1) - (r_1/r_1' + 1)]r_2'$. By further transformation we arrive at the result that $\overline{C}/C_s = \overline{R}^2/R_s^2$, where $\overline{C}$ and $\overline{R}$ correspond to the saturation conditions of the magnetic circuit with the terminal voltage $\overline{F}_2$.

Dr. Behn-Eschenburg's method—the "pessimistic" method—is based on the equation $\overline{F}_2 = F_2\left(1 - \frac{A_2'}{A_2''}\right)$. The exact equation for $\overline{F}_2$, however, as obtained from equation (IV.), is $\overline{F}_2 = F_2 \frac{R}{\overline{R}}\left[1 - \frac{A_2'}{A_2''}\frac{\overline{C}}{\overline{C}_s''}\right]$.

It will be seen, therefore, that Behn-Eschenburg simplifies this exact result by assuming $R/\overline{R} = 1$ and $\overline{C}/C_s'' = 1$. The first neglection has the effect of showing up the voltage drop lower than is actually the case, while the second assumption has, as a rule, the contrary effect.

If we substitute in the above equation RA_{1s}'/R_sA_{1s}'' for $A_2\overline{C}/A_2''C_s''$, we get

$$\overline{F}_2 = F_2 R/\overline{R}\left(1 - \frac{A_{1s}'}{A_{1s}''}\frac{R}{R_s}\right). \quad . \quad . \quad . \quad (VI.)$$

This is a corrected form of Dr. Behn-Eschenburg's method.

The meaning of the various symbols will be more clearly understood by reference to Fig. 7.

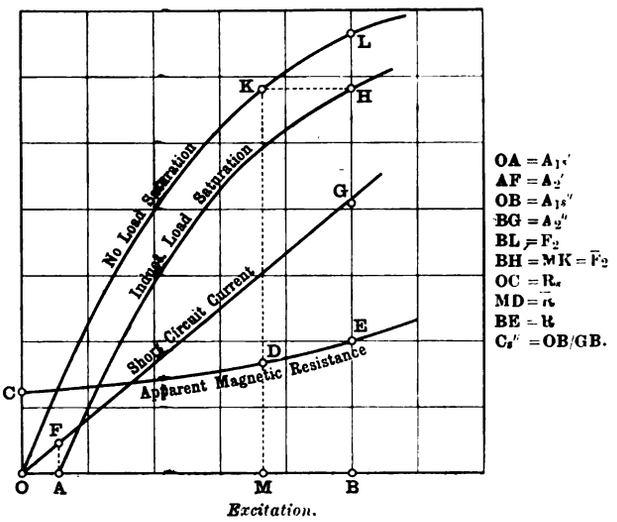

FIG. 7.

How far this corrected method approximates actual facts will be shown by a few examples. For the 200kw. 13,000-volt three-phase generator of Behrend's, Figs. 6, 7 and 8 (see *The Electrician*, Vol. LII., p. 411), we have, for instance :—

Excitation amperes.	Terminal voltage.		Voltage drop per cent.	
	Actual.	Corrected method.	Actual.	Corrected method.
40	3,380	2,750	56·0	64·5
80	10,100	9,700	25·7	28·7
100	12,370	12,400	19·1	19·0

For the same dynamo supplying single-phase current we have :—

Excitation amperes.	Terminal voltage.		Voltage drop per cent.	
	Actual.	Corrected method.	Actual.	Corrected method.
80	10,400	10,600	23·5	22·0
100	12,400	12,700	19·0	17·0

The method thus proves to be a satisfactory one, although fine points, such as ohmic voltage drop, iron loss effects and the influence of the wave-form of the E.M.F. and of the armature current, have been neglected.

After having determined the drop of a machine for a given armature current and power-factor zero, the regulation for any other power-factor for the same current can be found by applying Kapp's method as already mentioned above.

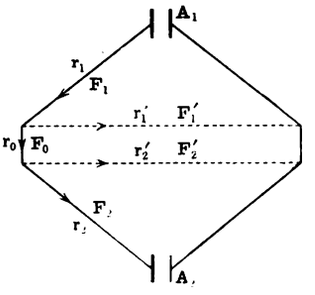

FIG. 8.

Although the corrected Behn-Eschenburg method, as represented by equation (VI.) and Fig. 7, gives good results for the experimental predetermination of the regulation, it is somewhat elaborate, and the method expressed in equation (V.) and Fig. 2, which is most simple and exact, is to be preferred. The latter corresponds to the rule laid down by the Committee on Standardisation of the American Institute of Electrical Engineers.

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DIRECT-READING MEASURING INSTRUMENTS FOR SWITCHBOARD USE.

The following is an abstract of the conclusion of the discussion on Messrs. Edgcumbe and Punga's Paper on this subject, which took place at the Institution of Electrical Engineers on Thursday, April 14th. The Paper and first part of the discussion appeared in our issues for March 25th, April 1st and April 8th.

Mr. W. A. PRICE said that Messrs. Crompton & Co.'s object had been to construct an instrument in such a way that a station engineer could verify with a considerable degree of precision, and with little difficulty and small appliances, that his instruments were accurate. Taking the voltmeter first, this consisted of an indicating instrument

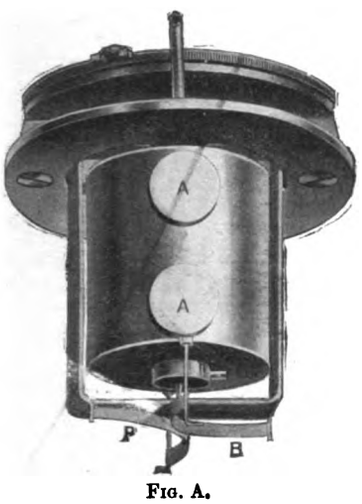

FIG. A.

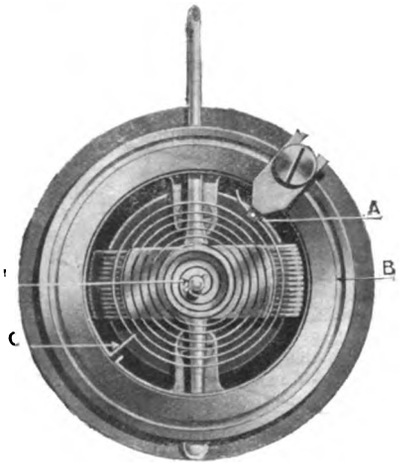

FIG. B.

in series with a resistance. With a voltage of 100, a resistance of something like 6,500 or 7,000 ohms would be required. If these instruments were to be capable of verification by the users it was evident that some process of standardisation must be necessary, and one immediately came to the point that the way in which the thing should be done was that the resistance in series with the voltmeter should bear some relation to the pressure to be applied to it, and the voltmeter should be then looked upon as merely an instrument for measuring the current carried by the resistance. With regard to ampere-meters, the essential part of the apparatus was the shunt which carried the current to be measured, the indicating instrument being nothing but an instrument which read the fall of voltage over the shunt when the current was passing. Therefore the resistances of the voltmeters and the shunts of the ammeters were the parts which would have to be standardised.

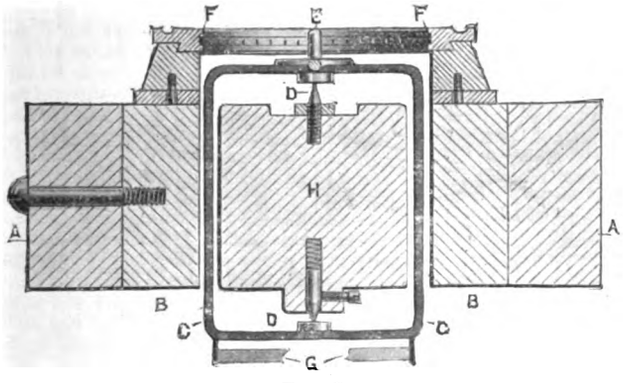

FIG. C.

The figures selected by Col. Crompton's firm were that a voltmeter should carry at its normal load 15 milliamperes, so that the voltmeters became mere milliampere-meters reading up to 15 milliamperes In the case of the ampere-meters, all the shunts were low resistances giving a voltage of 75 millivolts, and the ampere-meters became millivolt-meters, indicating the difference of pressure over the shunts to which they were connected. Thus, if an engineer knew that his shunts had their correct values he would only be concerned in ascertaining that the indicating instruments were in good order, and the process of ascertaining whether a millivolt-meter gave the proper reading—75 millivolts—or a milliampere-meter gave 15 milliamperes was an extremely simple operation. It could be done with one Leclanché cell, a simple rheostat and a standard instrument indicating with certainty the requisite number of milliamperes or millivolts. Having put into the hands of the engineer a method of testing whether his instruments were right or wrong, one naturally wished to apply the method so as to put the instruments right if they were wrong. This could be solved in dozens of ways, but the three diagrams below showed the manner in which it had been done by Messrs. Crompton. These were arranged so as to allow the adjustments to be made on the control-spring, the whole apparatus being connected up and mounted in its case. Fig. A showed the moving coil mounted on centres on its cylindrical core and connected by very thin silver ligaments to fixed pins forming its electrical terminals. These ligaments were so flexible that they did not interfere with the control of the movement by an independent bronze spiral spring. Fig. B showed the head of the movement with the arrangements for adjusting the control. The outer end of the spring was attached to a piece, A, fixed on a ring, B, with a milled edge, which could be turned round in its setting. The inner end was attached to a pillar, D, on the top of the moving coil. The spring passed through a hole in a small elastic ring, C, fitted into a groove in B in which it could be turned round. By moving the ring B, the zero of the instrument might be set, and by sliding the ring C in its groove the effective length of the spring and the sensitiveness of the instrument might be adjusted. By these two movements, the whole of the adjustment of the instrument could be made without touching the electrical connections or opening the case, and instrument cases were provided with small windows which gave access to the spring attachments for this purpose. Fig. C was a section of the whole movement showing, AA the permanent magnets, BB the soft steel pole-pieces, G the silver ligaments and F the adjusting spring.

Mr. JAMES SWINBURNE said he had not been working at instruments for something like 20 years, and, therefore, felt something like a Rip van Winkle. As regards non-magnetic springs, in the old days phosphor-bronze wire was found to be very good indeed, and when used for testing purposes it would go to zero more easily than was usually the case. Much had been said in the Paper with regard to temperature errors. Mr. Evershed and himself had worked a good deal at that in days gone by, and they had got out methods of compensating voltmeters for temperature by using wires of different specific resistance. In this way they had obtained voltmeters independent of temperature. Another point mentioned in the Paper was the compensation of wattmeters so as to eliminate the power spent in their own coils. This was also 20 years old, and it was very curious that neither of these things had ever been practically used. About 10, 15 or 20 years ago, Mr. Evershed made compensated instruments and put them on the market, but they were never heard of now. The experiments made in those days were in connection with incandescent lamps, when it was found that the wattmeter used nearly as much power as the incandescent lamp. It was, therefore, an important matter to correct them. The potentiometer method could be used in connection with a standard cell, and be made to read correctly. It was also possible to make a Wheatstone bridge read correctly. It only read right at present at a certain temperature, and if the temperature of the room was a little different, a different reading was obtained. With regard to hot-wire instruments, curiously enough the first hot-wire instrument, which was described in *The Electrician* long before they were made in this country, was compensated, and it had an ingenious arrangement. It had two wires, one working the index and the other the dial, so that if the wires expanded together there was no reading, but the reading was differential, and it got over the difficulty of the body of the instrument expanding. As the wires were horizontal one wire did not affect the other. He forgot the name of the inventor. Other things could be done with a double wire. When working off a gas engine or in a central station, by using two wires side by side it was possible to make a voltmeter read differentially, so that as long as the wires were doing the same thing no reading was obtained. The capacity arrangement for voltmeters referred to by the authors was very old, and had at one time been discarded for want of accuracy. He remembered two condensers being used the other way round in the eighties by Lord Kelvin for calibrating electrostatic instruments. He charged his capacities one after the other and got his full volts on his electrostatic instrument. The difficulty when shunting a bit of the capacity with an electrostatic instrument was that the instrument itself varied the capacity when it was working, so that the capacity shunted must be charged. Even then it was not easy to get a condenser so accurate that the various capacities remained the same. With an air condenser it might be done, but then the capacity would necessarily be small. With a paper condenser a large enough capacity was obtained but there were slight leakages which made it go wrong. In referring to the moving-coil ampere-meter, he did not think the authors quite appreciated the difficulties. It must have no temperature coefficient and take a very small E.M.F.; if the instruments were wound with a lot of wire in series to check out the error then higher volts were needed. Induction instruments were very important. But it appeared that Mr. Edgcumbe was under the impression that they depended upon the frequency. It was 10 years ago since he (Mr. Swinburne) had stated that, if properly designed, this should not be the case. The frequency cancelled out. Then again such instruments as Fig. 10 would do a great deal more than they got credit for. They would work as phase meters, so that a central station engineer having a lot of dynamos in parallel could tell by his instruments whether any dynamo wanted more steam or more excitation. This could not be determined from the ordinary instruments. He had tried to get central station engineers to take them up years ago, but they would not do so. They were satisfied with the methods they had and the only thing they were dissatisfied with was that municipal salaries were not higher. By making Fig. 10 a phase meter, the station engineer could tell whether he wanted more steam or more excitation. Having ascertained, for instance, that the excitation was right, if he could get a wattmeter something after the principle of the old ohmmeter with two fixed coils at right angles to one another, this would tell whether the machine was giving its full

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share of the output of the station, and from that the attendant knew whether he had enough steam or not. But they got no encouragement for making these instruments in those days.

Mr. J. H. NALDER, referring to soft-iron instruments, emphasised the necessity for using ample power. The type of instrument referred to in the Paper, as compared with more recent types, was distinctly deficient in power, and this was a very important matter indeed when one had to consider the question of transportation. The question also arose of putting soft-iron instruments in iron cases. This might have the effect of screening them, but, on the other hand, continuous-current instruments were liable to become magnetised, and an error of 5 or 6 per cent. was encountered, depending upon the magnetisation of the case. It would have been well if the question of a standard fall of potential had been raised in connection with moving-coil ammeters. Generally speaking he used 0·085, Mr. Price used 0·075, and Weston used 0·03 in the early days. But there was a distinct gain in using the bigger fall of potential notwithstanding the increased watts. Mr. Swinburne had mentioned the use of condensers in connection with electrostatic instruments. A case had come before him a short time ago in which he had to test a dynamo at double the working pressure. Owing to the difficulty of insulating the small condenser used, a reading of only 13,000 volts was obtained when actually the voltage was 20,000.

Mr. L. W. WILD, speaking with reference to wattmeters of the dynamometer type with large currents, said that these instruments could be made in three different ways: First, the whole current could be taken into the instrument; secondly, a portion only need be taken, and, in the third place, a current transformer could be employed. The first method involved a possible error from eddy currents induced in the instrument. Mr. Edgcumbe had stated that these eddy currents could be compensated for by adding a certain amount of self-induction in the pressure coil of the circuit. He did not quite agree with that, as he thought that this eddy-current effect was only another name for the skin effect which occurred in every large conductor carrying alternating current, and consequently the current was not evenly distributed in the conductor, and a certain amount of distortion of the field followed. The moving coil being some distance from the conductor, it would not always be working in the same strength of field as the frequency was altered, and he did not think the effect would in any way be proportional to the frequency, nor that, in consequence, it could be compensated for in any way. Turning to shunted instruments, he said that large errors were liable to occur owing to the self-induction of the instruments being different to the self-induction of the shunt. He made an experiment the other day on a shunted wattmeter with a non-inductive shunt, and, after calibrating the instrument for direct current, he tried it on an alternating current with a non-inductive load at 100 periods and found it read ·30 per cent. too little. On reducing the power-factor to 0·7 it read zero, and on reducing the power-factor below that, the wattmeter actually read below zero. This indicated that the current in the coil of the wattmeter was actually about 45deg. behind the current in the shunt. This was rather a large error to compensate for. The compensation could be carried out by putting self-induction in the shunt, or by putting self induction in the pressure coil of the wattmeter, or by adding resistance in series with the wattmeter. But they were neither of them very easy things to do. If resistance were added to the wattmeter, a larger shunt was immediately required. In the case of the particular instrument he had referred to, the actual fall of potential required in the shunt, if sufficient resistance were put into the wattmeter to make it read correctly with a power-factor of 0·5, would be about 20 volts. With 1,000 amperes in the shunt, this was equivalent to 20kw., which was rather large to allow for a single instrument. He was inclined to think that the most accurate method to employ with a wattmeter for large currents was to use a current transformer. These, however, required very careful design, and, unless core loss, magnetising current, magnetic leakage of the primary and the secondary, and self-induction of the wattmeter coil were all kept very small, the secondary current would not be in phase with the primary, but would probably lag by a considerable amount behind it There was no reason, however, why a current transformer could not be made with these losses so small that they might be totally neglected for any power-factor down to 0·5.

Dr. C. V. DRYSDALE said that the authors of the Paper were to be congratulated on having expressed part of the theory of the wattmeter in a very clear way, thus doing away with the idea that the wattmeter was a very complicated instrument, the theory and behaviour of which was beyond ordinary understanding. They were further to be congratulated on having put these principles into practice and having produced a wattmeter which from the tests he had made appeared to be fairly accurate at all ordinary power-factors. For some time past he had given some special attention to the dynamometer-wattmeter and in an article published in *The Electrician*, in March, 1901,* had put forward what he believed was a prettly closely accurate explanation of all the errors to which it was liable and of their approximate amount and methods of elimination. The authors' diagram in Fig. 13 required modification to take into account the capacity which always existed to a greater or less extent between the different parts of the non-inductive resistance, the demagnetising as well as the cross-magnetising effect of the eddy currents, and the reaction of these eddy currents on the shunt current. The effect of capacity had not been lost sight of by the authors, and the remedy of winding the resistance in sections was quite effective. It was, nevertheless, well to have as clear an idea as possible of all the phenomena which might occur, as this was of assistance in judging the extent to which they might be eliminated. For this reason he had drawn two vector diagrams, the first for a wattmeter in which there were no eddy currents the second in which these were taken into account. Dr. Drysdale continued: In Fig. D the wattmeter shunt is regarded as having a non-inductive resistance, r_1, shunted by a capacity, K, which are in series with the coil having resistance r_2 and self-induction L. The total voltage V across the shunt may be divided into two parts, V_1 and V_2, across the non-inductive and inductive resistances respectively. Starting with V_1, the voltage across the non-inductive resistance, we have clearly a current V_1/r_1 in the non-inductive resistance in phase with V_1 and a current V_1Kp in the capacity, leading 90deg. Combining these we get the total shunt current c. If we multiply the current c by r_2 we clearly get the drop in the second coil due to the resistance, which is in phase with c, and we also have an inductive drop cLp leading the current by 90deg. By combining these two voltages, cr_2 and cLp, we get the total voltage V_2 across the inductive coil, and the resultant of two voltages V_1 and V_2 was evidently V, the voltage at the shunt terminals. The diagram is, of course, extremely exaggerated, as

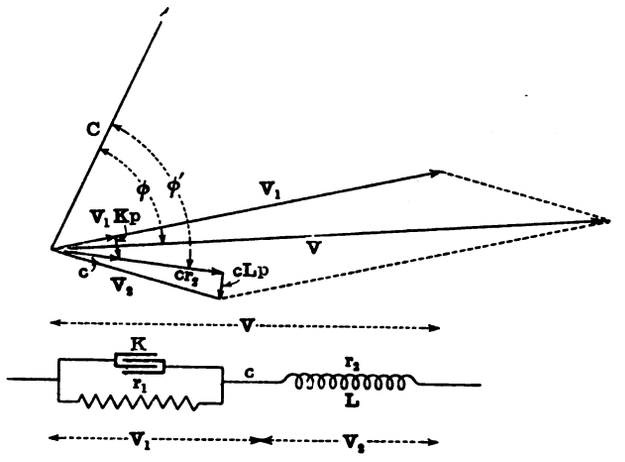

FIG. D.

otherwise it would be impossible to indicate the various parts. In practice, with any ordinary wattmeter, none of the lines would differ from one another by more than 1 or 2deg., and consequently the only effect of self-induction and capacity is to alter the phase of the shunt current and not appreciably to alter its magnitude. It is easy to show from the geometry of the figure, as I have before done analytically, that the angular phase displacement is $(L-Kr_1^2)p/R$, where R is (r_1+r_2), the total resistance of the shunt. The diagram Fig. E shows the modifications that must be made to take into account the influence of eddy currents in the case or other metal parts of the instrument. C, as before, represents the main current, and may also be taken to represent its magnetising force. There is, however, a second usually much smaller magnetic field from the shunt-coil in

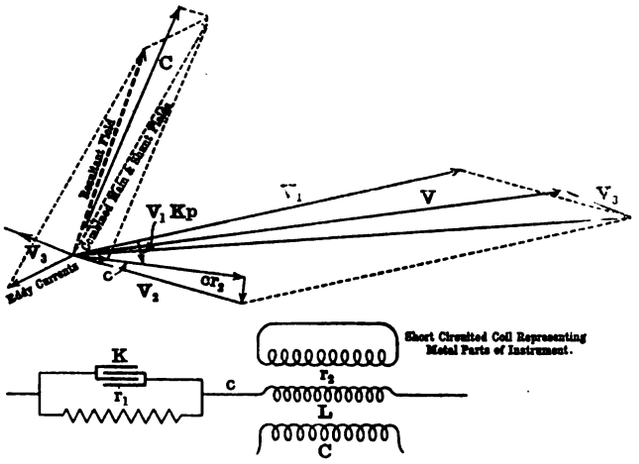

FIG. E.

phase with the current c. If the main and shunt coils are approximately at right angles, as in most deflectional instruments, their fields combine to an elliptical field, but if the coils are parallel, as in the Kelvin watt balance and my own deflectional wattmeter, they will combine to a field as shown in the diagram. This resultant field will produce a voltage, V_3, inducing eddy currents which will lag a considerable amount behind V_3 if in copper, less in brass. The combination of the field, due to the eddy currents with the combined main and shunt fields gives the resultant field affecting the shunt coil, and which must be perpendicular to V_3. This resultant field, of course, induces an E.M.F., V_3, in the shunt circuit, so that the total P.D. on the shunt will be as shown.

* Vol. XLVI., p. 774.

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The speaker then emphasised the point that eddy currents should be scrupulously eliminated by avoiding all metal parts but the coils, and laminating or stranding the latter if of any size. The authors' contention that mutual induction between the coils did not affect the reading of the instrument was only correct if the shunt was accurately non-inductive, otherwise the shunt would have a small secondary effect. He did not think any appreciable error could arise from the skin effect or unequal distribution of current in the main coils of a wattmeter if the main coils were carefully stranded. In his own wattmeters, in which the coils could be arranged in various combinations, he had never been able to find any trace of unequal distribution so far as any effect on the shunt coil was concerned. Moreover, he was unable to agree with the last speaker's suggestion to make use of shunts for heavy currents, as he believed that very serious errors would almost inevitably arise. Lastly, as to the suggestions to use transformers in wattmeters: He had recently found that with ordinary small instrument transformers, a phase displacement of 2 to 3deg. was common between the primary and secondary voltages, and of 10deg. or more between the currents. In the former case, by means of the formula given in the Paper, which was a slight modification of that originally given by him in *The Electrician*, it would be seen that the error in the power-factor might amount to more than the total amount in the dielectric. The conditions for securing accurate wattmeters were exceedingly simple. All metal cases and supports must be avoided—in this respect we were in advance of Continental makers—and care must be taken that the self-induction and capacity in the shunt do not cause a phase displacement of more than, say, a quarter of a degree. For the user to see whether his instrument is correct, he need only try it against standard P.D. and current instrument on non-inductive load at two different frequencies, or with D.C. and A.C. (eliminating the earth's field) and see that it gave no deflection on a circuit of no power-factor. This could easily be done when a two-phase supply was available, by connecting the main and shunt coils to the two circuits, taking care that the main coil was connected through glow lamps or other non-inductive load. The correctness of the phase relation between the lines could easily be checked by a voltmeter.

Mr. E. B. VIGNOLES said it was a complete fallacy to say that the primary function of the switchboard instrument was to measure. Primarily it was an indicating instrument, in order to enable the switchboard attendant to find out what was happening on his circuits, and in a very large proportion of cases the question of accuracy hardly came in at all. A well-known firm of consulting engineers specified that feeder ammeters should be right within 10 per cent. The same firm of consulting engineers, however, also specified that voltmeters should be correct to within 1 volt in 450. Of course, the instruments might be accurate to that extent when they were first installed, but they would not remain so. The primary essential in switchboard instruments was that they should be visible at a distance. There must be a bold scale with large figures. Such instruments could never be very highly accurate, if only on account of parallax. One of the fads of instrument work was the edgewise instrument, but they were very difficult to read owing to the curve of the scale being so great that one got a large parallax. He believed that moving-coil instruments were going to be the instruments for switchboard work, because they could be made interchangeable in the way that Col. Crompton and Mr. Price had spoken of. So far as manufacture went, however, he did not think it would be possible to attain the accurate standardisation of parts that Col. Crompton anticipated; and it would be useless as the magnets would vary 10 or 20 per cent.

Mr. W. DUDDELL, speaking with regard to hot-wire instruments, said he could not agree with the authors as to the hysteresis error. He had not found these instruments do quite so nicely as the Paper intimated. He would like to ask Mr. Edgcumbe if he found them free from temperature error. Mr. Swinburne had referred to compensating hot-wire instruments. This was nice in theory but not in practice. He had done considerable work on hot-wire instruments, but had not found them to be suitable for switchboard work. Mr. Mather and himself had gone into the question of wattmeters very deeply during the past four years, and he hoped at a future date to bring wattmeters forward which worked up to 100 amperes. The policy of standardising the drop of volts on the shunt of moving-coil ammeters and the current through moving-coil voltmeters was adopted by most firms on the Continent. Messrs. Hartmann and Braun had an instrument in which both the drop of volts and the current was standardised, and this firm would supply shunts out of stock. One of these, when applied to an instrument which he had bought four years ago was correct to within ½ per cent. The 75 millivolts drop mentioned by Mr. Price seemed very reasonable, but he would very much like to know what was the temperature error. There seemed to be a little more copper necessary for the field of the instruments referred to than with the ordinary field. With regard to the capacity-shunt for electrostatic instruments, if the latter were properly designed so that the insulation resistance of each condenser and the capacity were proportional to one another, then very accurate results could be obtained. The capacity of the ordinary electrostatic voltmeter was only 10^{-5}mfds., so that the variations of its own capacity were not of importance. The spark gap in these voltmeters ought not to be in the voltmeter itself, for then it produced ozone or something else which, after the voltmeter had been in use for a short time, caused corrosion and made the insulation fall to pieces.

Mr. W. H. PATCHELL said he strongly objected to too much damping. If a man went to the expense of putting up a good voltmeter he did not want to have the effect of a badly-used motor-starting resistance on his mains masked by any damping. On the other hand, however, he had had cases of hot-wire instruments which would show periodic swings due to the uneven turning of a machine. If the authors meant in the Paper that it was of little importance what current was taken by recording voltmeters, as well as ordinary voltmeters, he absolutely disagreed with them. Some years ago, when working with the ordinary Board of Trade pilot wire, it was found that, with two recording voltmeters on the three-wire system, if one were disconnected the other one would fly up due to the three-wire effect. He got Mr. Elphinstone to go closely into it. This gentleman got out an excellent type of permanent magnet recorder, and he was sorry that Mr. Elphinstone was at present in America, and, consequently, unable to tell them all about it. As regards edgewise instruments, he had found these very convenient indeed for measuring the feeder amperes, although they were more susceptible to stray fields than dial instruments were. He did not think that hot-wire instruments had had fair play. He knew of hot wire instruments which were more correct throughout the year than instruments made by Weston or Nalder. As regards the disposition of the shunts, it was important what energy was used in the shunts, because the heating effect of shunts at the back of the board was sometimes inconvenient. He had got over this difficulty by separating the shunt from the board by copper strips which acted as radiators and which had the laminæ vertical instead of horizontal. He was glad to see there were signs of regeneration on the part of the instrument makers, but they would have to be careful if instruments similar to those suggested by Messrs. Crompton and Price were going to be used, because it would be possible for the switchboard attendants to fake the instruments in any manner they pleased. Adjustments should be simple but not too easy.

Mr. KENELM EDGCUMBE, replying, said that the standardisation of drops and shunts was a step in the right direction, and for switchboard and other portable instruments it was a thing which might well be adopted. The method described by Mr. Price of altering the control by altering the position of the springs was very neat; it could also be done by means of magnetic shunts on the magnets. With reference to Col. Crompton's remarks on corrosion he had never noticed this on phosphor bronze springs except when it was due to bad flux in soldering. Magnets sometimes gave trouble, but this was easily got over by painting. As regards the pivots, the only thing to do was to keep the case air-tight. Mr. Rennie spoke of the want of a standard of accuracy for switchboard instruments. This would be a good thing and he had hoped that other speakers would have given their views upon the subject. But he did not know who was going to fix this. He was afraid that even the Board of Trade could not manage that. The 8ft. shunt alluded to by Mr. Rennie must have been for a potentiometer and not a direct-reading instrument. He did not think anyone would object to one-tenth of a volt drop suggested by Mr. Rennie although it was very easy to bring it down to one-twentieth or one-fortieth. As regards hot-wire instruments Mr. Rennie had hinted that Mr. Trotter had something up his sleeve, but, personally, he had not very much faith in this type. Both Mr. Campbell and Mr. Evershed had referred to set-up instruments. It was a good thing to set an instrument up by 25 or 30 per cent. because although all the errors were increased, the electrical errors and frictional errors were far smaller than observation errors due to parallax, and, therefore, if the scales could be opened out so much the better. He agreed that paper scales were by far the most accurate. Mr. Evershed was down upon the cylinder form of damper. The time of coming to rest could be brought down to 1½ seconds and no one could complain of that. Mr. Evershed also spoke of extraordinary inductions in the air-gap. He presumed that the measurements had been accurately made, as Mr. Evershed usually was so accurate; but he had never yet come across an instrument with more than 1,500, and perhaps 700 should be taken as the lower limit. High density was detrimental to a magnet keeping its strength. The temperature coefficient of induction instruments was a matter which would have to be gone into more fully, but Dr. Benischke gave the temperature coefficient as ranging from 0·25, as was given in the Paper. Prof. Ayrton had alluded to the Hartmann and Braun methods for keeping down the thermo-currents. This was neat, but certainly not new. It was used in Col. Crompton's laboratory 10 years ago in connection with potentiometer shunts. The arrangement, which Prof. Ayrton also referred to, of putting capacity in series with a condenser was certainly very neat. He did not know that it had ever been applied, neither was he aware of the 1893 patent. With reference to condensers, it was essential that the dielectrics should be all the same, otherwise the thing would depend upon the frequency. But the capacities required were very small, and therefore there was no difficulty in getting a satisfactory air condenser having the requisite capacity. Prof. Ayrton had objected to one of their formulæ, but the Paper said it was only approximate. At 0·8 power-factor the error was about one hundredth per cent., so it was not very important. The accurate formula was very cumbersome. With regard to standardising shunts and so on, most engineers would probably prefer to put in a standard shunt and measure the actual current on the instrument. As regards voltmeters, he did not think there was any advantage in Mr. Price's arrangement. There would be some advantage in the case of ammeters if the engineer was satisfied that he was calibrating his instruments. Mr. Swinburne did not agree that induction instruments in general were much affected by frequency. As a matter of fact, he had tested some of Mr. Swinburne's instruments and found them affected by frequency, and this he considered to be inherent in the type. Mr. Wild alluded to wattmeters with shunts, but he did not know of any form of wattmeter with non-inductive shunts of the fractional type which could be used both for alternating and continuous currents. Dr. Drysdale seemed to imply that his firm's "Universal" instruments were compensated by a non-inductive resistance. This was not so. It was simply that the density was kept low and the construction was such that there was practically no drop.

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EDDY CURRENTS IN CABLE SHEATHS.*

BY M. B. FIELD.

(Continued from page 1020, Vol. LII.)

In dealing with the sheath losses in multiple core cables we must form a mental picture at least of the approximate distribution of the external magnetic field produced at different periods of the cycle by *all* the currents within. There is no difficulty in constructing the external and internal lines of force, provided the surrounding medium be not magnetisable, and we propose to consider briefly how this may be done.

In Fig. 8 we represent the two conductors of a circuit, current flowing up one and down the other. If $j_1 j_2$ is any line of force passing through the point j, we know that the total number of lines of force which have cut across or surround j is given by the expression†

$$\frac{2c}{10} \log_e \frac{r_1}{r_2}.$$

But since no lines of force can cut one another, *all* points on this line of force must be surrounded by the same number of lines, hence the condition

$$\frac{2c}{10} \log_e \frac{r_1}{r_2} = k, \text{ or merely } \frac{r_1}{r_2} = \text{constant},$$

holds for the complete family of lines of force of this system.

We can readily express this condition in polar co-ordinates if we remember that

$$r_1^2 = \frac{b^2}{4} + r_0^2 + b r_0 \cos\theta.$$

$$r_2^2 = \frac{b^2}{4} + r_0^2 - b r_0 \cos\theta.$$

But in Appendix II. we point out that these lines of force consist of a series of eccentric circles, and we give the rule for finding the centre of any given line of force.

In the various cases subsequently treated we find the simplest way of constructing the field is to calculate the value of k for a number of points along a number of radii. We can then plot k and r for each radius, and by interpolation draw a family of lines of force, each line passing through the same value of k in each radius.

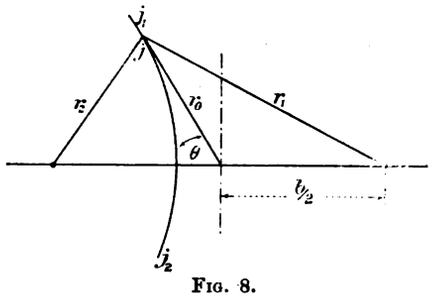

FIG. 8.

If we further mark against each line of force its respective k-value, we obtain a chart showing, not only the general distribution of the field of force, but the total number of lines that surround any point in that field, and, furthermore, by taking the distance measured normally between any two consecutive lines and dividing the difference of their k-values by it, we obtain the strength of magnetic induction at this part of the field.

Such charts have been carefully drawn out by the aid of formulæ given in Appendix II. for certain specific cases, viz. :—

A three-core cable when the current in one core is $+2c$ amperes and in the other two $-c$ amperes; (9)

A three-core cable when the current in one core is 0, in the second $+c$ and in the third $-c$ amperes. These two configurations occur three times per cycle in every three-phase three-core cable, and therefore enable us to form a fairly good idea of the sort of irregularly rotating magnetic field continually cutting the lead sheath and producing eddy currents therein (see Fig. 10A).

Fig. 11A represents the configuration in the case of a two-phase cable, with two insulated cores and a common outer conductor, when the currents in the two inner conductors are $+c$ amperes and in the outer conductor $-2c$ amperes, and Fig. 11B represents the configuration when the current in the one core is c, in the other zero and in the outer sheath $-c$. This, similarly, represents to an exaggerated degree the field surrounding a so-called concentric cable when the inner conductor is really eccentric to the outer.

Lastly, Fig. 10B represents the configuration around the two-phase cable at successive intervals of the half cycle.

In constructing these diagrams no account has been taken of the fact that the conductors are spiralled round the axis of the cable. At points very near to the cable—*e.g.*, points on the sheath—the effect of the "lay" of the cores may be neglected.

It will be observed that in all the above cases the integral of current density over the whole cross-section of the lead must be zero. This must manifestly be so, for, if not, there would be on the whole a current flowing longitudinally in the sheath. This current would produce magnetic lines surrounding the cable ; but since the core currents inside can produce no such field and the sheath entirely surrounds these cores, it is not possible for the induced sheath currents to produce such a distribution.

Similarly, the integral of current density taken round the periphery of the sheath or any other concentric part is zero (see Appendix II.).

This is an important point, for under these circumstances it is clear there will be no progressive variation of potential along it, so that we may apply our previous rule that the loss in any longitudinal strip is V^2/R, where V is effective E.M.F. induced and R the resistance of the same.

The E.M.F. generated per unit length parallel to the cable will be $10^{-8} \frac{dk}{dt}$ volts. We can make this calculation for all points round the sheath of the cable in any particular instance, and construct a curve showing the E.M.F. per unit length longitudinally and the position around the sheath. Calling this E.M.F. as before v, we take the mean square value, divide by the specific resistance and

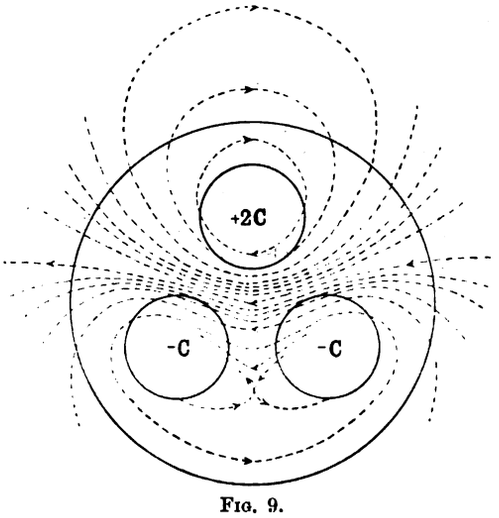

FIG. 9.

multiply by the area of exposed cross-section of the sheath to obtain the total loss per unit length. Fig. 12 represents the variation of v for different points around the circumference of the three-core cable above considered.

It is perhaps hardly necessary to point out that in making the calculation of the loss per mile of cable, we have to take our length a little greater than the total length of the cable and the area of cross-section of the lead sheath correspondingly less, as we must consider our imaginary strips which form the sheath spiralling round the axis with exactly the same lay as the cable cores, so that each strip may be considered at every point along the cable the same distance from any one conductor.

In the case of the three-core three-phase cable we can calculate the E.M.F. at the six points on the sheath, 1, 2, 3, 4, 5, 6, as if we had merely two conductors, each of these points being situated at the same distance from two cores. The maximum E.M.F. at 1, 2, 3 will be the same, likewise at 4, 5, 6; hence, if we calculate it as previously explained for two points diametrically opposite, say 1 and 5, and take the root mean square of these values, this will be good enough for a rough estimate of the sheath loss. For example, we find the E.M.F. at 1 is 20·3 volts per mile, and at 5, 12·6 volts per mile in the case of a three-core cable having the following dimensions :—

Circular cores of radius	0·275in.
Distance between centres of cores	0·8in.
Distance between centre of cable and centre of core	0·463in.
Mean radius of sheath	1·05in.
Thickness of sheath	0·188in.
Current per core (effective)	200 amperes.
Frequency	60 amperes.

* "A Theoretical Consideration of the Currents induced in Cable Sheaths, and the Losses occasioned thereby." Paper read before the Institution of Electrical Engineers on April 14th.

† In speaking of the number of lines of force that surround a given point, we really mean the number of lines which may be considered as having cut across *unit length* of an imaginary conductor passing through the point in question, parallel with the current-carrying conductors.

Thus j is considered as the end view of a conductor, and the number of lines surrounding j is the number that enclose the conductor per unit length.

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Since the loss is proportional to the square of the E.M.F., we have to take the $\sqrt{\text{mean sq.}}$ of the above values rather than their true mean $\sqrt{\frac{20{\cdot}3^2+12{\cdot}6^2}{2}}=16{\cdot}9$, hence the total sheath loss per mile will be 0·67 w. per mile.

In the above examples we have considered in each instance high-tension cables. The losses in the lead sheaths of heavy three-phase low-tension distributing cables would, of course, be very much greater.

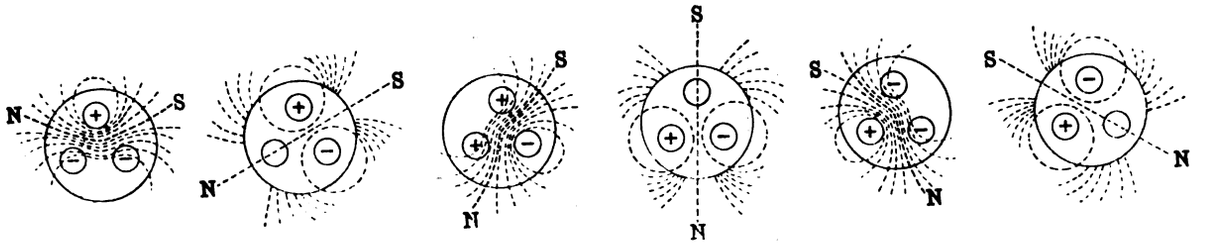

Fig. 10A.—Successive Distributions of Magnetic Field around Three-Phase Cable during One-half Cycle. Time Intervals of $\frac{1}{12}$th Cycle.

The Board of Trade are, nowadays, advocating a copper earthed sheath directly under the lead, which will manifestly considerably add to this loss.

Suppose we take the worst case of a copper sheath directly beneath the lead, made up of strips of copper $\frac{1}{32}$in. thick, wound

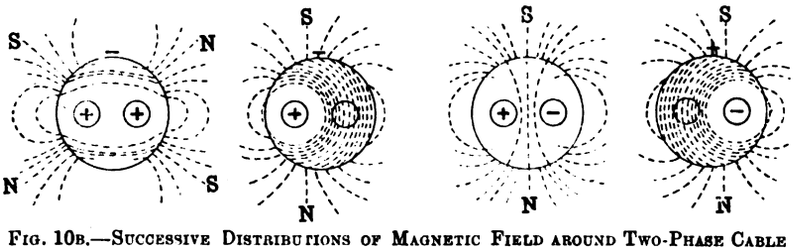

Fig. 10B.—Successive Distributions of Magnetic Field around Two-Phase Cable during One-half Cycle. Time intervals of $\frac{1}{8}$th Cycle.

with the same lay as the cores, then the resistance of this earth sheath will be approximately one-half of that of the lead, so that the total sheath loss is brought up to 2kw. per mile, which is by no means a negligible quantity.

If we further assume that our three-core cable is laid in an iron trough or is steel armoured, we know that the total external field

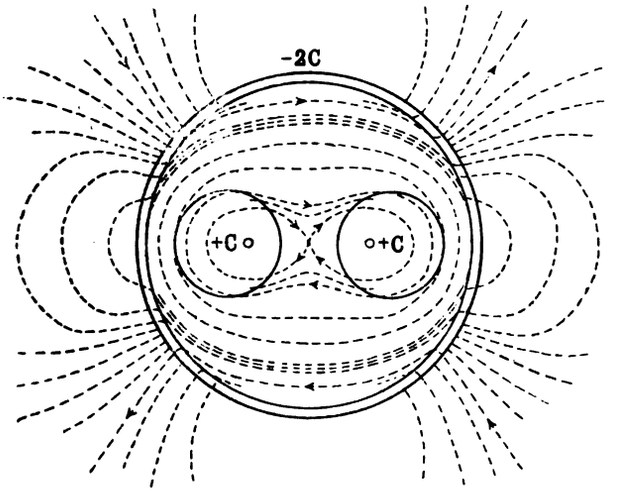

Fig. 11A.

will be largely increased, to what extent is difficult to say: the problem of calculating the field of force due to an unsymmetrical arrangement of conductors in an iron trough is an extremely complex one. We have no experiments to guide us, and it is dangerous to hazard a guess, although we feel that to say that the total field may be increased two or three times is not at all outrageous. The losses depend on the square of the field, so that doubling the field strength at every point (actually the whole distribution of magnetic field would be changed) would mean four times the loss, or 8kw. per mile, while trebling it would mean a loss of 18kw. per mile. These possible causes of loss cannot, therefore, afford to be overlooked by engineers.*

If the copper strips forming the earth shield be not wound on with the same lay as the cores, there will be a relative crossing between core and copper strip, which means that for a certain length the E.M.F. induced in each strip will be in one direction, and this will gradually change until it is in the opposite direction as we go along the cable; the total induced E.M.F. over that length of strip which forms one complete spiral round any one core being zero. The eddy currents will, therefore, at places leave the copper strips, forming a closed circuit by means of the lead, thus longitudinally along one strip, into the lead, from lead into another strip in which an opposite E.M.F. is induced, and back through this strip to the starting point. Each passage from copper to lead will interpose extra resistance in the path of the eddy current, but by the process of manufacture the contact between the copper and lead is bound to be so intimate that it is doubtful whether this forms any effective bar to passage of the eddy currents.

The best method to overcome this loss is, *first* to wind on the copper strips with a lay as different from that of the cores as possible, and then to apply a thin coat of paint before applying the lead sheath. This coat of paint will be amply sufficient to prevent the eddy currents leaving the copper, but should leakage occur from one of the high potential conductors, this insulation would either be instantly broken down, or failing this, would be sufficiently low to form a thoroughly good earth.

For example, if ω_1 equals the resistance per unit length o lead sheath, ω_2 that per unit length of copper earth shield,

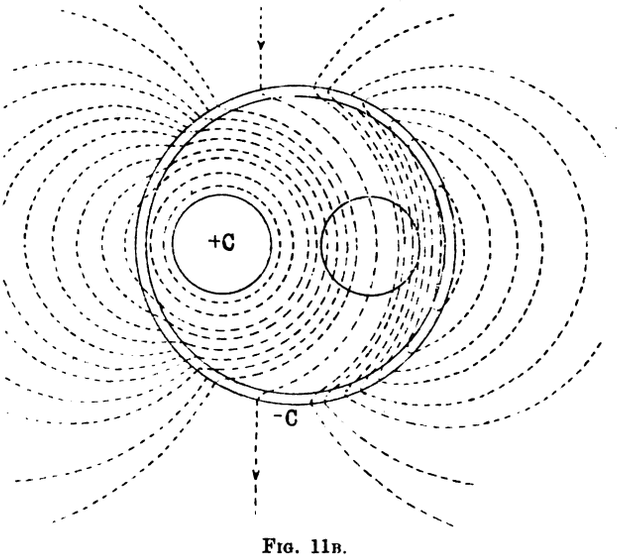

Fig. 11B.

and Ω the insulation resistance of the coat of paint separating unit lengths of lead and copper sheaths, then the resist-

* It appears to be generally considered advisable to provide a copper earth shield where the armouring is applied in the form of steel tapes, partly on account of the difficulty in making suitable electrical connections in the armour at a cable joint. Where the armouring takes the form of steel wires outside the cable, or where the cable is drawn into iron pipes which are carefully bonded together where they make joint, extra earth shields are considered unnecessary.

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ance* between lead and copper measured at one end of the cable is

$$\sqrt{\Omega(\omega_1+\omega_2)}\,\frac{1+\epsilon^{-2ql_1}}{1-\epsilon^{-2ql_1}},$$

where $q=\sqrt{\frac{\omega_1+\omega_2}{\Omega}}$, and l_1 is the length of the cable.

If now we take a particular case and write:—

$\omega_1 = 120\times10^{-6}$ ohms per foot (corresponding to an area of cross-section of lead sheath of 0·785 sq in.);

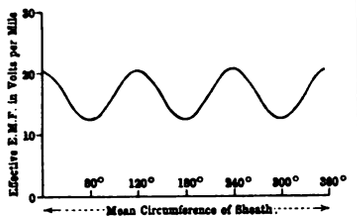
$\omega_2 = 89\times10^{-6}$ ohms per foot (corresponding to an area of 0·196 sq.in.);

$\Omega = 53$ ohms (measured between 1ft. length of lead sheath and the same length of earth shield);

then $q = 1{\cdot}73\times10^{-3}$; for values of l_1 greater than $\frac{3}{2q}$ we may call $\frac{1+\epsilon^{-2ql_1}}{1-\epsilon^{-2ql_1}}$ unity. This value of $l_1 = 866$ft. Hence for all lengths greater than $\frac{1}{6}$th mile we could in the above case take the resistance measured at one end between copper and lead as $\sqrt{\Omega(\omega_1+\omega_2)} = 0{\cdot}0916$ ohms.

Such a low insulation as this would conduct any leakage from one of the cores direct to the earth, whereas an insulation resistance of 53 ohms between 1ft. length of lead and copper would be an effectual bar to the circulation of eddies between them.

Lastly, we will consider very briefly the case of concentric cables. Let us suppose that due to faulty manufacture a certain amount of eccentricity exists. The field of force will be that represented in Fig. 11B. External to the outer conductor, the field will be that due to two currents concentrated at the centres of the inner and outer conductors respectively, while inside the outer conductor the field will be that due to the inner conductor only.



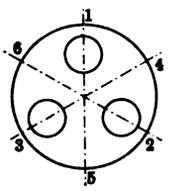


Fig. 12.

It is easy to show that a cable carrying 200 amperes, having an eccentricity of $\frac{1}{8}$in., would produce an E.M.F. in a parallel pilot wire situated 4in. away of 3 to 4 volts per mile. A telephone connected to a few miles of such a pilot wire would give a very loud humming, and it is clear that if the cable and pilot wire were laid in the same iron trough a very much smaller eccentricity would produce a loud humming in the telephone connected to a pilot wire. We think, however, this can hardly account for the phenomenon observed by Messrs. Constable and Fawssett, and referred to earlier on in this Paper, for even supposing an eccentricity to exist throughout the whole length of the cable, it is hardly possible that there would be no twist in the cable, which, of course, would neutralise the effect.

If, on the other hand, two or more concentric cables were connected in parallel at both ends, and the resistance of one outer, say, were increased unduly due to a faulty connection at some junction-box, the correct distribution of current between the various cores would be disturbed, under which circumstances telephonic phenomena would be readily accounted for.

In the foregoing Paper it has been our endeavour to show how the sheath loss in any cable likely to be met with in practice may be readily estimated, with any required degree of accuracy, by anyone provided with a table of logarithms, and the examples given have been merely by way of illustration.

*If we apply between the lead sheath and earth shield a constant P.D. V, and consider the current flowing after the steady state has been reached.

Let v_1 be the potential at any point of the positive conductor and v_2 the potential at a corresponding point of the negative conductor (*i.e.*, copper and lead respectively); if c_x be the current at any point flowing longitudinally, we have

$$-\frac{dv_1}{dx}\cdot\frac{1}{\omega_1}=\frac{dv_2}{dx}\cdot\frac{1}{\omega_2}=c_x \quad\text{and}\quad -\frac{dc_x}{dx}=\frac{v_1-v_2}{\Omega},$$

or

$$\frac{d^2c_x}{dx^2}=\frac{\omega_1+\omega_2}{\Omega}c_x.$$

If the cable be of finite length we must write the solution of this equation in the form

$$c_x = c_1(\epsilon^{-qx}-\epsilon^{-q(2l_1-x)}),$$

where $q=\sqrt{\frac{\omega_1+\omega_2}{\Omega}}$.

Hence $c_0 = c_1(1-\epsilon^{-2ql_1})$ and $V=\Omega q c_1(1+\epsilon^{-2ql_1})$.

Hence $$\frac{V}{c_1}=\Omega q\left(\frac{1+\epsilon^{-2ql_1}}{1-\epsilon^{-2ql_1}}\right).$$

If the resistance be measured at any point other than at the end of the cable a smaller value will result.

In Appendix II. we give, by way of example, a few symmetrical arrangements of conductors where the value of k is readily calculable; but the general method is applicable to any system of straight parallel cylindrical conductors enclosed by any shape of non-magnetisable sheath. We have in short

$$k=\tfrac{1}{2}(c_1\log r_1+c_2\log r_2+c_3\log r_3+\&c.),$$

where $c_1+c_2+c_3+\&c.=0$, k is the constant of the line of force passing through the point, whose distance from the centres of the various conductors is represented by $r_1r_2r_3$, &c. (the point being external to the conductors), and where $c_1c_2c_3$ are the values of the currents in amperes in the various conductors. If we know how these vary, we know $\frac{dk}{dt}10^{-8}$, which is the longitudinal E.M.F. per unit length at the point of the field in question.

If the conductors be not cylindrical, we can either resolve them approximately into several conductors of circular cross-section, or replace the expressions $\log r_1$, $\log r_2$, &c, by $\frac{1}{A_1}\Sigma\delta A_1\log r'$, $\frac{1}{A_2}\Sigma\delta A_2\log r''$, &c.; that is to say, for each core we take each element of area, multiply by the logarithm of its distance from the point in question, add all up, divide by the total area, and insert this value in place of merely the logarithm of the distance from the centre, as in the case of cylindrical conductors.

Having found the value of the E.M.F. acting at a sufficient number of points over the cross-section of the sheath, we obtain the mean square value over the cross-section, and divide by the resistance of the sheath to obtain the total loss.

(To be concluded.)

CORPORATION TELEPHONES.*

BY A. R. BENNETT.

The first independent telephone exchange constructed by any local authority was that of the States of Guernsey, which was established in July, 1898, and which is consequently in its seventh year of working. From a small beginning, it has developed until at the present moment there are 1,230 telephones at work in the island As the population is only 40,300, this gives one telephone to every 33 souls, and makes Guernsey the best telephoned area in the United Kingdom. The accounts at December 31st last showed a net profit of £201, after providing for interest, sinking fund, and a special contingency fund.

The second exchange to be established was that of the Corporation of Glasgow, which commenced to work in March, 1901. That has also been extremely successful, as, beginning with promises for 3,000 instruments, it has now 11,200 actually working, with a constant stream of orders always flowing. The last published accounts showed a surplus of over £2,000, after allowing for interest and sinking fund. Another financial year will end on May 31st next, when it is expected that a considerably larger surplus will be announced.

The third corporation exchange was that of Tunbridge Wells. The scheme was a very small one, providing only for 300 lines, but the success of the service was so great, that 300 instruments were working within a few weeks of the opening, and in the course of a few months the number had reached nearly 900, which had to be grafted on a system which was originally far too small. The Corporation exchange met with the most determined opposition on the part of anti-municipal traders, and of the landed gentry in the neighbourhood, and the Town Council ultimately parted with their undertaking to the National Telephone Co. They received £3,000 in excess of their outlay, and secured a permanent flat rate of £6 per annum for their burgesses, together with the abolition of terminal fees on trunk calls.

The next exchange to be started was that of the Corporation of Portsmouth, which was opened in March, 1903. From a small beginning, the exchange has prospered mightily and has at present some 1,700 telephones speaking, with many others to join up, augmented daily by new orders. The first financial year only ended on March 31st last, and the accounts are not yet available, but are expected to show a profit of about £1,000 on the first year's working.

The fifth exchange to get into operation was that of the Corporation of Swansea, which was opened in August, 1903, and has at present nearly 800 telephones joined up and many more to follow.

The sixth exchange was that of the Corporation of Brighton, which was opened in November, 1903, and has now 900 telephones working, and about 1,000 more to join up.

The system in Guernsey was at first nearly all overhead, as it was felt desirable to have the routes well defined before undertaking underground work. The poles used are creosoted Norway fir, of the usual sizes. A few standards have been erected on the roofs,

* Abstract of a Paper read before the Glasgow Local Section of the Institution of Electrical Engineers, April 12th.

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but only where absolutely unavoidable. These standards are exactly the same as I designed for the National Telephone Co. in 1881, built up and spliced in the same fashion, and are fitted with the same channel iron arms, which I designed at the same period. The insulators used throughout are of the single shed pattern, known by my name, which also dates from 1881. As the island is small, and no chance exists of long-distance trunk communications, it was decided to employ silicium bronze wire of an unusually small gauge—namely, No. 19—which electrically is quite sufficient for such a restricted area. The original wire, put up seven years ago, is still intact, and shows little signs of wear. It has withstood many gales with great success; interruptions to service through storms, even the most severe, are extremely rare. As the routes filled up and the subscribers increased markedly, it was deemed desirable to lay underground cables. The respective mileages of metallic circuit at December 31st last was 318 miles underground and 827 miles overhead. The type of underground cable used throughout is air-space paper-insulated, the gauge of the conductors being No. 22. The cable is lead-sheathed and armoured with steel tape, finished over all with a serving of jute. I believe that these were the first armoured cables ever used for telephone work. It is nearly seven years since the first cable was laid, and not a single fault has occurred in any of the cables from first to last.

The switching system used in Guernsey is that known as the Bennett ring-through. This was originally patented in 1891, and put into use in a small way just before the death of the late Duke of Marlborough led to the new telephone company being merged with the National. The system has been fully described in Preece and Stubbs' work on Telephones, and in Mr. Joseph Poole's "Telephone Handbook" and in other publications,* so that I need not describe it minutely to-night. This ring-through system has been adopted to a large extent in Sweden and Norway, on the Continent and in South Africa. The system has fulfilled all expectations in Guernsey, where the service is generally considered as satisfactory. I need scarcely mention that all lines in Guernsey are on the metallic circuit principle. This applies universally to the corporation exchanges.

In Glasgow there are 19 switch rooms. In 14 of these the ring-through system, practically the same as in Guernsey, is fitted, but in the remaining five switch rooms, those in the central parts of the city—namely, Renfield-street, Hillhead, Bridgeton, Kinning Park and Queen's Park, the five chief exchanges, were constructed on the call-wire principle, in deference to the wish of the Telephone committee, which, before a start was made, considered the question carefully. On three of these central exchanges, however—Hillhead, Kinning Park and Queen's Park—ring-off drops on the ring-through system have been fitted so as to render it unnecessary for subscribers on those exchanges to call off after a connection; they simply press the red button, establish an earth connection at their instrument, and cause the central ring off battery to work the indicator. This saves much time on the call-wire, and leaves it clearer for those calling for connections. The same system will soon be in operation at Bridgeton, and the Central will also be fitted later on. A new exchange to relieve the Central will shortly be opened in Nelson-street, Trongate, in the new building of the City Improvement Trust; this will be on the ring-through system entirely. The abolition of the call-wire system is under consideration, but, so far, nothing to replace it has been settled upon.

The construction work in Glasgow is to a very large extent underground. After the recently-constructed Post Office system in London, the Glasgow Corporation is the largest underground system in the United Kingdom, and that by a very long way.† In Glasgow, to a very large extent, the underground cables are taken into subscribers' premises in the same way as gas and water. This is a more expensive method than was contempled in the original estimate, but when once done is much freer from disturbances than the ordinary overhead wire. Away from the centre of the city such a method of distribution would prove extremely costly, and the the usual method followed is to lead the underground cable up a distributing pole or to a distributing standard on a roof, there making what is called a pot-head joint, and connecting the underground metallic circuits to overhead distributing wires by an intervening link of wire insulated with vulcanised indiarubber, protected by waterproof braiding. The cable employed for branches into buildings and to distributing points is armoured with steel tape, as I have described in connection with Guernsey. It is laid in a creosoted wooden trough of rectangular section. The armoured cable, being very flexible, lends itself readily to distributing purposes, and the creosoted wooden trough can be easily adapted to corners by sawing.

The insulators used in Glasgow on the overhead part of the system are of the same type as in Guernsey, except that on the longer lines double shed insulators are employed. Bronze wire is used for distributing purposes, but the gauge is No. 18, weighing 40lb. to the mile. On junction lines, such as those to Bearsden, Stepps and other outlying places, hard-drawn copper wire weighing 100lb. to the mile is the standard. In the overhead distributing wires to subscribers' premises, no twisting or crossing is employed, that being found to be unnecessary. On the junction lines metallic circuits are crossed at intervals of a mile or less, according to the disturbing inductive effects which may happen to be in the neighbourhood, and this crossing is found to be sufficient for all purposes. The system of twisting overhead loops is extremely expensive to carry out, and renders the discovery of faults, and the restoration of wires after being broken down, an extremely arduous task. With the system of crossing all these difficulties disappear. The poles used for distributing are generally of creosoted wood, but sometimes they are of square pitch pine, and more rarely of steel tubes. At terminal poles, where all the pull is one side of the insulator, what are known as J bolts are employed, which prevents a twisting strain being thrown on the wooden arm. These wooden arms are usually of oak, but recently we have tried karri wood, which promises to be very successful. Sometimes an effort is made to give an ornamental appearance to the pole by means of wrought-iron brackets. Where roof standards are employed, they, with their fittings, are all of the same type as in Guernsey. Recently an ornamental iron finial has been adopted for the poles and standards; this also acts as a lightning discharger, as the earth wire, with which all poles are fitted, is fixed in direct metallic connection with it. When the hanging of overhead wires above the tramway trolley lines cannot be avoided, a small cable made up of vulcanised indiarubber-insulated wires containing a standard steel core is used, the core being sufficiently strong to support the span.

The switchboard used at the central exchange is designed for 10,000 subscribers. At the present moment nearly 7,000 stations are served from it. The switchboard is flat, so that operators may sit on both sides. The jacks are two-point only, with a third connection for the test circuit. They are arranged vertically, but no trouble is experienced from the accumulation of dust, the danger of which is sometimes urged as a strong objection to vertical jacks. The cords and plugs are hung from a canopy suspended from the roof so as to leave a clear space for the operators' hands. The cords contain three conductors, two for the metallic circuits and one for the test circuit. At the sections of the board devoted to junction line working the cords are single for the service of the incoming junction lines. The outgoing junction lines are distributed amongst the operators, who are provided with speaking-keys, by means of which they can ask connections from the various outlying switch rooms. The method of disposing of the multiple cables is, I believe, unique. At the central exchange the multiple cables are laid on either side of the switch table under movable flooring, in guides which are so arranged that any particular cable can be located without difficulty. The connections to the spring jacks are taken off at the proper intervals and led under the flooring into the body of the table, and thence up to the spring jacks, sufficient spare cable being provided to enable the spring-jack strips to be taken out, examined and readily repaired.

The same type of switchboard is used at the Bridgeton, Hillhead, Kinning Park and Queen's Park switch rooms, but these switch rooms being on a much smaller scale, it has not been necessary to make any special provision for the cabling, which is readily contained in the bodies of the tables. These branch switch rooms, however, differ from the central in having the ring-off indicators fixed to the canopies, the ring-off drops coinciding with the pairs of cords. At all other switch rooms vertical boards are employed on the ring-through system, as already described. The largest of these is at Govan, which serves 232 stations. The central and most of the branch switchboards have been manufactured by the British Insulated and Helsby Cables (Ltd.) of Helsby, only the tables at Maryhill, Shettleston and Bearsden being provided by the Ericsson-Bell Telephone Co.

The Corporation have nearly 250 public telephone offices in use, most of which are fitted with a penny-in-the-slot collecting machine made by the International Electric Co. of London, by means of which the fact that a penny has been dropped in is signalled to the operator at the exchange. This is done by a contact arm divided into segments, which make contact with the coin and produce a number of makes and breaks in the operator's 'phone. At the central the public telephone lines are brought to a separate switch table, as the checking of pennies is apt to interfere with the rapid work at the main board. Connections are got between the public telephone switchboard and the main board by means of junction lines and speaking keys. The public telephones are used very largely and provide a traffic which continually grows.

The ringing of subscribers' bells, when necessary, is effected by means of magneto-generators driven off the electric lighting mains. One generator is used for the central and another supplies current to the principal branch exchanges by means of metallic circuits specially reserved for that purpose. Turning now to the Ports-

* See *The Electrician*, Vol. XLVII., p. 785, in which the system is described in connection with the Tunbridge Wells exchange.—Ed. *E.*

† [A detailed description of the Glasgow system appeared in *The Electrician*, Vol. XLVIII., pp. 333 and 374. To avoid repetition, therefore, this part of the Paper has been considerably abridged.—Ed.]

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mouth Corporation telephone exchange, there is little to differentiate it from Glasgow, except that the switching system is different. Cast-iron pipes are used for the ducts, the cables and manholes are to the same specification, the distributing poles are also the same, and the bronze wire employed for distributing is No. 18, of the same specification as in Glasgow. Hard-drawn copper wire is used for the junctions, and Portsmouth possesses probably the longest junction route in the country, as, in order to reach Gosport, which is only distant ½ mile across the harbour, a circuit of nearly 20 miles has to be made. This is owing to the inadaptability of the bottom of the harbour for submarine cables.

The Portsmouth switching system is the same as in Guernsey and the branch exchanges in Glasgow, except that the calling is not done by a magneto-generator, but by a central battery at the exchange, which is brought into operation by putting an earth, by means of a finger key on to one leg of the subscriber's line. This causes the subscribers' line indicator to be operated until the operator plugs into the answering jack, when it is automatically restored to its neutral position. The wiring of the multiple jacks on the Portsmouth board is somewhat of an innovation. The spring jacks consist of two pairs of springs, an inner pair and an outer pair. The outer pair of springs is in parallel circuit with the subscriber's line, and all speaking is done through this outer pair of springs. The inner pair of springs of the several jacks are connected in series, and the last spring is permanently earthed through the indicator and the central battery. The insertion of a plug in any of the jacks on a subscriber's line connects the operator's set to the line and at the same time causes the inner pair of springs to open and to interrupt the indicator circuit, so that the indicator is cut out wherever an operator plugs in or two subscribers connected. This device answers very well and saves much complexity, because the usual American practice is to cut the indicator out by means of a relay worked off the test circuit. This is clumsy and expensive, and imports into the switchboard a multiplicity of relays, which are very fallible pieces of apparatus. Each operator's position is fitted with a pilot indicator, known as a "star," which is connected in a local circuit with all the ordinary indicators, and shows up prominently and makes a sharp click whenever one of the ordinary indicators on a position becomes deflected. Instead of these pilot indicators, relays and ruby-coloured lamps have been tried. They answer very well, but, being quite silent, are more liable to escape the operator's notice.

The central battery consists of a duplicate set of Hart accumulators, from which not only the calling, but the speaking circuits are worked. These are charged by a motor-generator driven off the electric lighting mains. A separate generator is used for ringing purposes during the day, but during the night the alternating electric lighting current which is used in Portsmouth is employed for ringing the alternating bells, being transformed down by an ordinary translator. The Swansea Corporation telephone system is exactly the same as at Portsmouth, except that glow lamps are added to each operator's position, which indicate when an unusual flow of current is passing over the lines joined to that position. This enables any leakage on the outside lines to be very speedily detected. The underground and outside work at Swansea is the same as at Portsmouth, the ducts being 3in. cast-iron pipes, and the cables, poles, insulators, and wire being to the same specifications. The switchboards at Portsmouth and Swansea were manufactured by the British Insulated and Helsby Cables Co.

At Brighton several deviations were made from previous practice, The underground ducts in the central district consist of 4in. octagonal stoneware pipes laid in cement concrete, the joints first having been covered with adhesive tape. The laying, jointing and alignment of these octagonal ducts require much greater care than the laying of iron pipes, but when once finished satisfactorily they make an extremely good job. In the outlying districts in Brighton. where only one duct is employed, a 3in. cast-iron pipe is laid. Apart from this, the outside work is the same as in the other places.

The switching system employed, however, although essentially on the same plan as at Portsmouth and Swansea, differs in an important detail. In those places the exchange is called by pressing a button. At Brighton the exchange is called by the act of lifting the telephone from its rest. This is effected by means of a passing contact attached to the switch arm, which, when the 'phone is lifted off, momentarily earths the subscriber's loop. This momentary earth causes a current from the central battery at the exchange to flow and brings down the signalling indicator. This indicator is restored to its normal position by the act of inserting the answering plug, the indicators being combined with the spring jacks, so that the insertion of a plug mechanically restores the shutter. The operator then takes the message and makes the connection called for, at the same time ringing the called subscriber's bell by means of a finger switch. The switch-cord is divided into two portions by the insertion of a translator, which insulates the one subscriber's line from the other and causes all speech exchanged between them to be carried on by induction. A ring-off indicator on the usual ring-through principle is bridged across the cord on each side of the translator, one drop being coloured red and the other yellow. When the called subscriber lifts his 'phone off to reply the yellow drop falls and shows the operator that the connection is effective. By touching a button she restores the shutter of the yellow drop. When the subscribers are finished they both place their telephones on the rest, an act which operates a passing contact in the opposite direction and brings down both the yellow and the red drops, and this is the signal for disconnection. The ring-through principle is maintained, so that if the called subscriber does not answer promptly, the caller, by turning his generator handle, can ring his bell as often as is necessary. This system is as near fool-proof as is possible, as the subscribers are not left to touch buttons or turn handles for the purpose of calling-on or ringing-off, the natural actions of lifting off and putting back the 'phones accomplishing these purposes. With the exception of the second ring-off drop, this system is in accordance with a patent which I took out in 1891, and which has never hitherto been put into practical use owing to the difficulty of constructing a really trustworthy passing contact, and also the difficulty of combining such a system with a ring-through arrangement. Both these difficulties have now been successfully overcome, and I am pleased to say that the Brighton exchange is giving the greatest possible satisfaction to the subscribers. The other arrangements at Brighton are identical with those already described in connection with other centres. The switchboards were manufactured by the Ericsson-Bell Company, of Christiania and Glasgow.

The only other system remaining to be referred to is that of the Corporation of Hull, which is now in course of construction, and is expected to be in operation in June or July. The ducts used there are of the Albion Clay Co.'s socket and spigot type, with Stanford joints, a type which has been successfully used in Hull both for the electric light and tramway system. They are 4in. diameter within ½ mile of the exchange, where the largest-sized cables will prevail, and 3in. diameter beyond that distance. The switching system will be identical with that employed at Brighton, and the other details both outside and in will be the same as in the other centres.

In opening the discussion on Mr. Bennett's Paper,

Mr. H. L. WEBB considered that Mr. Bennett had worked the wrong way about. He had fixed a rate in advance and then tried to make his system fit his rate. The proper method of working the thing on engineering lines was to find out what the thing was to cost and then fix the rates. As a general rule, the whole question had been put on the basis of making a rate of about £5 and making the average capital cost range from £14 or £15 a line up to about £20 a line, and this had been put forward in such a way that the engineering—the real engineering—question had been entirely omitted. All through the Paper there were descriptions of systems which made the telephone subscriber the operator. In his (Mr. Webb's) opinion, the subscriber himself should have the least possible amount of work left to him; the work should be done by the expert, who was the operator at the exchange. At this late day it seems to him almost absurd to have to enumerate the objections to the call-wire system, but since it had been adopted in Glasgow, and had been held up as a modern and up-to-date system, giving an efficient service, he thought it only proper that they should be pointed out. In the first place was the objection of relying upon the subscriber to do part of the work that should be done at the exchange. Then it made the subscriber's service dependent on two sets of lines being in order, and increased the plant at the most costly part—the line plant. It resulted in a mixed system, because in small exchanges, where the subscribers are scattered, it became necessary to revert to some system of direct signalling, so that in the same general exchange area there were two methods of working. A man might have to use the telephone in a different way, say, in his house and in his office Then a great objection to the call-wire system was that the subscriber had to give two numbers, so that the percentage of errors due to wrong numbers was much increased by the use of the call wire. This question of numbers was so important that in New York they had recently decided not to increase a telephone exchange above 10,000 subscribers, so as not to get numbers of more than four digits. Then the call-wire system made the junction working more awkward. The operator had temporarily to abandon listening on the call wire while she was getting the junction call through. At the busy times that was a disadvantage. At the busy times of the day, also, the work both for subscribers and for the operators got very trying. With several people trying to struggle through at the same time, the strain on the operators was hard, and the strain on the subscriber was hard also. In ordinary working, when a call came in opposite an operator and she was already engaged, the next operator took it up for her, and by this "team working" a high average efficiency and a rapid average answer was obtained. With the call wire, this "team working" was impossible. Supervision was also difficult on the call-wire system. The call-wire system had been abandoned a great many years practically everywhere, except in municipal telephony. The speaker then proceeded to criticise the ring-through system. If it was necessary to depend upon the subscriber to call off and to ring his correspondent, and so forth, there was necessarily much time wasted. In New York, with magneto calling and ringing off, on an average 27·6 seconds elapsed from the time the first subscriber called to the time the called subscriber answered, and 17·1 seconds from the time the conversation was finished to the time the two lines were restored to their normal condition. Five years later, when the common battery system was wholly introduced

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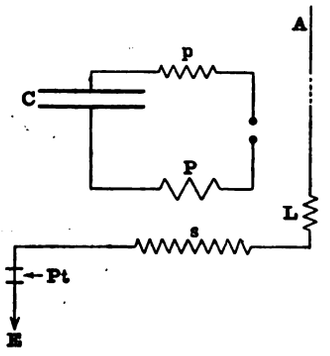
in New York, the time of connection was reduced to 23·7 seconds, and the disconnection came down from 17·1 to 2·8. With junction calls it was found that, with common battery working, the total gain in the operating of each average connection was 34 seconds. This increased the capacity of the operator and the capacity of the junction wire, the latter being an important item in any large system. and he contended that all the antiquated notions that involve making the subscriber the operator were bad telephone engineering. They missed the fundamental point of the whole thing, which was to make the average connection as quickly and as economically as possible. There was only one other point that he particularly wanted to mention—viz., that of surplus plant in the shape of ducts. If the system is to be flexible, so as to take on subscribers in all parts there must be spare capacity. Subscribers move, some give up the service while others come on in a different place, so that, even if the system did not grow, there must always be a margin of surplus facilities. Unless, therefore, the estimate included a margin for surplus plant, it would in the course of time, be falsified.

The discussion was then adjourned until the next meeting of the Local Section on May 10th.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E FOURNIER D'ALBE.]

Resonance in Aerial Systems.—A. H. Taylor outlines a simple method of attaining resonance in systems subject to electric oscillations of high frequency. Sharp resonance effects occur only when the damping is small compared with the energy supplied. Such a system as is shown in the diagram gives little damping in the non-radiating, low-resistance circuit consisting of the condenser C, a spark-gap, and the low-inductance P of the primary of a Tesla coil. The aerial A is coupled magnetically to the system by being connected to the secondary of the Tesla coil S, one end of which is earthed. Such an arrangement has been used by Brown, Marconi, Fleming and many others. The damping of the oscillations in the aerial is very great, but the energy supplied from the circuit is also great, so that the total damping is comparatively small. The resonance of aerial systems may be very elegantly demonstrated in the lecture room by placing a small lamp, say, 1 c.p. at 4 volts, either directly in series with the receiving aerial, or across the spark-gap of the primary circuit of the receiver. To transmit enough energy it is necessary to operate the induction coil with alternating current.



[A. H. TAYLOR, *Physical Review*, April, 1904.]

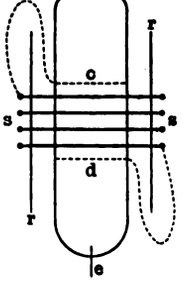
Substitute for Quartz Fibres.—K. E. Guthe has found that soapstone or steatite is much more easily worked than quartz, and gives fibres of practically the same elastic qualities. The soapstone, when heated to a high temperature, becomes exceedingly hard, and is used commercially under the name of "lava" for making apparatus intended to be able to stand high temperatures, tips of gas burners for example. While it cannot be melted before an ordinary blow-pipe, it melts before an illuminating gas-oxygen jet and forms a clear bead, usually of a greenish tint, due to the presence of traces of iron. The original soapstone or the "lava" will do equally well, the most convenient form being small cylindrical sticks. With a small, quiet flame it melts without boiling. After taking the pearl out of the flame, the thread is drawn, its thickness depending upon the temperature and the rapidity with which it is drawn. Very fine fibres can thus be secured. The fibres should not be heated after being drawn. In a Bunsen burner, for instance, they will immediately become white and break to pieces. The tensile strength of steatite fibres is at least as large as that of quartz, and the coefficient of simple rigidity is almost exactly the same. Steatite fibres may be bent more than quartz fibres without breaking. The substance is easily secured, an old jet of a gas burner furnishing a large number of fibres.

[K. E. GUTHE, *Physical Review*, April, 1904.]

Conductivity in Electrostatics.—Since Faraday's researches concentrated the attention of physicists upon the medium separating conductors, the most fruitful advances have been made in connection with the dielectric field, and the electric permeability is the only characteristic which occurs in all the formulæ of electrostatics. W. von Nicolajew points out, however, that since no known body possesses absolute non-conductivity, the conductivity should enter into electrostatic formulæ as often as the specific inductive capacity, and that the neglect of this factor makes modern electrostatics too much of a fiction. He quotes some experiments in electrostatics, some of them original, in which the conductivity plays a more important part than the inductive capacity, and yet is usually left out of account. A piece of paraffin suspended in air beside a charged conductor is attracted by the latter owing to its higher dielectric constant. If the conductivity of the air were very much higher than that of the paraffin, the latter would be repelled instead. If the medium and the suspended body have nearly the same dielectric constant, the effect of the conductivity may very well mask that of the dielectric constant. A cylindrical block of paraffin is suspended in kerosine beside a charged pole. It is repelled and set rotating, as in Quincke's experiments with a body between the plates of a condenser. Pieces of colophony, glass, ebonite, or paraffin immersed in vaseline oil are attracted by the charged conductor, if the conductivity of the vaseline oil is smaller than that of the bodies immersed. Although the dielectric constant of the paraffin differs very little from that of the vaseline oil, the attraction is energetic, and is due to the difference of conductivity. If a small brass ball is suspended beside a paraffin block in air ionised by radium and kept charged by a condenser, it gradually points away from the block and is set in rotation. When a plate of glass is substituted for the paraffin the ball is attracted, thus showing that the ionised air has a lesser conductivity than the glass and a greater conductivity than the paraffin. The formulæ of electrostriction used for calculating the forces on an isotropic dielectric fail when applied to these experiments.

[W. VON NICOLAJEW, *Physikalische Zeitschrift*, April 1, 1904.]

Electrodeless Ring Current.—E. Lecher has done some work on the electrodeless ring current described by J. J. Thomson, and gives the following view of its genesis as a result. Between the beginning and the end of the coil a great alternating difference of potential is created by the impedance. This produces a strong ionisation of the gas and a to-and-fro motion of electricity. The luminosity is driven towards the wall by the magnetic forces of the coil. A further increase of the luminosity is probably produced by the induction currents proper, but these can only occur in strongly-ionised gases. The author uses the arrangement shown in the diagram. Two rings, *c* and *d*, are laid close about the vacuum tube, and are connected with the two ends of the coil *s*, which is separated from the vacuum tube by a tinfoil tube *rr*. The rings *c* and *d* by themselves produce a feeble luminosity, but the coil *s* by itself produces no effect through the tinfoil. The whole arrangement gives a beautiful Thomson ring. If the rings *c* and *d* are omitted and the gas is ionised by a large influence machine through the platinum wire *e*, no luminosity is produced. What is wanted is the strong and timely alternate ionisation by rapid impedance discharges. Hence the arrangement fails if the tinfoil is removed and the diameter of the coil is made much greater than the diameter of the vacuum tube.



[E. LECHER, *Physikalische Zeitschrift*, April 1, 1904.]

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WIRELESS TELEGRAPHY AND THE WAR.

It is naturally impossible that, in the history of recent warfare, there should be any precedent for the treatment of newspaper correspondents at sea possessed of wireless telegraphic apparatus. "Special correspondents" with belligerents on land are accorded certain facilities and have to suffer certain restrictions, but, from the nature of things, they are evidently admitted to take part in the campaign only on sufferance, and must regard this as a particular courtesy extended to them and to the journals they represent. Moreover, the fact that they are with the army, by no means implies unrestricted permission to despatch messages, for, especially during recent campaigns, it has been the practice to subject all telegrams and even letters to the severest censorship. The case is entirely different at sea, however. Until wireless telegraphy had become a practicable method of communicating intelligence, a newspaper despatch boat could not do much harm by the messages it transmitted home. However close it might be to the actual field of operations, hours, if not days, must elapse before it could return to port and deliver itself of its news. Moreover, obviously it would not be feasible for it to be allowed to come and go unrestrictedly in and out of a port belonging to one of the belligerents, so that hitherto there has been little or no danger of important information being conveyed to the enemy through the medium of a naval war correspondent. The enterprise of *The Times*, in organising its special reporting service in the Far East, has completely changed these conditions, however. Not only has our contemporary chartered its own despatch boat, the "Haimun," for the use of its special war correspondent, but it has fitted this steamer with wireless telegraph apparatus capable of transmitting messages from the present scene of the warlike operations on sea to the British port of Wei-hai-wei. This little vessel was within a comparatively short distance of the two fleets during the naval engagement that resulted in the sinking of the unfortunate "Petropavlovsk," and *The Times* has, therefore, been able to supplement the official reports with a graphic description of the action at the entrance to Port Arthur, as well as of the torpedo destroyer attack to the east of the harbour which preceded it, and covered the laying of the mines.

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This grand record in journalism, by means of a bold application of the most recently discovered means of telegraphy at sea, has been received with enthusiastic commendation on all sides; but it has been followed by an announcement which has aroused much surprise and unfavourable comment. The following Russian circular note has been communicated to the various neutral powers:—

I am instructed by my Government, in order that there may be no misunderstanding, to inform your Excellency that the Lieutenant of His Imperial Majesty in the Far East has just made the following declaration:—"In case neutral vessels, having on board correspondents who may communicate news to the enemy by means of improved apparatus not yet provided for by existing conventions, should be arrested off Kwantung, or within the zone of operations of the Russian fleet, such correspondents shall be regarded as spies, and the vessels provided with such apparatus shall be seized as lawful prizes."

No action of this nature has been taken by the Japanese, although there can be little doubt that the "Haimun" has been in touch with the Japanese warships which are equally equipped with wireless telegraph apparatus. This is the more significant from the fact that wireless telegraphy formed an important function in the engagement itself, as Admiral TOGO was in communication with his advance squadron by this means while he with his main fleet remained out of sight of Port Arthur. Possibly, at the request of the Japanese Admiral, the installation on the "Haimun" is being worked in such a manner as not to interfere with the Japanese communications, or perhaps merely the fundamental notes of *The Times* installation and that of the Japanese Navy are sufficiently different for the two systems to remain quite independent of one another. The "Haimun" has never yet sailed in Russian waters, and it is generally considered that Russia, in threatening to treat *The Times* correspondent as a spy should he be arrested "within the zone of operations of the Russian fleet," is exceeding her rights as a belligerent. Other opinions prevail, it is true. For instance, General GREELY, Chief Signal Officer of the United States Army, thinks that correspondents using wireless telegraphy "invite the fate of anyone except belligerents who signal from a battlefield," but, on the other hand, the definition of a spy, as recognised by International Conventions, is one who disguises his own identity and insinuates himself within hostile territory for the purpose of communicating with the enemy,—a method of procedure of which *The Times* correspondent is certainly not guilty. Still, there is little doubt that if the Russians can capture the "Haimun" within the "zone of operations," they would be entitled to prevent her further employment for the conveyance of news either by wireless telegraphy or otherwise. Either the Russians or Japanese would be within their rights if they prevented—by force if necessary—the transmission of any signals from the despatch boat likely to prejudice the serious business which they have to carry on as belligerents. At present there is no apparent reason why it should be to the interest of either side to suppress the "Haimun's" news service. The vessel was, in fact, boarded by a Russian cruiser a fortnight ago, but was not detained longer than was necessary for an examination of her papers and log and the interesting wireless telegraphic equipment. As the Russian views with regard to the harmlessness of this equipment have apparently changed, however, we hope that the "Haimun" will endeavour with success to keep out of the clutches of the CZAR'S officers. While we do not believe that the Russian Government's spiteful threat would be put into execution if the vessel were captured, it would still be a matter for extreme regret if this novel and enterprising application of electrical science did not continue to obtain the success it deserves.

METHODS FOR INCREASING THE TRANSMITTER ENERGY OF WIRELESS TELEGRAPH SYSTEMS.

BY PROF. FERDINAND BRAUN.

[*Translation.*]

In 1898* I mentioned arrangements for the transmitter of wireless telegraph installations, known to-day as closed circuit ("gekoppelte") systems. The open circuit of the transmitter is not directly excited, as was the case with the Marconi arrangement generally used at that time, but is connected with an "oscillatory circuit" containing condensers and self-induction and serving as an energy reservoir. Three ways of transmitting the energy to the transmitter have been mentioned by me:—

(1) The first one, represented by Fig. 1, is called "excitation by induction"; (2) the second method, shown in Fig. 2, is the so-called "direct method"; and (3) combinations of both (Figs. 3A, 3B, and 4).

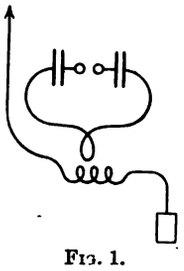

FIG. 1.

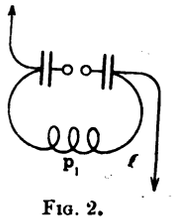

FIG. 2.

All three arrangements† come to the same in principle‡; they differ only in flexibility with regard to the choice of the degree of the coupling ("Koppelungsgrad"). The conditions obtaining in practice limit the natural period of oscillation of the oscillatory circuit to certain values. Assuming that it is desired to keep this substantially constant, then the product of the capacity C and the self-induction p_1 of the oscillatory circuit has to fulfil this condition.

The energy available for the radiation is $CV^2/2$, in which V denotes the potential to which the jars are charged. There are, therefore, two theoretical possibilities of increasing this energy (if a continuous supplementary supply of energy by other means, different in principle, is left out of consideration): (1) By increasing the capacity; (2) by raising the charging voltage. Both possibilities will be discussed.

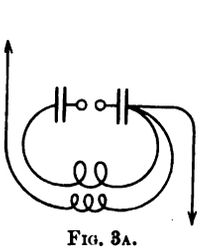

FIG. 3A.

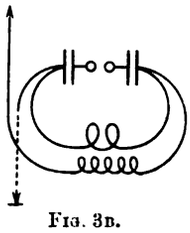

FIG. 3B.

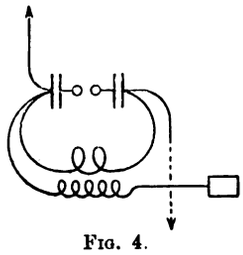

FIG. 4.

(1.) According to our assumption, an increase in capacity will necessitate the simultaneous lowering of the self-induction p_1. But the degree of coupling τ of the oscillatory circuit and the transmitter is given by the equation $p_{12}^2 = \tau^2 p_1 p_2$, in which p_1 = self-induction of the oscillatory circuit, p_2 = self-induction of the antenna and p_{12} = coefficient of the mutual self-induction of both. This formula is not exact in our case, but it gives approximate results. The coupling-coefficient τ must be kept above a certain value as the increase of the amplitude of the potential, and, therefore, the effect at a distance depends upon it. This potential may, according to M. Wien,§ be increased up to $\sqrt{p_2/p_1}$ times its original value. Assuming that $p_{12} = p_1$, as is the case with the direct method, then $p_1 = \tau^2 p_2$ and, since p_2 is determined sub-

* German patent No. 111,578 of October 14, 1898. English patent No. 1,862 of January 26, 1899, published on January 27, 1900.

† The first arrangement has been adopted by Marconi in the English patent No. 7,777, applied for on April 26, 1900, the second arrangement in the English patent No. 410, applied for January 7, 1901, the third arrangement is still free.

‡ J. Zenneck, *Physikalische Zeitschrift*, 4, p. 656, 1892-1893.

§ M. Wien, *Annalen der Physik*, 4, 8, p. 686, 1892.

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stantially by the total length of the transmitter, it follows that the coupling of the whole system decreases with the reduction in the self-induction of the oscillatory circuit—*i.e.*, *the capacity of the condensers must not be increased indefinitely.*

But this is not the sole reason. Besides this theoretical reason, there is also a practical one, based on the fact that the capacity cannot be increased without giving rise to a simultaneous increase in self-induction of the condensers, originating in the coatings of the jars themselves, but especially in the connections. This distributed self-induction cannot be employed for the transmission of energy to the transmitter, and it acts like the internal resistance of a galvanic cell with regard to the current output of the latter. In this case a limit is soon reached when the parallelling of many small cells conduces to no further advantage.

(2.) We may now consider the alternative case, where the charging voltage is increased. Even assuming that it is technically possible to produce electricity of sufficient amount and at any pressure, there still remain difficulties in the way

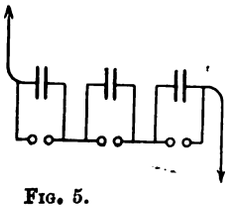

Fig. 5.

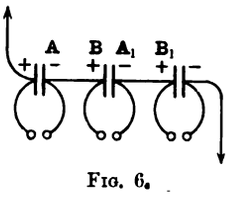

Fig. 6.

of the dielectric strength of the inside and surface of the insulators. The spark will either jump the dielectric at the edge or, if the edges be insulated in a perfect manner, through the mass itself. And if this is to be avoided, then the condensers will possess a large internal self-induction. But there is a second difficulty. Experience has proved long ago that the length of spark (which increases of necessity with the rise in potential) cannot be usefully increased indefinitely. With small capacities, the consumption of energy in the spark attains quickly a high value; with larger capacities this takes place with less rapidity, but on the whole it may be said that from a certain value the voltages do not increase correspondingly with the spark-gaps.* And thus, here again practical limits are drawn.

It was essentially these reflections which induced me, as long ago as 1898, to search for methods which—*without altering the frequency of oscillation*—would allow the energy disposable for radiation to be increased *in such a manner that the economy of a single jar-circuit is retained.*

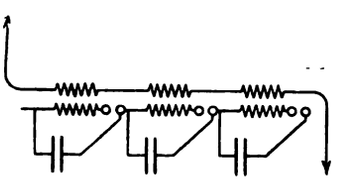

Fig. 7.

These reflections led at the time to the arrangements of Figs. 5 and 6.† A number of condenser circuits of exactly the same frequency are connected in series. The transmitter passes through them all. As shown by the polarity signs (±), the condensers were charged in series. The energy of n capacities C is $\frac{1}{2}(C/n)(nV)^2 = nCV^2/2$. Each spark, however, has only a damping corresponding to the part V of the P.D. The inductive application of this series arrangement is shown in Fig. 7. An arrangement, intended for oscillations of the transmitter of less intensity but of longer duration, is represented in Fig. 8. The spark-gaps need not be exactly alike. If a large non-inductive resistance (a wet thread) be inserted into one of the condenser circuits, then the spark of the corresponding circuit will be dull, while all the other sparks appear bright and penetrating. The arrangement acts, therefore, as if each circuit discharged into itself. A similar experiment proves, however, that strong equalising currents also occur in the connecting wires AB, A_1B_1. Experiments with this arrangement have been repeatedly made on the fortifications of Strasburg. An inductive coupling, for instance, was employed when carrying out trials conjointly with Capt. von Sigsfeld in the summer of 1901, and both the direct and inductive couplings were used by my assistants Herren Brandes and Mandelstam, who carried out experiments in the summer of 1902.

I reverted to these arrangements in the autumn of 1902, after having developed methods which allowed the phase-

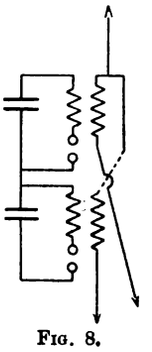

Fig. 8.

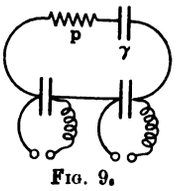

Fig. 9.

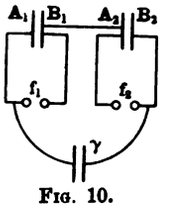

Fig. 10.

differences between rapid oscillations to be detected and measured without influencing in a disturbing manner the system to be tested. The outcome of these experiments was that the oscillatory circuits were coupled more closely; such a coupling, which assists the simultaneous jumping of the spark, exists already in the isochronous oscillation of the transmitter, which passes through the entire system. A few other coupling arrangements are shown in Figs. 9 and 10. In Fig. 9 the "coupling-circuit" is represented by the capacities γ, suitably dimensioned, and the self-induction p, while in Fig. 10 a coupling-circuit is given by the circuit γ, f_1, B_1, A_2, f_2. The oscillation which is set up therein by the spark f_1 must then compulsorily cause a spark at f_2. Another form is indicated in Fig. 11. As shown, the condensers are in connection with large non-inductive or inductive resistances w_1 and w_2.

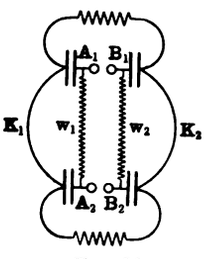

Fig. 11.

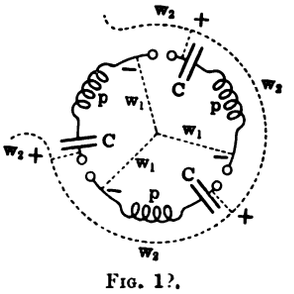

Fig. 12.

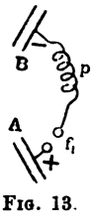

Fig. 13.

They are charged in parallel. If, for instance, a spark jumps the gap A_1B_1, then the connections K_1 and K_2 cause a spark to occur also at A_2B_2. It may be shown that this occurs absolutely simultaneously if K_1 and K_2 are as free as possible from self-induction. By introducing self-induction into one of these, the difference in phase may be regulated. I shall again refer to this and other similar arrangements, and shall now pass on to the consideration of a series of further dispositions. One type is shown in Fig. 12. The condensers are charged in parallel, and are connected for this purpose with non-inductive or inductive resistances w_1 and w_2. As soon as *one* spark occurs, the whole circuit closes within itself; the large charging resistances are then, as is well known, practically inactive.

The considerations from which this arrangement has been developed are very simple and clear. Assuming, for reasons of simplification, that all capacities C and all self-inductions p are equal; n capacities then contain a total energy of $nCV^2/2$, in which V equals the charging voltage. The period of oscillation, however, depends upon the product Cp, because the

* Experiments on this point are being carried out in the Physical Institute of the Strasburg University, but are not quite concluded.

† German patent No. 109,378 of January 26, 1899. Substantially the same arrangement is claimed by the Marconi Company in claim No. 2 of an English patent of the year 1901 (see *The Electrician*, Vol. L., p. 185). My English application (No. 1862, of January 26, 1899) had been evidently overlooked.

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capacities when discharging are in series, and have, therefore, a capacity of C/n only, while the self-induction is then represented by the product np. Therefore, the period of oscillation is of the same value as in the case where *one* condenser C is closed by *one* self-induction p. Obviously, the damping of the spark is also the same. We may pick out the circuit: coating + A, spark-gap f_1, self-induction p, coating – B, as representing a system by itself (Fig. 13). Let us call it a "partial" system. In it a certain quantity E of electricity, having a potential V, is discharged with a certain frequency N through a self-induction p, the conditions being the same as in a system (single system) obtained by forming the coatings + A and – B into a condenser of capacity C. If wholly unforeseen peculiarities of the spark do not exist, then the spark will also act in the same manner as in a single system. This is confirmed by experiment.

I have convinced myself of this in various ways. It is possible to obtain—*e.g.*, as in Fig. 14—the same effects (final voltages, heating effects, &c.) simultaneously on each of three artificial transmitters, which are tuned to one another. *The same efficiency is therefore obtained with* n *oscillatory circuits as applies to each one of them. And that there is no appreciable difference in phase* is easily demonstrated in various ways.

It is obvious that in all possible arrangements the energy will be efficiently transmitted by induction. Fig. 15 indicates the arrangement for the series connection. It is, however, also possible to excite n separate transmitter wires when using the direct connection. A convenient arrangement for this case is indicated by Fig. 16. The great advantage of these arrangements is that the parts are charged with *small voltages* when connected in parallel, and that it is only when discharging that the parts connect themselves in series. No adjoining parts, therefore, have differences in potential which exceed the practical limits laid down by questions of insulation.

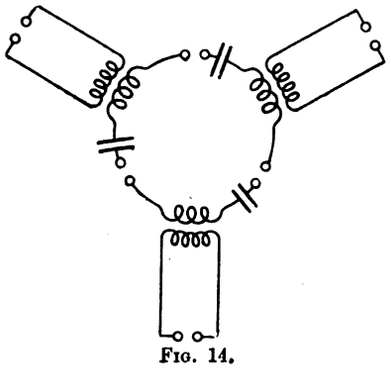

Fig. 14.

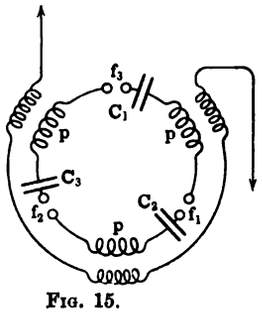

Fig. 15.

It is also clear that it is possible to increase—without altering the frequency of oscillation—the energy of the single system whenever the energy limits in such single systems are reached.

Turning now to a different point: Experiments up to now indicate that for each system (possessing, for instance, a given capacity) there is one most advantageous value for the spark-length, independent also, perhaps, of the frequency and damping, be the latter brought about by non-inductive resistances or by radiation. For this spark-length the percentage of absorbed energy is a minimum, and both above and below this value the percentage consumption of energy increases. The problem to be solved then is this: One is obliged to work with larger discharge voltages than correspond to this best value for the spark-length, but it is desired, nevertheless, to keep the consumption of energy in the spark down to the minimum value.

The arrangements used in this case are based upon the following considerations:—Although we know but little of the nature of the spark, we may assume that its behaviour is definitely determined by the electric field *before* the discharge and *during* the discharge. Inasmuch as the field *before* the discharge is determined in the first place by the potential *differences** (and only to a very subordinate degree by their absolute values—*i.e.*, the flow of the lines of force to the surrounding bodies), and *during* the discharge by the flow, one should obtain sparks of the same behaviour (*i.e.*, having the same energy, consumption, &c.) if both conditions are fulfilled.

The arrangement shown in Fig. 17 fulfils these conditions: the postulated initial conditions of starting are fulfilled directly and the conditions of flow are very likely also fulfilled according to the experience just mentioned.

This experiment was altered by Herrn Rendahl in my Institute, as indicated by Fig. 18. In this arrangement the small auxiliary condensers γ_1, γ_2 and γ_3 effect a suitable distribution of the potential in accordance with the spark-gaps. This arrangement is similar to that formerly termed "connection in cascade," which has been used in practice in connection with electrostatic voltmeters. I have used the latter method already some time ago for calibrating such instruments.

The capacity of the small "voltage-distributors" is of no account in considering the energy of the whole system. In order to disconnect their oscillations from the system large non-inductive or inductive resistances may be inserted between the spark-knobs and the auxiliary condenser.

It is needless to emphasise the difference between this arrangement of the spark-gaps and the subdivision of the latter by inserting insulated balls; the latter method is, in fact, valueless. By thus suitably dividing up the spark-gaps, large voltages may be used economically. According to the results of measurements carried out at this Institute, the most advantageous partial P.D. for spark-knobs of the usual size is about 15,000 volts.

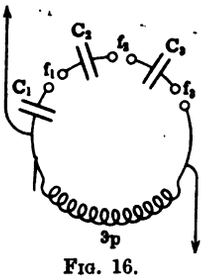

Fig. 16.

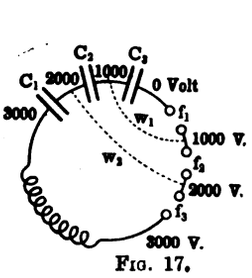

Fig. 17.

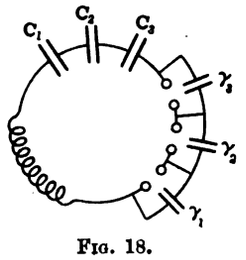

Fig. 18.

SINGLE-PHASE MOTOR DESIGN.

An interesting patent for "Improvements in Field Magnets for Alternating-current Motors" (No. 17,185 of 1903) has just been published. The patentees are Dr. Giorgio Finzi and Signor Emil Korrodi, of Milan. The following is the complete specification:—

This invention relates to field magnets for alternating-current motors, which presents the conditions for an efficient commutation of the current and at the same time permits of attaining a high value for the power-factor. Briefly stated the conditions for efficient commutation are as follows:—

The factors which influence the variation of the current in the short-circuited coils and the current density under the brushes, are: (*a*) The contact resistance at the brushes. (*b*) The resistance R_s of the short-circuited coils. (*c*) The resistance R_v of the connections between winding and collector. (*d*) The inductance of the short-circuited windings which generate the E.M.F. E_s of the self-induction. (*e*) The E.M.F. *ee* generated in the windings through the leakage field.

In alternating-current motors the E.M.F. produced in the short-circuited windings through the periodic variations of the field strength must also be considered.

With continuous current good results are attained both theoretically and in practice when the inducing field presents such a form that it produces in the short-circuited windings an E.M.F. e_1 which at that moment corresponds to the following formula: $e_1 = E_s + I_1 (R_s + 2R_v)$. The thickness of the bushes g does not exceed that of a segment of the commutator, together with insulation h, when I_a is the current in the armature. Figs. 1 and 2 are graphic representations of the formula. Fig. 1 applies to continuous-current motor with normal values for the resistances R_s and R_c. Fig. 2 shows the manner in which the proportions vary with the increase of the sum of the resistances $R_s + 2R_v$ and applies to the case in which an alternating-current motor is supplied with continuous current.

With alternating-current motors, however, the increase of the resistance is indispensable if the additional short-circuit currents produced through the variations of the magnetic field in the short-circuited coils is to be kept within bounds. This necessitates an alteration in the form of the pole-pieces in order to obtain a suitable leakage field. In view of these theoretical considerations, the forms of pole-pieces illustrated in Figs. 3 and 5 are given by way of example. The field magnets are composed of segments s (Fig. 3, right-hand half) or complete sheet metal rings (Fig. 3,

* This is obtained in a perfect manner if one electrode perfectly surrounds the other, as was indicated by me in my German patent of January 26, 1899.

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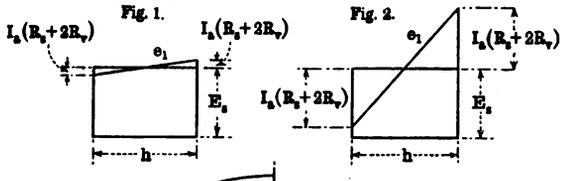
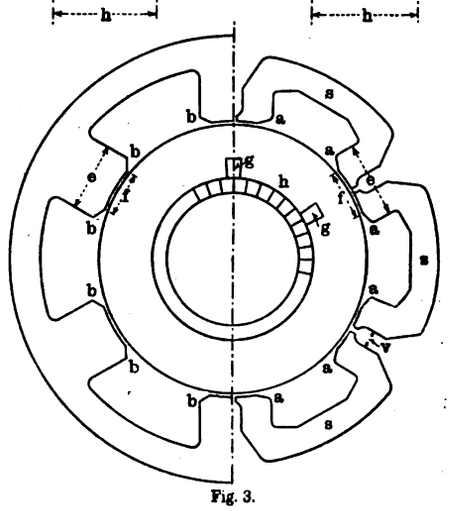
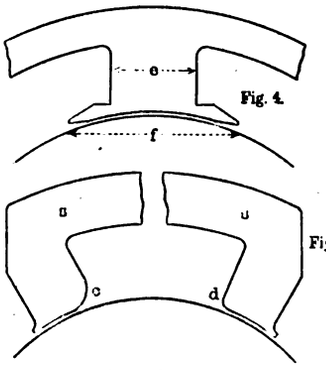
left-hand half) with poles of special form, so that that cover only a small portion of the armature surface. This construction differs totally from that hitherto adopted for motors and generators with collector (Fig. 4), where the proportion between the covered and the total armature surface varies between 0·6 and 1. The novel construction permits of obtaining a somewhat high power-factor, even with low angular velocities and a small number of poles, which differs but slightly from that which is usual with continuous-current motors.

Under these conditions it is possible to build alternating-current motors in such a manner that efficient commutation is possible, and sparking at the collector decreased or, practically speaking, obviated, without its being necessary to have recourse to special measures, only known theoretical data as to commutation in continuous-current machines being followed. In order that a good power-factor may be obtained it is well to reduce the E.M.F. of the self-induction E, of the armature to a minimum by a suitable reduction of the armature surface covered by the poles. For this purpose the special forms *a*, *b* (Fig. 3), *c* (Fig. 5), *d* (Fig. 6) of pole-pieces are particularly adapted as they decrease in cross-section towards the armature in such a manner as to taper off instead of presenting the usual pole extensions.

When the magnet frame is composed of segments *s* (Fig. 3, right-hand half) the core width *e* of the pole is greater than in the first case (Fig. 3, left-hand half) owing to the interval *v* between two segments constituting a pole. This construction, which is known *per se*, presents, however, another advantage, that of decreasing the armaturere actions (transverse magnetic flux).







The containing lines best adapted for the form of tapering pole-piece are: Straight lines and convex curves as in Figs. 3 and 5 *a*, *b*, *c* which give an advantageous leakage field for the commutation of alternating current.

A field magnet for collector motors supplied with alternating current and constructed with the special form of pole-pieces, of which Figs. 3, 5 and 6 show examples, should therefore fulfil the following conditions:—

1. Reduction of the E.M.F. of the self-induction of the whole armature owing to the tapering of the pole-pieces in accordance with Figs. 3, 5 and 6 (*a*, *b*, *c*, *d*).

2. Generation of a strong leakage field for the commutation, so that any adjustment of the brushes *g* is unnecessary for both directions of rotation.

The patent has only one claim, which is as follows:—

Magnetic frame or field magnet for alternating-current motors with collector, characterised by the fact that the pole surface opposite to the armature is decreased in cross-section by tapering towards the armature in order to obtain efficient commutation and a high power-factor.

The date of the patent is August 7, 1903.

ALTERNATORS IN PARALLEL.*

BY H. BOHLE.

(*Continued from page 996, Vol. LII.*).

So far we have taken only regular changes into account. But oscillations due to other causes than those mentioned may result. These should be considered separately, in a similar manner to those above, and we should then see that their periodic times do not approach a dangerous value. Assuming, for instance, a twin engine with cranks at 90deg., we must consider especially those oscillations whose times are equal to the time of one revolution, or half, or a quarter of a revolution. Especially should the oscillations of the

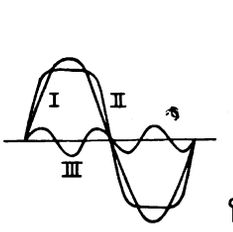


Fig. 35.

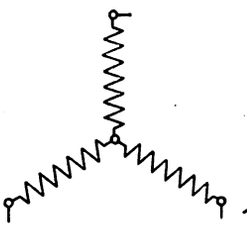


Fig. 36.

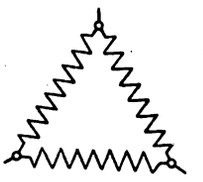


Fig. 37.

regulator be considered. Good results may be expected, however, in all cases as long as Z does not nearly approach unity. With Z nearly equal to unity there is practically resonance, and, if other oscillations interfere at the same time, things become worse. To root out the evil, increase or decrease the moment of inertia according to the value of *q*, as stated above; as regards multi-crank engines, damping would also improve matters.

It must now be seen how far the shape of the curves of the E.M.F.s affect parallel working (see also "Parallel betrieb von Wechseltrommaschinen," Dr. Gustav Benischke). So far it has been assumed that the curves of both machines or the curves of the network and the alternator under consideration are of the same shape. Assume now that the velocities are equal. A single-phase

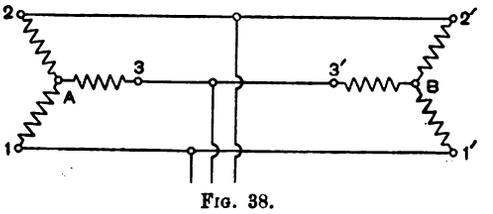


Fig. 38.

set will be considered first, having the curves I. and II. (Fig. 35). No. I. follows a sine law or $E_I = E_1 \sin wt$, while the other curve follows the law $E_{II} = E_1 \sin wt + E_3 \sin 3wt$. It is seen that the instantaneous values differ at any time, so that there is an equalising current of the pressure shown by curve III., and equal to $E_2 - E_1 = E_3 \sin 3wt$.

The frequency of this current is three times that of the original currents, so that the impedance of its circuit will also be nearly trebled. The latter is $\sqrt{R^2 + (3wL)^2}$. From this it follows that the equalising current will not be large, unless the curves differ very much. In most practical cases these equalising currents will never be of any importance.

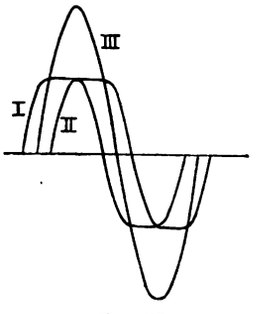


Fig. 39.

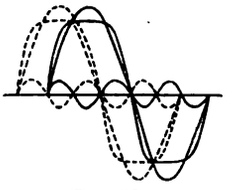


Fig. 40.

Considering three-phase alternators, we must distinguish between star and mesh-connected machines (see Figs. 36 and 37). Fig. 38 shows two star-connected machines in parallel. Their neutral points are not connected. Equalising currents may circulate in the circuits (*a*) 1, 2, 2_1, 1_1, 1; (*b*) 2, 3, 3_1, 2_1, 2; (*c*) 3, 1, 1_1, 3_1, 3.

Taking the (*a*) circuit, net pressures 1, 2 and 1_1, 2_1 are opposed to each other. Let now the phase pressure 1 follow the law $E_1 \sin wt + E_3 \sin 3wt$, as shown by curve I. (Fig. 39). The pressure-curve

* Paper presented at the Leeds Local Section of the Institution of Electrical Engineers, Jan. 21st. (See *The Electrician* of Jan. 22nd, p. 511.)

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of phase 2 has, of course, the same shape, lagging, however, by 120deg. In addition to this, 1 and 2 are connected in series, or, in other words, they lag by a further 180deg. This gives a total lag of $\pm 120+180=60$deg. or 300deg. Curve II. will, therefore, lag actually by 60deg. (or 300deg., which is the same thing) in regard to I., the resultant of both being the net pressure III., which follows a pure sine law. That this must be the case will easily be seen from Fig. 40, in which the curves are divided into their harmonic components—viz., $E_1 \sin wt$ and $E_3 \sin 3wt$. We see that the components $E_3 \sin 3wt$ balance each other and the simple sine curves remain. A similar state of things occurs in alternators with pointed curves of the form $E_1 \sin wt - E_3 \sin 3wt$.

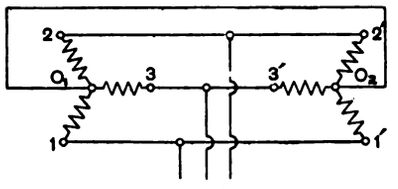

Fig. 41.

If, now, two such machines are joined in parallel, the curves of the equalising circuits will be sine curves, so that, with equal excitations, there cannot be any equalising currents, even if one machine has phase pressures of the pointed form and the other of the flat form, or pure sine curves.

If, however, the neutral points (Fig. 41) of the two machines are connected, the equalising currents may pass through the circuits (*a*) 1, 0_1, 0_2, 1_1, 1; (*b*) 2_1, 0_1, 0_2, 2_1, 2; (*c*) 3, 0_1, 0_2, 3_1, 3; and they will actually do so as the inductance of these circuits is halved. Such machines may be compared to three single-phase machines whose returns are joined to a common conductor. The equalising current in the neutral wire will be about three times larger than that in any external conductor.

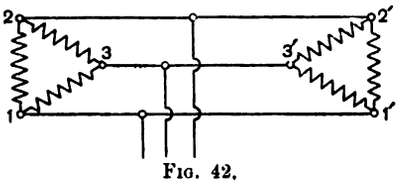

Fig. 42.

With mesh connections (Fig. 42) there is no neutral wire, the network pressures and phase pressures being equal. Assume now that that the first machine has a phase pressure of the form $E_1 \sin wt + E_3 \sin 3wt$, while the phase pressure of the second machine follows a simple sine law. The difference between the two will then be $E_3 \sin 3wt$. But the two phases join to one external conductor, differing in phase by 60deg., so that the components $E_3 \sin 3wt$ balance each other, as in Fig. 40. In the machine itself, however, the equalising currents will flow, and, as the circuit is closed on itself, an internal current of strength $3E_3 \sin 3wt / \sqrt{R^2+(3wL)^2}$ will circulate. This current will also

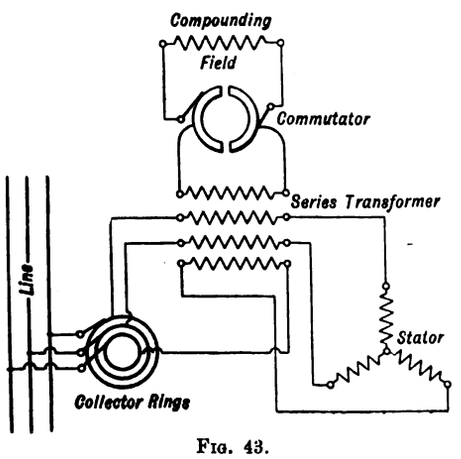

Fig. 43.

flow whether the machine is joined in parallel to another or not. Star-connected machines have, therefore, an advantage over mesh-connected generators.

Now consider how far the compounding of alternators for constant pressure will affect parallel working. Up to the present compounding has been done by converting part of the main current, the direct current being then sent through an auxiliary winding on the field magnets. Such an arrangement is shown in Fig. 43, which will be self-explanatory. But compounding is also dependent upon the phase difference, and some very ingenious devices have been invented to overcome this difficulty. These inventions have, however, not come into extensive use on account of their complication. Such a compensated alternator is shown in Fig. 44, which needs no further explanation. A very neat, simple and effective way of compounding was invented a year or two ago by Mr. Heyland, and which is as follows:—Fig. 45 shows an ordinary two-pole synchronous generator, whose rotor is provided (besides its ordinary winding) with a kind of secondary winding, similar to an amortisseur of Leblanc, this winding ending in a commutator. By means of the brushes BB

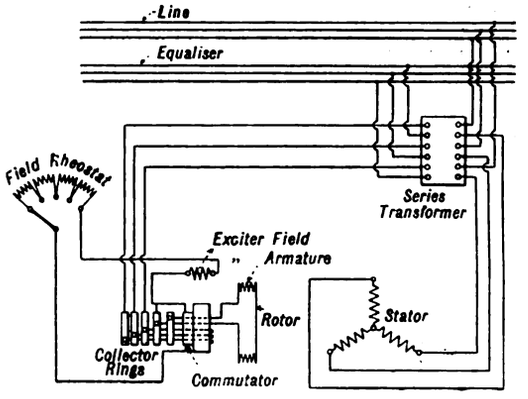

Fig. 44.

current may be passed through this special winding. If now these brushes are joined in series with the stator winding, it will be evident that, by means of proper proportions and suitable brush positions, a field can be set up which neutralises the stator reaction entirely, and, as this winding rotates in synchronism with the field, no E.M.F. of self-induction will be produced, so that the pressure at the brushes need only be high enough to overcome the ohmic

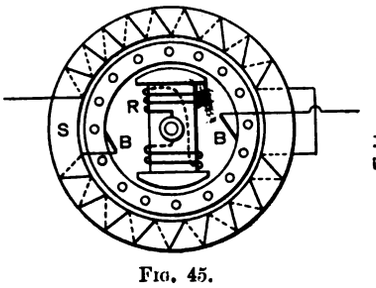

Fig. 45.

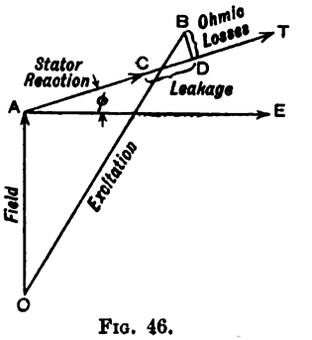

Fig. 46.

resistance. This way of compounding will be seen from Figs. 46 and 47. Fig. 46 shows the diagram of a single-phase generator for any load for a machine of low saturation, which is, of course, a necessity for compounding.

Let AE be the direction of the pressure, AI that of the current, ϕ the angle of phase, then the resultant field may be represented by OA perpendicular to the pressure. In order to find the excita-

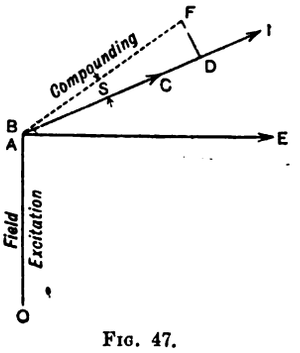

Fig. 47.

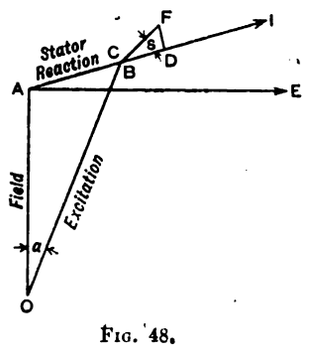

Fig. 48.

tion mark off in the direction of the current the armature reaction AC, to which must be added the leakage and ohmic losses, the latter perpendicular to CD. The resultant OB will then represent the excitation. In order to keep the pressure constant the exciting current must be increased in the ratio OB/OA. In other words, the pressure would drop in the ratio OA/OB with constant excitation; the compounding should do this automatically. Fig. 47 shows how to accomplish this. Simply balance ACDF. The resultant OB will then coincide with OA. In Fig. 45 it is seen how this is done in practice. A current is sent through the brushes BB into the rotor.

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which corresponds to the vector FB of Fig. 47. The field of this current depends upon the number of turns of the compound winding and the current. The latter is given by the stator winding, and may be regulated by means of a shunt to the compound winding. Its direction is given by the position of the brushes in regard to the neutral axis. Both conditions and also the angle which denotes the movement of the brushes, as well as the ratio of the compound winding to the stator winding, will then be constant for all loads, so that one regulation will be sufficient. It is only necessary to precalculate the conditions approximately. If, then, the armature reaction or leakage does not come out as expected, exact regulation may be obtained by means of a shunt to the compound winding and by shifting the brushes.

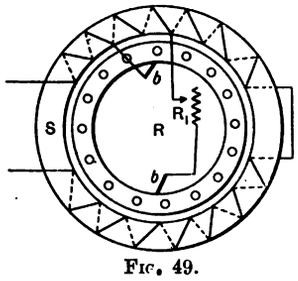

FIG. 49.

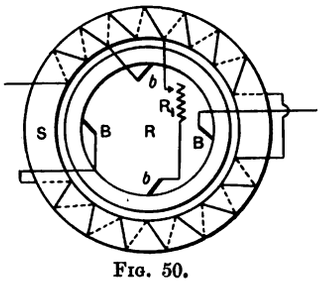

FIG. 50.

Compounding of generators is only suitable for single machines, parallel working of several compounded machines being impossible. The maximum number will be two, with equalisers, because parallel working is only possible when synchronising currents are allowed to flow. Where several machines are to be run in parallel it is, however, sufficient to have two or even only one machine compounded. All wattless currents will then be taken over by the compounded machine, keeping the network pressure constant, while the not-compounded generators deliver pure watt currents. The same thing applies to a generator which feeds motors. If the former is com-

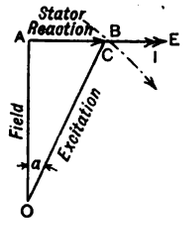

FIG. 51.

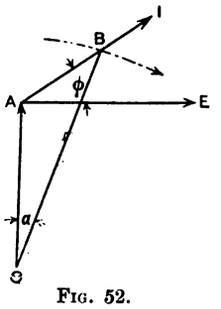

FIG. 52.

pounded, the latter should not be so. It may, however, be partly compounded, as shown in Fig. 48. The compounding current must then be correspondingly smaller. In Fig. 48 only the leakage and the ohmic losses are neutralised.

Theoretically and practically there is here an extremely simple and effective way of compounding. A synchronous generator requires, of course, a special compound winding; but this is not the case with asynchronous generators, in which the rotor winding serves also as a compound winding, another pair of brushes being only required. An asynchronous generator, with and without com-

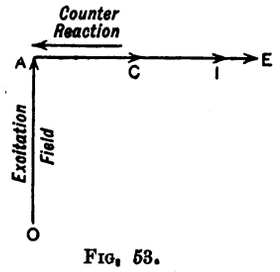

FIG. 53.

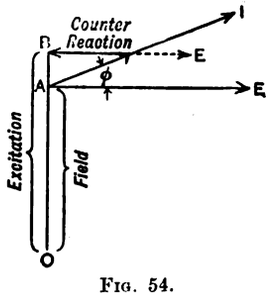

FIG. 54.

pounding, is shown in Figs. 50 and 49. The brushes BB are for compounding, *bb* for excitation. For generators, working singly, the above conditions for synchronous generators hold, and the diagram will look like Fig. 47. For parallel working, however, the conditions are much more favourable. In Figs. 51, 52, 53 and 54 both kinds of generators are compared.

Take the case of a motor and a generator, both of which should not be compounded. The primary machine, compounded for constant pressure, may also be replaced by the constant network pressure. The motor may however, be under-compounded, as shown in Fig. 48, and the ideal diagram, without leakage and ohmic losses, is then obtained. Let AE be the direction of the pressure and AI that of the current. Figs. 51 and 53 are for non-inductive loads, 52 and 54 for inductive loads with phase angle ϕ. Figs. 51 and 52 are for the synchronous type and 53 and 54 for asynchronous generators.

Let OA, perpendicular to the pressure, be the resulting field, equivalent to the network pressure, AB the reaction corresponding to the current, OB will then be the excitation. Figs. 51 and 52 will be understood from the previous remarks. Considering diagrams 53 and 54, it must be remembered that in the cage rotor currents are produced (on account of the slip) equal, but opposed to the watt component of the stator current. These currents will, therefore, neutralise the watt component of the stator reaction, but they do not balance the wattless component. In other words, the asynchronous generator has no stator reaction as regards watt currents, but only as regards wattless currents. This is of the greatest importance. The reaction as regards wattless currents is absolutely essential for parallel working, but the reaction as regards watt currents is a necessary evil of the synchronous generator. The stator reaction limits also the degree of overloading, and has the effect that the motor lags with regard to the generator by an angle, A, and if this angle becomes 90deg. the machine will drop out of step. With asynchronous generators there is no angle A, so that the dropping out of step of these generators need not be considered at all. The direction of the poles of two parallel running asynchronous generators is always the same, and the lead which is shown by the angle A of synchronous machines is here represented by the slip. The latter is no disadvantage; in fact, it acts as an elastic connection. The engines of such alternators need not have a higher degree of uniformity than is required for direct-current machines. The angle A of synchronous machines has also the disadvantage that cos ϕ can never be constant, and will vary according to the load. This may partly be overcome by making cos ϕ at no load greater than unity, becoming unity for a mean load and less than unity for full load. The point B will then move on the dotted lines (see Figs. 51 and 52). With asynchronous generators the point B is fixed. If the rotor is over or under-excited, cos ϕ will be less than unity, but in all cases an increase in the load increases cos ϕ. With proper regulation cos ϕ may, however, be unity for all loads.

(*To be concluded*).

CORRESPONDENCE.

THE COMPLETION OF THE PRACTICAL SYSTEM OF UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As it is intended that recommendations should be made at the forthcoming St. Louis Congress with regard to electrical units, it is desirable that all possible systems should be fully discussed in order that the best system may be finally adopted. At present we have no less than three systems, the electrostatic C.G.S., the electromagnetic C.G.S. and the "Practical" systems, with various powers of 10 and of 3×10^{10} and an occasional 4π coming into the exchange ratio. We certainly ought to have one system only, and as the electrostatic system is rarely employed, the real fight is between the electromagnetic and the practical ones.

Hitherto the practical system has been handicapped in the race for adoption for all purposes by the gratuitous assumption that it necessarily involved as the units of length and mass the quadrant (10^9cm.) and the eleventh gramme (10^{-11} gramme) which are of rather inconvenient magnitude. The practical system has consequently never been completed, and has only been applied to electrical work.

Four fundamental quantities are really necessary for a system of electrical units, Length, Mass and Time usually being three of them. In the electromagnetic system, Magnetic Permeability is taken as the fourth, that of air being the arbitrary unit. Fessenden and Fleming have already shown that, by calling the permeability of air 4π units instead of 1, the 4π can be eliminated from most of the electrical equations in which it occurs. The practical system at present contains the joule, watt, ampere, coulomb, volt, ohm, farad and henry. The first two taken together, and also the ampere and coulomb, involve the second as the unit of time. As it has never been applied to magnetic quantities, the practical system has not at present a unit of permeability, although it is generally tacitly

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assumed that that of air is taken as in the electromagnetic system. But by making a suitable choice of the units of permeability and mass we can fit any unit of length to the practical system of electrical units, and when we are at it we may as well modify the definition so as to get rid of the 4π at the same time.

But permeability is not the best quantity to take as the fourth fundamental, since its accurate comparison is a matter of some difficulty. Electrical resistances can be accurately compared with comparative ease, and we have excellent material standards of resistance. By taking as the four fundamental or arbitrary units the metre, kilogramme, second and ohm (defined from a mercury or wire standard) we get a complete system which includes all the established practical electrical units, and gives units which have a convenient magnitude for most purposes. Instead of resistance we may take electricity, with the coulomb, defined from the electrolysis of silver, as the fundamental unit. One advantage of this would be that the dimensions in terms of the fundamentals would have no fractional indices, but the material standard is not quite so direct.

In order to eliminate 4π we must define μ and κ thus :—

$$\mathfrak{B} = \mu\chi/\mathsf{L}, \qquad C = \kappa\mathsf{S}/\mathsf{L},$$

where χ is the excitation or current-turns applied to a length L in order to give a flux density $\mathfrak{B}$, and S is one active surface of a plate condenser of capacity C and having its plates separated by a distance L. Using these definitions instead of the ordinary ones, the permeability of air is $4\pi \times 10^{-7}$ henrys per metre, and its permittivity (specific inductive capacity) $(1/36\pi) \times 10^{-9}$ farads per metre. With these definitions the 4π re-appears in the equations for the force between two poles or two charges, but by modifying the definition of pole strength and replacing the square of a distance by the surface of a sphere we can get rid of it there as well.

Since the kilogramme is a primary unit in the proposed system, its name ought not to have the multiplying prefix "kilo." It may be called a "k'gram" or simply a "kram." The writer suggests that the name "Newton" be given to the unit of force (10^5 dynes), but that we should be very chary of giving new names to any of the other units. Even without the addition of any other new names, all the electrical and magnetic units can be distinguished by compound names which in no case involve more than three of the well-known ones. For instance, the unit of flux is the volt-second and of flux density the volt-second per square metre.

When the practical system was started names of great scientists were given to its units. The 1900 Paris Congress broke away from this principle, and adopted two such names for C.G.S. units. The American Institute of Electrical Engineers is now making further proposals in the same direction. The result can only be confusion. Let us be consistent and confine this class of names to one system only. But on no account should such names be proposed for any units except those in everyday use; it is quicker to write or comprehend "volt per metre" than to look up a pocket-book to find out whose name has been appropriated for the unit of electric field.

It is also undesirable to have too many prefixes for sub-units. Only those representing powers of 1,000 have been found really useful, and the others should be abandoned. "Centi" is an apparent exception, but that is entirely due to the position of the centimetre in the C.G.S. system. But even the centimetre is not used to the extent its position there would lead one to expect; the millimetre, a 1,000al. sub-unit of the metre, is found more convenient and is more generally employed. The chief advantage claimed for the C.G.S. system over others based on the French measures is that in it the density of water is very nearly 1 unit. But that advantage is more imaginary than real, as water is not the only standard used for specific gravities.

The writer, therefore, advocates the use of a system based on the metre, kilogramme, second and ohm; the gradual lapse of all others and their ultimate abolition. The advantages of the proposed system may be summarised as follows :—

1. The fundamental units have actual material standards.
2. They are already legalised in this and other countries.
3. No alteration is required in the units now in commercial use.
4. The proposed system includes the units in terms of which almost all instruments are calibrated.—Yours, &c.,

Bristol, April 18. DAVID ROBERTSON.

DANGER OF ELECTROSTATIC SHOCKS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest your leading article and the correspondence on the subject of the accident at the Bow works of the Charing Cross and Strand Company, and I am not inclined to accept the assumption that "residual charge" or any thing mysterious was the cause of the accident. In the course of many experiments on E.H.T. cables, when it has often been necessary repeatedly to alter the connections, I have adopted the practice of having the cores of the cables earthed before handling them. In doing this I have often noticed the long time which a cable may retain its charge after being disconnected from an alternate circuit, but I have never come across a case of a cable which acquired a considerable charge after being earthed for a few seconds.

In this connection I may mention that I disagree with Mr. Nisbett's statement that "I (I quote Mr. Nisbett) should expect that the potential at any time left in a cable by an alternating E.M.F., even when the circuit is interrupted at the maximum volts, could be only a fraction of the square root of the mean square volts on the circuit—say, not more than half." I may say that I have found experimentally that on switching off a cable it is often left charged, not to one-half the R.M.S. volts but to the maximum volts of the wave, which may be and is frequently more than 1·4 times the R.M.S. volts. One core of 36 miles of cable which was being disconnected might have a capacity to earth of 10mfd. to 12mfd. This capacity, if charged to 1,500 or 2,000 volts, might well give a fatal shock without any weak heart assumptions.

Taking the facts as given in your leader as substantially accurate, I do not believe that the R.M.S. volts were zero when the cable was switched off by the main switch, or that the cable was completely discharged, as you assume in your leader. The alternator was slowed down: this may mean to about one-third speed, which would reduce the R.M.S. volts to 3,300. The field was reduced: this I take to consist in switching in all the field resistance, usually equal to the resistance of the alternator field, which would, *if done very slowly*, further reduce the voltage of the alternator to, say, 60 per cent. of its value. If the field resistance was *quickly* switched in, the current would not nearly fall to one-half its value, owing to the self-induction of the field, so that the R.M.S. voltage may well have been 2,000 volts when the field circuit was opened. Opening the field circuit does not instantly stop the field current, still less annul the field of the alternator, for field switches are usually constructed to leave the field short-circuited. In fact, the field of large machines takes some considerable time to die away. If, therefore, the main switch was opened fairly quickly after switching off the field, the R.M.S. voltage on the cable at the time of opening the switch might well be 1,000 to 1,500 volts. As the supply is three-phase, one of the cores must be at or near the top of wave (*i.e.*, 1,400 to 2,100 volts core to core or, say, 1,000 to 1,500 core to earth) when the main switch was opened, leaving ample charge in one of the cores to give a fatal shock.

In reply to this it will be said, but the voltmeter read zero—quite so. A R.M.S. voltage of 2,000 volts will give but a very small deflection on a 10,000-volt alternating-current voltmeter; and, further, if, as I believe is the case, the voltmeters are worked through transformers, then the very low frequency caused by slowing down the engine will still further reduce this already small deflection, leaving the pointer so little off zero that the deflection might be taken for the ordinary zero error.

In conclusion, I think that the explanation of the accident is that the main switch was opened before the R.M.S. volts on the cable were zero, leaving a static charge in one core of the cable which produced the fatal result. The voltmeter failed to indicate the fact, partly owing to the closeness of the scale

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at low readings and partly to the very low or possibly zero frequency at which it was working.—Yours, &c.,

London, S.W., April 18. W. DUDDELL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With the facts as stated, it would appear impossible for the accident to have occurred from residual charge. I have known cases, in cables of great capacity, where the existence of a small residual charge has been proved with alternating currents; but in all the cases that have come under my notice, both the quantity and duration of charge have been so minute as to cause no danger.

This accident only goes to prove what the experience of many engineers has really shown—viz., that it is only safe to work on cables that are actually earthed. In other words, the cables which have once been earthed and then freed may, by induction or other means, be raised to a considerable voltage, and a safe rule is only to allow men to work on cables where they are earthed.—Yours, &c. CAUTION.

London, April 19.

PARLIAMENTARY INTELLIGENCE.

THE GAS ENGINE SUB-STATION SCHEME.

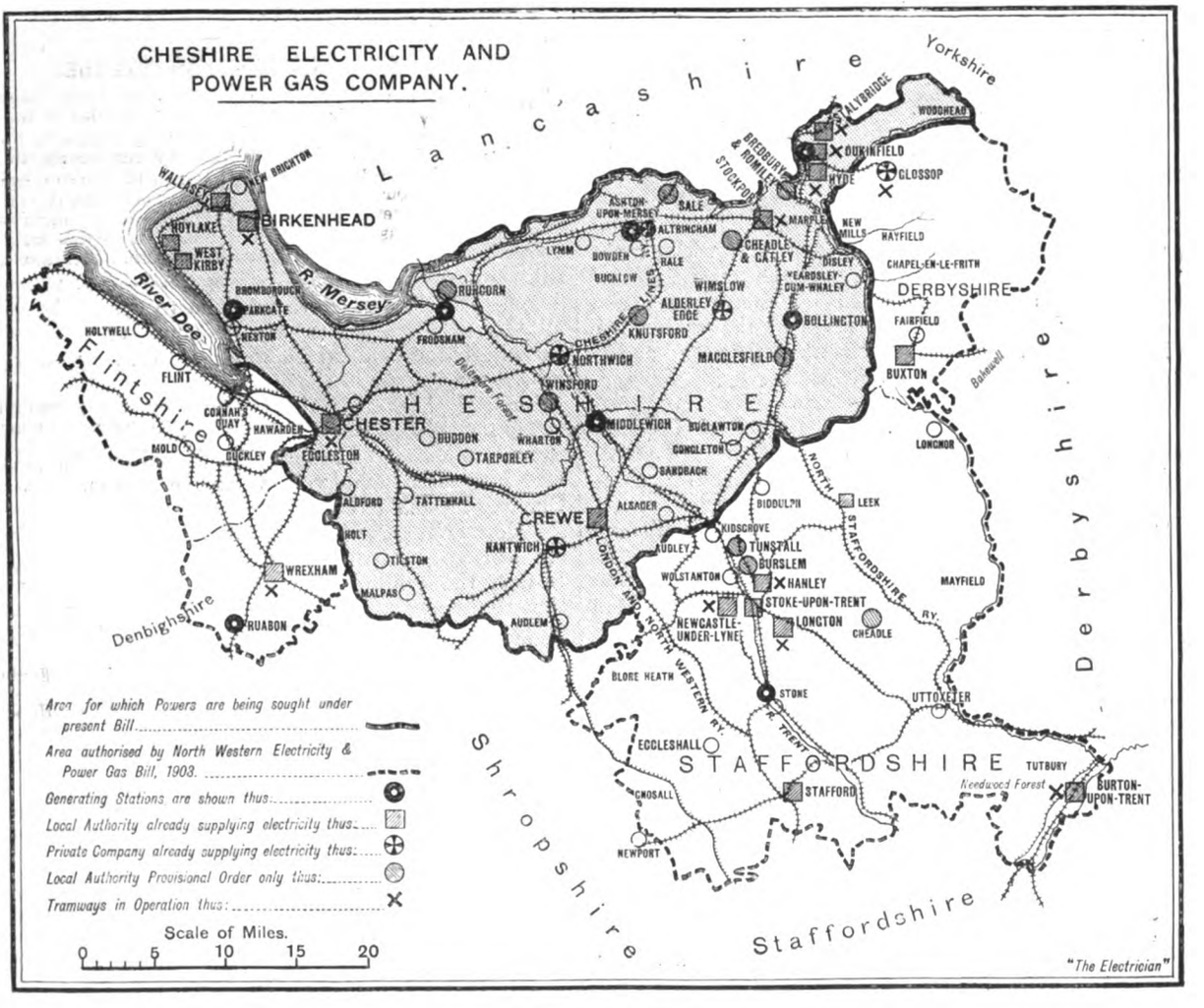
CHESHIRE ELECTRICITY AND POWER GAS BILL.

Mr. Cawley's Committee of the House of Commons commenced consideration of this bill on Monday. Amongst the opponents to the measure are: Altrincham Electric Supply Co., Corporations of Crewe, Stockport and Cheshire, the Stalybridge, Hyde, Mossley and Dukinfield Electricity Board, Cheshire Lines Committee, and several railway companies.

Mr. SHIRESS WILL, K.C., who appeared for the promoters with Mr. Greig, said the bill sought to incorporate and confer powers on the Cheshire Electricity and Power Gas Co., and the object of the company was two-fold—viz., to supply electricity and power gas. The capital of the company was £1,000,000, with borrowing powers of £333,000. The district comprised 1,023 sq. miles, and contained one city, three county boroughs, six boroughs, 36 urban districts, and 18 rural districts, making in all 59 local authorities. Of these, those opposing were very few indeed, and were, for the most part, local authorities or others who were already giving a supply of electricity. There were the Altrincham Electric Supply Co., the Stockport Corporation, the Crewe Corporation, the Wallasey Urban District Council and the Stalybridge, Hyde, Mossley and Dukinfield Electricity Board. On the other hand, there were 25 local authorities in favour of the bill, and there were also 23 local authorities remaining neutral. There were 15 statutory electricity undertakings in the area. As far as gas was concerned, the bill followed the South Staffordshire Gas Bill and the North-Western Electricity and Power Gas Bill of last year. The latter promotion included the area at present being applied for, but a House of Commons Committee decided that the proposed capital was not sufficient for the whole area, and therefore Cheshire was excluded. But the present bill was an independent one and was not promoted by the North-Western Electricity and Power Gas Co. As regards electricity, the bill followed the Yorkshire and other similar acts. But the difference in this case was that the percentage of the total power taken by any consumer which could be used for lighting was limited to 30 per cent. The bill also included a provision for the payment of interest out of capital during construction. A report had been made by the Board of Trade that the bill followed precedent, and therefore any discussion as to its character could not arise. It was proposed to erect six generating stations. The price for electricity was upon a sliding scale, and the maximum was as low as ¾d. per unit; whilst for gas the charge was 3d. per 1,000 cubic ft. for any quantity not less than 4,000,000 cubic ft. and 4d. per 1,000ft. for any quantity less than that.

Mr. JOHN STURGEON, consulting engineer to the scheme, said it was not proposed to supply Mond gas as an illuminant. The cost of running by gas engines supplied with Mond gas was one-fourth the cost of running by steam raised by Welsh coal.

Under cross-examination, Witness said he was not aware whether Mond gas could be treated so that it could be utilised for lighting purposes. He admitted there was a clause in the bill which stipulated that the power gas should not be used for lighting, but it appeared to him somewhat superfluous. Chester was excluded from the area because the field for the supply of power was not so large as in Stalybridge, Hyde, Mossley and Dukinfield. It was only possible to distribute Mond gas for 5 miles, and then it would have to be recompressed and distributed another stage. Some loss was occasioned in this way, and eventually all



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the original power would be exhausted. There was thus a limit to the distance of distribution in this way. Witness was also cross-examined on behalf of the Corporations of Stockport and Crewe with a view to getting both these areas cut out of the bill.

On Tuesday the Committee only sat for a short time.

Mr. H. A. HUMPHREY was called for the promoters, and gave evidence largely on the proposals of the bill with regard to the supply of power gas. All the estimates were based upon a selling price of 2d. per 1,000 cubic ft., and at that price the cost of a horse-power per hour would vary between 1d. and ½d. Cross-examined by counsel for the Altrincham Corporation as to the position of the latter should the power company absorb the Altrincham Electric Supply Co., witness said he was unable to answer the question.

Mr. SHIRESS WILL explained that in all electric lighting provisional orders powers to purchase a local company was given to the local authority at the end of 42 years. Assuming the power company absorbed a distributing company such as the Altrincham Company, the power company also took over all liabilities of the latter, and therefore the rights of the local authority were not interfered with in any way. Even the purchase of the small company by the power company would be subject to the approval of the Board of Trade.

On Wednesday Mr. HUMPHREY was cross-examined at great length by counsel for the numerous petitioners against the bill. He said the company had agreed to pay a licence of £25,000 for the manufacture of Mond gas. The bill provided for the acquisition of the Northwich Electric Supply Co., and under the agreement with that company this would require £35,000. Powers were also taken to pay interest out of capital during construction to the extent of £40,000. He maintained that all these figures were not injudicious, and neither would he depart from his estimates for three gas power stations amounting to £1,080,000. As to the need for the scheme, he thought the nature of the area covered was sufficient to warrant the success of the undertaking.

Some local evidence was then called as to the desirability of the scheme.

Yesterday, Mr. JAMES FAWCUS, who has been concerned in the promotion of the Yorkshire Power Co., the Lancashire Power Co., and the Trafford Park Power Co., said he considered the area scheduled in the bill one of the best districts in England for which Parliamentary powers had not been obtained. There had been some difficulty in getting capital for such undertakings, but in the case of Yorkshire and Lancashire the inauguration of the works was close at hand. It would be impossible to get much of the first capital from the public, and the methods adopted in connection with the Yorkshire scheme were those which would have to be followed. Here the promoters subscribed or underwrote £120,000, and the contractors either took their contract in shares or underwrote a large amount of capital at the time of the issue of the prospectus. The cost of underwriting was 5 per cent.

Cross-examined: The Trafford Park Power Co. was authorised to supply Mond gas, but had not yet commenced to do so. The reason for this was not that it was not considered remunerative, but because of the smaller area over which the company had powers to operate. Personally he was not putting any money into the Cheshire undertaking because of his financial obligations to the other companies he had mentioned.

Mr. S. Z. DE FERRANTI was then called to give evidence on the possibilities of the scheme and also on finance. [The Chairman asked that he should confine himself as far as possible to the latter]. With regard to obtaining capital for these power undertakings, he said it was usually found that the public would not subscribe at the commencement. In connection with the Midland Electric Corp. for Power Distribution, practically all the money had been found by people interested in the welfare of the electrical industry. £400,000 had been found in this way. Of a dozen schemes of this character with which he was familiar, only two had succeeded in obtaining money by public subscription. These were the Newcastle Electric Supply Co. and the South Staffordshire Power Gas Co. The reason why the former concern had succeeded in raising some capital in this way was that it had previously been carrying on the electric lighting of Newcastle in a very satisfactory manner. This showed that the public when they had a record to go upon would subscribe to these concerns. He contended that the Stalybridge, Mossley, Hyde and Dukinfield scheme was a power scheme only in name. It was obviously not on a sufficiently large scale, and was really only a municipal undertaking on a somewhat larger scale than was usually the case.

Mr. E. M. LACEY, the consulting electrical engineer to the scheme, said that his estimates were based upon 5,000kw. stations, although it did not follow that all the stations would be of that size. Some would be larger and some smaller. But the cost of a 5,000kw. station with gas-driven alternators would be £179,000. 100 miles of mains for each station would cost £69,000. Sub-stations for each generating station would cost £27,000. These estimates included land and 10 per cent. for contingencies. The total cost of the three generating stations which it was first intended to erect would be £538,000.

Under cross-examination Mr. Lacey admitted that there was a discrepancy between his present estimates and those which he put in last year in connection with the North-Western scheme, but this was accounted for by the fact that last year's bill was the first of its kind. With that experience before him, and also his experience with actual contracts for the Lancashire power scheme, it was found that his last year's estimates could be modified. Prices were also lower now. As an instance of this, he had recently had a tender for a 1,000kw. plant which was 30 per cent. cheaper than a similar plant last year. It was British plant. The generating pressure would be 10,000 volts. The cost of sub-stations in connection with the Lancashire scheme was £22,000, so that his estimates were well within actual cost price. He was only asked to prepare his estimates just before Easter.

The CHAIRMAN: Have you used Mond gas in connection with any of your other undertakings?—No. It is only within quite a short time that we have satisfied ourselves that sufficiently large gas engines could be made.

Have you any means of raising capital or helping to raise it for this scheme?—So far as I am concerned I have finished my work when I have reported to the promoters upon the capital expenditure.

You have nothing to say upon finance beyond that?—No, except that I see no reason why the capital should not be found quite as easily as in the other power schemes.

But it is a fact that the South Staffordshire Mond Gas Co. has not laid a single pipe. Do you, in face of that and the fact that you look to Mond gas to give you economical production of electricity, think that people will be found who will put their money into the scheme?—I think so. Personally, I only look to the gas to introduce a little extra economy.

But would you, as an expert engineer, stake your reputation in advising a large corporation to put down a Mond gas plant in preference to steam?—Oh, yes.

Mr. E. A. CAROLAN, a director of the British Thomson-Houston Co. and of the Lancashire Electric Power Co., gave it as his opinion that the capital ought to be found. It was impossible for individuals to say how much they would invest until the bill was passed.

The room was then cleared, this being the close of the promoters' case, when the parties were re-admitted,

The CHAIRMAN said: The Committee have come to the unanimous decision that the preamble of the bill is not proved.

EAST LONDON AND LOWER THAMES ELECTRIC POWER BILL.

The consideration of this bill was resumed by Mr. Cawley's Committee of the House of Commons on Friday last week.

Mr. BALFOUR BROWNE, for the promoters, asked that any decision should be deferred until Monday, when he would be in a position to put a very strong case before the Committee.

Several objections were made to this course, and,

Mr. W. RIGBY was called for the promoters. He said he was a railway contractor, and acting on the advice of the solicitors and engineers to the scheme, he was prepared to invest £10,000 in the scheme. If any portions of the area were struck out, or any limitation of the powers of the company made, he would have to reconsider his position.

After a short deliberation,

The CHAIRMAN said: The Committee are unanimous that the preamble of the bill is not proved.

THE ELECTROLYSIS CLAUSE.

The Torquay Tramways Bill, which is promoted by the Dolter Electric Traction Co., and has been passed by a Committee of the House of Commons, will be opposed by the Torquay Corporation in the House of Lords. It will be remembered that the company bought the Council's consent to the measure by inserting a special "electrolysis" clause similar to the famous "Sheffield" clause (see *The Electrician*, Vol. LII., p. 869). Now, however, Lord Morley, Chairman of Committees in the House of Lords, has struck out this clause, as well as the similar one accorded to the gas company, in spite of the traction company's protests.

THE METRIC SYSTEM.

Weights and Measures Bill.

In the House of Commons on Friday last week, this bill came up for second reading.

Mr. BOUSFIELD, who introduced the measure, said the object of it was to secure greater uniformity in the administration of the law relating to weights and measures, and the proposal was to give the Board of Trade greater power in enforcing the law than it at present possessed. Sec. 4 of the bill provided for the adoption of the metric system for those purposes for which the Troy and Apothecaries' measures are now employed. This, he contended, would produce no disorganisation of trade, but would be an instalment of the reform which he was sure 90 per cent. of the members desired. There was a measure with regard to this matter before the other House, but it was unlikely that any Government would propose a reform of this description *en bloc*. However, he did not regard this section of the bill as vital, and would abandon it if it were condemned by the judgment of the House.

Sir A. ROLLITT seconded the motion for second reading, and heartily approved the section relating to the metric system.

Mr. T. H. Robertson, Sir G. Bartley, Mr. J. F. Hope opposed the measure, especially with regard to the section concerning the adoption of the metric system, and other members having spoken,

Mr. BOUSFIELD offered to withdraw sec. 4.

Mr. GERALD BALFOUR said he was very glad to hear this, as the section in question only touched the fringe of the subject, and, he ventured to think, ought never to have been introduced into the measure at all.

Sir F. S. POWELL said he supported the bill now that sec. 4 was taken out.

The bill was then read a second time, and after a short discussion was referred to the Standing Committee on Law.

[We refer to this bill in our Editorial columns.]

DONCASTER CORPORATION BILL.

This omnibus bill, which has been before the Police and Sanitary Committee in the House of Commons for some days, includes the extension of the municipal area with regard to the supply of gas, water and electricity.

Mr. BALFOUR BROWNE, K.C., for the promoters, said the districts which it was proposed to incorporate were, for the purposes of the supply

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of electricity, Balby-with-Hexthorpe, Wheatley, Warmsworth, Bentley-with-Arksey, Kirk Sandall, Loversall, Sprotborough, Cantley, Armthorpe, Car House and Elmfield. Practically speaking, from the point of view of the local authorities, this portion of the bill was unopposed. The only opposition was that of the Yorkshire Electric Power Co., which was authorised by an Act of Parliament in 1901. As a matter of fact, however, the company was not yet in a position to supply electrical energy, and as the Doncaster Corporation was not asking for a monopoly in the districts named, no harm would be done.

Mr. W. B. WOODHOUSE, engineer and manager of the Yorkshire Electric Power Co., said that a great deal of work had been done upon the first generating station of the company, and they were now almost ready to supply. A large number of local authorities had approached them, and in many cases detailed proposals had been arranged.

Mr. FREEMAN, K.C., in addressing the Committee for the company, said that practically speaking the Doncaster Corporation was asking for the districts in question to be locked. If the Corporation was allowed to supply in those districts, it would mean to all intents and purposes a monopoly.

Mr. PAGE, K.C., for the promoters, replied that Parliament had never yet given a monopoly to a private company under such conditions.

The CHAIRMAN then stated that the Committee found the preamble of the bill proved with regard to the extension of the limits of supply of electrical energy asked for, with the proviso that the Yorkshire Electric Power Co. should not be required to obtain the consent of the Doncaster Corporation before it could supply within the extended limits.

BAKER STREET AND WATERLOO RAILWAY BILL.

In the House of Commons on Thursday last week, on the motion for third reading of this bill,

Mr. CAUSTON moved that a clause be inserted compelling the company to construct subways at the Elephant and Castle for the convenience of pedestrians. When the bill for the railway was originally promoted a clause was inserted by agreement with the then vestry of St. George-the-Martyr (Southwark) to construct such subways, but since the undertaking had come into the hands of Mr. Yerkes, the liability to carry out this duty was repudiated.

Mr. RUSSELL REA, who was chairman of the Committee which considered the Baker Street and Waterloo Railway Bill this year, said that that bill modified the original proposal, and the Committee was convinced that inasmuch as it would be almost impossible, or at any rate exceedingly difficult, to construct a station on the old site, a modification to this effect was passed. The Committee at the same time came to the conclusion that the Act of 1900 did not impose any obligation upon the railway company to construct the foot passenger subways if no station were constructed there.

Capt. Norton, Sir F. Banbury, Mr. Corrie Grant and Mr. Cust supported the motion, and stigmatised the action of the railway company as a deliberate act of bad faith.

Mr. J. W. LOWTHER supported Mr. Rea, on the ground that the true interpretation of the clause in the Act of 1900 did not bind the company to construct the subways if they did not construct the station. On the other hand, however, he would suggest that the Southwark Borough Council and the company should come to an arrangement on the matter to share the cost of constructing the subways, as to judge from a letter from Mr. Yerkes to the Council it was evident that he did not think he was fulfilling the whole of the obligations which his predecessors had entered into.

Other members having spoken,

The House divided, with the result that Mr. Causton's motion was negatived by a majority of 10.

The bill was, therefore, reported for the third reading.

L.C.C. OPPOSITION TO A SUBURBAN TRAMWAY.

A Committee of the House of Commons, presided over by Mr. Compton Rickett, commenced consideration of the London, Camberwell and Dulwich Tramways Bill yesterday.

Mr. H. LLOYD, K.C., for the promoters, asked that this bill might be considered in conjunction with the London County Council (Tramways and Improvements) Bill, which would come before the same Committee, for the reason that the London County Council was proposing to construct competitive lines.

Mr. ERSKINE POLLOCK, K.C., for the London County Council, objected on the ground that the L.C.C. bill was an omnibus bill, and only competed with the London, Camberwell and Dulwich Tramways Bill to a very small extent.

The CHAIRMAN said he would form his own judgment as the London, Camberwell and Dulwich Tramways Bill proceeded.

Mr. LLOYD, continuing, said that the London, Camberwell and Dulwich Tramways Bill sought powers to reconstruct and work by electric traction the tramway lines now in the hands of the existing company. The lines were authorised by several acts dating from the year 1882, but for several reasons, although they had nearly all been constructed, no adequate service had ever been maintained upon them. The dates of purchase by the London County Council dated from Aug. 10, 1903, but that body had decided not to purchase the lines. Consequently the company consulted Mr. Stephen Sellon, with the result that this bill was promoted. Both the Camberwell Borough Council and the London County Council had applied to the Board of Trade to have the lines pulled up, but without success. The Camberwell Borough Council opposed the bill and refused to give the necessary consent for certain street widenings. The London County Council opposed on general grounds.

Mr. STEPHEN SELLON said it would only require £120,000 to convert the 3⅛ miles of track to electrical working, including generating station, &c. He estimated that a traffic of 4¾ millions of passengers would be carried under the new conditions, and that a revenue of £6,000 per mile would be made.

On Friday last week,

Mr. SELLON continued his evidence, and dealt further with the possible traffic over the lines. He asked that the London County Council should be allowed to purchase the undertaking at the end of 30 years as a going concern and not under the "old iron" clause of the Tramways Act of 1870, and he would be prepared to arrange mutual running powers with regard to certain of the London County Council's lines.

The CHAIRMAN asked the promoters to consider their position and let him know what their attitude would be if any portions of the lines were refused.

On Monday, Mr. HUTCHINSON, for the promoters, said that the promoters regarded the re-construction of the tramway along the whole length of Rye-lane as a very important feature of the future success of the scheme, but if the Committee thought the granting of this would not be expedient, they would be prepared to carry out the remainder of the scheme and to guarantee the finding of the necessary capital. At the same time it must be remembered that the company had certain existing rights in Rye-lane which it did not wish to surrender.

Some discussion having taken place as to the widening of Rye-lane,

The CHAIRMAN said he must frankly say that the Committee had not a great deal of sympathy with the promoters, but from the point of view of public convenience they had a fairly strong case. It was, therefore, largely from this point of view that the Committee would consider the bill. The line was authorised by Parliament 20 years ago and obviously the necessity was greater to-day than it was then. It would certainly be better for all the lines in the district to be in one hand and under one control, and he was sorry that the London County Council had not seen fit to negotiate with the company for the absorption of the undertaking. The company was in the position of obstructing the construction of the lines, if the bill was not passed, for several years.

Mr. SELLON was then examined as to the width of roadway and pathway which the proposed widenings would allow.

Mr. T. S. TURNBULL, chairman of the London, Camberwell and Dulwich Tramways Co., said he was satisfied with the estimates of the engineers and was prepared to find the necessary capital. If the Committee thought fit he would sign an agreement to do so, and have the agreement scheduled to the bill, but in the event of any further curtailment of the powers sought, other than those already indicated, he would wish to consult his co-directors.

The CHAIRMAN suggested that this course should be adopted. Local evidence was then called in favour of the tramways.

On Tuesday, Mr. T. S. TURNBULL stated that his guarantee to find the necessary capital was on the assumption that the line was passed as far as Peckham Rye Station. On this assumption, he and his friends would be willing to enter into a binding agreement to find £120,000.

Evidence was then given by the Home Office and the Police Authorities with regard to objections to certain of the street widenings proposed by the promoters.

Mr. SELLON was recalled, and maintained his assertion that the proposed widenings were fully sufficient for the purpose.

Cross-examined by Mr. LOUIS COWARD, K.C., Witness admitted that the 8ft. of pavement which it was proposed to take in Peckham Rye was an extension of the frontage of shops there, upon which the tradesmen displayed their wares.

On Wednesday Mr. A. RYDE gave evidence as to the valuation of property in Rye-lane. The cost of the land for the purpose of a generating station and widenings he put at £14,254.

A large number of local witnesses were then called in favour of the bill.

Yesterday, Col. YORKE, of the Board of Trade, gave evidence at the request of the Committee. Generally the width of the roadway and pathways in Rye-lane under the scheme would not come up to the standard usually laid down by the Board of Trade, but with a system of automatic signalling, which he thought would be quite practicable, he saw nothing in the scheme which would prevent the sanction of the lines by the Board. Personally, he thought electric tramways increased vehicular congestion, and made very little difference to pedestrian congestion. No line down Rye-lane would ever be allowed a statutory speed of more than 8 miles an hour.

The room was then cleared, and after a few minutes

The CHAIRMAN announced that the Committee would hear the remainder of the bill.

Evidence was then called on behalf of the Camberwell Borough Council as to the general undesirability of the line in Rye-lane.

The Committee again adjourned.

OTHER ELECTRICAL BILLS.

In the House of Commons, on Friday last week, the *Acton Improvement Bill* and the *Charing Cross, Euston and Hampstead Railway Bill* were read a third time.

On Tuesday in the House of Lords, the *Kettering Improvement Bill* was reads second time. *Barrow-in-Furness Corporation Bill* and the *Southport-Lytham Tramroad (Extension of Time) Bill* were read a third time and passed.

A Committee of the House of Lords, presided over by the Earl of Lauderdale, considered the *Lancashire Electric Power Bill* yesterday. There is only one opponent—viz., the Radcliffe Urban District Council. The object of the bill is to acquire some 20 acres of land on lease for 999 years from the Earl of Derby for an additional generating station, one of the original sites having been abandoned on account of lack of facilities

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for getting water for condensation, &c. The new site is on the river Irwell in the area of the Radcliffe Urban District Council, which body seeks protective clauses which Mr. Baggallay, K.C., for the promoters, contended were going beyond the general law as laid down in the Electric Lighting Acts and the Electric Lighting Clauses Act. The bill also asks for power to pay interest out of capital during construction. Mr. Hutchinson, for the Radcliffe Urban District Council, argued that he was merely asking for the same protection as had been given to other local authorities under the Companies Act of 1900. He had an electric light station, tramways were authorised, and the Urban District Council was the road authority. He asked for protection with regard to all these. As the bill stood now, the power company would appear to have unrestricted rights in respect of all these. Mr. Baggallay, in response, pointed out that all the protection which the petitioners could claim under the general law had been given them. The Committee upheld this view, and unanimously found the preamble proved.

The *Dundee, Broughty Ferry and the District Tramways Bill* has been certified as having complied with the Standing Orders of the House of Commons applicable to Scottish provisional orders.

All opposition to the *Lothians Electric Power Bill* has now been settled, and the measure has been withdrawn from the group of bills which the Earl of Lauderdale's Committee is considering. The Lothians Power Bill seeks to incorporate a company for establishing electricity works for the supply of electrical energy in bulk in the county of Midlothian (excluding Edinburgh, Leith, Stow, Heriot, Fala and Soutra) and portions of the counties of Haddington, Peebles and Lanark. The sites scheduled for generating stations are at Kingsknowe, Lasswade, West Linton and Auchengray. Some particulars of a possible amalgamation with the Fife Power Co. were given in our issue for Jan. 8, p. 462

The *Ulster Electric Power Bill* has also been withdrawn from the Earl of Lauderdale's list owing to its now being unopposed. The measure has scheduled practically the whole of the province of Ulster, the proposed capital of the company being £900,000.

RUSSIA AND WIRELESS TELEGRAPHY.

Mr. BRYNMOR JONES asked whether the Secretary of State for Foreign Affairs had received any communication from the Russian Government as to the possible treatment of neutral vessels having on board correspondents who might, by means of improved apparatus, communicate news to the Japanese fleet or army now operating against Russia, and of its intention to treat such correspondents as spies; and, if so, would he lay the communication upon the table, or state its purport?

Lord PERCY, in a printed reply, stated that a Russian Circular to the Powers had been communicated to His Majesty's Government on 15th inst., and was now under consideration. [The text of this Circular will be found in our leading article this week.]

LEGAL INTELLIGENCE.

The Underground Electric Railways Co. of London (Ltd.) and the Commissioners of Inland Revenue.

On Monday Mr. Justice Channell had before him a special case, which raised the question of the amount of stamp duty payable by the Underground Electric Railways Co. of London (Ltd.) under the agreement by which they acquired control of the Brompton and Piccadilly Circus, the Charing Cross, Euston and Hampstead, the Great Northern and Strand and the Baker Street and Waterloo Railways.

By agreement, dated June 25, 1902, with the Metropolitan District Electric Traction Co., the Underground Electric Railways Co. (Ltd.), which had been formed with a capital of £5,000,000 in £10 shares, agreed to purchase the whole of their undertaking. Part of the consideration was (1) that £500,000 should be paid in cash by the new company on completion of the purchase, together with 5 per cent. interest on £250,000, (2) £500,000 in shares; and (3) the profits in the new company available for dividend in respect of each year should be applied: (*a*) in payment of a cumulative dividend at rate of 5 per cent. per annum on the amount for the time being paid up on any shares issued by new company, and (*b*) in paying to the Traction Company or its assigns as a further part of the consideration for the sale such a sum as should be equal to a dividend of 3 per cent. on amount for time being paid up on such of the original ordinary share capital of 5 millions in the new company as should for the time being have been issued by the new company, On July 8, 1902, an instrument was presented on behalf of the new company for the purpose of being stamped, and the Commissioners of Inland Revenue, in assessing the duty payable, computed the consideration for the property agreed to be sold as £1,947,583. 18s. 5d., which, after making certain deductions, was put at £1,527,357. 17s. 11d. The great question was whether the Commissioners were right in including therein £780,000 under clause 3 of the agreement. The Commissioners held that the sum contingently payable out of profits in each year under the sub-clause was "part of the consideration for the sale," and that, so far as such sum was capable of ascertainment at the date of the agreement, it was liable to *ad valorem* conveyance duty at the rate of 10 per cent.

The company, on the other hand, submitted that such sum was incapable of assignment by reason of the remoteness of the contingency upon which the payment must be made. At the date of agreement the whole of the ordinary share capital of 5 millions in the new company had been issued, and on 100,000 of such shares £5 per share had then been paid up, while on the remaining 100,000 shares £2 per share had been paid, amounting together to £1,300,000. Upon the last-named sum £89,000 was what was equal to a dividend of 3 per cent. for one year. As that annual sum (specified in second sub-clause) was, in the opinion of the Commissioners contingently payable either in perpetuity or for an indefinite period within the meaning of sec. 56 (2) of the Stamp Act, 1891, they were of opinion that the duty fell to be charged upon the aforesaid annual amount, multiplied by 20, in accordance with the provisions of the section; and accordingly they assessed, together with other duty on the remaining part of the consideration, a duty of 10s. per cent. upon £780,000, which amounted to £3,900. The argument, on behalf of the Railways Company was that this was not a periodical payment within the meaning of the act; hence the present appeal.

His LORDSHIP, in giving judgment, said it appeared to be a case in which the parties took uncertainties into consideration; that was to say, double contingencies, in respect to the dividend which must be earned by the new company, as well as the amount which must be raised in shares up to a certain period. The main point of uncertainty was that bearing reference to the earnings which would give a sufficient profit to pay anything between 5 and 8 per cent. payable to the old company. Taking everything into consideration, he could not come to the conclusion that the Crown were entitled to put their finger down at a certain date and say, "There is so much due and payable here." Therefore he must give judgment for the appellants, with costs.

Mr. ROWLATT (for the Commissioners) asked for a stay of execution for a fortnight, with the view to an appeal, and this was granted.

H. Sutton & Co. (Ltd.)

On Tuesday, in the High Court, Mr. Justice Buckley had before him a petition by James Hinks & Sons for the winding-up of the above company. This was a judgment creditor's petition. Sutton & Co. (Ltd.) carried on business as electricians at Muswell Hill, and petitioners obtained judgment for £45. 19s. and £8 costs on March 4. The petition was presented on March 11, and on March 29 the company passed a resolution for winding-up. Petitioners were prejudiced by the voluntary winding-up, as the auditor of the company had been appointed liquidator, and he had also been appointed receiver in a debenture-holders' action. Counsel for petitioners said that having regard to the necessity for strict independent investigation, and to the manner in which the company's assets had been dealt with, and particularly as to the circumstances under which the debentures in the company were issued, unsecured creditors would be prejudiced by a voluntary winding-up conducted by the present liquidator. The company had various contracts in hand, and received payment from time to time as the work proceeded. Supervision implied that the liquidator would have to go to Court for directions in the various matters.

Having heard the views of opposing counsel and of opposing creditors, his LORDSHIP said petitioners had not made out a case of prejudice, and were not entitled to a compulsory order. There was nothing against the present liquidator (Mr. Littlejohn), so all he could do was to make a supervision order.

National Electric Wiring Co. v. Miller.

A Divisional Court (the Lord Chief Justice and Justices Wills and Kennedy) on Monday and Tuesday heard this appeal of plaintiffs from a decision of Judge Smyly at the Shoreditch (London) County Court.

Mr. BAILHACHE, for appellants, said that the action was brought by the company for the wrongful removal of a "free" wiring installation put into a house of which defendant was landlord, the installation being put in at the request of a former tenant. The company's agreement was with the former tenant, but at the foot of the agreement was a memorandum signed by or for the landlord (the defendant). The memorandum was in the following terms:—"I, the undersigned, being the landlord of the above-named consumer, and being the owner of the premises, hereby consent to the installation of wires and fittings in the said premises upon the terms and conditions of the above agreement, and agree that the said wires and fittings shall not be removed without the consent of the Council and Wiring Company in writing." The fittings were removed by the tenant who succeeded, and plaintiffs were suing the landlord for breach of his agreement with the company. These agreements were always subsidiary to what were called the "head agreements." The municipality or company obtained powers to supply electricity, and they, in many cases, entered into agreements with a wiring company to put electric installations into houses in their district upon terms, these terms being embodied in the agreements with the consumer.

The LORD CHIEF JUSTICE: Is it agreed that the defendant (the landlord) is bound by the memorandum?

Mr. BAILHACHE: That is the point. The County Court judge says he is not.

The LORD CHIEF JUSTICE: On what ground?

Mr. BAILHACHE: He decided that the memorandum was a licence and not an agreement. A point was taken in the Court below of the power of the defendant's son to sign the agreement on his father's behalf, but that point was effectually disposed of by the admissions in the County Court action. The agreement is made between three parties, the supply undertakers (Metropolitan Borough of Hackney), the Wiring Company and the consumer, and stipulated that the Wiring Company put in the installation free of any initial expense, the consumer having the option of buying the installation. Until so bought, and so long as he uses the installation, he pays a rent for it. It had been held that the word "used" meant "opportunity to use." As against the original consumer, so long as the installation was *in situ* the Wiring Company was entitled to rent for the opportunity of user, but if the installation

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had been removed, then it was open to the consumer, so long as he had not himself removed it or authorised the removal, to say "I shall no longer pay you any rent because I do not, in fact, use the installation and my opportunity to use it has gone." On the strength of agreements of this kind many thousands of pounds had been invested in these installations, so that it is important to have it decided exactly what the landlord's liability under these agreements is. The amount involved in this case was small—about £3. 4s.

The LORD CHIEF JUSTICE: The new tenant was not a party to the pulling down?

Mr. BAILHACHE: No. With regard to the words "agree that the said wires and fittings shall not be removed" that was an undertaking by defendant that the installation should not be removed. Of course, some limitation must be put on this principle. If a burglar broke in and stole the fittings, the landlord would not be liable for that. His (counsel's) contention was that that was an undertaking by defendant that the fittings, &c., should not be removed by his tenants.

Mr. Justice WILLS: I think that, as soon as this discussion becomes known, you will get no landlord to sign such an agreement in future.

Mr. BAILHACHE: What plaintiffs want is to be protected against the very thing which has happened in the present case. The only person who could protect was the landlord, and the landlord had made an agreement to do so with the Wiring Company. There was nothing in the world to prevent him making a similar agreement with the new tenant that he himself lets in. In the present case the defendant had not protected plaintiffs at all. If the defendant did not mean to undertake an obligation of this kind, why did he not put into the agreement submitted to him that the wires and fittings should not be removed by him or without his consent?

Mr. ELDON BANKES, K.C., then argued in support of the County Court judge's decision on the point of construction.

The LORD CHIEF JUSTICE, in giving judgment, said he never desired to send a case back, but it was practically impossible for them to give a satisfactory judgment in the present case without the facts being further stated, especially in view of the argument that there was a contract in the present case. A good deal might turn upon what the actual position of the landlord was. All he said was that it was impossible for the Court to say that this was a licence only. He agreed with Mr. Bailhache's argument that the words "agree," &c., did import a contract of some kind or other, but he thought a very grave question would arise as to the contract itself. There would also be some question as to the agency of the person who signed the agreement for the landlord. He thought that before the Court attempted to say what the rights of the parties were, the case must go back for further investigation, and must come up again on an agreed state of facts. The costs of the appeal as well as the costs of the trial to abide the result of the second trial.

Justices Wills and Kennedy concurred.

National Telephone Co. v. Eardley.

At Birmingham County Court on Monday, plaintiffs sued a local solicitor (Mr. E. J. Stanbury Eardley) for £10, one year's telephone rental. Defendant counterclaimed £2. 14s. 1d. for failure of consideration for a period during which he was cut off from the use of the telephone.

Mr. WALKER, who appeared for the company, stated that under the agreement the company were entitled to payment of the annual subscription in advance, and they also had the right without prejudice to disconnect the instrument if payment were not so made. As to the counterclaim, he submitted that the consideration had not failed. The instrument, which constituted the major part of the consideration, still remained in the office, and, that being so, defendant was not entitled to sue for the failure of part of the consideration.

Evidence having been given,

Mr. PRITCHETT (for defendant) submitted that there was no power to recover rent for the period during which the instrument was disconnected There ought to be a deduction from the full rent proportionate to that period. He had offered to pay £10 less that sum, and he submitted that it was unjust for a company to be allowed to deprive a customer of the use of his instrument and choose their own time for suing him.

His HONOUR (Sir R. Harington), in giving judgment, said that he must follow the decision of the superior Courts, but he was bound to say that, independently of those decisions, he would have come to the same conclusion on the agreement. On the day when the year commenced the company had a right to recover £10, and they might have recovered it at once by bringing an action. They, however, reserved by their agreement a right to disconnect anyone whose subscription was in arrear without notice and without prejudice to the other clauses of the agreement—viz., their right to recover in advance. Nothing had happened to deprive them of their rights under the agreement. He had no option but to give judgment for plaintiffs, with costs.

Employers' Liability.

At Brompton (London) County Court on Monday, Judge Stonor and a jury heard an action brought by a fitter's mate, named Burr, under the Employers' Liability Act, against the Underground Electric Railways Co. of London, claiming £261. 6s. as damages for personal injuries alleged to have been sustained owing to negligence on the part of defendants or their servants. It appears from counsel's statement that Burr had been engaged to assist in unhooking and lowering heavy tackle, and in the course of the work had received an injury to his hand, partly incapacitating him from following his employ. The evidence for the defence went to show that the work of moving the tackle was carried out in the usual manner, and that the accident arose from no cause over which defendants had control, but was due to the fault of plaintiff.

The jury found that plaintiff met with his injuries through "a pure accident." This was a verdict for defendants, for whom Judge Stonor gave judgment, with costs.

Under the Workmen's Compensation Act plaintiff was awarded 16s. per week (as half his usual wages), dating from a fortnight after the accident to the present time, and 10s. per week so long as he is prevented, by the effects of the accident, from following his ordinary employment.

Knight v. Isle of Wight Electric Light and Power Co.

In the Chancery Division on Friday, Mr. Justice Joyce directed this motion (to sequestrate defendant company for committing a breach of an injunction to abate a nuisance) to stand over until 29th inst., as the affidavits were not complete.

National Electric Traction Co. (Ltd.)

On Tuesday, when Mr. Justice Buckley reached the petition for the winding-up of the above company, it was announced that the petitioner's debt had been satisfied, and the petition was dismissed.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Journal of the Institution of Electrical Engineers." Vol. XXXIII. Part 2. (London: E. and F. N. Spon.) 5s.

"The Electrical Industry: Lighting, Traction and Power." By A. G. Whyte. (London: Methuen & Co.) 2s. 6d.

"Practical Slide Making." By G. T. Harris. (London: Iliffe & Sons.) 1s.

"The Income Tax Burden." By T. Hallett Fry. (London: Horace Cox.) 6d.

"Die Prüfung von Gleichstrommaschinen in Laboratorien und Prüfräumen." By Carl Kinzbrunner. (Berlin: Julius Springer.) 9m.

"Notes on Blacksmiths' Work." By Major R. F. Sorsbie, R.E. (Chatham: W. and J. Mackay & Co.)

"Radium und andere radioaktive Substanzen." By Ernst Ruhmer. (Berlin: F. and M. Harrwitz.) 2.50m.

"Elektrische Fernphotographie und Ähnliches." By Dr. Arthur Korn. (Leipzig: S. Hirzel) 1m.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A competent designer of alternate-current generators, motors and transformers is wanted by Messrs. Vickers, Son and Maxim, River Don Works, Sheffield. Applications to electrical department. See advertisement.

An assistant lecturer and demonstrator in engineering is required at Merchant Venturers' Technical College, Bristol. Salary £170, which may raise to £220. Particulars from the Registrar, to whom applications by April 30. See advertisement.

There is a vacancy for a pupil at the Cromer electricity supply station. Applications to the manager. See advertisement.

Aldershot Urban District Council require an assistant electrical engineer at a commencing salary of £80 per annum. Applications to the clerk (Mr. W. E. Foster) by May 2. See advertisement.

Exeter Council require a shift engineer for their electricity station. Applications to town clerk (Mr. Geo. R. Shorto) by May 4. See also advertisement.

Partick electricity department require an assistant mains superintendent. Applications to the burgh electrical engineer, Mr. H. B. Maxwell. See advertisement.

The Governors of Woolwich Polytechnic require a head of the department of mechanical and electrical engineering, also first and second assistant; acting head of department of mathematics and experimental physics, also senior and junior lecturers and demonstrators; head of department of chemistry and metallurgy and assistant lecturer and demonstrator. Applications to the principal (Mr. Wm. Gannon, M.A.) by April 26.

A lecturer and demonstrator in electrical engineering is required at the School of Engineering, Electricity and Technical Science, Canterbury College, University of New Zealand. The appointment will be for three years; salary, £300. Particulars, &c., from the Agent-General for New Zealand, 13, Victoria-street, London, S.W. Applications by 28th inst.

A second foreman is required in the instrument room at the Indian Government telegraph workshops at Alipore, Calcutta. Forms of application from the Director-General of Stores, India Office, London, S.W., by May 10.

An assistant engineer is required for Bolton tramways department. Applications by 29th inst.

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Mr. Hugh Ramage, B.A., A.R.C.Sc., F.I.C., of St. John's College, Cambridge, has been appointed by Norwich Town Council as organiser of higher education and principal of the technical institute at a commencing salary of £400 per annum.

Mr. J. S. D. Moffett has been appointed manager of Rochdale Corporation tramways at £300 per annum.

Mr. Fred. Williams of Maidstone has been appointed assistant electrical engineer at Leek.

Aberfeldy.—The Electric and Water committee are to consider and report upon a proposal submitted by Messrs. Cumming and Duff for the erection of electricity works and for the conversion of the railway between Aberfeldy and Ballinluig to electric traction.

Abyssinian Telegraphs.—A new telegraph line has been opened between Massawah, Asmara and Addis Abeba, 800km. in length. The line has been constructed by the Italian Government by arrangement with that of Abyssinia.

Argentina.—The Compañia Alemana Transatlantica de Electricidad offer to supply electric current for lighting the port of Buenos Ayres at 3½c. gold per unit. The cost of energy now supplied from two Government stations is 8c. gold per kilowatt hour.

Buenos Ayres Municipality are considering the question of imposing a heavy tax upon telephones in the city.

The Great Southern Railway Co.'s power station is in an advanced state, and the Rosario Railway Co.'s generating plant has arrived at Buenos Ayres. The consulting engineers (Messrs. Livesey, Son and Henderson, of London) are sending out a representative to superintend the installation of these and the Western Railway plants.

The construction of an extension nearly 2 miles in length, from Belgrano to Nuñez, has been commenced by the Buenos Ayres and Belgrano Tramways Co.

Beeston.—The Board of Trade have postponed, until June, 1905, consideration of the question of revoking the Council's electric lighting order, 1902.

Belfast.—The tramway company and the Corporation have come to terms as to the purchase of the company's undertaking by the Corporation. The Corporation Tramways Bill will now proceed unopposed.

Bermondsey (London).—The Council recently called the attention of the Board of Trade to the decision in the case of "Colwell and others *v.* St. Pancras Borough Council" (reported in our issue of Feb. 12), and requested the Board to promote legislation to obviate the prejudicial effect of this decision. The Board has intimated that the question is receiving their attention. The Council will send representatives to the conference convened by St. Pancras to petition the Board of Trade to promote legislation enabling electricity undertakers to acquire land compulsorily for electricity generating works.

Bethnal Green (London).—The Council have definitely decided to proceed with their electric lighting scheme, estimated to cost nearly £100,000. Messrs. R. Hammond & Son are the consulting engineers.

Bridlington.—The laying of the electric lighting mains was commenced on Tuesday.

Burslem.—In reference to the note which appeared in our last issue under this heading, the position is that the Electric Lighting committee on Wednesday week decided to adopt a scheme prepared by the consulting and borough electrical engineer (Mr. Ashton Bremner) for combined destructor and electricity supply works. Mr. Bremner is solely responsible for the scheme.

Burton-on-Trent.—The Corporation have authorised application to the Local Government Board for sanction to a loan of £15,665 for electric lighting extensions.

Dunfermline.—Mr. J. Alex. Bell, city electrical engineer of Aberdeen, has been retained to advise the Dunfermline Council on the subject of electricity supply.

Cardiff.—In a report, the borough electrical engineer and tramways manager (Mr. Arthur Ellis) states that the net profit on the electric lighting undertaking for the past year was about £2,500, an increase of 41 per cent. compared with the previous year.

Carnarvon.—An inquiry was held here on Wednesday into the application of the Corporation for sanction to borrow £17,000 for electricity supply.

Mr. Ellis Griffith, M.P., for the Council, said a provisional agreement had been entered into with the National Electric Construction Co. for erecting and maintaining the works for a period of years. The Corporation would provide capital and the company would pay interest and sinking fund (£510 per annum). The Corporation would have the option of taking over the undertaking at 10, 15 or 20 years. If the receipts were more than £1,530 a year the Corporation would get whatever surplus there was. The company would maintain the plant, and the Corporation had satisfied themselves as to the financial stability of the company. The Council's electrical engineer had reported favourably upon the company's scheme.

The Mayor (Councillor Thomas), the borough accountant, the borough treasurer and other local witnesses gave evidence in support of the application.

The Manager and Secretary of the company (Mr. W. B. Cownie), said his company had carried out many contracts for various Government departments and local authorities.

The Council's consulting electrical engineer (Mr. T. P. Wilmshurst, of Derby) gave technical evidence.

Chester.—The Lighting committee have reduced the candidates for the position of city electrical engineer, in succession to Mr. F. Thursfield, to six, who will be interviewed by the committee, and three or four names will be submitted to the Council for final selection. The names of the gentlemen left in are W. J. Bache (Gloucester), S. E. Britton (Motherwell), L. R. Lee (senior assistant at Manchester), H. Richardson (Dundee), S. D. Schofield (Shipley) and P. S. Thompson (Malvern). The salary attached to the appointment is £300 a year, rising by £50 a year to £500.

City of London.—The Court of Common Council have made an arrangement for the supply by the City of London Electric Lighting Co. of current at 8d. for lighting and 2d. for power to the Guildhall buildings and the Corporation's premises at Great Tower-street. A proposal to re-wire the municipal buildings and to commence by expending £200 on the re-wiring of the art gallery was referred to a committee.

Customs Duties.—The Swedish Riksdag has passed the bill imposing an ad val. duty of 15 per cent. on imported electrical machinery.

Machinery and apparatus for electric locomotion and for electric street lighting are now admitted free into British Guiana.

A duty of 4s. 1d. per cwt. has been fixed by the Swiss Customs department upon imported electric locomotives.

Dalkeith.—Messrs. Crompton & Co. agreed some time ago to establish electricity works here, but the Council now demur to the price per unit quoted for lighting the municipal buildings (4½d. per unit), and also object to giving a guarantee as to the number of hours the street lamps will be alight. The company decline to reduce the price, and suggest 3,000 hours per annum as the minimum for the use of the street lamps. If these terms are not agreed to, the matter will go to arbitration.

Darlington.—The Electric Lighting and Tramways committee decided to give notice of intention to press for the penalties from the contractors for delay in the equipment of the electric tramways. It was also decided to levy a rate of 1d. to cover the anticipated loss on the first year's working. A sub-committee has been appointed to consider the questions of "free" wiring, supply of motors, &c.

Electric Working on the Stage.—It is said that the new variety hall about to be erected on the site of the old Lyceum Theatre, Wellington-street, Strand, London, is to be fully equipped with plant for working the stage apparatus electrically.

Exhibition.—Finchley (London) Council have decided to hold an exhibition of electrical fittings, &c., from 20th to 28th prox.

Finchley.—The first six months' working of the Electricity department has resulted in a small deficit of £280.

Fulham (London).—On Wednesday the Lighting committee notified that Mr. A. J. Fuller, the borough electrical engineer, had communicated to the committee as to the urgency of making provision at the generating station for the increased anticipated demand for current next winter.

They (the committee) had given instructions for full reports to be prepared showing the financial position of the undertaking, and Mr. Fuller was to submit plans and particulars of his complete scheme of extensions. The committee recommended that one 750kw. Curtis turbine generating set be installed on temporary foundations at a cost not exceeding £7,000.

The recommendation was agreed to.

The same committee reported that as difficulties were experienced by local authorities in complying with the requirements of the Postmaster-General as to the preparation of plans of electric light mains, &c., a conference of municipal authorities owning electricity undertakings had been held, and a deputation was appointed to wait upon the Postmaster-General. This deputation had come to an agreement with the Postmaster-General which involved the purchase of two sets of plans of the whole borough to the scale of 10ft. to the mile. All existing scales will be entered up on these plans, one copy to be retained by the Council and the other by the Postmaster-General. With regard to future scales, the Postmaster-General has agreed to return to the local authorities such sheets as may be required from time to time for the purpose of having them made up to date. The purchase of these plans will cost £50, and their completion will employ a temporary assistant at 30s. a week for three months. The committee recommended that the foregoing expenditure be sanctioned subject to the full conference of local representatives approving the arrangement come to.

This recommendation was also adopted.

Glasgow.—A decision has been given by Mr. R. Jackson, assessor of railways and canals, on the question of the rating of the Corporation tramways.

Mr. Jackson states that it is difficult at such an early stage of the development of electric tramways to determine "the probable annual

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average cost of repairs, insurance and other expenses necessary to maintain the undertaking." Having examined the published accounts of the Tramways committee, and given due weight to the representations of parties and to decisions bearing upon the questions in dispute, he thinks that the deduction to which the Corporation were entitled in respect of expenses (including rates and taxes) specified in sec. 37 of the Poor Law Act, 1845, from the gross rent or value of the undertaking for 1903-4 should be 36 per cent. of said gross rent or value. The decision means a saving to the Tramways department of about £4,000 per annum.

Gravesend.—In consideration of extra services, the Council have granted their electrical engineer (Mr. C. F. McInnes) an honorarium of 50 guineas.

Grays.—The salary of the Council's electrical engineer (Mr. E. D. Long) has been increased by £25 per annum.

In future consumers are to have the option of being charged at a flat rate of 5d. per unit, or 7d. and 3d., against 7d. and 4d. as heretofore.

Hammersmith (London).—A report upon the position of the electricity department was presented to the Council on Wednesday by the borough electrical engineer (Mr. G. Gilbert Bell), in which it is stated that the capacity of the present plant is only 50,000 8 c.p. lamps, and that there is a practical certainty of this being exceeded during the coming winter.

Mr. Bell thinks it would be wise to plan a complete scheme before proceeding with any portion of the extensions, so that the present and each future extension would form a portion of one large station capable of generating current in the most economical manner. He suggests the building of an entirely new boiler house to contain 12 boilers with economisers, forced draught apparatus, feed pumps, air and water heaters, &c., these boilers delivering superheated steam into an engine room built at the north end of the boiler house and forming a continuation of the present engine room where the new generating machinery will be fixed. There would be room for another boiler house, and a further extension of the engine room would form the completed generating station so far as the present site would allow. That was upon the assumption that the turbine generating sets are found to be satisfactory, in which case the arrangement would, he thought, enable them to instal machinery having a total capacity of 17,000kw. when completed. He estimates that a higher ratio of increase must be allowed for in coming years owing to the lower rate at which current will be supplied inducing a greater demand. It was necessary to commence carrying out the following section at once—viz., two boilers capable of supplying a total of 40,000lb. of steam per hour, with the necessary forced draught apparatus, feed pumps, economisers, air and feed water heaters, steam piping, &c., and two generating sets giving an output of 1,500kw. each under normal load. Those sets could easily be installed if it was decided to have steam turbines instead of slow-speed reciprocating engines, but if turbine manufacturers are unable to offer any advantages over slow-speed engine builders, and it was decided to adopt a duplication of present sets, then it would be necessary to extend the present engine room in order to accommodate two sets of that size. Those two sets would more than double the present capacity of the station. Mr. Bell estimates the probable cost of immediate requirements would be as follows:—Two boilers (including brickwork, feed water heater, economisers, forced draught plant, feed pumps, piping, &c.), £12,100; two 1,500kw. steam turbines, £20,000; ash conveyor hopper, feed water reserve tank, battery, boosters, foundations, steel chimney, flues, extension of condensing main, &c., £5,900, contingencies, £2,000; total, £40,000. He suggests that the specification be an open one in order to allow contractors to quote for various types of plant under strict guarantees.

Consideration of this report and of a recommendation by the Electricity committee for its adoption is postponed.

In another report Mr. Bell states that at present the electrical department

Has several consumers whose accounts for electricity amount to over £600 per annum each, and, as most of those are largely extending their works, the question of taking the whole of their power supply from the department or putting down their own plant is receiving consideration. Therefore he considers it an opportune moment to give every inducement to those large consumers to take further supplies from the department, and he suggests offering substantial discounts when the accounts reach a certain sum per annum. 1½d. per unit without discounts (Mr. Bell continues) does not compare very favourably with gas or steam for large powers constantly working, so that the department had to rely entirely upon the subsidiary advantages (which are slight so far as large consumers are concerned) for the balance to be in their favour. For small consumers, who only use their motors for short periods during the day, 1½d. per unit was a reasonable price, but for large consumers, whose load was practically steady throughout the regular working hours, greater advantages must be offered to induce them to increase their consumption.

Power was given the committee to negotiate special agreements for the supply of electricity in bulk to large consumers for power upon the following terms:—

Supply to be given at a uniform rate of 1d. per unit, winter and summer alike, for a minimum period of five years on the understanding that the whole of the consumer's power supply is taken from the Council, the minimum amount of current consumed to be 200,000 units per annum, of which the consumption for lighting must not exceed 10 per cent. In order to induce present consumers to continue increasing their demands for electricity for power at the existing price (1½d. per unit) the following discounts be allowed: 5 per cent. when the electricity account reaches £250 per annum, 10 per cent. on £500, 15 per cent. on £750, 20 per cent. on £1,000, 25 per cent. on £1,250 and 33⅓ per cent. on £1,500, each year to be considered separately and no agreement to be made for more than one year.

It was resolved to obtain, at a cost of £124. 10s., an Andrews' discriminating transformer for the protection of duplicate feeders.

A motion that the arc lamps be kept alight all night instead of being extinguished as at present at 1 a.m. was carried.

Hampstead (London).—The capital expenditure on the electricity department has increased during the four years Hampstead has been a borough council from £160,000 to £350,000, and the consumers have increased from 1,671 to 3,600.

In regard to the plans of electric lighting mains, &c., required by the Postmaster-General at a scale of 10ft. to the mile, the Borough Council have approved the Lighting committee's recommendation that the electrical engineer (Mr. Cottam) be instructed for the present to follow the custom already adopted as they found there were no ordnance survey maps of London to the required scale, and that the sketches with dimensions at present supplied gave more information than could possibly be put on a 10ft. scale plan. (See also Fulham Note on this subject.)

The Council have decided to support Poplar Council in their endeavour to get the Board of Trade to introduce a bill to amend the nuisance clause in Provisional Electric Lighting Orders, and to give undertakers power to acquire compulsorily property adjoining generating stations.

The charge for electric current for power has been reduced to 2d. per unit for first 80 units, 1½d. for next 80, 1½d. for next 140 and 1½d. for all units above 140. The Council have also decided to enter into arrangements with contractors for letting out electric motors on hire.

In a communication received by the Council from the Postmaster-General on the subject of placing telephone lines underground, it is stated that there is an electrical objection to placing short sections of telephone line underground; that circumstances will not justify him in placing a certain proposed line underground; and that, as the number of subscribers was not likely to be large, it was improbable that the wires would look unsightly. To meet the wishes of the Council, and to preserve the amenities of the locality, he was, however, prepared, as an exceptional case, to erect light ornamental iron poles, and to paint them any colour desired by the Council.

Heywood.—The arbitration proceedings to settle the conditions of working the tramways in Heywood, Bury and Rochdale, recently acquired from the local company, will take place at the end of May.

Hove.—The Council have decided to curtail their original scheme for laying mains on the solid system in the Aldrington district, and the Board of Trade have been asked to approve the modified scheme. Negotiations are proceeding with Brighton Corporation and the Hove Electric Lighting Co. for a supply of current.

Ilford.—The Council's electric tramways carried during the first year's working 5,056,461 passengers, 1,901,551 being halfpenny, 1,829,574 penny, 394,732 three-halfpenny, 758,409 two-penny and 172,194 workmen's fares. The average daily takings were £60. 12s. 5d., and the receipts for the year were £22,587. 17s. 1d., added to £607 for advertising on the cars.

Kalgoorlie (Western Australia).—The receipts of the municipal electricity department last year were £14,414, the expenses £10,708. The station has a capacity of 536kw., and for street lighting there are 38 arcs and 520 incandescents. A new 200kw. steam turbine generator and a 250 H P. boiler are being put in to meet the increasing demand for current.

Lambeth (London).—The large hall of the Lambeth baths is supplied with electric energy by the South London Electric Supply Corp., and the Borough Council have also independent plant, but the London County Council have now made the following requirements:—

(1) That both the Council's and the company's current for the licensed portion of the building shall be entirely separated from the supply for the unlicensed portion, and shall, moreover, be controlled from separate switchboards and pass through separate main fuses; (2) that either an alternative light for the licensed portion of the building shall be installed, or that an undertaking shall be given that the Council's private plant shall be kept running whenever the hall is in use for public entertainments; (3) that a skilled electrician shall be employed on the premises at all times when the hall is in use; (4) that a few (specified) defects in the installation shall be remedied and the re-wiring of the premises completed. Orders have been given for the re-wiring of the building. With regard to the secondary supply required in (2) the Baths committee are considering the advisability of laying on gas instead of adopting what they believed would be the more costly expedient of running the Council's plant whenever the hall was engaged.

Leicester.—The first trial trip over the new municipal electric tramways took place on Wednesday.

Leigh (Lancs).—The Council have engaged Mr. G. F. Metzger to advise as to the steps to be taken for the most economical working of the electricity undertaking in the future, and the application for sanction to borrow £8,030 for electric lighting extensions has been temporarily postponed.

Light Railway.—The Light Railway Commissioners have issued the draft of the Bradwell and Castleton Light Railway order. The company has a capital of £56,000 in £10 shares, and five years are allowed for the completion of the line.

Londonderry-Moville Light Railway.—The Judicial committee of the Irish Privy Council have granted the application of the promoters for an order approving the construction of a light railway between Londonderry and Moville.

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Lowestoft.—The borough electrical engineer (Mr. G. A. Bruce) reports that there are now 485 private consumers connected to the mains, representing 23,896 8 c.p. lamps.

Manchester.—The accounts of the electricity department for the past year and the estimates for the current year have been issued.

The total expenditure for the past year was £261,850. Running charges amounted to £53,196 for an output of 28,953,459 units, compared with £48,489 for 17,400,223 units in the previous year, or 0·44d., as against 0·67d. per unit. The saving was mainly due to reduced consumption of coal, oil, waste, water, &c., and to the plant costing less for maintenance. Fixed charges were £208,654, which, divided by the aggregate of consumers' maximum demands (measured at the generating stations), equalled £12. 1s. per kilowatt, compared with £140,365 or £10. 19s. per kilowatt. The additions are principally for (*a*) distribution wages from £7,525 to £12,448, caused by the 20 new sub-stations being fully manned and used during the whole year; (*b*) rents, rates and taxes from £12,172 to £15,419; (*c*) interest and sinking fund from £76,538 to £107,727; (*d*) £25,000 for renewals. Management expenses showed a substantial reduction, from £14,615 to £11,766. The income for the last two years was, 1902-3, £178,285; 1903-4, £246,457; increase £68,172. From the sale of current for power the income was £13,830, or £1,766 less than last year, notwithstanding the increase of 766,511 units in the quantity sold, which was due to the reduction in price.

The estimates for the current year put the increased sale of current as follows:—On lighting, 20 per cent.; on power, 35 per cent.; on traction, 7 per cent. It is expected that £25,000 further will be available for transfer to renewal suspense account. On capital account the committee propose to spend £10,600 on buildings and machinery at Dickinson-street, £4,300 at Bloom-street, £82,000 at Stuart-street (building, machinery, railway, &c.) and £42,700 on buildings, transformers, &c., at distributing stations. £45,000 is down for mains, £5,000 for meters and £3,500 for motors, a total of £193,100 £54,000 is needed for sinking fund, £66,500 for interest, £19,130 for rents, rates and taxes, £23,430 for repairs, maintenance and renewals of buildings, machinery and mains, £40,950 for coal, £8,020 for oil, waste, water, engine-room stores, &c, £14,700 for wages and salaries, £13,400 for distribution cost and £6,650 for management.

The Tramways committee estimate that the traffic receipts will this year amount to £635,583, making, with miscellaneous revenue (including payments from Salford) of £5,082, a total of £640,665. For the year ended March 31, the approximate income was £611,830. 12s. 3d. It is estimated that this year's expenditure will be £434,903, including power expenses £110,563, traffic expenses £211,021, rent of tramways £21,390, repairs and maintenance £51,054, general expenses £39,875. Interest on loans, &c., require £50,033, sinking fund £34,822, renewals £51,600, depreciation and reserve £19,307, leaving a surplus of £46,000. Last year's expenditure was £191,880. 17s. 9d. On capital account the expenditure was £356,493, including land and buildings £4,400, cars and car equipments £67,000, permanent way, &c., £7,500.

Middlesbrough.—The Council have declined a recommendation to adopt a flat rate of 4d. per unit for electric current.

Motormen's Wages.—The North Eastern Railway Co. have come to the following arrangement as to the wages and working hours of motormen on their new electric trains:—

1. The work of motormen shall be retained in the locomotive department.
2. Engine drivers who feel disposed to apply for transfer from steam engines to the motors shall be accepted, and be paid the maximum rate for motormen.
3. The terms of pay and service shall be as follows:—First year, 32s. per week; second year, 34s.; third year, 36s.; fourth year, 39s.
4. Uniform to be supplied by the company, the day to be a 10 hours one, each day standing by itself, and time and a quarter to be paid for overtime.

Municipal and County Club.—The Lord Mayor of London will be the guest of the evening at the house dinner of this club to be held at the Club House, Whitehall-court, on May 19.

Municipal Telephony.—A difficulty has arisen in regard to intercommunication between the Swansea municipal telephone and the National Telephone Co.'s services. The Corporation claims the right to have its telephone system linked up with the National, the subscribers now reaching the number entitling the Corporation to intercommunication facilities. The company, however, insists on examining the Corporation's books, with a view to checking the number of subscribers, and this the Corporation will not agree to, as the Post Office authorities have accepted its figures. The Corporation have decided to lay cables between the company's and the town's exchanges, and should the company still maintain their present attitude, the Corporation propose to apply for a mandamus to compel them to grant the facilities asked for.

Notice of motion has been given by Bailie Shaw Maxwell that Glasgow Corporation departments (other than the Fire Brigade and Police offices) requiring telephones should take them exclusively from the Corporation telephone department.

Newcastle-on-Tyne.—The chairman of the Tramways committee (Councillor Cail) and Councillor Gillespie have resigned membership of the committee:—

It appears that the committee appointed six representatives to attend the conference of municipal authorities on running powers (reported in another column) and Messrs. Cail and Gillespie, who were not chosen, then resigned their seats.

Newton Stewart.—After considering an electric lighting scheme prepared by Mr. John Gordon of Glasgow the Council decided to ascertain whether a company would undertake the work.

Norwich.—To give the Electricity committee an opportunity of experimenting with street electric lighting notice has been given to the British Gas Light Co. of intention to purchase the ordinary street lamps in several thoroughfares.

Penrith.—The Council are proceeding with their electric lighting scheme, and application has been made for sanction to a loan.

Perth.—The Council have disapproved the action of the Special Provisional Order committee in adding a clause for borrowing £10,000 for tramways.

Poplar (London).—Cable extensions, estimated to cost £2,367, have been authorised by the Council.

Postal Telegraph Clerks' Association.—At the annual conference of this association which concluded its sittings at Liverpool a few days ago.

Mr. J. Andrews, the president, in his address, said the telephone service was represented at the conference for the first time. Referring to the appointment of a committee of business men to inquire into the wages question, &c., he remarked that it was admitted that the telegraph service was not conducted on business lines or for making large profits, but with a view to the benefit and convenience of the public. In that case there seemed no necessity to pick a jury of business men to inquire into the sufficiency of wages. What they asked for was a committee of the House of Commons. While the official witnesses had access to all necessary information the men were refused the same privilege.

Resolutions were passed urging the Postmaster-General to abolish the practice at certain offices of compelling operators of both sexes to enter in the time book all reliefs from the instrument room, and that not less than 30 minutes' relief should be allowed to telegraphists on all duties of eight hours, irrespective of any other privileges granted, and protesting against the entire abolition of meal reliefs on certain divided attendances, &c. Another resolution was passed protesting against the continued refusal of the Postmaster-General to restore the £190 maximum promised to London and other telegraphists; against the widespread stagnation in promotion, suggesting revisions at intervals of not more than three years; against the passing over of competent men for promotion and a refusal to state the reasons or allow access to official endorsements; against the refusal to concede risk allowances to counter telegraphists; against the taking in secret of departmental evidence before the Wages committee; and reaffirming the previous decision of the Association to press for the appointment of a Select committee of the House of Commons to investigate these and all other causes of dissatisfaction in the postal telegraph service.

A resolution was adopted expressing the opinion that the time had arrived when the charge for inland telegrams should be 3d. for 12 words and ½d. for each additional word. It was also decided to ask for a weekly half holiday for telegraphists and for a calendar month's annual leave for all who had reached the salary of £150 per annum.

(Altogether the conference appears to have been engaged in a comprehensive review of the P.O. telegraph situation. But what particular right has such a body as the Telegraph Clerks' Association to advise on the question of 3d. telegrams?)

Railway Electrification in Australia.—Mr. T. Bent, the new Premier of Victoria, has consulted a local electrical engineer as to the conversion of the suburban railways and tramways to electric traction. Preliminaries for a similar conversion of the South Australian lines are being arranged by the Premier, Mr. Jenkins.

Railways in West Africa.—The subject of the electrical working of narrow gauge and other railways is one which is receiving much attention just now in electrical circles, and the following particulars concerning some of the principal lines of railway in West Africa will prove interesting. They are extracted from a Paper read by Mr. F. Shelford before the Colonial Institute on April 12:—

In Sierra Leone a line 222 miles long has been nearly completed, traversing the Colony from west to east, and forming probably the longest continuous length of railway of 2ft. 6in. gauge in the world. In Lagos a 3ft. 6in. gauge line, 125 miles in length, has connected up the three largest towns on the West Coast—Lagos, Abeokuta, and Ibadan. On the Gold Coast a line of 170 miles, of the same gauge, has placed Kumasi, the capital of Ashanti, within 16 days of Great Britain, and the French authorities have connected St. Louis and Dakkar by rail, and are proceeding with metre-gauge railways connecting Kayes and Koulikoro, in Senegal, Konakry and Kouroussa, in French Guinea, and Kotonou and Paouignau, in Dahomey. The Belgians have already connected Matadi and Leopoldville with a 2ft. 6in. gauge, and are proceeding with extensions.

Ramsgate.—The Board of Trade have granted a provisional electric lighting order to the Ramsgate and District Electric Supply Co. which revokes the Corporation order of 1900. The Corporation can acquire the undertaking (on 12 months' notice) at the end of seven years, the price to be value of the undertaking as a going concern, to be ascertained by arbitration.

Rotherham.—The "Advertiser" of the 16th inst. contains some notes on local topics by a contributor who signs himself "Vulcan," and though we take no exception to the literary merit of the contribution it is clear that the writer's knowledge of electrical matters is limited. In his efforts to prove that the Corporation are ill-advised in substituting electric for gas lighting at the workhouse he

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confuses the capital charges with the works costs of the electricity department. It is inconceivable that such ill-informed criticism can have any effect upon the Council, who appear to have secured a good customer in the workhouse authorities, as they will take a minimum of 30,000 units per annum at 3d. per unit. In a report recently prepared by the borough electrical engineer (Mr. E. Cross) upon the proposal to extend the mains to the workhouse it was stated that the works costs for generation of current during the past year was not much more than ½d. per unit. If "Vulcan" had known more of the subject upon which he has thus ventured an opinion he would have seen that the "deal" with the workhouse authorities is one which is likely to considerably benefit the Corporation electricity undertaking. The ratepayers, we feel assured, will see the matter in this light. We regret to see such an able journalist as "Vulcan" devoting his talents to obstructing progress.

Southampton.—The Council have reduced the price of current to the Tramway committee from 2¼d. to 2⅛d., and for private lighting have adopted a flat rate of 4½d. to consumers on the 200-volt circuit.

Stirling.—The Town Council have ordered a report to be prepared upon the proposal to adopt electric traction on the tramways within the burgh and on to Bannockburn, in addition to the report on the electrification of the entire line from Bridge of Allan to Bannockburn.

Baillie Wylie said that £21,000, which the tramway company asked for their undertaking, would be a load on the capital expenditure from which there would be little or no return, as the existing tramways would be of no use.

Stoke Newington (London).—The Borough Council have agreed to pay Messrs. Talbot and Stevenson a fee of 50 guineas for advising them upon electric lighting matters, a commission of 2½ per cent. for drawings, specifications, &c., and a further 2½ per cent. on capital outlay for supervising the work; subject to the condition that, if further work is proceeded with, half the fee of 50 guineas is to merge into any commission that may become payable.

No objection will be offered to the use of the conduit system on the London County Council tramways in High-street, but the Council consider the necessary widenings should be paid for as a Metropolitan improvement.

Stourbridge.—An inquiry was held on Thursday last into the application of the District Council to borrow £16,000 for electricity supply.

The Town Clerk (Mr. W. W. Goddard) said a provisional order was obtained in 1899. The scheme was delayed by litigation with the owner of the site. The destructor portion of the scheme came to a head last autumn, and, as the result of an inquiry, the Council received sanction to borrow £4,750 for a destructor, £750 for purchase of a site, £250 of which was to be allocated to a site for electricity works. The Council had under consideration a proposal for allowing a company to contract for the erection of a station and supply current for a period of years, but a decision was only arrived at on Aug. 31 last, when it was decided to apply for sanction to borrow £16,000 for an electric lighting scheme prepared by Mr. J. B. Clarke, who was appointed as electrical engineer at £200 a year for three years and expenses for plans and specifications and attendance at the inquiry. Tenders had been obtained, but contracts had only been entered into provisionally.

Evidence of ratepayers in support of the application was taken.

Mr. S. Fiddian opposed the scheme as he contended it would mean a very serious loss to the town and they had distinct offers before them by the Midland Electric Corpn. for Power Distribution who offered to supply the Council with electricity in bulk at a reasonable figure. The corporation had laid mains to Stourbridge boundary on both sides, and had quoted 3d. per unit on the maximum-demand system and 0·825d. per unit for anything over a stipulated consumption. In regard to the possibility of the British Electric Traction Co. purchasing power from the Council for their Kinver line, he had it on the authority of the manager of that company that within the last fortnight an agreement had been signed for the Midland Electric Corpn. to provide power for that company. There were practically no works or offices within the compulsory area that they could supply; the demand would depend on shopkeepers and a few private residents. Their largest factory had its own electric lighting plant. Gas was extraordinarily cheap at Stourbridge (2s. per 1,000 for power and 2s. 8d. for light).

The Inspector (Mr. F. H. Tulloch) said, strictly speaking, the Council would not be entitled to spend any of the £16,000 on mains alone, unless they went in for the whole scheme. Should the Council desire to do that, they would have to apply to the Local Government Board, who would decide whether or not a second inquiry was necessary. He intimated that, in view of a recent amended offer by the Midland Electric Corpn., and the nature of the opposition, it appeared to him that the whole subject required further thrashing out.

Mr. Sellick said that a serious loss would occur if now the Council could not put down electric generating plant in conjunction with the destructor works. A special boiler had been installed in connection with the destructor solely with a view to use in the generation of electricity.

The Electrical Engineer (Mr. Clarke) said the boiler at present in position in connection with the destructor was large enough to do the present estimated output for 12 months.

The Inspector: If the electrical works are not established, do I understand there will be a loss on the destructor in consequence?

Mr. Clarke: The loss will be that we shall have no revenue from the steam the destructor is able to generate.

The Inspector thought all these matters should be carefully considered by the Council, and if anyone could throw fresh light on the subject he should be glad to listen. He wanted the Council to give consideration to the terms of the letter which had been handed to him. They must weigh it up carefully. He should, he thought, tell his Board that the Council ought to know more about the offer of the Midland Electric Corpn. before a decision was come to.

Telephone Conference.—The Court of Common Council (City of London) has authorised the Streets committee to arrange a conference at the Guildhall of representatives of local authorities in the London telephone area to consider the proposed purchase by the Government of the National Telephone Co.'s undertakings.

Torquay.—Mr. H. Lancaster, manager of the Dolter Electric Traction Co., maintains (in a communication to a councillor) that the agreement between the company and the Council is not invalidated by being struck out of the company's bill now before Parliament. The company objected to the special electrolysis clause. Mr. Lancaster traverses the statement that the motor buses at Eastbourne are working satisfactorily and quotes figures which put the working cost of the buses at 1s. 1½d. per mile run, whereas tramcars, carrying four times as many persons, only cost 6d. per car-mile, exclusive of capital charges.

Uganda.—An interesting report on the Uganda Railway, prepared by Mr. A. E. Cruickshank, traffic manager of the railway, has recently been published. Mr. Cruickshank concludes his report with the statement that light feeder railways are badly required in the districts served by the Uganda Railway. These light lines would open up large tracks of splendid country. Mr. Cruickshank suggests that 10 or 20 miles constructed yearly on economical lines would prove a profitable enterprise, as the districts along the route are thickly peopled.

West Bromwich.—An inquiry was held here last week into the application of the Council for permission to borrow £2,998 for electric lighting extensions.

Wireless Telegraphy.—After a number of experiments the Consolidation Coal Co. of Baltimore, U.S.A., have equipped their steamers with apparatus for the working of wireless telegraphy on board. The vessels are employed in towing coal barges from Baltimore to Boston and other parts in the north, and the apparatus is designed to keep the vessels in constant communication with the shore by means of the wireless stations along the coast from Annapolis, Maryland, to the Nantucket lightship. It is said that the system is being worked effectively by the masters of the steamers without expert assistance.

Workhouse Lighting.—Newcastle-on-Tyne Guardians are adopting electric lighting for the aged and infirm wards and hospital at the workhouse, and also in new buildings. Current will be taken from the Newcastle and District Electric Supply Co.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Manchester Waterworks committee invite tenders for the supply, delivery and erection at their Longdendale works of one 90 B.H.P. turbine with direct coupled dynamo, switch and distribution boards, sluice and regulating valves, &c.; four electric motors with starting switches, lead-covered feeders, junction boxes, &c.; overhead equipment of existing railway track, rail bonds, electric locomotives, &c.; switch and distribution boards, conductors, incandescent lamps, &c. Tenders to chairman, Town Hall, Manchester, by 28th inst.

The Metropolitan Borough of *Hackney* invite tenders for electricity supply mains (feeders and distributors). Specifications, &c., may be inspected at the offices of the consulting engineer (Mr. Robert Hammond, M.Inst.C.E.), 64, Victoria-street, Westminster, S.W., and may be obtained on and after May 4. Tenders to the deputy town clerk (Mr. W. A. Williams), Town Hall, Hackney, N.E., before 4 p.m. May 26. Further particulars are given in an advertisement.

Glasgow Corporation invite tenders for supply and erection of four sets of 800kw. dynamo panels. Specifications, &c., from the chief engineer (Mr. W. A. Chamen), 75, Waterloo-street, Glasgow. Tenders to town clerk (Mr. J. G. Monro), City-chambers, Glasgow, by May 9. See also advertisement.

London County Council require tenders for the following switchgear—viz., (*a*) one extra high-tension three-phase board with operating table and instrument board, (*b*) one low-tension combined direct-current and three-phase board, (*c*) one combined extra high-tension and low-tension sub-station board, and (*d*) one extra high-tension and low-tension transformer board, and for the erection and connecting up of the same at the Council's electricity generating station at Greenwich. Tenders to Mr. G. L. Gomme, County Hall, Spring-gardens, S.W., by May 17.

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Poplar (London) Borough Council invite tenders for the supply of cables and the supply and erection of a battery. Further particulars, with specifications, &c., from the borough electrical engineer (Mr. Percy N. Hooper), Glaucus-street, Bromley-by-Bow. Tenders to the town clerk (Mr. Leonard Potts), Council Offices, High-street, Poplar, by 9 a.m. May 7. See also advertisement.

Birmingham Public Works committee invite tenders for supply and delivery of 1,000 tons 7in. tramway rails (British standard section No. 4) with all necessary fishplates. Drawings may be seen and specifications obtained from the city engineer and surveyor (Mr. John Price), to whom tenders by 25th inst. See also advertisement.

The Building Committee of Visitors of Monmouthshire Asylum, *Abergavenny*, require electric lighting schemes for the institution and tenders for carrying out same. Particulars from the medical superintendent (Dr. James Glendenning). Tenders (addressed Chairman of Committee) to the asylum by 10 a.m. May 24. See also advertisement.

Cleckheaton District Council invite tenders for the supply and erection of one 350kw. steam generator. Specifications, &c., from the electrical engineer (Mr. A. Pickersgill), electricity works, Cleckheaton. Tenders to the clerk (Mr. J. Armitage), Town Hall, Cleckheaton, by May 2. See also advertisement.

Dublin Lighting committee invite tenders for the supply and erection of a steam-generating three-phase extra high-pressure set of plant, consisting of Belliss engine and condensing plant combined with 1,500kw. Dick-Kerr, E.C.C., Oerlikon or Westinghouse alternator, steam and exhaust piping and extension to switchboard. Specifications, &c., may be seen at the offices of the city engineer (Mr. Spencer Harty), City Hall, Dublin, and at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, London, S.W., after 22nd inst. Tenders to the chairman, 8, Cork-hill, Dublin, by noon May 9. Further particulars are given in an advertisement.

Kilmarnock Corporation invite tenders for tramway permanent way construction, excavations, concrete foundations, steel rails, fishplates, and special work, paving, &c. Copies of specification, forms of tender, &c., after April 18, from the town clerk, Mr. W. Middlemas. Specifications and drawings can be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, London, S.W. Tenders to the town clerk's office before noon May 17. See also advertisement.

Govan Town Council invite tenders for 12 months supply of engine room stores, oil, &c., cables, cable accessories, bitumen, meters, house fuse-boxes, arc-lamp carbons, joint-boxes, motors, motor starters, iron castings, cast-iron pipes, ironmongery, paints, &c. Schedules and forms of tender from the burgh electrical engineer (Mr. T. C. Parsons), Helen-street. Tenders to the town clerk (Mr. A. Macdonald), Town Hall, Govan, by April 26. See advertisement.

The Magistrates of the City of *Utrecht* (Holland) invite tenders for the supply and laying of a complete cable network, consisting of feeding and distributing mains, joint boxes, service boxes and other accessories. Tenders on prescribed forms, and addressed to the Magistrates of the city, must be delivered before May 31. Specifications and forms of tender may be obtained at the town clerk's office, Town Hall, Utrecht, on payment of 1s. 4d. See also an advertisement elsewhere in this issue.

The directors of the *Great Western Railway Co.* require tenders for the supply and erection of four 200kw. and 10 400kw. motor-generators (three-phase h.-t. to continuous-current l.-t.); four natural-draught cooling towers; electrically and hand-driven overhead travelling cranes and runways; and coal and ash conveyors, coal hoists and ash hoppers. Tenders to secretary (Mr. G. K. Mills), Paddington Station, London, W., by April 26.

Heckmondwike (Yorks.) Electric Lighting committee invite tenders for feed pump and pipe work, steam traction generator, water-tube boiler, main switchboard panels, induced draught apparatus and underground feeders. Plans, &c., from and tenders to the consulting and resident engineer (Mr. G. H. Carter, A.I.E.E.) by April 26.

The Council of the Metropolitan Borough of *Hammersmith* invite tenders for the supply of two 1,500kw. turbine or slow-speed engine generating sets with condensers, and high-pressure steam boilers with superheaters capable of evaporating 40,000lb. of steam per hour. Tenders to the Town Hall, Broadway, Hammersmith, by 4 p.m. May 18.

Burslem Corporation invite tenders by noon May 14 for supply and erection of electricity generating plant, including boilers, engines, dynamos, switchboard, cables, arc lamps, accumulators, and refuse destructor plant.

The Urban District Council of *Royton* and *Crompton* invite tenders for permanent way construction. Tenders to chairman of Tramways committee by noon 30th inst.

Bradford Corporation invite tenders for constructional ironwork for their Valley-road electricity works. Tenders by May 2.

Aberdeen Electric Lighting committee invite tenders for surface condensing plant, air pump and piping. Tenders to Mr. J. Alex. Bell, Electricity Works, Millburn-street, Aberdeen, by noon April 30.

Wallasey District Council invite tenders for condensing plant. Tenders by May 7 to Mr. H. W. Cook, Public Offices, Egremont, Cheshire.

Tynemouth Corporation invite tenders by April 30 for service fuses.

Buenos Ayres Municipality invite tenders up to May 30 for the construction of a system of overhead electric tramways between Buenos Ayres and Ortuzar, Devoto and General Urquiza. The conditions and other particulars can be seen at the Municipal Public Works Department, Buenos Ayres.

The Director of the National School of Industry, *Buenos Ayres*, has been authorised to spend the sum of about £1,250 in the purchase abroad of physical, mechanical and chemical apparatus, &c., and the Director of the National Chemical Office at Buenos Ayres (Dr. Luis Ruiz Huidobre) is coming to Europe with a view to the purchase of apparatus and materials for the use of the chemical laboratories over which he presides. Nearly £1,800 has been voted for these requirements.

The "Madrid Gazette" for April 16 contains the conditions of tender for the maintenance and working of the submarine telegraph cables belonging to the Spanish Government between Cadiz and Teneriffe, and for certain subaqueous cables in the Canaries; also for the laying of three new telegraph cables (*a*) between Barcelona and Mallorca, (*b*) between Tangier and Ceuta, and (*c*) between Charafinas and Nemours. Also for the repair of the existing telegraph cable between Tangier and Terifa. Tenders for these contracts are to be sent in within 60 days of April 16 to the Director of Posts and Telegraphs, 10, Calle de Carretas, *Madrid*. Specifications and other information concerning these contracts are given in the "Gazette."

The "Madrid Gazette" for April 13 contains an order authorising the grant of a concession for the construction and working of a tramway for goods and passenger traffic from Vallirana to Barcelona (*Spain*).

The "Madrid Gazette" for April 15 announces that tenders for a concession for the construction and working of an electric tramway from Ubeda to Santuario de la Yedra, Jaen (*Spain*) will be adjudicated on June 20. Further particulars are given in the "Gazette."

Tenders are invited by the municipality of San Luis Potosi (*Mexico*) for the electric lighting of the city by not less than 150 arc lights, to be in operation by the end of the year. The contract will be for 15 years. Deposit by successful tenderer, $5,000. Tenders by May 15.

TENDERS RECEIVED AND ACCEPTED.

Loughborough Town Council have received the following tenders for a storage battery:—

	Supply of battery.	Maintenance.
Pritchetts and Gold (*accepted*)	£1,100 0 0	£65 0 0
Watkin Bros.	1,510 0 0	90 0 0
A.B.P. Accumulator Co.	1,320 13 0	131 0 0
W. O. Roper & Co.	1,208 0 0	120 0 0
Tudor Accumulator Co.	1,174 0 0	70 0 0
D. P. Battery Co.	1,140 0 0	..
Electrical Power Storage Co.	1,114 0 0	80 0 0
Hart Accumulator Co.	1,030 15 0	81 10 0
Chloride Electrical Storage Co.	1,000 0 0	120 0 0
Sanders, Rehders & Co.	972 2 0	75 18 0
A. Kramer	966 0 0	80 0 0
British Accumulator Co.	917 13 0	49 12 6

The D.P. Battery Co. quoted for maintenance from 5 to 8 per cent. on amount of tender, and offered as an alternative free maintenance for two or three years.

Wimbledon District Council have accepted the following tenders for stores for the electricity department:—

F. Bird & Co., engine room stores; Callender's Cable Co. and St. Helens Cable Co., cables; Callender's Cable Co., British Insulated and Helsby Cables (Ltd.) and Prestwich and Burt, joint boxes and jointing materials; British Westinghouse Co., transformers; Electrical Co., meters; W. H. Willcox & Co., lubricating oils; British Thomson-Houston Co. and General Electric Co., incandescent electric lamps; General Electric Co., arc lamp carbons.

Hanley Corporation have accepted tenders from the British Westinghouse Co. for a 500kw. steam alternator at £3,162; from Bertrams Limited, for condensing plant at £495; and from A. Bolton & Co., for superheaters at £388. Nineteen firms tendered. Five firms tendered for turbo-alternators, and 14 for reciprocating engines. Six transformers are to be purchased at an estimated cost of £245.

St. Pancras (London) Council received the following tenders for two 1,000kw. steam turbine-dynamos to replace four of the old steam dynamos at King's-road station:—

C. A. Parsons & Co. (*accepted*)	£14,000
Do. (alternative)	12,495
Richardsons, Westgarth & Co.	15,012
Willans and Robinson	13,706
British Thomson-Houston Co.	12,580

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Brighton Corporation have accepted the following tenders for the telephone department :—British Insulated and Helsby Cables (Ltd.), cables at £2,613. 5s. 6d.; Messrs. W. C. Yuille & Co., 867 lengths of cast-iron pipes at £205. 18s. 3d. There were three tenders for the cables and five for the pipes, the lowest in each case being accepted.

The Metropolitan Asylums Board have accepted the tender of Mason, Cash & Co. for the installation of fire alarms and telephones at Leavesden Asylum at £294. There were 23 tenders, varying from £294 to £960, the covering estimate of the engineer-in-chief being £450.

Worcester Corporation have accepted the tender of the Nevile Engineering Co. for the erection of an iron platform and staircase for the switchboard at Powick generating station at £90, and that of Electromotors Limited for the supply of motors on the hire-purchase system.

Bruce Peebles & Co. have received an order from Burton-on-Trent Corporation for a 500kw. single-phase alternator for direct coupling to a Willans central-valve engine, and from the East Rand Proprietary Mines for a 250kw. direct-coupled set.

Warrington Corporation have accepted the tender of the British Thomson-Houston Co. for the supply of electric motors for 12 months at schedule prices, and that of Johnson and Phillips for paper-insulated cables at £225. 10s. 8d.

Ilford District Council have accepted the tender of the British Thomson-Houston Co. for the supply of B.T.-H. Edison incandescent electric lamps for 12 months ending March 31, 1905, and for the supply of O.K. ampere-hour wattmeters for the same time.

Gravesend Town Council have accepted the following tenders :—Reason Mfg. Co., for demand indicators; Electrical Co., for incandescent lamps, &c.; Ferranti Limited, for meters; W. H. Willcox & Co., Stone & Co. and F. Bird & Co., for engine-room stores.

Pontypridd Council have accepted the tenders of the South Wales Electrical Co., R. Alger & Sons, Arnold & Co. and Bedford and Gray for wiring premises in the district on the prepayment system.

Todmorden Corporation have accepted the tender of Priestland and Ryland for the erection of electricity works and refuse destructor buildings, and that of Pulman & Sons for ironwork.

The tender of Mr. Geo. Holloway has been accepted by Handsworth District Council for the reconstruction of the tramways for electric traction at £9,945.

Watford General Hospital Board have accepted the tender of H. Downer for wiring and fitting up the hospital for the electric light at £379. 12s. 9d.

The tender of the Lancashire Dynamo & Motor Co. has been accepted by Salford Corporation for 12 months' supply of motors of 5 H.P. and upwards for the third year in succession.

Lowestoft Council have accepted the tender of Mr. W. Vaux for a tramway tower waggon at £75.

Leek Council have accepted the offer of the National Telephone Co. for an installation of fire-call bells at an annual rental of £11. 5s.

Birtley Iron Co. have placed an order with Bruce Peebles & Co. for electrically-driven haulage gear.

BUSINESS NOTICES.

The Rhodes Electrical Mfg. Co. have secured from Messrs. Heenan and Froude a contract for the supply of the first lot of motors for coupling up to their ventilating fans in connection with the Underground Electric Railways Co.'s work of ventilating the Baker Street and Waterloo Railway. The Rhodes Company have laid down additional plant and tools in order to cope with the large increase in their business, and have made considerable constructional alteration at their Bradford factory. The company are now in a position to quote for any sizes of alternating-current machines up to 20 H.P., single or polyphase.

Mr. G. Braulik announces that he has been appointed sole agent in this country for the "Regina" enclosed arc lamp. A price list is now available.

Signori C. Olivetti & Cia, electrical instrument makers, have removed their establishment from Ivrea to 4, Via Broggi, Milan.

LIQUIDATIONS, BANKRUPTCIES, &c.

At Preston Bankruptcy Court last week, Gavin Knox Gilchrist, electrical engineer, St. Anne's-on-the-Sea, was examined. Debtor started business in August, 1900, as Gilchrist & Co.

In June, 1902, he disposed of his business to a company for £2,500, in 2,500 fully-paid £1 shares. Those were allotted to a lady relative, from whom he had borrowed money, and he became a director. There was no fixed salary. Liabilities £4,711. 13s., deficiency £109. 4s. 4d.

First meetings of creditors and contributories of the Electric Timber Seasoning and Preservation Co. (Ltd.) will be held 29th inst. at 33, Carey-street, London, W.C.

Claims against the British Electric Separating Co. (Ltd.) by May 31 to Mr. R. P. Pike, 35 and 36, Wind-street, Swansea.

The Argentina Electric Traction Co. (Ltd.) is to be wound up voluntarily. Mr. A Clements, 83, Cannon-street, London, E.C., is liquidator.

Sale by Auction.—Mr. Henry Sherley-Price (of Wheatley Kirk, Price & Co,) has been appointed by the Court to sell by public auction in one lot as a going concern, at the Mart, Tokenhouse-yard, London, E.C., early in May, the extensive freehold and well-equipped car-building works known as the Castle Car Works, Hadley, near Wellington, Salop, together with the fixed plant and machinery and trade connection. The works have been erected within the last five years, and were specially designed for turning out at lowest cost between 600 and 700 tramcars per annum. The plant is by eminent makers, and was laid down with every regard to efficiency and economy. An electric power station supplied the whole of the electric drive throughout the works, and elaborate heating, ventilating and lighting services are installed. There is a railway siding into the works, and a canal adjoins. The loose plant, with stock, stores, &c, must be purchased at a valuation. Further information from the receiver and liquidator (Mr. H. D. Eshelby, F.C.A., of Messrs Harmood, Banner & Son), 24, North John-street, Liverpool; of Messrs. Gribble, Oddie, Sinclair and Johnson, solicitors, 38, Bedford-row, London, W.C., or of the auctioneers, 46, Watling-street, London, E.C., and Albert-chambers, Albert-square, Manchester. An advertisement contains further particulars.

Plant for Sale.—East Ham Urban District Council invite tenders for the purchase of one 150 I.H.P. cross-compound Musgrave engine, direct coupled to a 100kw. Dick-Kerr direct-current generator. The plant may be seen at work at the generating station, and is being disposed of in consequence of alterations at the works. Information from the engineer and manager (Mr. W. C. Ullmann), Nelson-street, East Ham. Tenders to the clerk to the Council (Mr. C. E. Wilson) by noon May 3. See also advertisement.

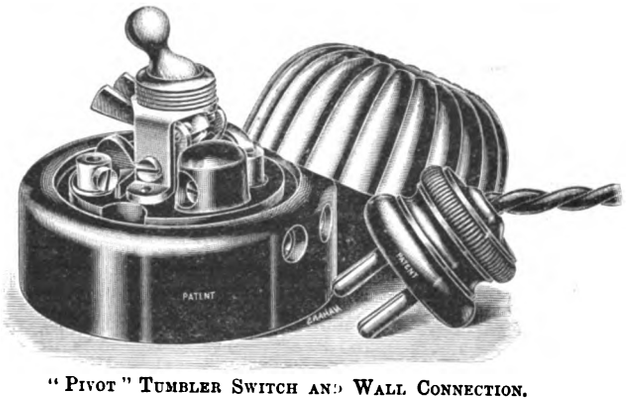
An electric lighting installation, suitable for a country house, is advertised for sale on another page. The plant consists of a J. and P. dynamo (50 amperes 135 volts), an 11 H.P. Priestman oil engine, a battery of 53 E.P.S. cells, &c., and is being removed to make room for a larger one. Applications to Messrs. Plenty & Son, Newbury, Berks.

About 300yds. of 19/16 cable, a new earth indicator, field rheostat, &c., are advertised for sale by Messrs. T. E. Evans & Co., 126, Bute Docks, Cardiff.

Messrs. Robert Lyon & Co. will offer about 4,000lb. of copper and German-silver electrical wire, cotton and silk covered, for sale by tender on Tuesday next, April 26, at their offices, 27, Cornhill, London, E.C. See also advertisement.

Offices to Let.—Exceptionally well-lighted drawing offices on ground floor in Westminster, also five rooms on second and third floors, are advertised to be let. Applications to Messrs. Fox and Preece, solicitors, 15, Dean's-yard, Westminster, S.W.

"Pivot" Combination Tumbler Switch.—The appended illustration represents the "Pivot" combination tumbler switch and wall connection for 2½ amperes and 200 volts, manufactured by



"PIVOT" TUMBLER SWITCH AND WALL CONNECTION.

Mr. A. P. Lundberg, of 477-487, Liverpool-road, London, N. At present these switches are arranged to suit the "Dot" gauge of two-pin plug, but we understand a pattern is shortly to be made suitable for the larger gauge of plug (the "Universal"). The switch movement is identical with that of the "Pivot" tumbler switch. Four substantial terminals are provided, having $\frac{5}{32}$in. holes. The two additional terminals allow the switch to be used in a number of ways. Thus it may be connected in the plug circuit or may be quite independent of it; or it may, if desired, control other circuits in parallel with the plug circuit. The switch should be found convenient for charging small accumulators through a lamp. The contacts of the plug part can be specially arranged to supply current for Nernst lamps and for similar cases where any change of polarity must be guarded against. Both in workmanship

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and appearance this new switch comes up to the high standard of excellence for which all articles made by Mr. A. P. Lundberg are well known.

Application of Electric Motors to Machine Driving.—Messrs Johnson and Phillips are issuing a small handbook with the above title. Copies of the handbook can be obtained, free of charge, by those contemplating the introduction of electric driving into their works.

Catalogues, &c.—The Electrical Co., 121-125, Charing Cross-road, W.C., forward two interesting letters from Mr. Waterland, resident engineer at Dartford., describing the results obtained with the 200 Nernst lamps which are used for street lighting at Dartford. Mr. Waterland puts the renewals in connection with these 200 street lamps at 15 burners a week. For the whole of 1903 the renewals on 188 posts averaged 8s. per post, including the cost of some renewals due to faults which occurred on the mains during the heavy rains of last summer. The lighting hours in Dartford for 1903 were 3,870, and Mr. Waterland considers that a great saving has been effected in adopting Nernst lamps in place of incandescent electric lamps for street lighting. Nernst lamps are exclusively used for this purpose at Dartford.

Mr. E. C. Koop, of Moor-lane, London, E.C., issues particulars of a new drawing apparatus, designed to enable the draughtsman to work either sitting or standing.

The Brush Electrical Engineering Co. are issuing a description of the Brush-Gutmann meter, for which the company are sole agents in Great Britain and the Colonies.

The Klein Engineering Co., of Manchester, have ready a catalogue illustrating some of the recent installations of condensing and cooling plants carried out by the company.

Messrs. W. N. Brunton & Son, of Musselburgh, Scotland, have ready a new edition of their catalogue of resistance material. We have made reference in these columns to previous issues of this catalogue, and may now state that a quantity of new data, &c., has been added to this the third edition of a useful trade list.

The Electrical Co. also forward a new pamphlet, "Handbook on Electricity Meter Testing." This is fully illustrated, and gives simple directions for using test terminals for both continuous and alternating current, formulæ for testing, hints on counting, notes on testing and apparatus for calibrating electricity meters, &c. Accompanying this pamplet is a useful 8vo. binding case, containing the company's recently published pamphlets on "Luna Arc Lamps," "Fans and Ventilators," "Incandescent Lamps," "Nernst Lamps," "Electric Fittings" and "Luna Flame Arc Lamps."

The latest illustration of "J. and P." plant issued by Messrs. Johnson and Phillips shows their installation at Barnsley electricity station.

Timothy Morris (Ltd.), Birmingham, have issued a new catalogue of magneto-electric machines, &c.

The Bath Electric Mfg. Co., Locksbrook Engineering Works, Bath, have ready a pamphlet describing a number of cheap electric resistance pieces.

Type No. 4 of Mordey's patent fuse for pressures up to 2,000 volts is described in a leaflet issued by Ernest F. Moy (Ltd.).

Pamphlets 165 and 166 of the British Thomson-Houston Co. describe and illustrate open arc lamps and electromagnetic track brakes respectively. This latter apparatus was fully described and illustrated in *The Electrician* of March 25, page 901.

Telpherage as a means of hauling light and heavy goods from place to place on extensive works premises is coming to the fore. In a pamphlet just issued by Messrs. Siemens Brothers & Co. the telpher installation at the company's extensive Woolwich works is described and illustrated. The system is particularly valuable where corners have to be negotiated or in any position where the travel is intricate. It is somewhat remarkable that this system of handling goods has not been more generally adopted at railway termini, where almost hourly passengers are inconvenienced by the passage of large trolleys, loaded and unloaded, passing backwards and forwards on departure and arrival platforms. There seems to us great waste of energy in connection with this traffic.

City of London Directory.—The 34th annual edition of this useful directory and guide to the City of London is issued by the proprietors of the "City Press," Aldersgate-street, E.C. The work has been carefully revised under new editorial management, and contains all the special information concerning the City Corporation, the City Officials, Committees, Livery Companies, &c, which have formed a feature of this work for many years. There are numerous indications that the book is corrected to date, as events of quite recent occurrence are noted. The price of the work is 12s. 6d.

A New Alloy.—Under this title a note recently appeared in *The Electrician* relating to an alloy of aluminium and magnesium (called Magnalium) which is being used in the manufacture of scientific instruments. Mr. J. Arthur Williams, of 92, Hatton-garden, London, E.C., supplies this material, and has ready printed particulars and price lists. Some samples are also available.

Imports.—The following are the values of imports to this country during March:—

Electrical machinery, £43,432 (a decrease of £1,308 compared with March, 1903); telegraph cables and apparatus, £2,512 (decrease £3,448); other electrical goods and apparatus, £68,630 (increase £631). The totals for the three months ended March 31 last were respectively £139,336 (decrease £44,935), £9,246 (decrease £13,750) and £208,060 (increase £37,026).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from April 13 to 19, with the ports of destination:—

Africa—Alexandria, £616 (including £441 telegraph material); Cape Town, £1,315 (including £175 telegraph material); Durban, £935; East London, £321; Port Elizabeth, £327. *Argentina*—Buenos Ayres, £2,594 (including £356 telegraph material); Rosario, £141 (telegraph material). *Australasia*—Adelaide, £30; Auckland, £375; Brisbane, £115; Hobart, £79; Launceston, £56; Melbourne, £305; Otago, £965; Perth, £980; Sydney, £872; Wellington, £2,971. *Ceylon*—Colombo, £94. *Brazil*—Pernambuco, £126 (and 620 cwt. telegraph wire). *China*—Shanghai, £1,833 (including £1,700 telegraph cable). *Colombia*—Santos, £660. *Denmark*—Copenhagen, £240 (telegraph material). *France*—Paris, £351. *Germany*—Bremen, £50 (telegraph material); Hamburg, £155 (including £135 telegraph material). *Gibraltar*, £36. *Holland*—Amsterdam, £30; Rotterdam, £10. *India*—Bombay, £2,150; Calcutta, £591; Madras, £237; Marmagoa, £159 (including £128 telegraph cable). *Japan*—Yokohama £1,343. *Malta*, £42. *Perim*, £22,000 (submarine cable). *Philippines*—Manila, £40 (telegraph instruments). *Portugal*—Lisbon, £30 (telegraph instruments); Oporto, £858. *St. Helena*, £150 (telegraph paper). *Seychelles*, £26 (telegraph material). *Straits Settlements*—Penang, £352; Singapore, £28. *Sweden*—Karlskrona, £210 (telegraph cable); Stockholm, £380 (telegraph cabe). Total £45,178, against £920,238 in the corresponding week last year (April 15 to 21).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PAYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1902.

25,435 O'NEIL Electric telegraphy.
26,190 BEER. Electric signalling apparatus for railways.

1903.

1,855 JUSTICE (Hogg). Wireless telegraphy.
1,995 BASTIAN and SALISBURY. The "Vapour Lamps."
3,425 LEITNER and LUCAS. Controlling electric circuits.
3,581 HOCKEN, HOCKEN and BROOKS. Cable drum.
3,863 SLUCE and CHASE. Cut-outs.
3,939 BROOKES (Betts and Thomas). Fixture studs for electric lamps and other electrical appliances.
4,077 MAYOR, GRAFTON and MAYOR AND COULSON. Armatures for alternating-current motors.
4,275 H. W. W. DIX and J. SANDFORD. Electric regulating switches.
4,413 WHITNEY. Collecting and putting to practical use the electricity from the interplanetary ether.
4,533 CROMPTON & Co. and GOLDSCHMIDT. Regulating the voltage from alternating and continuous-current generators by alternate-current excitation.
4,643 CAROLAN (G.E. Co., U.S.). Fans or blowers.
4,645 CAROLAN (G.E. Co., U.S.). Arc lamps.
4,704 HEYS (Hutchison Acoustic Co.). Telephone receivers.
4,781 APPLEYARD. Bobbins or formers for electrical purposes.
4,840 LEWIS. Indicators, announcers and similar apparatus.
5,011 MASON and BROWN. Switch for motor cycles and vehicles.
5,046 OLIVER. Arc lamps.
5,587 LATHAM and BOYES. Mouthpieces of transmitters and receivers.
5,744 FISHER. Electrical measuring instruments.
5,796 BEYREISS. Electromagnetic stopping device for shuttle embroidery and similar machines.
5,918 HEYS (Hutchison Acoustic Co.). Switch for use in charging storage batteries.
6,016 MOORES and ASHTON. Fuze boards.
6,140 WEBB. Electric ignition apparatus.
6,405 HAMILTON-ADAMS. Carbon holders for arc lamps.
6,466 STEWART and SHANKS. Electric control of pump discharge and water supply to closets and the like.
6,483 CAROLAN (G.E. Co., U.S.). Electric controllers.
6,485 CAROLAN (G.E. Co., U.S.). Reactance coils.
6,486 CAROLAN (G.E. Co., U.S.). Induction electric motor armatures.
6,489 CAROLAN (G.E. Co., U.S.). Controlling devices for air brake and other fluid pressure systems.
6,491 CAROLAN (G.E. Co., U.S.). Alternating-current motors.
6,493 CAROLAN (G.E. Co., U.S.). Electric metering systems.

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6,501 CAROLAN (G.E. Co., U.S.). Forms for winding coils.
6,954 DIAMANT. Forming lead peroxide on plates of accumulators.
6,998 CLAREMONT and STRATTON. Manufacture of standard electrical conductors.
7,134 CAROLAN (G.E. Co., U.S.). Methods of coating and impregnating porous materials with oils, varnishes or the like.
7,137 CAROLAN (G.E. Co., U.S.). Selective transmitting systems.
7,256 HAWKINS. Explosion engine commutators.
7,415 LEWIS. Two-way switch.
7,452 CAROLAN (G.E. Co., U.S.). High-tension circuit breakers.
7,454 CAROLAN (G.E. Co., U.S.). Connecting rods.
7,456 CAROLAN (G.E. Co., U.S.). Supports and casings for contactors.
7,459 CAROLAN (G.E. Co., U.S.). Arc lamps.
7,527 GROCOTT. Ceiling roses, cutouts and the like.
7,612 POCKLINGTON and SIMPLIFIED UNDERGROUND CONDUCTOR Co. Conduits.
7,899 BRITISH WESTINGHOUSE ELECTRIC AND MFG. Co. (Tilden). Prepayment electricity meters.
8,023 OLIVER. Arrangement and construction of arc lamps.
8,195 PLISSON. Electricity meters.
8,262 JOYCE. Combined bell push and fire alarm.
8,468 MINGAY. Electric lamps for bakers' ovens and the like.
8,474 LOVELACE. Electric ignition devices for internal combustion engines.
8,555 READ. Electric light wiring and casing for internal work.
8,676 CANEE. Plates or electrodes for accumulators.
9,173 NAYLOR and NAYLOR. Metal clamp for supporting standards and brackets of overhead wires.
9,264 HAYNES. Electrically-heated hand tools.
9,311 ISABELLA CHRISTINA CLARK, ALFRED JOHN DAVIES and WILLIAM LIVINGSTONE RUSSELL, executrix and executors of the estate of Alexander Melville Clark, deceased (Hartmann and Braun). Alternating current meter.
9,590 CAROLAN (G.E. Co., U.S.). Exhausting and sealing incandescent lamps.
9,649 HIRST & SON (LTD.) and HIRST. Transmitting current to tramcars, &c.
9,712 COOPER. Electric railway and tramway systems.
9,728 MENGES. Electric connecting devices applicable to lamp-holders, wall-plugs and the like.
9,832 BOEHM. Electric lamps.
10,096 GUYON. Electric ignition apparatus for gas and like engines.
10,646 SOMERVILLE and HOWARD AND BULLOUGH (LTD.). Switches.
10,927 EFFERTZ. Protective and advertising device for telephones, &c.
11,088 GUEST, KEEN AND NETTLEFOLDS (LTD.) and WAKEMAN. Arc lamps.
11,276 RODERBURG. Electrodes for secondary batteries.
11,442 VOGEL. Arc light electrodes.
14,563 BALL. Switches.
15,420 KAISER. Electrolytic production of zinc.
16,232 WEAVER. Manufacture of resistances.
17,034 DUBRETET. Induction transformer for wireless telegraphy.
21,637 PETERS. Electrical alarm clock.
22,087 DESPRADELS. Establishing electrical correspondence selectively.
24,500 WEINTRAUB. Rectifying and obtaining light from alternating currents. (Date applied for, March 23, 1903.)
24,501 WEINTRAUB. Rectifying alternating currents. (Date applied for, March 23, 1903.)
24,502 WEINTRAUB. Rectifying and obtaining light from alternating currents. (Date applied for, May 9, 1903.)
24,744 HILKIER. Thermometric devices for giving alarm in case of fire or sudden increase in temperature.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

A.E.G. ENGLISH MFG. CO. (LTD.)—Reg. April 19, capital £150,000 in £5 shares, to acquire patents, patent rights or privileges relating to electric lighting, and in particular rights for the United Kingdom in an invention known as the "Nernst Lamp," to adopt an agreement with the Allgemeine Elektricitäts Gesellschaft, Berlin (vendor company), to construct, lay down, fix and maintain cables, wires, accumulators, lamps and other plant, works and conveniences, and to carry on the business of producers and suppliers of electric light, mechanical engineers, electricians, suppliers of electricity, manufacturers of electrical accessories, &c. The subscribers (with one share each) are Franz and Felix Deutsch, C. F. de Nordwall, J. Stottner, electrical engineer, O. Loewi, manager, C. Geistorfer and S. Bensinger. First directors, Felix Deutsch, Franz Deutsch, P. Mamroth and C. F. de Nordwall.

HYDERABAD ELECTRIC LIGHT AND TRACTION CO. (LTD.)—Reg. April 13, capital £10,000 in £1 shares, to construct, maintain, develop and extend or further the construction, equipment, extension and development of tramways, tramroads and light railways, to facilitate the working and maintenance thereof, to establish, promote and finance tramway, light railway and electric light and power companies, &c. First directors, John Kerr, M.P., and G. Fleet. Reg. office, Worcester House, Walbrook, E.C.

MORTGAGES AND CHARGES.

AMERICAN ELECTRICAL NOVELTY AND MFG. CO. (LTD.)—£10,000 debentures, created March 30, 1904, have been registered. Property charged, company's undertaking and property, present and future, including uncalled capital. No trustees.

ANCHOR CABLE CO. (LTD.)—Charge reg. March 30, for unspecified amount, the instrument being stamped to cover £10,000, to Messrs. H. Drake and T. O. Callender, secured by undertaking and all the property and assets, including the uncalled capital.

KENT ELECTRIC POWER SYND. (LTD.)—Mortgage or charge on company's assets, present and future, including uncalled and unpaid capital (if any), created April 9, 1904, to secure £1,000, has been registered. Holders, Hon. J. B. Lubbock and G. C. Curtis.

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—Issue on March 30 of £10,000 5 per cent. mortgage debentures, part of series created Feb. 18, 1904, to secure £100,000. Property charged, company's undertaking and property, present and future, except uncalled and unpaid capital. Holders, T. E. Hodgkinson and J. W. B. Pease. No trustees. No previous issue of same series.

SCOTTISH HOUSE-TO-HOUSE ELECTRICITY CO. (LTD.)—Mortgage or charge, dated March 31, 1904, supplemental to bond and disposition in security (in Scotch form), dated Aug. 18, 1903, to secure £75,718. 1s. 4d. (and 6 per cent. interest) has been registered. Property charged, company's undertaking and property, including Coatbridge and Airdrie undertakings, benefit of contracts, book debts, uncalled capital, &c. Holders, County of London and Brush Provincial Electric Lighting Co.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (April 21, 1904). Price of silver 24 1/16d. per oz. (April 21). Consols 88 1/8—88 1/4 for money, 88 1/4—88 3/8 for account; 2½ per cent. annuities 87½—88 (April 21). Consols Pay Day May 5; Stocks and Shares Continuation Days, April 26 and May 10; Ticket Days, April 27 and May 11; Pay Days April 28 and May 12; Mining Share Carry-over Days, April 25 and May 9.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—The thirteenth drawing for payment of 164 4 per cent. mortgage debentures will take place at noon May 2 at the offices of the company, Electra House, Finsbury-pavement, London, E.C.

BIRMINGHAM AND MIDLAND TRAMWAYS (LTD)—At the meeting last week the chairman (Mr. C. S. B. Hilton) referred to the acquisition of the interest of the British Electric Traction Co. in certain local companies, and said that the idea of consolidating all the tramways of the district was not a new one. It was one of the first schemes taken in hand by the British Electric Traction Co., which acquired the various tramway undertakings, and converted as many of the lines as possible to electric traction. There were then six different companies operating in the district. The gauges were not uniform, some of the lines were worked by steam, some by horses, and some in other ways. The total mileage was then about 50, and to-day they had 94 miles of tramways and light railways, the majority worked on the overhead electric system. Those that were not so worked were in process of conversion. Another 23 miles of tramways and light railways were authorised, and those they hoped would be constructed shortly on the same system. In Smethwick the company had acquired from the local authority their electric lighting order, and the supply of electricity for power would, they hoped, be considerable. They were also negotiating with Oldbury Council. A contract had been obtained from Rowley Regis District Council for the erection and equipment of 2½ miles of line on a lease to the company for 21 years.

CITY OF BUENOS AYRES TRAMWAYS CO. (LTD.)—The total receipts for the year amounted to £268,307, compared with £269,443 in 1902. Working expenses were £192,260, compared with £192,799, leaving a profit of £76,847. After payment of interest, dividend to June 30, and placing £3,000 to reserve the available balance was £36,645, out of which a dividend of 4s. per share, making 8 per cent. for the year is declared.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The directors recommend a dividend at the rate of 5 per cent. per annum on the ordinary shares, tax free, for the half-year ended Dec. 31.

EASTERN EXTENSION AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—Subject to confirmation by the shareholders, the directors have declared a dividend for the quarter ended Dec. 31 last of 2s. 6d. per share, together with a bonus of 4s. per share, or 2½ per cent., making a total distribution of 7 per cent. for the year 1903, payable 5th prox. The share register will be closed from 27th inst. to 4th prox. inclusive.

NORTHWICH ELECTRIC SUPPLY CO. (LTD.)—The shareholders have decided to transfer their undertaking to the Cheshire Electric and Power Gas Co. on condition that the capital invested is repaid, with an additional sum to make up (with dividends paid) 7½ per cent. per annum, and a further 5 per cent. on ascertained value.

OSWESTRY ELECTRIC LIGHTING AND POWER CO. (LTD.)—A dividend of 3 per cent. per annum has been declared.

SOUTH LONDON ELECTRIC SUPPLY CORP. (LTD.)—During the quarter ended Lady Day 2,120,539 units of electric current were sold, realising £18,000, compared with 376,227 units and £7,305 for the corresponding quarter of 1903.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to appoint a settling day in and grant a quotation to a further issue of 10,000 £5 fully-paid ordinary shares and 10,000 4½ per cent. £5 fully-paid cumulative preference shares of the *Charing Cross Electricity Supply Corporation (Ltd.)*, and also to allow £3,599,268 5 per cent. profit-sharing secured notes (fully-paid provisional certificates) of the *Underground Electric Railways Co. of London (Ltd.)* to be quoted.

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BABCOCK AND WILCOX (LTD.)—At the meeting on Friday the chairman (Mr. John Dewrance) moved the adoption of the report given in our last issue. He said the profit of the past year had been earned in the face of the keenest possible competition and the most pressing condition of trade which had perhaps ever been known during the history of the company. They had assets and liabilities amounting to £1,173,000 nominally, but if they took this market value it would be found that the actual value of the shares amounted to considerably over £2,000,000. Their policy in the past had been to write down their assets when they had a margin above what was required to pay a good dividend until those assets stood at very much depreciated values. Goodwill stood in the books at absolutely nothing. The profit had been made by superior organisation and machinery.

BROMLEY (KENT) ELECTRIC LIGHT AND POWER CO. (LTD.)—In their report for 1903 the directors state that the lamp connections have increased from 35,743 to 47,030 8 c.p., and sale of current from £7,938 to £9,843. 3s. 8d. Large additions have been made to the generating plant to meet the increased demand. Including £147. 10s. 1d. from last year, and allowing for bad and doubtful debts, the profit was £7,143. 18s. 6d. After payment of interest, &c. (£2,845. 0s. 8d.) the amount available is £4,298. 17s. 10d. An interim dividend at rate of 4 per cent. per annum was paid in October, and a balance dividend at the rate of 6 per cent. is now recommended, making 5 per cent. for the year. £1,500 is put to reserve for renewal of plant.

CALCUTTA ELECTRIC SUPPLY CORP. (LTD.)—Subject to audit, the directors recommend payment of a dividend for the December half-year at the rate of 8 per cent. per annum, making 7 per cent. for the year.

CHISLEHURST ELECTRIC SUPPLY CO. (LTD.)—The number of equivalent 8 c.p. lamps connected at Dec. 31 last had increased from 8,329 to 10,819, and the gross revenue from £2,365 to £2,892. A dividend of 3 per cent. (tax free) is recommended, £250 being placed to reserve for renewal of plant.

GREAT NORTHERN TELEGRAPH CO. (LTD.)—The accounts for 1903 show total traffic receipts £449,170. 9s. 8d., less loss on exchange £5,202. 5s. 6d., making, with balance from 1902 (£66,598. 5s. 6d.), interest (£3,723. 14s. 3d.) and sundries (£27,218. 6s. 2d.), a total of £541,508. 10s. Expenses were £109,408. 1s. 8d. The interim dividend of 5 per cent. absorbed £75,000, and it is now proposed to pay a final dividend of 7½ per cent. (15s. per £10 share), requiring £112,500, and a bonus of 2½ per cent. (£37,500). £55,555. 11s. 1d. has been transferred to reserve and renewal fund, £5,555. 11s. 1d. to pension fund of staff, £2,500 directors' remuneration, £77,777. 15s. 7d. to dividend equalisation fund, and the balance (£65,715. 10s. 7d.) is carried forward.

W. GRIFFITHS & CO. (LTD.)—The chairman (Mr. W. A. Mitchell), at the meeting on Tuesday, referred to the trouble which had arisen over the company's contract with the London County Council. The real facts (he said) were that a foreman who had worked for them for some little time, when the contract was nearly completed, made use of materials in a manner of which the directors had no cognisance. He was discharged, and then became the medium of giving information as to what would be found if the work he had himself superintended was opened up in certain places. He then returned to the service of a competing firm of contractors. Simply because of the action of that man they were deprived of another contract for which their tender had already been recommended for acceptance. The total amount of bad work done would not have profited them to the extent of a £5 note on a contract of some £95,000. Passing to other matters, Mr. Mitchell said the directors hoped to enter into an arrangement with the proprietors of the G.B. surface-contact system of electric traction, which system had been extremely well reviewed in the technical Press. They felt sure that great benefit to their company would result. The system had undoubtedly a great future before it, and he believed he was revealing no secrets when he said that certain Corporations were preparing to adopt it for their tramways.

JOHANNESBURG.—The Johannesburg City and Suburban Tramways Co. will meet on May 30 to consider a provisional agreement for the sale of their undertaking to the Municipal Council for £150,000, payable in municipal 5 per cent. bills, redeemable before Jan. 31, 1905.

ORIENTAL TELEPHONE AND ELECTRIC CO. (LTD.)—The directors' report for the year 1903 states that, including £1,954. 18s. 9d. brought forward, and deducting £5,379, 7s. 10d. for interim dividend on the ordinary shares, the amount available is £10,523. 9s. 7d. After payment of the preference dividend a final dividend of 3½ per cent. on the ordinary shares (tax free), making 6½ per cent. for the year, is declared, against 6 per cent. for 1902, £1,500 is put to reserve and £1,737. 2s. 8d. carried forward. The Telephone Co. of Egypt, in which this company is largely interested, continues to extend its operations. The exchanges worked directly by the company continue to expand, and this has been particularly noticeable at Singapore, where an extension of the company's licence for a period of 31 years has been secured. The Indian local companies have brought increased revenues into their accounts for the year, and the Bombay Company has paid its usual dividend of 6 per cent.; the Bengal Company, to strengthen its resources, has reduced its usual dividend from 6 to 5 per cent. In order to make a commencement with the underground cabling in India, the services of a special telephone engineer were engaged to lay out plans, and to advise the board as to the best system to adopt in that country. He has completed the surveys of Calcutta and Rangoon, and is now on his way to Singapore for the same object. It has been deemed advisable by the directors that the company, at places where long leases are unobtainable, should secure its own freehold premises, so as to avoid any possibility of having to remove its exchanges after cables have been installed. This has been done in Rangoon, the Bombay Company has recently acquired land on a 99 years' lease, and negotiations are in progress at Singapore. The China and Japan Telephone Co.'s exchange at Hong Kong has made substantial progress, and an extended licence is now being negotiated with the Colonial Government. The electrical branch of the company's operations shows a considerable increase in the volume of business transacted over 1902.

PARIS.—The new municipal loan of 170,000,000 fr. for further extension of the Metropolitan Underground Railway has been covered 89 times over.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 16	1,207	+ 836	46	55,286	+ 11,243
Airdrie	,, 8	199	...	9	1,653	...
Ayr Corporation	,, 16	207	— 104	48	12,995	+ 118
Barnsley	,, 8	231	+ 57	14	2,219	- 68
Barrow	,, 8	211	+ 141	9	1,878	+ 845
Bexley District Council	,, 14	177	...	27	4,359	...
Birkenhead	,, 17	1,011	64	...	...	...
Birmingham Corporation	,, 16	969	...	15	4,351	...
*Birmingham Tramways Co.	,, 16	5,227	— 47	15	77,405	+ 8,980
*Blackburn Corporation	,, 15	774	- 317	3	2,904	+ 81
Blackpool Corporation	,, 14	533	- 1,107	2	1,979	+ 26
Blackpool and Fleetwood	,, 16	267	- 428	16	3,671	- 344
Blackp'l, St. Anne's & Lytham	,, 14	240	+ 240	24	4,126	+ 3,547
Bolton Corporation	,, 17	1,810	- 57	3	4,796	- 295
Bournemouth Corporation	,, 18	1,148	+ 341	2	2,718	+ 246
*Bradford Corporation	,, 16	3,661	- 761	§3	9,876	+ 464
Brighton Corporation	,, 17	881	- 49	2	2,344	- 112
Brisbane Tramways	Mar. 2	2,330	- 45	9	20,446	- 261
*Bristol Trams & Carriage	April 15	4,725	- 919	21	96,592	+ 3 139
*Buenos Ayres & Belgrano	Mar. 18	3,029	- 57	¶22	69,882	+ 3,186
	,, 20	3,082	+ 30			
Burnley Corporation	April 6	945	+ 222	3	3,149	+ 592
Burton Corporation	,, 17	331	...	37	12,320	...
Calcutta Tramways Co.	,, 16	R33,208	- R3,161	16	R553,185	+ R77,970
Camborne-Redruth	,, 18	111	...	24	2,610	...
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 16	6,597	- 857	16	111,392	- 588
Chatham & Dist. Lt. Rys.	,, 14	578	- 78	15	7,781	+ 1,389
City & South London Rly.	,, 17	2,704	- 360	16	49,644	- 1,171
Cork Electric Trams Co.	,, 14	434	- 44	15	5,904	- 190
Darwen Corporation	,, 15	210	- 52	2	518	109
Devonport & Dist. Trams.	,, 8	561	+ 58	14	6,494	+ 922
Dover Corporation	,, 16	201	- 29	3	550	- 57
Dublin & Lucan Railway	,, 17	102	- 55	16	1,505	+ 48
Dublin Southern District	,, 15	799	- 342	¶16	65,768	+ 432
Dublin United	,, 15	3,774	- 203			
Dudley—Stourbridge	,, 8	1,173	+ 392	14	10,722	+ 798
Dundee Corporation	,, 13	892	- 13	...	...	...
East Ham Council	,, 16	707	- 19	2	1,812	+ 54
Gateshead & Dist. Trams.	,, 8	990	+ 49	14	12,201	+ 703
Glasgow Corporation	,, 16	18,997	+ 770	46	624,690	+ 57,597
Gravesend—Northfleet	,, 8	343	+ 124	14	3,094	+ 535
Gt. Northern & City Rly.	,, 16	908	- 82	9	8,463	...
Greenock & Port Glasgow	,, 8	489	+ 16	14	6,510	+ 613
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 8	819	+ 33	14	3,518	+ 884
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 16	2,047	+ 261	2	5,003	+ 107
Ilford District Council	,, 16	426	- 79	...	...	...
Ilkeston Corporation	,, 13	119	...	22	2,734	...
Ipswich Corporation	,, 16	399	...	2	1,126	...
Isle of Thanet Co.	,, 16	424	- 202	...	...	...
Kidderminster & District	,, 8	182	+ 67	14	1,411	- 5
Kirkcaldy Corporation	,, 13	204	...	7	1,393	...
Lanarkshire Trams Co.	,, 14	562	...	15	8,591	...
Leeds Corporation	,, 16	5,124	- 719	3	17,736	+ 835
Liverpool Corporation	,, 9	10,463	+ 50	15	143,583	+ 8,272
*Liverpool Overhead Rly.	,, 17	1,629	— 194	16	24,742	+ 155
*London County Council	,, 9	11,770	+ 2,726	§1	15,864	+ 3,662
Lowestoft	,, 16	143	...	¶38	7,668	...
Manchester Corporation	,, 16	11,367	- 643	2	23,494	- 578
Mersey Railway	,, 16	1,591	+ 183	15	21,896	+ 5,857
Merthyr	,, 8	286	+ 65	14	2,759	+ 260
Middleton	,, 8	403	+ 19	14	3,615	+ 239
Nelson Corporation	,, 17	103	+ 41	3	346	+ 158
Newcastle-on-Tyne Corp.	,, 16	3,396	+ 99	15	52,296	+ 6,614
Newport (Mon.)	,, 16	448	- 7	2	1,212	+ 171
Oldham, Ashton & Hyde	,, 8	641	- 16	14	7,071	- 833
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams.	,, 15	1,334	+ 34	15	20,781	+ 2,790
Peterborough	,, 8	190	- 3	14	1,648	- 180
Poole and District	,, 8	439	+ 124	14	3,418	+ 66
Portsmouth Corporation	,, 16	1,678	- 292	§2	4,847	+ 198
*Potteries	,, 8	1,903	+ 315	14	28,167	+ 1,873
Reading Corporation	,, 14	568	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 8	175	+ 97	14	757	+ 146
Salford Corporation	,, 18	3,942	+ 668	3	10,482	+ 481
Sheerness	,, 6	77	...	14	659	...
Sheffield Corporation	,, 17	4,392	- 283	§3	15,084	- 671
*Southampton Corporat'n	,, 14	915	- 129	...	...	...
Southend Corporation	...	...	...	...	...	...
Southport Tramways	,, 8	443	+ 106	14	3,555	+ 379
S. Staffordshire Trams.	,, 8	1,075	+ 186	14	10,609	+ 561
Stockport Corporation	,, 15	419	+ 66	2	987	+ 221
Sunderland Corporation	,, 17	1,119	- 17	3	2,889	- 263
*Swansea Trams	,, 8	613	+ 70	14	6,564	+ 288
Taunton Trams	,, 8	91	+ 32	14	686	- 84
Tynemouth and District	,, 8	335	...	14	3,021	- 56
Tyneside Trams Co.	,, 18	281	+ 222	15	4,308	+ 523
Wallasey District Council	,, 16	651	- 67	13	1,660	- 70
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 14	691	...	7	2,805	...
Weston-super-Mare	,, 6	108	+ 66	14	417	+ 42
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 8	589	+ 145	14	4,847	- 58
Worcester	,, 8	376	+ 202	9	2,832	+ 1,005
Wrexham	,, 8	140	- 91	14	1,420	- 91
Yorkshire Woollen District	,, 8	810	+ 576	14	7,402	+ 3,097

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., April 20.	Rate per Cent. Yielded.	Dividend Due.	Business Week to April 20		Share.	Last Dividend	Name.	Price Wed., April 20	Rate per Cent. Yielded.	Dividend Due.	Business Week to April 20.	
						Highest.	Lowest.							Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.						**TELEPHONES.**		£ s. d.			
5	2/6	†Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4⅞—5⅛	4 17 7	April, Oct	5 3/32	4 13/16	5	3/0	Chili Telephone (fully paid)	4⅜—5⅛	5 14 3	August ..	..	..
St.	6%	Do. Permanent 6% Deb. Stock	127 —132	4 11 11	..	..	..	St.	6%	National Co. Pref. Stock	103 —105	5 14 10	..	104½	103
St.	34/2	Auckland Elec. Trams 5% Deb. (red.)	98 —100	..	..	99½	99	St.	5%	Do. Def. Stock	91 —93	5 8 9	..	92½	86½
10	10/0	Barcelona Tramways Ord.	6 —8	6 5 0	..	6⅞	6½	10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 —12	5 0 0	Feb, Aug	11½	11½
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..	10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	10⅞	10⅜
St.	4½%	Do. 4½% Deb. Stock (red.)	90 —95	4 14 9	..	..	..	5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5½	4 15 3	Feb, Aug	5⅝	5⅛
100	5%	Do. 5 per Cent. Debs.	95 —98	5 2 0	..	..	..	St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 —99	3 11 5	June, Dec	98½	98
1	..	Bath Elec. Trams Pref. Ord.	⅜—⅝	..	..	..	..	St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101 —103	3 18 9	..	103	101½
1	..	Do. 5% Cum. Pref.	¾—1	..	..	..	..	1	0/7½	Oriental	⅛—1⅛	6 6 8	April, Oct	1	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	2	..	1	..	Do. 6 per Cent. Cum. Pref.	1 —1½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	..	..	..	5	3/0	United River Plate	5½—6	5 16 3	July	5⅝	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	..	..	5	2/6	Do. 5 per Cent. Cum. Pref.	4⅝—5⅛	4 15 3	June, Dec	5⅛	5
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 10 0	Feb, Aug	..	..	St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 —105	4 15 3	June, Dec	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 18 0	..	..	..			**ELECTRICITY SUPPLY.**					
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..	1	..	Blackheath & Greenwich Dist. Ord.(f.p.)	⅜—½	..	..	..	..
St.	6%	†British Columbia Elec. Rlwy. Def. Ord.	97 —100	6 0 0	..	..	..	1	0/8⅓	Do. 7% Cum. Pref.	1⅛—1⅜	..	..	1⅜	..
St.	5%	Do. Pref. Ord. Stock	99 —102	5 0 0	..	..	..	St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	113 —116	3 17 7	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10⅝	5 11 7	..	10⅝	10½	10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	..	..
40	4½%	† Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104⅞	4 6 7	..	..	..	10	4/6	Do. 4½ per Cent. Cum. Pref	9⅝—10½	4 5 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..	10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
10	6/0	British Electric Traction Ord.	8½—9½	8 8 6	..	9 3/16	8 15/16	St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10 —10½	5 14 4	Feb, Aug	10 1/16	10¼	St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	102 —105	4 7 8	..	..	..
St.	5/0	Do. 5 per Cent. Perpetual Debs	114 —117	4 6 0	..	117½	..	5	5/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	..	..
5	3/0	†Buenos Ayres and Belgrano Ord.	2⅜—3	5 0 0	..	2⅜	2⅜	5	3/6	Do. 7 per Cent. Pref.	10½—10⅔	3 5 1	Mar, Sept	..	..
5	3/0	† Do. 6 per Cent. "A" Cum. Pref.	5½—5⅝	5 4 4	..	..	..	5	3/0	Calcutta Electric Supply Ord.	6⅞—7½	4 9 8	..	7	6⅞
5	3/0	† Do. "B"	4⅞—5⅛	5 14 4	..	5	..	St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 —109	3 13 8	..	..	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	..	..	5	4/0	Charing Cross & Strand Electric Sup.	7 —7½	5 6 8	Feb, Aug	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	4 19 6	..	100½	..	5	2/8	Do. 4½ per Cent. Pref.	5½—5⅝	4 5 9	Feb, Aug	5 1/16	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	98 —100	5 0 3	..	..	..	5	2/8	Do. City Undertaking 4½% Cm. Pref.	4⅝—5	4 10 0	..	..	..
5	3/6	†Calcutta Tramways	6¾—7½	4 2 8	..	7	6¾	5	1/7	Do. Do. (1903)	4⅝—5	..	..	..	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 4 0	..	..	..	St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 10	..	103½	103
1	1/0	Cape Electric Tramways Shares	1⅝—2⅜	8 0 0	..	2⅜	2	5	3/6	Chelsea Electric Supply Ord.	6 —6½	4 4 7	March ..	..	..
St.	4%	Central London Ordinary Stock	92 —95	4 4 2	June, Dec	94	..	St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 3 1	Jn, Dec ..	..	..
St.	4%	Do. 4 per Cent. Pref. Stock	98 —101	3 19 9	..	..	..	10	5/0	City of London Electric Lighting Ord.	10½—10⅝	4 13 0	Feb, Aug	..	..
St.	4%	Do. Deferred Stock	85 —88	4 11 3	..	87	..	10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅜	13⅜
100	4%	Do. 4 per Cent. Debs.	110 —113	3 10 9	..	..	..	St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec ..	124½	..
5	2/6	†City of Birmingham Trams. 5% Cm. Prf.	4½—5	5 0 0	..	..	..	St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	..	..
100	4%	† Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..	10	4/0	County of London & Brush Prov. Ord.	7 —8	5 0 0	..	7 1/16	..
St.	2½%	City and South London Rly. Con. Ord.	49 —52	4 11 4	Feb, Aug	51½	..	10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	..	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 8	Feb, Aug	..	..	St.	4½%	Do. Deb. Stock (all paid) (red.)	106 —109	4 2 11	..	..	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..	St.	27/6⅔	Do. Second Deb. Stock Prov. Certs.	99 —102	..	..	100¼	100
St.	5%	Do. (1901)	119 —122	4 2 10	..	119	..	5	3 6	†Folkestone Electricity Supply Co. Ord.	5½—6	4 11 8	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	111	109½	St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 8 0	..	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt. Db.(rd.)	101 —104	4 18 1	..	..	..	10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..	5	5/0	†Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..	St.	..	I of W. Elec Lt. & Power 4½% Db St. (red.)	102 —104	..	..	..	..
5	6/0	Electric Lgt. & Tract. of Aust. 6% Cm. Prf.	1½—2½	12 0 0	..	..	..	1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	1⅜—1⅝	..	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 —97	5 3 1	..	..	..	5	7/0	Kensingtn & Knghtsbdge Ord.	11 —12	5 0 0	..	..	..
10	..	Gt. Northern & City Rly. Prf. Ord. (4%)	5¼—6½	4 12 2	..	..	..	5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
10	8/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..	St	4%	Kensingtn. & Knghtsbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —104	3 16 11	..	..	..
10	10%	‡ Imperial Tramways Ord	18½—19½	4 12 4	Mar, Sept	..	..	3	..	London Electric Supply Ord.	1 —1½	..	..	1 1/16	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..	5	3/0	Do. 6 per Cent. Pref.	4½—5	6 0 0	..	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	103 —110	4 1 10	Jan, July	..	..	10	9 6	Metropolitan Electric Sup. Ord.	18 —19	4 12 1	April, Oct	18⅜	18⅛
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..	5	1/4½	Do. 4½ per Cent. Cum. Pref.	5½—5⅝	4 3 9	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..	St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —118	3 19 6	Jn, Dec ..	..	..
10	1½%	†Liverpool Overhead Railway Ord.	4⅛—4⅜	2 16 5	Feb, Aug	..	..	St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —98	3 11 9	..	..	..
10	5%	† Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..	100	4¼%	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
St.	4%	† Do. 4 per Cent. Deb.	99 —101	4 0 0	Jan, July	..	..	10	6/0	†Notting Hill Electric Ord.	12½—13½	4 8 11	March ..	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11½—11⅝	4 5 2	..	11 1/16	11⅛	100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 18 5	..	..	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	101 —103	3 18 5	..	..	..	5	4/0	Oxford Electric Ord.	5⅜—6	5 8 4	March ..	..	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	6	..	St.	4%	Do. 4% Deb. Stock	96 —99	4 0 9	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..	1	..	Rand Electric	⅞—1	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..	100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	98 —101	4 9 1	April, Oct	..	..
1	..	Metropolitan Electric Trams Def	¾—1	..	..	..	..	5	9 6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	..	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	..	..	..	5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..	St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 5 0	..	..	..	5	4/0	Smithfield Markets Electric Sup. Ord.	3 —3½	5 14 3	..	..	..
5	..	New General Traction Ord.	⅛	..	..	..	..	St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1 —2	..	May	..	..	5	3/0	South London Electric Supply Ord.	3 —3½	4 5 8	..	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 —102	4 18 0	..	..	..	5	2/6	Urban Electric Supply Ord.	4⅜—4⅝	5 2 6	..	4⅜	..
10	10/0	†Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..	5	2/6	Do. 5% Cum. Pref.	4½—5	5 0 0	..	4⅝	4½
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..	5	7/0	Westminster Electric Supply Ord.	12½—13½	5 0 0	Mar, Sept	13	12⅝
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 —106	4 5 11	..	..	..	5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..			**ELECTRIC MANUFACTURING &c.**					
1	..	Do. 6% Pref. (£1 paid)	..	..	..	..	..	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜—½	10 0 0	..	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	April, Oct	..	..	1	..	Aron Electric Meter 6% Cum. Pref.	2 3/16—2 5/16	..	Mar, Sept	..	..
St.	3%	Waterloo and City Ord.	89 —92	3 8 4	Jan, July	..	..	5	4/0	British Insulated & Helsby Cables Ord.	5⅞—6⅛	6 8 0	July, Feb	..	..
					June, Dec	..	..	5	3/0	Do. 6 per Cent. Pref.	5½—5⅝	5 4 4	Jan, July	..	..
		TELEGRAPHS.						St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —107	4 4 1	..	..	..
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	98⅜	..	St.	4½%	British Thoma'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	101½	100½
10	..	Amazon Telegraph	2⅜—3⅛	..	Jn, Dec ..	..	..	5	3/0	British Westinghouse 6% Pref.	3⅜—4⅛	7 1 2	..	4 1/16	3 13/16
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..	St.	4%	Do. 4 per Cent. Mort. Deb. Stock	91 —94	4 6 3	..	..	..
St.	12/6	†Anglo-American	48 —51	5 14 7	F, My, Ag, N	..	..	2	..	Brush Electrical Engineering	⅛—¼	..	March ..	..	..
St.	25/0	† Do. Preferred	92 —94	6 2 3	F, My, Ag, N	93½	91⅞	2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	¾—1	..	Mar, Sept	..	..
St.	2/0	Do. Deferred	7⅛—7½	1 5 10	F, My Ag, N	..	..	St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
100	£8	†Commercial Cable Capital Stock	175 —185	7 11 3	Ju, Ap, Jy, O	..	..	St.	4½%	Do. Perpetual 2nd Deb. Stock	72 —77	5 18 4	Jan, July	72⅝	..
St.	4%	Do. 4 per Cent. Deb. Stock	91 —93	4 6 3	Jn Ap, Jy, O	..	..	5	5/0	Callender's Cable Construction Ord.	10⅜—11½	6 10 5	Jan, July	11 3/16	10½
10	7/0	Cuba Submarine Ord.	7½—8½	9 8 5	Feb, Aug	8½	..	5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5⅝	4 6 11	Jan, July	5½	..
10	10/0	Do. Preference 10 per Cent.	15½—16½	6 1 3	Feb Aug	..	..	St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 3	Nov, May	104½	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..	1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅛—¼	6 17 2	..	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..	St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
50	4½%	Do. 4½ per Cent. Deb.	99⅝—102⅝	4 9 3	Jan, July	..	..	1	0/7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March ..	..	..
20	3/0	Direct United States Cable	10½—10⅝	6 0 11	Ja, Ap, Jy, O	10½	10 1/16	3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅜—2⅛	6 18 4	Jan, July	..	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	98 —101	4 9 1	Jn, Dec ..	..	..	100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96 —99	5 2 0	Jan, July	..	..
St.	25/0	†Eastern Ordinary	121 —126	5 11 1	Ja, Ap, Jy, O	125	121	5	..	Dick, Kerr & Co. Ord.	7⅜—8⅜	..	..	8⅛	..
St.	17/6	† Do. 8½ per Cent. Pref. Stock	85 —88	3 19 6	Ja Ap, Jy, O	87	86	5	3/0	Do. 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104 —107	3 15 8	May, Nov	..	..	St.	4½%	Do. 4½% Deb. Stock	102—104	4 7 2	..	..	..
10	2/6	Eastern Extension	11½—12	5 16 8	Ja, Ap, Jy, O	12	11½	5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	103 —106	3 16 0	Feb, Aug	103	..	5	..	Do. (£5 paid)	½—1½	..	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	99 —102	3 19 0	Feb, Aug	..	..	St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101⅞—104⅞	3 18 2	May, Nov	..	..	St.	5%	Do. 5 per Cent. 2nd Deb. Stock	74 —79	6 6 7	..	..	..
10	5/0	Great Northern of Copenhagen	27 —28	4 9 3	Jan, July	25⅜	..	5	2/6	Edmundson's Elec. Corp. Ord.	5⅜—6⅛	5 12 0	H'lf-yearly	6 1/16	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —101	4 9 6	June, Dec	..	..	5	3/0	Do. 6 per Cent. Cum. Pref.	5⅝—6	5 0 0	..	5 3/16	5⅛
25	12/6	Indo-European	42 —45	5 11 1	May, Nov	44	43½	St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 5 2	..	106½	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec.	..	..	2	1/2½	Electric Construction Co.	1½—1⅝	6 71 2	Jan, July	1 1/16	1 1/16
10	2/0	West African Telegraph Shares	5 —6	1 18 4	..	..	..	2	2/9⅓	Do. 7 per Cent. Cum. Pref.	2⅜—3	4 13 4	July	..	..
2½	..	West Coast of America	1/16—3/16	..	..	..	..	St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 10	Jan, July	..	..	1	..	Electrolytic Alkali Ord.	¼—½	..	..	..	..
10	..	West India and Panama	⅝—¾	..	May, Nov	1/16	..	1	7½	Do. 7 per Cent. Cum. Pref.	¾—1	..	..	..	..
10	8/0	Do. 8 per Cent 1st Pref.	5⅞—6⅛	9 12 0	May, Nov	6⅛	..	St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4⅛—5⅛	..	May, Nov	..	..	10	5/0	General Electric (1900) 5% Cum. Pref.	9 —9½	5 5 3	..	..	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 18 4	Jan, July	..	..	St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
10	3/0	Western Telegraph	12½—13½	5 8 8	Mr, Jn, O, D	12⅜	12 1/16	5	9/0	Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	11⅞	11⅝
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 17 9	June, Dec	..	..	5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99 —102	3 19 5	..	100½	..	St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..	..
								10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 7	Feb, Aug	18⅝	..
		FINANCIAL, INVESTMENT, &c.						100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 5	Mar, Sept	..	..
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..	10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
10	2/0	Globe Telegraph and Trust	8½—9	4 8 11	Ja Ap Jy O	8⅞	8 7/16	12	36/0	Telegraph Construction & Mainten'ce.	84 —87	6 9 10	Mar, July	85	..
10	5/0	Do. 6 per Cent. Pref.	12½—12⅝	4 14 2	Ja Ap, Jy, O	12 5/16	12 1/16	100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
8	4/0	Reuter's	6⅝—7⅛	5 6 8	April, Oct	..	..	5	..	Willans and Robinson Ord.	2⅜—3⅛	..	Apr, Oct	3 1/16	2⅝
100	6%	†Submarine Cables Trust (Cert.)	117 —122	4 18 4	April, Oct	121½	120	5	..	Do. 6 per Cent. Cum. Pref.	3½—4½	..	Apr, Oct	..	..
								St.	4%	Do. 4 per Cent. 1st Mort. Debs.	90 —96	4 5 9	May, Nov	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

A YEAR ago Mr. FIELD caused considerable uneasiness in the minds of supply station engineers by demonstrating to them, both by arrays of symbols and by unmistakable oscillograph records, the serious rises of pressure that could be caused in cables by resonance effects. In his Paper, which we conclude this week, he deals quantitatively with another phenomenon to which much attention has not been devoted hitherto—viz., the losses in cable sheaths. The first part of this Paper dealing with single cables in iron pipes, and single lead-covered cables adjacent to one another, may be passed over as being mainly of educational value, as single-core cables are now rarely employed for alternating-current work. The portion of the Paper dealing with three-core cables is of considerable interest, however, and assuming that Mr. FIELD is right in his premises, his solution appears to be correct. It is not certain, however, that a "cylindrical" distribution of current exists in the conductors; the reaction of the magnetic field which the author plots would tend to distort the current distribution, and therefore reduce the effect. Again, the shielding action of eddy currents on the inside of the sheath are not fully taken into account, and their effect, also, would be to minimise the loss due to this rotating field.

MR. FIELD points out that the copper tape sheath placed beneath the lead of extra-high tension cables at the instance of the Board of Trade increases the eddy current losses, and his suggestion that this tape should be painted is ingenious. Following the lines of his investigation, however, it would appear that if the "lay" of the tape is left-handed when the field rotates right-handedly (or *vice versâ*) the effect should be equally good. This suggests that if a three-core lead-sheathed cable, with copper tape under the sheath, be connected up to a three-phase supply, the loss in the cable sheath will be different according to the direction of rotation of the field. Is this so in practice? It can easily be determined experimentally. In fact, it should not be impossible to determine all these losses experimentally, and so to ascertain whether Mr. FIELD has not over-estimated them. In the meantime we prefer to believe that Mr. FIELD'S results are maximum values, which are rarely, if ever, attained under normal working conditions. The most difficult part of the problem will be to determine what portion of the losses recently attributed to dielectric hysteresis are really due to eddy currents.

THAT an electrically driven tramway car or other vehicle, when running down hill or slowing, can be made to return to the line some of the power which has raised or accelerated it, has been known "from the beginning." How to realise this possibility has exercised the ingenuity of not a few inventors during the last 15 or 20 years. SPRAGUE was one of the earliest, whilst in recent years much has been claimed for the Johnson-Lundell system, but little has yet been accomplished in this direction with continuous-current motors. Our readers will know that Mr. J. S. RAWORTH claims to have made a success of his arrangement and to have obtained a substantial economy by its use on the hilly tramway lines of Devonport. The abstracts of Mr. RAWORTH'S patents printed elsewhere in this issue will, therefore, have some interest. The problem has been attacked in a new way, and the automatic return of current is ensured by the use of a shunt-wound motor instead of the series-wound pattern generally accepted hitherto as the only practical form.

THE proposal to use shunt-wound motors for traction purposes is a kind of heresy to-day, but as the heresies of one generation have so often become the gospels of the next, it should not be curtly dismissed on that account. Two reasons occur to us for supposing that Mr. RAWORTH will have to use larger and heavier motors for a given service than are required with the usual methods of control. The first is, that,

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as the motors are in use as generators whenever a car is descending a hill or pulling up, they get no cooling time. This is also true of series motors when used for braking purposes, and, as a fact, it is found inadvisable to make such use of motors on hilly lines. The second reason is that, as a greater magnetic flux is requisite to return current to the line at a given speed than to drive the car at that speed, the whole magnetic circuit must have a larger section than is needed for motor purposes. This is true, of course, whether the field winding is series, shunt or compound. The great attraction of the shunt motor is that no field has to be reversed to get the regenerative or braking effect, and the efficiency of the braking so obtained is due, we believe, to the fact that the car is held in to a controllable speed from the very beginning of its descent. Practically every "runaway" car accident arises from the car being allowed to attain an excessive speed, followed by the "skidding" of the wheels as the brakes are jammed on. "Track" brakes, when properly used, have a similar virtue. A track brake should be applied when starting to descend a grade; it then holds the car to a safe speed, easily controllable by the hand brake. The track brake, however, is not automatic.

WHETHER these advantages outweigh the well-known reasons which have led to the general adoption of series motors for electric traction is debatable, and can only be settled after a more extended and public use of Mr. RAWORTH'S system than has yet been made. The saving of power may be a matter of very small or of quite considerable importance, according to the conditions of supply and the nature of the road. Safety of operation on severe gradients is of the first importance, and it may prove that Mr. RAWORTH'S invention will relieve the anxieties of those tramway managers, who dread a day of "greasy rails." We hope that the arrangement will be put to the test on a sufficient scale and under such conditions as to provide answers to the questions that can only be settled by experience.

AN article by Mr. L. J. HUNT, entitled "Notes on the Design of Electrical Machinery," appears elsewhere in this issue, and, although it might appear to the casual reader to be merely a highly mathematical and academical treatise on details of machine design, it nevertheless contains some valuable information of practical utility. The empirical formula which Mr. HUNT gives us for determining the commutation properties of continuous-current machines is very simple, and ought to be of service to those designers whose time or inclination does not allow them to devote much attention to the full investigation of the complex process of commutation. The formula must be regarded as a rough-and-ready one, however, in which the refinements insisted on by some writers have not been introduced. It is generally agreed, for instance, that such a formula ought to take account of the free length of the armature winding, and not merely of the length of the armature. Since, however, the influence of this free length is but a fraction of that of the embedded length, and as, moreover, the ratio of embedded length to free length does not vary greatly in modern machines, the error from this source is not likely to be serious. Mr. HUNT'S experiments with regard to the ratio of field ampere-turns to armature ampere-turns are also of practical value, and he shows experimentally that this ratio in itself has not the important bearing upon the commutation of a machine which some dynamo designers still attribute to it. Equally valuable are the figures given by the author for the contact resistances of various grades of brushes at different current densities, as such figures are rarely given by writers, who prefer, as a rule, rather to assume likely values than to go to the trouble of determining them experimentally.

A BYE-LAW, recently issued by the London County Council, is to the effect that the driver of every vehicle must have a clear view of each side of the road. This bye-law will come into force next month. It will be remembered that the London County Council tramcars are of the reversed stairway pattern, and consequently the stairway affords a considerable obstruction to the driver on one side. The police, whose duty it will be to enforce the new bye-law, have called the Council's attention to the matter, and it is being considered by the Council and the Scotland Yard authorities. It is amusing that the first case to arise under the London County Council's new bye-law should be in connection with their own cars. The difficulty may be overcome to a considerable extent by perforating the riser of the stair which is on a level with the driver's eyes, and this expedient has been adopted on some cars recently made by the British Railway and Tramway Carriage Works. The disadvantage of the reverse stairway type of car was pointed out, it will be remembered, in the Board of Trade suggestions published in *The Electrician*, Vol. LI., p. 668.

IN our Parliamentary columns this week it will be observed that two gas bills, which have passed the unopposed Committee of the House of Lords, have in them clauses empowering the companies in question to apply for Electric Lighting Provisional Orders under the Electric Lighting Acts. It is true that the districts in question are of no great size or importance, but we cannot regard as good policy the principle of granting electric lighting powers to gas companies. There is a great danger that the powers so obtained might be secured with the intention of never putting them into force, thus postponing the day of competition and depriving the district of the advantages of electricity supply.

LAST February we commented on the result of the vibration case at St. Pancras, in which an injunction was granted against the St. Pancras Borough Council for vibration nuisance. Under the present Electric Lighting Acts, although an electricity undertaking is bound to give a supply continuously, there is nothing which will exempt it from liability for nuisance under the ordinary law of the land. The cases in which injunctions of this nature have been sought are, fortunately, not very frequent, but in the majority of them, judgment has been given against the electricity works. A particular difficulty has been that the electricity undertakers are often unable to buy all the property adjoining the site

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chosen for their electricity works, for the owners of the property, and even the tenants, are in a position to demand an excessive price by threatening subsequent application for injunction for nuisance. In commenting on the recent St. Pancras case, we suggested that an endeavour should be made to obtain a short Act of Parliament to empower an electricity undertaking to bring a dispute of this character compulsorily to arbitration. The St. Pancras Borough Council, however, desires to go further, and has decided to convene a conference of Local Authorities and companies owning electricity undertakings in London and the provinces, with a view to promoting legislation for obtaining compulsory powers of purchase and for the repeal or modification of clause 77 of the Electric Lighting (Clauses) Act and of clause 17 of the Electric Lighting Act of 1882, referring to actions against undertakers for nuisance and damage. We wish the campaign every success.

THE attempt of the Barnet Gas and Water Co. to secure, in a bill of its own promotion, the insertion of a clause giving it the right to claim compensation against any electrical undertaking for alleged electrolytic damage to its mains, failed somewhat ignominiously on Friday of last week. Capt. JESSEL'S Committee of the House of Commons, realising at the very outset that this was an effort to modify the existing law on the subject of electrolysis in connection with gas and water mains, quickly made up their minds on the point, and refused the application without calling upon the opposition to produce evidence. Protection against electrolytic damage to gas and water mains due to electric traction currents, in addition to the safeguards provided by the Board of Trade regulations, has been granted in two notable instances—viz., Sheffield in 1901 and Brighton in 1903—but these were in respect of specific undertakings, and in the case of Brighton the extra protection only had reference to a certain few miles of lines. In every other case in which the promoter has not agreed to the clause, the Committees have refused it, but such clauses have been inserted in other Bills by agreement, or as the price of a Local Authority's formal assent to the measure in question. Had the Barnet clause been allowed, however, a precedent of a dangerous character would have been provided, inasmuch as the Middlesex County Council and the Finchley Urban District Council being in possession of electric traction and electric lighting powers respectively, and having already constructed works, the clause, as it was proposed to be worded by the Barnet Gas and Water Co., would have been retrospective in effect. The Crystal Palace Gas Co. has also a similar clause in its Bill this year, and we trust that this will also have to be deleted.

THE Gas Company's witness brought the usual samples of pipes to demonstrate to the Committee the nature of this electrolysis danger which the company wished to avert. In this case the samples came from Manchester, where the tramways have not yet been running for three years. In three years we do not believe that any tramway upon which the Board of Trade regulations are strictly observed could destroy pipes electrolytically even under the most unfavourable conditions. If the specimens shown really represented electrically-caused damage, it can only have been the result of the drastic method which the Manchester Corporation formerly adopted for burning out faults on its electric lighting mains. Such cases would be extremely rare, and, moreover, if damage had been caused in this manner nothing under the Electric Lighting Acts would prevent the owner of the pipes from obtaining full compensation.

THE Valuation Bill introduced by Mr. LONG in the House of Commons on Tuesday only just touches the fringe of the subject, and so far as "special properties" are concerned, things are left to all intents and purposes exactly as they were before. The Government, we are told, intend to deal with railways and canals, and, we presume, electric tramways and like properties, in a separate measure. What are the chief points of "novelty" referred to by Mr. LONG? A single authority, the County Council or County Borough, is to be substituted for the various authorities which may at present, if they so choose, severally assess a property. Seeing, however, that in ninety-nine instances out of a hundred, Local Authorities, notwithstanding their technical rights, accept the valuation of the local Poor Law authority, the Bill merely proposes to give legal sanction to an almost invariable custom. The association of the Surveyor of Taxes with the Valuation Authority is intended no doubt to put a check on the marked tendency of Local Authorities to run up the assessments of "special properties" in order to ease the burden of the householder and shopkeeper. Some such control is certainly wanted, but the Surveyor of Taxes has no expert knowledge of the valuation of tramways, light railways or electricity supply undertakings for the purposes of local taxation, and his intervention is not likely, therefore, to prove of much value in such cases. The other points in the Bill which were alluded to by the President of the Local Government Board have no bearing on the assessment of electrical properties.

Opening of the New Exeter Electricity Works.—The new electricity works of the Exeter Corporation will be opened by the Mayor of Exeter on Tuesday next. The actual change over, however, from the single-phase to the two-phase mains was completed quite satisfactorily during the Easter holidays. The works were fully described and illustrated in our issue for December 11 last.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Cayenne—Pinheiros	Aug. 18, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Tourane—Amoy	Nov. 10, 1903 ..	April 26, 1904
Tarifa—Tangier	Jan. 18, 1904 ..	—
Dakar—Conakry	April 11, 1904 ..	—

Royal Society.—Among the Papers down for reading yesterday were the following:—"Further Experiments on the Production of Helium from Radium," by Sir Wm. Ramsay, K.C.B., F.R.S., and F. Soddy; "The Effects of Changes of Temperature on the Modulus or Torsional Rigidity of Metal Wires," by Dr. F. Horton; "The Sparking Difference Between Electrically-charged Surfaces—Preliminary Note," by Dr. P. E. Shaw; "On the Changes of Thermo-electric Power Produced by Magnetisation, and their Relation to Magnetic Strains," by Dr. S. Bidwell, F.R.S.

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Influence of Light on the Formation of Accumulator Plates.—In a recent article in the *Centralblatt für Accumulatoren*, D. Tommasi draws attention to the fact that the negative plates of lead accumulators are more quickly formed when the process is carried out in the light than in the darkness. With the positive plates the reverse is the case. G. Rosset, writing on the same subject, points out that the law may be expressed more scientifically in the one sentence: Darkness favours the oxidisation of lead and light favours the reduction of lead oxide.

The South-Western Polytechnic.—Earl Cadogan, K.G., has consented to distribute the certificates and prizes gained during the past session by the students of the evening classes and the day classes for men and women of the South-Western Polytechnic, and to formally open the new buildings, on Friday, May 6th. The chair will be taken at 8 o'clock p.m. by Mr. R. C. Antrobus, chairman of the governing body. The distribution will be followed by a concert, under the direction of the head of the music section, Mr. Seymour Dicker. On the following evening a conversazione will be held from 7 to 10 p.m., when the Institute buildings, including the laboratories, workshops, &c., will be open for inspection. Exhibits in science, art and domestic economy will be on view. There will also be scientific lectures and demonstrations. Musical and gymnastic entertainments will be rendered by the students of the respective departments.

Mr. Carnegie's Gift to American Engineers.—The *Electrical World* of New York states that in order to enable the three American engineering societies to avail themselves of Mr. Carnegie's gift of a building for headquarters and library purposes, &c., the conference committee has had drafted a bill incorporating what is known as the United Engineering Society to hold the property for the societies. This bill was introduced in the State Senate by Senator Townsend, of Utica, and has already passed both the Chambers, and has gone to the Governor for signature this week. The bill is virtually a transcription of the act incorporating the Cooper Union, its purposes being in most respects, if not all, identical with regard to the public objects of the building. Six architects of good standing have offered to enter a limited competition for the plans of the engineering building as well as of the Engineers' Club. These six firms will be paid for their plans, and, in addition, there will also be an open competition, in which the first four competitors will receive prizes.

Institution of Civil Engineers.—At the annual general meeting of the Institution of Civil Engineers, held on Tuesday evening, the result of the ballot for the election of Council for the session 1904-5 was declared as follows:—

President, Sir Guilford L. Molesworth. *Vice-presidents*, Mr. F. W. Webb, Sir Alexander Binnie, Prof. Alex. B. W. Kennedy, Mr. W. R. Galbraith. *Other members of Council*, Messrs. C. N. Bell (Wellington, N.Z.), C. A. Brereton, R. Elliott-Cooper, Col. R. E. B. Crompton, C.B., Messrs. W. J. Cudworth (York), G. F. Deacon, F. Elgar, R. Hadfield (Sheffield), G. H. Hill, C. W. Hodson (Bombay), J. C. Inglis, G. R. Jebb (Birmingham), T. C. Keefer (Ottawa), A. G. Lyster (Liverpool), J. A. McDonald (Derby), W. Mathews, C.M.G., Sir Charles Metcalfe (Cape Town), the Hon. C. A. Parsons (Wylam-on-Tyne), Messrs. A. Ross, W. Shelford, C.M.G., Alexander Siemens, John Strain (Glasgow), Sir John I. Thornycroft, Prof. W. C. Unwin, Sir Leader Williams (Manchester), and Mr. A. F. Yarrow.

Among the awards for Papers read during the session 1903-1904, is a Telford premium to Mr. Alexander Millar for his Paper on "The Electrical Reconstruction of the South London Tramways on the Conduit System." (See *The Electrician*, Vol. LII., pp. 474 and 498).

Wireless Telegraph Notes.—In the course of a leading article discussing the position of wireless telegraphy in connection with the war in the Far East, *The Times* on Monday states that their correspondent on board the "Haimun" is duly accredited at the Japanese headquarters, and is accepted as *The Times* correspondent by the Japanese military authorities. He is subject to the same restrictions which the Japanese Government imposes upon every other newspaper correspondent, and the Japanese Government is aware that he uses a wireless telegraph apparatus by which he establishes a connection between a British ship and British territory at Wei-hai-wei. Moreover, the Japanese Government has formally sanctioned the use of this apparatus. Our contemporary is unable to say whether there is a censor on board the "Haimun."

According to a Central News telegram from St. Petersburg, the Czar has signified his approval of the declaration made by Admiral Alexeieff regarding the use of wireless telegraphy during the Russo-Japanese war.

It is reported that the Government have obtained a site between South Shields and Sunderland for the purpose of erecting a wireless telegraph station. This site is at Marsden Hall, a building which has stood unoccupied for over three years. It is about 220ft. above the level of the sea, and quite close to the edge of the cliff.

Tests of Steam Turbines.—The following is an account of reception tests on a 1,200kw. to 1,400kw. three-phase turbo-generator built by Messrs. Brown-Boveri & Co. for the power-station in Rheinfelden (see the note in *The Electrician*, Vol. LII., p. 621). The turbo-generator is designed for steam at a pressure of 180lb. per square inch, superheated to 260°C. to 270°C., and generates current at a pressure of 6,800 volts when running at 1,500 revs. per min.:—

Steam		Vacuum Per cent.	Kilowatt.	Steam consumption per kw.-hour Lbs.
Pressure. Lbs. per sq. in.	Temperature. Degrees C.			
171·0	252	96·0	1,440	15·9
172·0	249	96·2	1,217	15·9
173·5	246	96·4	720	17·85
167·0	244	97·0	378	21·0
176·0	205	96·8	No load. Excited.	2,680lbs. per hour

Obituary.—With deep regret we announce the death on April 12th, at the age of 52, of Mr. T. J. Wilmot, who for the past 19 years has held the position of superintendent of the Commercial Cable Co.'s station at Waterville, Ireland. Mr. Wilmot took a great interest in all matters affecting the locality; he was captain of the fire brigade, and took an active part in all philanthropic and other movements. The funeral took place on Friday last, and, as a mark of respect to the deceased superintendent, traffic over the company's entire system was, by order of Mr. George G. Ward from New York, suspended for five minutes while Mr. Wilmot's remains rested outside the office at Waterville. The coffin was borne to the grave by members of the staff, and was followed by a large concourse of the late superintendent's colleagues and friends and by residents of the district, with whom he was very popular. The wreaths sent were choice and numerous, and were received from colleagues and friends of the deceased in the Commercial Cable Co., the Direct United States Cable Co., the Anglo-American Telegraph Co., &c., in all parts of the world.

Messrs. Wheatley Kirk, Price & Co. desire to express their grateful thanks for the numerous expressions of sympathy which have reached them on the recent sudden decease of Mr. S. Sherley-Price, one of their junior partners. The large number of communications received prevents individual acknowledgment.

Opening of the Scarborough Electric Tramways.—The system of electric tramways which is being equipped in Scarborough by the Scarborough Electric Tramways Co. will be opened by the Mayoress of Scarborough on Friday next, May 6th. The Scarborough Tramways Company was authorised by special act in 1902 to lay down 3 miles of double track and $1\frac{3}{4}$ miles of 3ft. 6in. gauge single track. All of this has been put in hand, Messrs. A. A. Campbell Swinton and J. E. Waller having acted as consulting engineers to the company. Current will be supplied by the Scarborough Electricity Supply Co. The rails weigh 90lb. per yard, and are of the girder type. The maximum gradient on the system is 1 in 10·5, and the sharpest curve has a radius of 35ft. Span wires, centre poles and rosettes are employed on different parts of the line for supporting the trolley wire, which is of 00 gauge hard-drawn copper. The feeders are Messrs. Callender's vulcanised bitumen, 0·04 sq., in. laid solid in wood troughing outside the tracks, the return being by means of the rails and one return feeder. The cars, which number 15, are of the Brush double-deck type, and are equipped with two hand brakes and one electric brake. One section only of the

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ine has been as yet completed, and a very successful trial trip was run last week. The cars have a seating capacity of 20 nside and 20 outside. The capital of the Scarborough Company is £96,000.

Electric Lighting at the Royal Waterloo Hospital.—The new Royal Waterloo Hospital at the corner of Waterloo Bridge-road and Stamford-street is being erected in three sections, so as to avoid interference with the working of the existing hospital, and the first section is rapidly nearing completion. A very complete electric light installation is being put in by Messrs. Vaughan, Brown & Co., and there are already about 124 lamps connected in the first section. This number will be increased to over 200 in the course of a few days. Screwed steel tubing, the smallest of which has a diameter of ⅜in., is being used throughout, and there is no smaller wire than 3/22 employed for any work whatever. Inspection boxes, fitted with watertight covers easily removable are sunk into the concrete floors at convenient intervals, and also above fittings suspended from the ceiling below. For branches, inspection tees with hinged covers fastened by one screw are employed, and these are also easily accessible. All switch leads are carried in steel tube embedded in the fireproof plaster walls, and, where possible, easy bends are adopted instead of elbows. The 5-ampere porcelain switches are mounted on wooden blocks, and were supplied by the General Electric Co. The quality of the whole installation is of the highest possible order. Energy is taken from the London Electric Supply Corporation's mains at 200 volts, and a special transformer will be provided. The architects are Messrs. Waring and Nicholson.

The Regulation of Alternating-current Motors.—An English patent (No. 26,378 of 1903) has recently been granted to Messrs. W. Lahmeyer & Co. for the "Regulation of Asynchronous, Alternating or Three-phase Current Electric Motors and Rotary Converters." It is proposed to regulate the speed of motors by inserting choking coils into the rotor circuit instead of wasteful resistances, as is at present generally the case. It is further suggested to regulate the choking effect by varying the reluctance of the magnetic path of the choking coil. This may be done by more or less saturating this magnetic path by a variable number of continuous-current ampere-turns. The amount of these may be regulated, either by hand or by automatic means, so as to maintain a constant speed of the motor. A purely electric method of automatically regulating the speed is this: The choking coil, besides being wound with the leads from the rotor, is also wound with two auxiliary coils, which oppose one another. One is permanently fed by continuous current from a constant-pressure supply, while the other receives its current from a small continuous-current generator (or from the generator proper in the case of a motor-generator) driven by the motor. If, now, the motor exceeds its normal speed, the voltage of the auxiliary continuous-current generator driven by it will rise, and the magnetising effect of the bobbin, which is permanently excited, will be opposed to a greater degree than before. The permeability of the magnetic circuit of the choking coil will increase in consequence, and the choking effect will become more pronounced—*i.e.*, the motor speed will decrease, and, if the arrangement be properly adjusted, the speed will be brought back to its proper value. If the motor speed decreases, the reverse actions take place.

The Institution Council Nominations.—At the meeting of the Institution of Electrical Engineers last night the President (Mr. R. Kaye Gray) who was in the chair, said that as that meeting was four weeks before the annual general meeting, in accordance with the articles of association he had to announce the nominations for the Council for next session. Before reading the list he would like to explain one matter—viz., with reference to the Presidentship. The lamented death of Mr. McMillan made the Council think that it would be advisable, in order to have a continuity of policy, that a Past President should be nominated by them, and after some consideration the Council thought they would submit his own name for one-half of the next session and Mr. Alexander Siemens' for the second half. Perhaps in doing this they might be initiating a new manner of election, but it was thought that there might be an advantage to the Institution to have the election of the President, or, rather, the coming into office of the President, to take place at the first meeting of the session—that was to say, some time in November—and that, therefore, in the interregnum between the last meeting of one session and the first meeting of the next there would exist a President and a President-elect. This had several advantages, which he thought the members would not fail to appreciate, in the management of the affairs of the Institution. The President and the new President would be together for about six months, and could exchange views with the officials of the Institution, and thus help towards a continuity of policy. With regard to the conversazione, also, it was thought that there might be an advantage if the invitations were issued in the name both of the President and the President-elect, thus making the conversazione a sort of introduction to the members of the President-elect by the President. The following is the new Council nominated:—

President.

Mr. Robert Kaye Gray.

Vice-Presidents.

Dr. J. A. Fleming. *Mr. W. H. Patchell.
Mr. J. E. Kingsbury. *Mr. W. M. Mordey.

Members of Council.

Sir J. Wolfe Barry, K.C.B., F.R.S. *Dr. R. T. Glazebrook, F.R.S.
Mr. T. O. Callender. Mr. F. E. Gripper.
Mr. S. Dobson. *Mr. J. S. Highfield.
Mr. B. Drake. *Mr. H. Hirst.
Mr. S. Z. de Ferranti. Mr. G. Marconi.
*Mr. J. Gavey, C.B. *Mr. C. H. Merz.
Mr. F. Gill. *Mr. C. P. Sparks.
Mr. A. A. Campbell Swinton.

Associate Members of Council.

*Mr. T. Mather, F.R.S. Mr. Sydney Morse. Mr. A. J. Walter.

The names marked with an asterisk are those of gentlemen nominated to fill the vacancies in the Council in accordance with Article 45 of the Articles of Association.

All the honorary officers, being eligible, are nominated for re-election.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, April 29th.

Institution of Civil Engineers: Students' Section.

11 a.m. Visit to the Holborn—Strand Improvement Works. Assemble outside Holborn Restaurant.

Institution of Electrical Engineers: Manchester Students' Section.

7:30 p.m. Meeting in the School of Technology. Paper to be read: "The Equipment and Maintenance of Electric Street Cars," by C. W. Crosbie.

SATURDAY, April 30th.

Institution of Electrical Engineers: Students' Section.

10 a.m. Visit to the works of the Western Electric Co., North Woolwich.

MONDAY, May 2nd.

Society of Engineers.

7:30 p.m. Jubilee Meeting at the Royal United Service Institution, Whitehall. Paper to be read: "British and American Coal-cutting Machines," by A. S. E. Ackermann.

WEDNESDAY, May 4th.

Institution of Electrical Engineers: Students' Section.

7:30 p.m. Meeting at 92, Victoria-street, Westminster. Paper to be read: "Alternating-current Commutator Motors," by F. Creedy.

THURSDAY, May 5th.

Institution of Electrical Engineers: Students' Section.

2:30 p.m. Visit to the works of the Electrical Power Storage Co., Millwall.

Röntgen Society.

8:30 p.m. Meeting at 20, Hanover-square, W. Paper to be read: "The Röntgen Society: its Past Work and Future Prospects," by J. J. Vesey. Mr. F. H. Glew will afterwards give a short account of some experiments with Alpha Rays.

FRIDAY, May 6th.

Tramways and Light Railways Association.

8 p.m. Meeting at the Society of Arts, when a topical discussion upon "Running Powers" will be opened by Mr. T. W. How.

Physical Society.

8 p.m. Ordinary Meeting at the Royal College of Science, Exhibition-road, South Kensington. [The change of date from May 13th to May 6th has been made owing to the Royal Society having chosen the former date for the annual conversazione.] Agenda: (1) "An Experiment with Lubricating Oil," by Mr. W. A. Price; (2) "Some Instruments for the Measurement of Large and Small Alternating Currents," by Mr. W. Duddell; (3) Exhibition of Apparatus from the National Physical Laboratory.

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A REGENERATIVE SYSTEM OF TRAMCAR CONTROL.

In *The Electrician*, Vol. LI., p. 526, appeared a description of a new system of control for electric tramcars, but, owing to the patent formalities being incomplete, it was not possible to give diagrams of connections or detailed particulars of the system. Now, however, the patent specifications are available, and we are able to give abstracts of them. The first, No. 3,657 of 1903, is for "Improvements in Regulating Devices for Electrically-propelled Vehicles," and Mr. J. S. Raworth is the patentee. Referring to Figs. 1 and 2, a regulating lever, *d*, which carries a pin, *q* (Figs. 6 and 7), and is pivoted at *e* in the controller casing *f*, is arranged to have a fore and aft movement after the manner of the reversing lever of a locomotive, and to carry contact pieces which slide over contact blocks, *gh*. These contact blocks are so connected up as to modify the strength of the shunt-motor fields *b*, *b*, either by varying the resistance in circuit therewith, or by altering the number of sections of the field windings, the arrangement being such that a forward movement of the regulating lever will reduce the strength of the field and increase the speed, while a backward movement will increase the field strength and reduce the speed. When the regulating lever reaches the blocks g^1, h^1, which are dead, the field circuit is broken entirely.

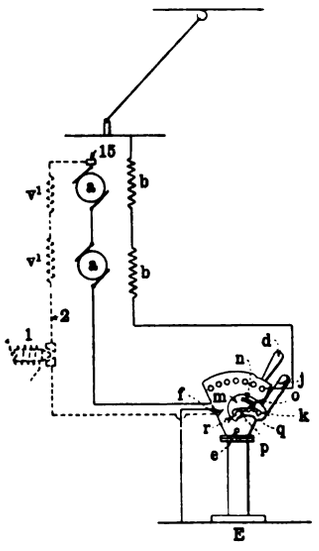


Fig. 1.

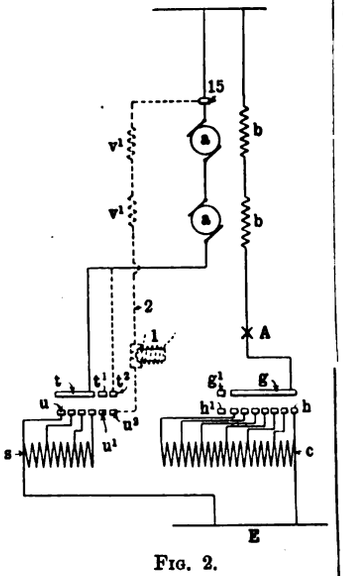


Fig. 2.

The armature circuit is controlled by the bell-crank lever *j*, which is pivoted at *k* and carries contact-pieces which move over the contact blocks *t*, *u*. When the lever *d* is in its most forward position—that is, when the field circuit is broken—*j* can be moved just sufficient to allow the pin *q* to leave the notch *r* and come into line with the slot *p* (Fig. 3). By moving *d* backward the field circuit is closed and the resistance *c* gradually removed. On reaching the most backward position the pin *q* comes into line with the slot *o*, and the lever *j* is left free to turn about the pivot *k*. It is then possible to close the armature circuit by a movement of *j*, and the car moves slowly forward. Until the pin *q* comes into line with the slot *n*, however, it is impossible to move *d*, and thus all resistance must be cut out of the armature circuit before the car can be accelerated by pushing forward *d*. The regulating or speed lever *d* is prevented by the length of the slot *n* from being pushed so far forward as to reach the contact blocks g^1, h^1, and thus break the field circuit while the armature circuit is still closed. To stop the car, the speed lever is drawn backward, thus strengthening the field, until the speed of the car becomes very low, whereupon the starting lever *j*, being thereby unlocked, opens the armature circuit automatically by the released energy of a weight or spring.

The switch governed by the power lever *j* can be so arranged that after breaking both positive and negative connections, *i.e.*, when its contacts are on the contact blocks t^1, u^1, it will short-circuit the armatures through a special series winding of fewer turns than is the case with ordinary series motors. For this purpose, as is shown in Figs. 1 and 2 in dotted lines, an additional pair of contacts, t^2, u^2, are provided in the power part of the controller. The power lever switch contacts move on to these whenever the power circuit is broken. To prevent the possibility of the armatures being short-circuited through the series-winding whilst the field is excited by the shunt winding, the controller is provided with an electromagnetically operated switch 1 in the short circuit. This switch is magnetised and held open by the shunt field current, the windings of the switch being connected in series with this circuit at A. An automatic switch, 15, disconnects the armatures from line or battery when they are short-circuited. The motors when thus short-circuited act as an emergency braking arrangement. In some cases, however, the special series winding may be replaced by a resistance, in which case the electromagnetic switch 1 is dispensed with. In descending hills, and when

Fig. 4.

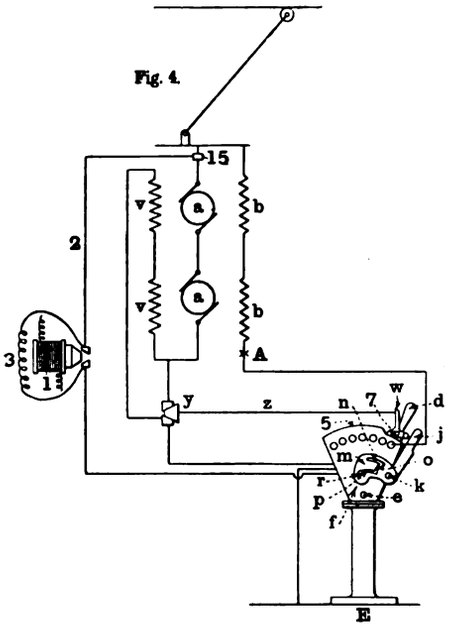


Fig. 5.

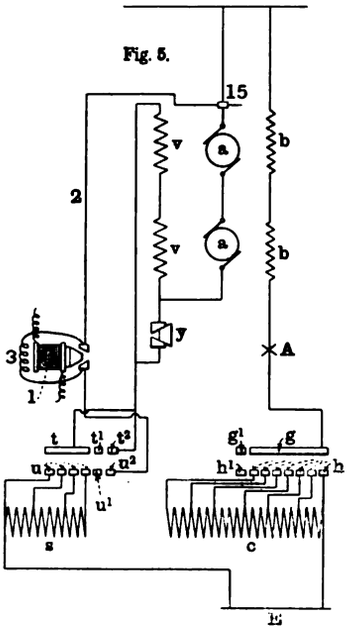


Fig. 3.

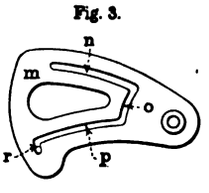


Fig. 7.

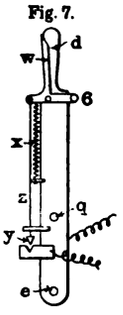
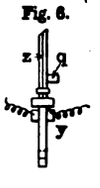


Fig. 6.



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stopping the vehicle, the motors act as generators and return current to line or to the battery, and thus act as a brake. The braking action is also in operation when the motors are short-circuited through the resistance, and when short-circuited through the special series windings v^1. The field-regulating contact blocks and those regulating the armatures are arranged in different zones for the better isolation of the one from the other, and the contact blocks for effecting the change from series to parallel may be swept by contacts carried by the power lever, but it is preferable to put them on a separate lever carrying a hollow cam, with which a pin on the power lever engages.

If it be desired to apply this regulating device to motors having series windings as well as shunt windings, then the controller or regulator is arranged with two handles or levers partially connected together and with a spring or its equivalent between them so arranged that when the handles are untouched the spring will force them into a position whereby a switch short-circuits the series coils, and the upper surface of the guide traversed by the handles is cam shaped, so that the short-circuit switch cannot be opened except when the shunt field is very strong. Figs. 4 and 5 illustrate diagrammatically an arrangement for the purpose, and Figs. 6 and 7 are detail views of the speed lever. The lever w is so arranged that normally it is maintained in a position remote from the speed lever d. This may conveniently be done by means of a spring, x. The second lever w controls, through a connector, z, a switch, y, which is caused to normally short-circuit the series coils v, that are so wound as to augment the fields when the motors are acting as generators. The upper surface of the controller casing f is so formed for a portion of its length, 5, that a pin, 6, on the second lever is in contact therewith, so as to prevent the lever w being moved to remove the short-circuit on the series coils v. Such movement is, however, permitted to take place when the pin 6 is opposite a recessed part, 7, of the controller casing. This recessed part 7 is so situated that the removal of the short-circuit on the series winding can take place only when the fields are near their maximum excitation by the shunt windings. In arranging the controller in a fore and aft position it is desirable that it should be placed parallel with the centre line of the car, but where this cannot conveniently be done it suffices to place it in such a position with regard to the driver that for him to push produces acceleration and to pull produces retardation.

Following are the claims:—

1. In a regulating device for vehicles propelled by electric motors, the combination with motors with a shunt field winding, of means for controlling the field circuit, means for controlling the armature circuit, and interlocking means so arranged that the armature circuit cannot be made or broken until the field circuit controlling means are in a certain position.

2. A regulating device for vehicles propelled by electric motors with a shunt winding wherein the means by which the armature circuit is closed or opened and the means which regulate the strength of the shunt excited fields and thus govern the speed of the vehicle are interlocked in suchwise that the armature circuit cannot be opened or closed until the fields are excited to a maximum, substantially as described.

3. A regulating device for vehicles propelled by electric motors of the kind herein referred to, wherein a speed lever and a power lever are so interlocked that when the armature circuit is closed, the speed lever can be moved through the full range of regulation and vary the motor fields to suit the speed required, but not so far as to break the field circuit, and when the armature circuit is open the speed lever can be moved to a greater extent so as to break the field circuit, substantially as described.

4. A regulating device for vehicles propelled by electric motors of the kind herein referred to, wherein the speed lever carries a pin that engages with slots in the power lever, the arrangement being such that according to which slot the pin on the speed lever is working in, the armature circuit is locked open or closed or the power lever is released to allow the conditions of the circuit controlled thereby to be changed, substantially as described.

5. In a regulating device for vehicles propelled by electric motors of the kind herein referred to, a plate carried by the power lever for interlocking the speed lever and the power lever, said plate having three slots therein which are adapted to be successively engaged by a pin on the speed lever in suchwise that when the pin is in one slot the armature circuit is locked closed, and the speed lever prevented from breaking the field circuit, and when the pin is in a second slot the power lever can be moved, the speed lever then being held immovable, and when the pin is in a third slot the power lever is so held that the armature circuit cannot be opened, but the speed lever can be moved so as to open the field circuit and, when moved to such position, be held, substantially as described.

6. A regulating device for vehicles propelled by electric motors having a series winding as well as a shunt winding wherein the series winding is normally short circuited, the arrangement being such that the short circuit cannot be removed except when the shunt field is very strong, substantially as described.

7. Regulating device for electrically propelled vehicles arranged and operating substantially as hereinbefore described with reference to and shown in Figs. 1 and 2 of the accompanying drawings.

8. A plate for interlocking the circuit controllers of motors of the kind herein referred to, constructed, arranged and operating substantially as hereinbefore described with reference to and shown in Fig. 3 of the accompanying drawings.

9. The combination with the interlocked speed and power levers of the regulating device hereinbefore described of a braking handle and a cam surface, so arranged that the cam surface prevents the said handle being actuated to remove the short-circuit on the series winding, except when the speed lever is in such a position that the shunt field is very strong, substantially as described with reference to Figs. 4 and 5 of the drawings.

The second patent, No. 3,658 of 1903, also granted to Mr. Raworth, relates to "Improvements in the Motors and Regulating Devices for Electrically-propelled Vehicles." The object is to return energy to the line in descending gradients and in arresting the motion of the car The motors are compound-wound, the series winding being arranged to strengthen the field when the armatures are returning energy to the line, and, therefore, to weaken the field when the motors are receiving energy from the line. Referring to Figs. 4 and 5, it will be seen that in starting the car the series field winding is short-circuited and has no effect on the field. To increase the speed the driver pushes the speed lever, and the braking handle moves with it, the shunt field being reduced by the insertion of resistance. If the speed increases too much, he draws back the speed lever, thereby removing resistance and strengthening the field. In descending steep hills the driver first draws back the speed lever until the increased strength of the field returns a strong current to the line, and then, if more retarding effort is required, he pulls back the braking lever, the effect of which is to remove the short-circuit of the series winding and to still further strengthen the field. The controller may be so arranged that in case of emergency, for instance the trolley leaving the line, further motion of the lever and handle will short-circuit the armature through the series winding, thus bringing the car to a stop, or nearly so, without any connection with the source of supply.

With such a system of control there is no necessity to provide the vehicles with brakes other than a hand-brake to hold the vehicle when stopped; but should the trolley leave the trolley wire, then, unless additional braking means are provided, there is great liability of a serious accident taking place. To avoid such an untoward occurrence by reason of the failure of supply of energy the power lever j is so arranged that, when released by the speed lever, it is moved on to contacts t^2,u^2, by which the armatures a are short-circuited on themselves. The driver, when he finds that the supply of energy has failed, also draws back the braking handle w to remove the short-circuit on the series fields. The motors then act as generators and also as a very powerful brake. It will be seen that with this arrangement the armatures can be short-circuited on themselves when the fields are excited to a maximum by the shunt windings b. This, of course, would be harmful. To overcome this defect the short-circuit 2 is provided with an electromagnetic switch 1, the windings of which are in series with the shunt windings at A. The switch is thus magnetised and held open so long as current flows through the shunt windings. However, in some cases, when it is desired that the motors shall form a brake that shall come into operation immediately the power circuit is opened, the contacts of the switch 1 are spanned by a resistance, 3, such resistance being cut out of circuit by the closing of the switch whenever the current through the shunt windings b is interrupted. The switch 1 may, if desired, be so constructed to perform all the operations necessary for short-circuiting the armatures through the series windings in the event of a failure of supply. Further, where there are two motors or more than one field coil in one motor, the two-motor coil or two or more coils of one motor may be ordinarily in series, but when great retarding effort is required, the two coils or sets of coils may be placed in parallel, thereby doubling the ampere-turns in the field or

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fields. Or the shunt windings may be in sections and so arranged that one or more or all of the sections may be brought into use as required, but so that on journeys where the car runs forwards and backwards the controllers shall be arranged that the sections principally used on the outward journey shall be the least used on the homeward journey to equalise the heating effect.

Following are the claims :—

1. A regulating device for motors having two field circuits controlled by two connected handles or levers, one of which is normally forced into a position in which a switch controlled thereby short-circuits the series field winding, substantially as described.

2. In a regenerative motor control system for electrically-propelled vehicles, the combination with motors having both shunt and series field windings, of means for controlling said shunt field circuit, means for controlling said series field circuit, means for controlling the armature circuit, and means for interlocking the armature circuit and shunt field controlling means, said series field circuit being normally short-circuited and adapted to be placed in circuit and augment the field when the motor is returning current to line.

3. In a regenerative motor control system for electrically-propelled vehicles, the combination with motors having both shunt and series field windings, said series winding being normally short-circuited, of means for controlling said shunt field winding, means for removing the short-circuit on said series field circuit, means for controlling the armature circuit and means for interlocking said shunt field and armature circuit controlling means, a circuit connecting one side of said motors with the earth side of said series winding, a normally open switch in said circuit, said switch being adapted to be closed automatically and short-circuit the motors on themselves when the shunt field and armature circuits are open.

4. Regulating device for electrically-propelled vehicles, arranged and operating substantially as hereinbefore described with reference to and shown in the accompanying drawings.

THE STEPNEY ACCOUNTS.

The electric lighting accounts of the Metropolitan Borough of Stepney to March 31st have just been published and show a further reduction in the average price obtained per unit. A statement of the capital account shows that £63,748 additional capital has been borrowed during the year, but against this there has been repaid a temporary loan of £10,000. Much of this extra capital has been expended on mains, machinery, buildings and a site for the new riverside station.

The Board of Trade units generated during the 12 months ended March 31, 1904, were 2,745,805, as compared with 1,948,906 of the previous year. Of these 2,745,805 the public lamps consumed 731,066, and private consumers by meter 1,802,445. The works used 73,358 units, and therefore 138,936 remain unaccounted for. A maximum demand of 1,268kw. was recorded during the year, and this gives a load-factor of 22·9 per cent., as compared with 21·1 per cent. for 1902-3.

The following table shows the principal figures for the year just completed and for that ended March 31, 1903 :—

Costs per Unit.

	1903.		1904.
Fuel	0·65d.	.....	0·64d.
Oil, waste, water and stores	0·04d.	.....	0·04d.
Wages at station	0·16d.	.....	0·15d.
Repairs and maintenance at station	0·05d.	.....	0·06d.
Total generating costs	*0·90d.*	.....	*0·89d.*
Total works costs	**0·96d.**	.....	**0·94d.**
Management and property charges	0·27d.	.....	0·23d.
TOTAL COSTS	**1·23d.**	.....	**1·17d.**

Receipts per Unit.

	1903.		1904.
Receipts for private supply	2·75d.	.....	2·66d.
Receipts for public lighting current	1·60d.	.....	1·61d.
Total receipts for current per unit	2·46d.	.....	2·36d.

Notwithstanding the fact that the average price per unit has been reduced from 2·46d. to 2·36d., there has been a balance of £12,792 carried to the net revenue account as compared with £9,499 in the previous year. After paying off interest on mortgage debt, instalment of capital account and cost of temporary work, the net surplus for the year is £5,936, or an increase of about £300 over and above that of the previous 12 months. This is undoubtedly a satisfactory state of affairs, and Mr. Tapper, the borough electrical engineer, is to be congratulated on the figures presented.

ELECTRICITY IN MINES.

A correspondent has sent us the following suggestions relating to the draft regulations issued by the Departmental Committee on the Use of Electricity in Mines. The regulations were given in full in *The Electrician*, Vol. LII., p. 689, and some suggestions as to their amendment were also made on pp. 764, 788 and 856 :—

Sec. I., Clause 5 (*b*) (1).—It is suggested that after the word "earth" should be added the words, "or they shall be fixed at such a distance apart or in such a manner that there shall be no danger from fire or shock."

Sec. I., Clause 7 (1).—That the clause should be amended to read:—"(1) No motor to be of less normal rating than 25 B.H.P., and no transformer shall be of less normal rating than 10kw." It is, at present, common practice to wind motors of 25 H.P. for pressures higher than medium pressure, and in the case of transformers these are wound for pressures higher than medium pressure as small as 10kw. and even in smaller sizes for special purposes.

Sec. I., Clause 7 (3).—That after the word "earth" should be added the words, "or they shall be fixed at such a distance apart or in such a manner that there shall be no danger from fire or shock."

Sec. I., Clause 10.—That the application of a pressure test of 50 per cent. in excess of the working pressure in the case of machinery or apparatus for a period of half an hour may permanently strain the insulation, and a flashing test at a potential two to two and a-half times the working pressure is suggested as being more satisfactory in detecting defects.

Sec. I., Clause 11.—That lamps suitably connected will operate sufficiently well as earth detectors on all circuits up to a medium pressure, the purpose being to indicate the existence of, rather than to measure the value of, a fault. The provision of instruments as indicated in this clause would be a costly matter, even if such instruments could be made reliable below medium pressures.

Sec. I., Clause 14.—That this clause should not apply to wiring on the main switchboard, where it is necessary, in many cases, to bunch small wires between instruments and their respective transformers, &c.

Sec. I., Clause 15.—That with an automatic cut-out on each pole the provision of a main switch in series with it is unnecessary.

Sec. I., Clause 26.—That the provision of telephones should be optional, and only compulsory when the conditions of the installation indicate that such provision would be essential to safe and efficient working.

Sec. II., Clause 3.—That a hand-railing should only be required where a switchboard attendant is always present, as such hand-railing renders the switchboard inaccessible, and in small power plants it is absolutely essential that the switchboard be readily accessible to the man in charge.

Sec. II., Clause 5.—That the following clause should be substituted :—"Every generator and feeder should be provided with an automatic cut-out capable of opening the heaviest overload which such circuit may experience under the severest emergency conditions. Every feeder circuit should be protected by a cut-out on each pole. Every continuous-current generator circuit should be protected by at least one maximum and reverse-current cut-out. In the case of three-wire systems, maximum cut-outs should be provided on both poles. It is recommended that the alternating-current generators be provided with energy reversal indicators. Suitable instruments should be provided for measuring the current and pressure of each generator."

Sec. II., Clause 7.—That no danger is incurred by attendants in cleaning the back of the switchboard carrying medium pressure. If the board is required to be sectionalised, it will be practically impossible in the original designs to provide for future extensions of the plant; such sectionalising will render the back connections of the switchboard extremely complicated, which will of itself be an additional danger. Further, if a ring 'bus bar be provided to admit of sectionalising, each individual panel will not even then be entirely free from pressure when isolated, due to the fact that the return half of the 'bus bar must necessarily cross the back of the isolated panel, and its return half will carry the pressure. The last paragraph of this clause provides that no work or cleaning is to be carried out on the switchboard while pressure above the limits of low pressure is on the board, so that even if it were practicable to arrange the switchboard so that the panels could be isolated it would appear to be necessary to remove pressure from the switchboard altogether before either cleaning or repairs were carried out; thus the provision of isolating switches for each panel is unnecessary if the latter half of this clause should be enforced. If this clause is enforced, the necessity for shutting down the complete plant before cleaning or repairs to the switchboard can be effected is likely to be attended with very serious danger in practically every case, as in many instances where electricity has been introduced to mining work it is used for pumping and ventilating, neither of which operations can be stopped for any length of time.

Sec. II., Clause 9.—That the last paragraph of this clause should be amended as follows :—"That all automatic cut-outs and fuses must be mounted in such positions and be so protected as to eliminate any risk of injury to the attendant."

Sec. II., Clause 10.—That this clause as it stands would necessitate the complete redesigning of what is generally accepted as the best modern practice for all switchboards used for medium pressures. Even under existing conditions it is extremely difficult to design a switchboard

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for medium pressures to ensure that the back connections are not complicated and crowded, owing to the necessity for using heavy back connections to carry the current required. As this clause would necessitate that all instruments, switches and fuses, and circuit breakers be fixed to the back of the switchboard, together with the necessary mechanical connections for operating the switches from the front of the switchboard, the arrangement of connections, &c, at the back would become exceedingly complicated, and such arrangements would tend to increase considerably the liability to break down. The prohibitive cost of such switchboards would tend seriously to retard the development of the use of electricity in mines.

Sec. II., Clause 13.—That a hand-wheel device for the adjustment of brushes is unnecessary on machines smaller than 100kw.

Sec. III., Clause 5.—The objection raised to metallic protection in sec. I., clause 5 (*b*) (1) would apply in this case.

Sec. III., Clause 9.—That after the words "square inch" at the end of this clause, the words "equivalent to continuous service" be added.

Sec. V., Clause 3.—That this clause should be amended to read as follows:—"The motors must not be worked at a duty such that, after six hours' run under normal working conditions, the maximum rise of temperature attained by any accessible part of the motor will exceed 100° F., as measured by the thermometer—the maximum temperature of the motor at any time, under normal conditions of service not to exceed 170° F." As it is the final temperature reached by the motor under normal conditions of working that is the limiting temperature, and it is suggested that the provision of such a final temperature limit is all that is required.

Sec. VII., Clause 6.—That the provision of strong glass covers enclosing vacuum lamps in gas-tight fittings involves excessive first cost, and is unnecessary having regard to the fact that the breakage of a vacuum lamp is attended with less risk than the breakage of a Davy lamp. Should mechanical protection be deemed desirable, it is suggested that a strong wire guard is all that is required.

POWER STATION DESIGN.*

BY C. H. MERZ AND WM. M^{c}LELLAN.

Introduction.

Power stations are designed for numerous purposes, from the small station for a town lighting or traction system to the large station for dealing with all the requirements of an industrial neighbourhood; it may, therefore, be advisable, although the general principles of design are identical, to say at the outset that many of the remarks as to detail which we shall make apply more particularly to the power station (5,000kw. or over) of a power supply undertaking—that is to say, of an undertaking whose object is to supply all the requirements (power, traction and lighting) of a district extending over a considerable area. If a station for power supply were designed on similar lines to many existing power stations for traction and lighting purposes commercial failure would almost certainly result. In the case of a tramway system the capital expenditure on the electrical equipment is not a very large proportion of the cost of the whole system; large sums, therefore, can be, and frequently are, expended on elaborate and ornamental buildings, on highly-finished equipment, on the provision of an excessive amount of spare plant, and on unnecessary duplication of auxiliary machinery, without appreciably affecting the commercial success of the system. In the case of power supply, however, there is a limit in price below which a supply company must keep if it is to get consumers at all. This limit is low because many large individual consumers are very favourably situated from a power generating point of view, and a power company can, therefore, only attain success by giving due consideration to the factors governing economical production. Reliability of supply must, however, take precedence over everything else, even over economy of production. It is impossible to contemplate interruption of supply to a manufacture, for if this happens a power company has failed in its purpose.

Since the early days of the distribution of electrical energy an amount of attention has been directed to the power station as compared with the distribution system which is hardly warranted by its importance from either an engineering or a commercial standpoint. The importance attached to the power station probably accounts for the lavish and unnecessary expenditure which has in many cases been bestowed upon it. † It may be worth while to carry the suggested comparison into detail, if only because the conclusions to be drawn materially affect the expenditure on the power station itself.

(1) The distribution system of a power scheme will usually consist of a three-phase supply at 40 or 50 cycles per second. We do not refer to the voltage, as this depends to a great extent upon the area covered, and in any case it can easily be transformed. The system of supply having once been decided upon and the cables laid, it is more or less permanently settled for better or worse, and cannot be changed without great expense.

(2) The expenditure upon the distribution system will probably, in the majority of cases, amount to more than 50 per cent. of that on the whole scheme, especially if the consumer's installation be taken into account. This, whether supplied by the power company or not, is really part of the system, in that the company must bear the expense of any alteration necessary on account of change of system.

(3) The manufacture of cables is well understood, and if they be properly designed and laid they are subject to a very small repair account. A smaller depreciation account is therefore justifiable than in the case of the power station.

(4) Large power schemes will probably eventually consist of a network of transmission cables, sub-stations and distributing cables, supplying all the power requirements of a neighbourhood and drawing a supply from more than one power station, the latter being located where electricity is to be obtained most cheaply from either coal or waste products.

(5) The distribution system has a comparatively high efficiency, probably not less than 75 per cent.

(6) On account of the high initial cost of installing the distribution system, in taking up ground, &c., and the difficulty of making small beginnings and economically adding to them hereafter, the distribution system should be, and generally is, put down with more margin for future requirements than is the power station.

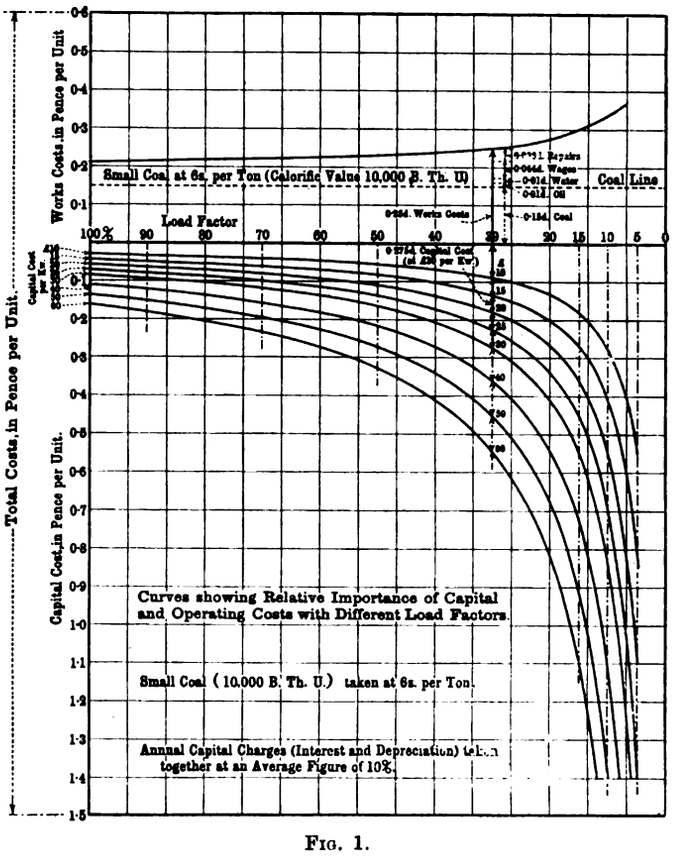
Works Costs in Pence per Unit
Small Coal at 6s. per Ton (Calorific Value 10,000 B. Th. U)
Coal Line
Load Factor
100% 90 80 70 60 50 40 30 20 15 10 5 0
Total Costs in Pence per Unit.
Capital Cost in Pence per Unit.
Curves showing Relative Importance of Capital and Operating Costs with Different Load Factors.
Small Coal (10,000 B. Th. U.) taken at 6s. per Ton.
Annual Capital Charges (Interest and Depreciation) taken together at an Average Figure of 10%.

FIG. 1.

On the other hand

(1) A power station has a comparatively low efficiency, not more than 10 per cent.; there is thus room for large improvement in the generation of power. For this reason the depreciation account must necessarily form a much higher percentage of the capital cost than in the case of the distribution system.

(2) A power station is capable of easy extension without affecting in a very marked degree the ultimate cost. It can therefore be begun on a smaller scale.

(3) It may pay in the future to change even the location of the power station, and to feed the system from some other site or sites where energy can be more cheaply generated.

We do not think it is wide of the mark to suggest that 10 per cent. per annum should be considered as sinking fund in deciding whether to spend more money than is absolutely necessary on any particular section of the plant in a power station in order to secure lower running costs. In stating this we have specially in mind the liability of change in the generation of power, both in method and in the location of the power station. The relative importance of capital cost and running cost may be seen at a glance for any particular values of either load-factor, capital cost or running cost from the curves attached (see Fig. 1). From these curves it will be seen that a reduction of the capital outlay by £1 per kilowatt has

* Abstract of a Paper read before the Institution of Electrical Engineers last night.

† When we consider that a boiler only costs £2 or £3 a kilowatt, and a turbine or high-speed reciprocating set £10 at the outside, it is surprising to find power stations running out (as they still do in many cases) to a total cost of £40 or even more per kilowatt. In other words, the mere collecting and joining together of the principal apparatus may cost three or four times as much as the apparatus itself.

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a greater effect on the running costs than has a reduction of the coal bill by 6 per cent.* This applies with a load-factor as high as 30 per cent.; it is therefore evident that for lower load-factors the question of limiting capital expenditure becomes of overwhelming importance as compared with that of reducing running costs.

Simplicity of Design.—Simplicity of design is desirable apart from (as well as on account of) the question of economical production, and generally speaking, it may be accepted that no complications introduced to facilitate the repair of a breakdown are justified should the complications themselves increase materially the risk of breakdown. That all the earlier station engineers should consistently disregard this axiom was perfectly natural. They came to regard breakdowns as inevitable, devoting their attention to minimising their effect rather than to reducing the amount of apparatus in which a breakdown could occur. Ten years ago Mr. Ferranti actually practised this doctrine of simplification, more especially with regard to the electrical side of the station, and as an example of its systematic and logical application the general arrangement of a Ferranti single-phase board is unsurpassed. In the design and general arrangement of the mechanical portion of the station equipment the complication which formerly existed now appears to be diminishing. For instance, at one time a ring steam main was considered necessary, but it was speedily realised that the inherent objections were very numerous, most engineers returning to the sub-divided straight main into which all boilers fed and from which all engines drew their supply of steam. Fortunately, cases of a burst steam pipe in a station have been rare, but the failure of a pipe or valve at full load anywhere near the middle of a main would probably result in shutting down the whole station, whether a ring main be used or not.

Sub-division of Plant and Apparatus.—The only way to remove all risk of a complete shut-down due to the failure of a steam pipe is to sub-divide the boiler-house plant into a series of groups, each group having no connection with its fellows.† In fact, it is now considered imperative in a large power station to sub-divide all parts of the apparatus, from the boiler house to the switchboard, into a series of units, each complete in itself.

Labour-saving Devices.—To obtain suitable labour becomes more and more difficult every day, not we hope, because the supply grows less, but because the demand increases faster than the supply. This matter is specially referred to, as the authors have found it difficult to justify the inclusion of a great proportion of labour-saving apparatus by any actual calculation of possible economies in capital or running costs. Take even the ordinary mechanical stoker; we doubt very much if, taking into account first cost and repairs and also efficiency, this is in practice justifiable except in order to meet the labour difficulty. Certainly in the case of most coal-handling plants it will be found that the cost of labour saved is more than counterbalanced by the charges for interest, depreciation and repairs on the elevating and conveying apparatus. We have known a case in which the capital and repair charges exceeded by 200 or 300 per cent. the economy in wages—there obviously the expenditure was not justified. Before expending money in labour-saving devices the pros and cons of the case should be sytematically considered. On the one side should be put capital charges, taken at not less than 15 per cent. on the capital cost and repairs—the latter to be estimated. On the other side should be put the saving in labour.

Provision for Extension.—Power stations for wholesale supply, if the eventual capital expenditure per unit sold is to be kept down, must not be designed for to-day. There is nothing which increases the station capital account so rapidly and prevents that gradual decrease of capital expenditure per unit sold which should take place with the growth of a system as alterations to existing work and re-arrangements in order to meet increased output. It is possible in laying out a station to avoid placing chimneys, flues, offices and elaborately-built brick ends so as to interfere with extensions to either boiler house or engine room, though it is to be feared that this is not always done. Having referred to the main principles governing power station design, we shall proceed to discuss some of their effects on actual design, on the assumption that the power station under consideration is for the supply of energy as three-phase high-tension current at 5,000 volts or over.

1. Type of Generating Plant.

High-speed reciprocating engines should obviously for the same power cost less than those of slow speed. They will, moreover, take up less room. On the other hand, the advocates of slow-speed engines claim that the repair bill of a high-speed engine is higher and the economy not so good as in the case of a slow-speed set. It is only in this country that the question as between the two types has arisen at all—neither on the Continent nor in the United States has any progress been made with high-speed apparatus, and the perfection to which high-speed engines have been brought in this country is all the more creditable in view of relatively slow progress in some other branches of the industry.* Every year steam turbines claim increasing attention.† They have already been adopted for the largest new stations in this country, on the Continent and in America. Opinion is, however, still divided with regard to their merits, and we are, therefore, perhaps justified in dealing with the question at some length. The present position of steam turbines may be said to be almost entirely due to the indefatigable energy of the Hon. C. A. Parsons, who has laboured many years on their development. A Swedish engineer, De Laval, has also been engaged on the subject for nearly, if not quite as long. His turbine,‡ however, runs at so high a speed (of the order of 10,000 revs. per min.) that it is impracticable except in comparatively small sizes. Of turbines§ more recently placed on the market the best known is, perhaps, the Curtis,‖ which has been developed by the General Electric Co. of America. Other types are the Rateau,¶ manufactured by the Maschinenfabrik Oerlikon (Zurich), and the Stumpf,** developed by the Allgemeine Elektricitäts Gesellschaft, Berlin. In addition to these there are various modifications of the Parsons turbine manufactured by different firms.

Whether the final form of turbine will be of the Parsons type, or whether it will be modified by the use of expanding nozzles†† or by other device, it is impossible to say at present. The turbine has, however, already reached such a high standard of efficiency compared with that obtainable within the temperature limits that unless these limits‡‡ are themselves largely varied it would seem to resolve

* On the basis of coal at 6s. per ton.

† When the initial capacity of a station is comparatively small and a cross connection is considered desirable it should be made through a length of pipe having stop valves at each end.

* See *Proceedings* of the Institution of Civil Engineers, Vol. CLI.: "High-Speed Electrical Generating Plant," by T. H. Minshall. According to figures recently published high-speed engines have been built with a consumption of only 16lb. of water per kilowatt hour (steam at 200lb. and 200°F. of superheat), which figure will bear comparison with the very best slow-speed results. [An abstract of this Paper was published in *The Electrician*, Vol. L., p. 256.]

† See Paper before the Municipal Electrical Association: "Steam Turbines," by S. E. Fedden, July, 1902 (*The Electrician*, Vol. XLIX., pp. 522, 588 and 880). Also "Some Notes on Steam Turbo-Electric Generating Plants," by Geo. Wilkinson, before the Leeds Local Section Institution of Electrical Engineers, October 1903 (*The Electrician*, Vol. LII., pp. 19 and 55, and subsequent correspondence).

‡ [See *The Electrician*, Vol. LII., p. 777.]

§ The only turbines of large size which have been running any considerable time are those of the Parsons type made by C. A. Parsons & Co., though the Westinghouse Company and Messrs. Brown, Boveri (who manufacture the Parsons turbine under licence) have also started up some large turbines within the last 18 months. The following table gives a few particulars of the various types of steam turbines:—

Type.	Output. Kw.	Speed r.p.m.	Approx. peri. speed in ft. per second.	Exp'nsion stages.	Total No. of rows of blades.	General characteristics.
Parsons	1,500	1,200	100 to 220	Continuous.	78	Drum construction—fall of pressure equally divided between stationary and moving blades.
Rateau	1,500	1,200	150 to 250	25	25	Disc construction—fall of pressure occurs only at nozzles in stationary discs.
Curtis	1,500	1,000	400	4	8	Disc construction — arranged vertically, two rows of revolving blades to each set of expanding nozzles.
Stumpf	1,500	3,000	1,400	1	1	Expanding nozzles, single disc, buckets similar to Pelton wheel.
De Laval	200	10,600	1,400	1	1	Expanding nozzles, single disc, drives dynamo through helical gearing

‖ See *Proceedings* of the American Philosophical Society of Philadelphia, April, 1903: "The Curtis Steam Turbine," by W. L. R. Emmet. [Also *The Electrican*, Vol. LII., pp. 88, 160, 242 and 596.]

¶ See Paper by Prof. Rateau before the Conference of the Institution of Civil Engineers, June, 1903. (*Engineering*, July 3, 1903, *seq.*)

** [See *The Electrician*, Vol. LII., p. 902.]

†† With the exception of those of the Parsons type all turbines have some form of expanding stationary nozzle.

‡‡ The principal sources of losses in a turbine are leakage, eddy or fluid friction and incomplete expansion. It is safe to assume that in no turbine will this be reduced to below 15 per cent. We may, therefore, assume that the best attainable result is that the turbine should return as useful work 85 per cent. of the total energy contained in steam between specified boiler and condenser temperatures. Assuming the efficiency of the dynamo, including the losses in bearings, excitation slip rings, oil pumps, &c., to be 90 per cent., then 1 kw.-hour in the switchboard will, with steam at 200lb. pressure superheated 200°F., and with a condenser

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itself almost solely into a question of first cost. Turbines of any type obviously possess certain inherent advantages over reciprocating engines—they are cheap, simple, take up little room, and have no vibration. If, therefore, they can be made to run with reasonable economy in steam consumption and repairs they fulfil the essential requirements for power supply much more effectively than can the best reciprocating engine whether high or low speed.

To any one with experience of large turbines there can be little or no question about any of these points, but as a great deal of information as to actual experience has not yet been published we may briefly refer to results obtained at Wallsend. We attach curves showing the steam consumption* of a 1,500kw. to 2,000kw. turbine which was installed at the end of 1901 (Fig. 2). The tests given were made after the turbine had run about 900 hours. After running 6,000 hours practically the same tests were repeated, and

It will be noticed that the 2,000kw. turbine ran 7,500 hours without ever having been opened up, and only on two occasions have the bearings needed any re-setting in order to keep the clearance correct, although they were three times examined and the clearance tested. In fact, the only faults of any kind which it has been necessary to repair have been the re-lining of one of the governor throttle valve chests and the renewal of an oil disc.

Steam turbines seem in every respect to be specially suitable for power scheme purposes, and, although they have taken many years to develop, it is probable that, had there been a demand 10 years ago for 2,000kw. generating sets, turbo-alternators would have been the only large size generating units in extensive use at the present day. Their earlier commercial success was prevented by the fact that there was only a demand for small sizes (300kw. and under), at which sizes any superiority which the turbine even at the pres nt

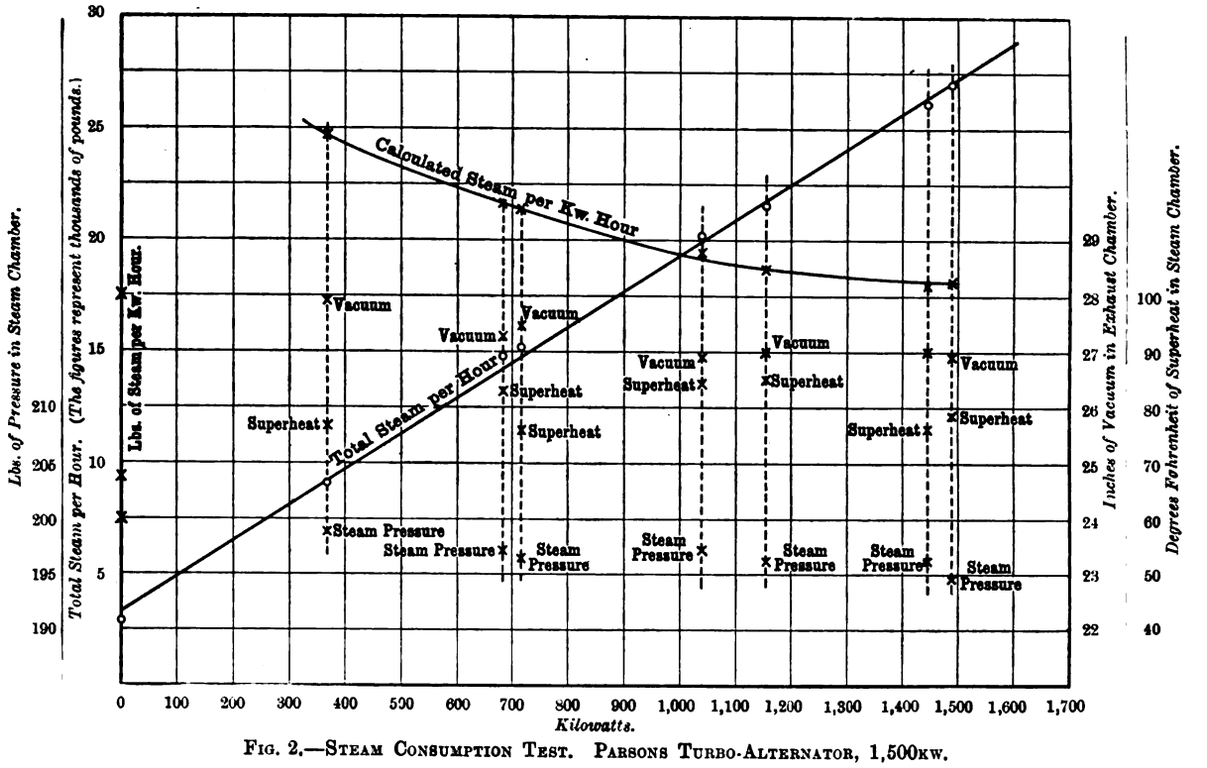
Lbs. of Pressure in Steam Chamber. (The figures represent thousands of pounds.)
Total Steam per Hour.
Lbs. of Steam per Kw. Hour.
Calculated Steam per Kw. Hour
Total Steam per Hour
Vacuum
Superheat
Steam Pressure
Inches of Vacuum in Exhaust Chamber.
Degrees Fahrenheit of Superheat in Steam Chamber.
Kilowatts.
0 100 200 300 400 500 600 700 800 900 1,000 1,100 1,200 1,300 1,400 1,500 1,600 1,700

FIG. 2.—STEAM CONSUMPTION TEST. PARSONS TURBO-ALTERNATOR, 1,500KW.

within the limits of observation the same results were obtained. The following table shows the hours of running, oil consumption, &c.:—

Log of No. 10 Turbine installed at the Neptune Bank Power Station of Newcastle-upon-Tyne Electric Supply Co.

Period.	Hours running.	Hours out of commission.	Remarks.
Dec., 1901, to Aug., 1902..	2,090	..	Thrust adjusted.
Aug., 1902, to Sept., 1902..	471	4	Do. do.
Sept., 1902, to Oct., 1902..	516	2	Thrust examined.
Oct., 1902, to Nov., 1902..	502	12	Governor overhauled.
Nov., 1902, to Aug., 1903..	1,788	18	Relay valve examined, thrust examined, new oil disc fitted.
Aug., 1903, to Dec., 1903..	1,596	4	Thrust examined.
Dec., 1903	549	12	Repairs to governor throttle valve chest.
	7,512	52	

Total hours run, 7,512. Out of commission for inspection and repairs to turbine, 52 hours. Oil used, 150 gallons at 3s. 6d. per gallon.

temperature of 100°F., require a consumption of 11·85lb. of steam—(from Rankine's formula). Turbines have already been constructed consuming 14·5lb. of steam per kilowatt-hour at full load with a steam pressure of 190lb. superheated 200°F. and with 27·9in. of vacuum in the condenser, so that future developments must be looked for rather in higher efficiency at low load and in the adoption of higher pressure or greater superheat.

* The data are taken from the log sheets of the Newcastle-upon-Tyne Electric Supply Co. who have operated two 2,000kw. turbo-alternators at their Neptune Bank power station, and who are now installing a further 10,000kw. of turbines at their new Carville station. It is thought that the facts stated justify conclusively the installation of the trial turbines three years ago and the orders for new turbines which the company have since placed.

time possesses over reciprocating engines is due to saving of labour and oil rather than to either lower cost or reduced steam consumption. In large units the adoption of turbines materially reduces the capital cost of a power station. This reduction amounts to from 15 to 20 per cent. over the whole station, even on present market prices, and it will be much greater when the manufacture of turbines has become as completely standardised as that of reciprocating engines; if the reduction be calculated on the engine and dynamo alone, the percentage is naturally very much greater. The mere fact that this saving is not available in small sizes greatly assists a power company in its competition with private plants. We are here discussing a station for power supply which involves alternating units, as large continuous-current turbo-generators, due to the troubles of commutation at high speed, have still a somewhat limited field.*

The high thermal efficiency of gas engines has long rendered their use attractive to power station engineers, more especially in the south of England, where coal is expensive; but, although we may eventually look forward to the time when a gas motor fulfilling the requirements of a power station will be obtainable, it can hardly be denied that, for this purpose, the gas engine has not at present

* In cases where it is necessary or desirable to generate continuous current, turbo-alternators plus rotary converters, even when the latter have to be installed in the same building, are frequently justifiable. If it be a question of a 500-volt network for traction or lighting, and the radius to be dealt with does not justify one or two sub-stations, rotary converters would be installed in the power house and the generators would be of the revolving-field type and wound for 330 volts so as to avoid step-down transformers. Switchgear between generator and rotary would be dispensed with, and each rotary and turbo set would be treated as one unit. The result would be:—*Capital Cost.*—Rotary plus alternator as against low-tension direct-current generator, an increase in first cost of perhaps £1 per kilowatt which should be more than saved by the reduced cost of turbines compared with reciprocating engines. The rotary would not, of course, cost as much as the continuous-current dynamo for the same output. *Annual Cost.*—A loss of, say, 5 per cent. in the rotary converter, as against the saving in steam, oil and repairs by the use of turbines.

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attained the same perfection as the steam turbine.* It is hardly open to question that steam turbines with a given amount of spare plant give greater security of supply than gas engines. It is also evident that the use of steam turbines simplifies the remainder of the power station and, generally, the system as a whole. Even if we say nothing about the difficulties attending the use of rotary converters of 40 or 50 cycles fed through long lengths of cable with gas engine-driven plant, we doubt whether a balance-sheet can be drawn so as to come out favourably to the gas engine at the present moment.† The saving of coal varies, of course, in different localities; but, even allowing for slight differences in favour of the gas engine compared with the steam turbine in this direction, we would at present for all ordinary power station purposes in this country decide in favour of the steam turbine. We would draw our balance-sheet as follows:—

Gas Engines.	*Turbines.*
Low coal bill,	Low oil costs,
High oil costs,	Low labour costs,
High labour costs,	Low repair costs,
High repair costs,	and (most important of all)
and (most important of all)	Low capital costs.
High capital cost.	

Low capital costs are even more important in this connection than in others, as depreciation charges are necessarily higher in gas engines than in turbines. Of course, such improvements in gas engines may be made as will result in their superseding steam turbines; but, if the advocates of gas engines are correct in stating that the present type of gas engine is being rapidly improved upon, it is the more advisable to instal at first a cheap plant in order to diminish the cost of superseding it when gas engines approach finality in development.

2. General Arrangement.

The buildings necessary for a large power station and its operation are: (*a*) Main buildings containing the generating machinery, (*b*) switch house, (*c*) offices, (*d*) stores and repair shops. The above buildings are frequently grouped into one block, and although this may result in some saving it would seem a mistake if we follow out the principle of sub-division. Some engineers prefer to keep the switchgear in an entirely separate building, and there is much to be said in favour of this course, especially if the number of feeders is greatly in excess of the number of generators. A modification of the idea would be to build a separate feeder house. The offices, stores and repair shops, however, should, in the opinion of the authors, always be placed away from the main power station buildings. The advantage of doing this is that they need not be built so substantially, and all fire risks are avoided.

In commencing the construction of a power station, the auxiliary buildings, repair shops, stores and all sidings should be put down before the main buildings are started. This will enable considerable economy to be effected in the cost of constructing the main buildings. Fig. 3 shows the general arrangement of auxiliary buildings at Carville. It will be observed (*a*) that the offices, stores and fitting shop are all separated from the main buildings, as is also the North-Eastern Railway sub-station. (*b*) Easy communication has been provided between the offices, the main switch gallery and the North-Eastern Railway sub-station by means of an overhead enclosed gangway. (*c*) Siding communication is provided between the stores and repair shops and the main buildings. (*d*) An overhead hand traveller connects the stores and repair shops. (*e*) Both a railway siding and a road run into the stores. (*f*) Stores and construction offices are combined with time office and main entrance to works. It may be mentioned that in this particular case these buildings also act as construction offices and repair shops for the whole of the Newcastle Company's system.*

With regard to the general lay-out of the main buildings, the modern station is tending towards what may be called the Complete Unit System.† For a large power station this tendency might with advantage be carried further than is the general practice at present, so that the only junction between the various units will be:—(1) At the railway siding or other source of coal supply. (2) At the river or other source of circulating water supply. (3) At the main 'bus bars. In fact, a large power station might with advantage be so designed that the boiler house plant, the steam-piping system, the generating system and the switchboard may all be entirely sub-divided into different units. The adoption of very large generating units has increased this tendency in recent power stations, which are now, in many cases, designed more after the lines of what might be termed marine practice—that is to say, each large generating set is provided with its own boilers and auxiliaries, and it is, therefore, under normal conditions entirely separate from the other units.

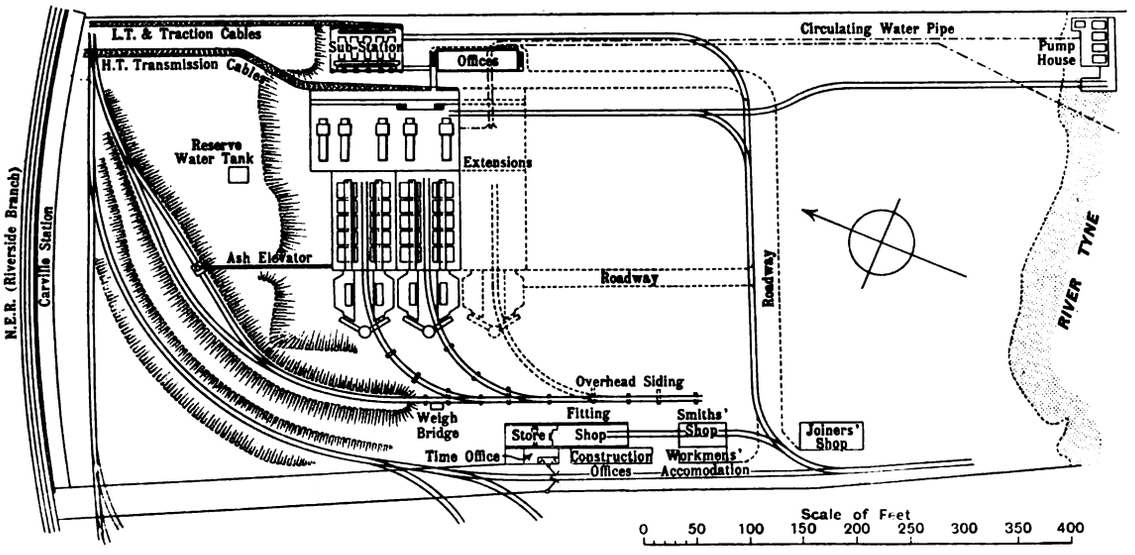

Fig. 3.—Plan of Site. Carville Power Station of the Newcastle-upon-Tyne Electric Supply Co.

The building itself may be treated merely as a shell to contain effectively, but as cheaply as possible, the generating plant. A steel-framed structure is in every way the most satisfactory, the filling in between the various columns being merely of the nature of a weatherproof screen wall, depending for its stability on the steel framing. This screen can be of brick, concrete or corrugated iron—the last has the advantage that it can be more easily altered.‡

* Apart altogether from the importance of utilising more efficiently the heat energy in coal, there are large possibilities in utilising gas which is a waste product, or which is obtainable in conjunction with some manufacturing process. These possibilities make it particularly desirable to utilise gas direct in the prime mover without the agency of steam. This Paper, however, refers essentially to the design of power stations where coal is the fuel, either in a boiler or in a gas retort. The conclusions drawn under this section must in no sense be taken as implying that in the opinion of the authors gas engines are impracticable for power stations where waste gas from blast furnaces or other source is available. (See also footnote †.)

† It is at present almost essential to use 40 or 50 cycles for power supply in order to deal with alternate-current lighting. If gas engines were used it would probably pay to utilise asynchronous alternators on the gas engines and to have one turbine always running on the circuit to keep the turning moment steady, and generally to control the system. It is the intention to do this in the Blaydon power station which the authors are at present erecting.

* [The Paper also contains a plan showing the position of the buildings at the Neptune Bank station of the Newcastle-upon-Tyne Electric Supply Co. A similar plan was published in *The Electrician* of June 21, 1901 (Vol. XLVII., p. 319), the only alteration since that date being the addition of a "switch house" against the side of the engine room alongside the switchboard.—Ed. *E.*]

† By a complete unit is not necessarily meant one generating set. A unit may consist of two or more generating sets with boilers and auxiliaries.

‡ This feature—namely, that it should be possible with the minimum of expense to take advantage of radical improvements—is also worthy of consideration in connection with the site chosen.

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The switch galleries must run parallel to the longitudinal axis of the engine room,* the boiler house being placed along the side of the engine house opposite to the switch gallery. In order to secure the shortest possible steam pipe, it is imperative that the boilers should be located directly opposite the engines they normally supply. For similar reasons these engines should be closely adjacent to their

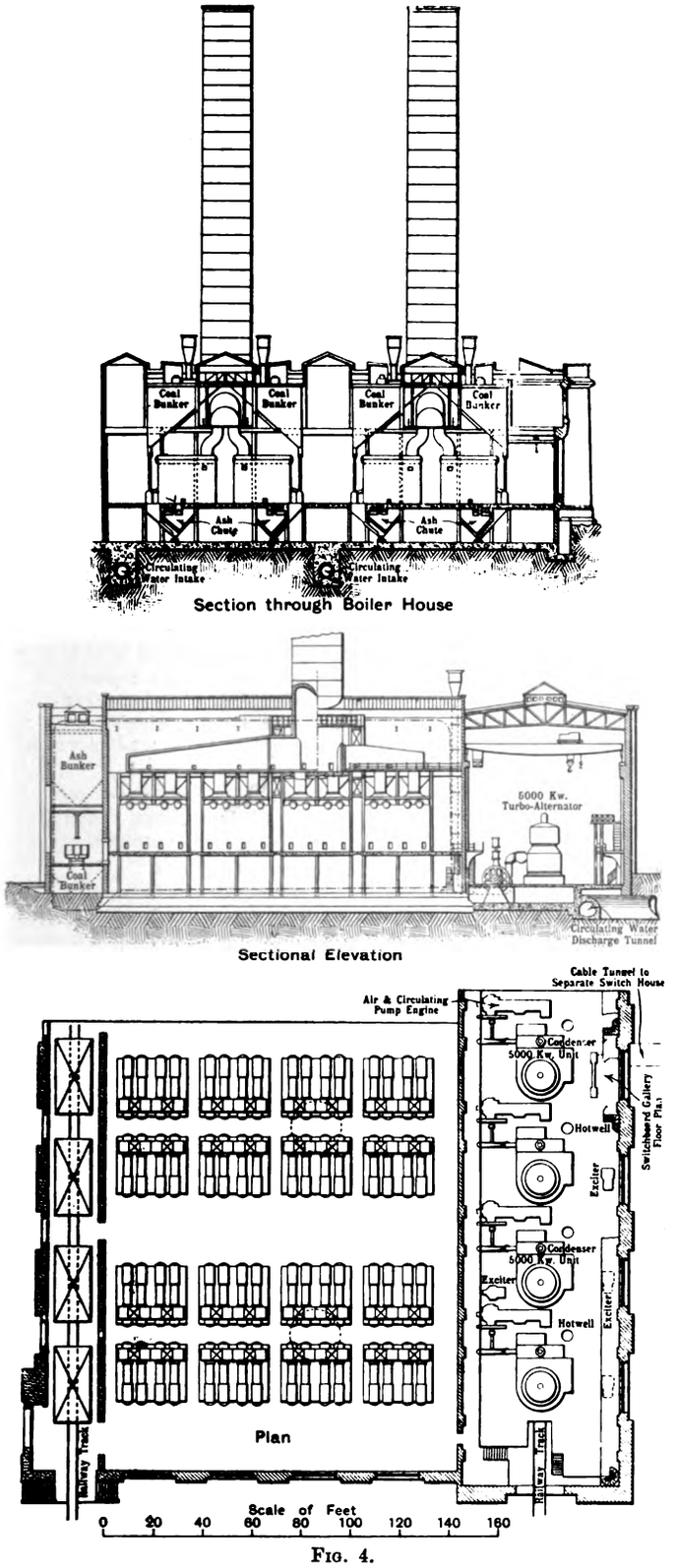

FIG. 4.

GENERAL ARRANGEMENT OF PLANT IN FISK STREET POWER STATION (COMMONWEALTH ELECTRIC CO., CHICAGO), SHOWING FOUR COMPLETE UNITS.

condensers, which, in turn, should be almost directly above the circulating water inlet and outlet mains. On the electrical side similar reasons hold, the generator panels should be as close as possible to their respective generators. In short, the whole lay-out should be designed with the idea of avoiding crossings and of obtaining the shortest and most direct run of all connections, whether piping or cables.

For a comparative large power station, of, say, an initial capacity of 10,000 kw. capacity of extension to three or four times this size, and especially for one utilising steam turbines, the general arrangement adopted for the Carville Works of Newcastle-upon-Tyne Electric Supply Co.* is convenient, as it fulfils the several requirements we have laid down, namely (1) simplicity of design, (2) subdivision of plant, (3) saving of labour, (4) ease of extension.

A turbine occupies so little floor space in comparison with its output that it is impossible to adopt what had almost become a standard arrangement—*i.e.*, having one or two lines of boilers parallel with the engine room—as by so doing sufficient boiler-house capacity could not be obtained without wasting an excessive amount of floor space in the engine room through spacing the turbines very far apart. In fact with turbines there are only two alternatives possible, either to have a two-storey boiler house or to arrange groups of boilers at right angles to the axis of the engine room, providing each turbine with its own group of boilers.†

(*To be continued*).

NOTES ON THE DESIGN OF ELECTRICAL MACHINERY.‡

BY LOUIS J. HUNT.

CONTINUOUS-CURRENT MACHINES.

It has been suggested by various writers that a radical difference should be made in the designs of continuous-current machines between those built for 100 or 200 volts and those intended for operating at 500 or 550 volts.

Generally speaking, in machines designed for working at 100 or 200 volts, it is quite easy to obtain thoroughly satisfactory commutation, the factor limiting the maximum output of such a machine being the rise in temperature of the armature. The case is different with dynamos and motors wound for working at a voltage of 500 volts or more. Here, generally, care has to be taken that the output is not limited by commutation troubles before the maximum output from the point of view of temperature rise has been reached. In order to reduce the number of designs as much as possible, it is advisable, at any rate, when dealing with small machines up to, say, 100 B.H.P., to design the armatures for 500 or 550 volts. It will then be quite easy to obtain excellent commutating qualities for all lower voltages.

If we design machines for 500 volts it will generally be found, especially for machines coming within the above-mentioned limits (100 B.H.P.), that it would be somewhat advantageous to use a larger total slot area for the lower voltage windings, which is tantamount to saying that machines wound for lower voltages can have stronger armatures than those wound for the highest voltages required. As above stated, it is, in the author's opinion, however, better to design small machines for the highest voltage required, on account of simplicity. In a given machine with a given value of magnetic flux the commutating qualities of an armature are inversely proportional to the volts per commutator part. It greatly simplifies shop work to use one size of commutator with one length of face for all voltages for small machines, and by suitably designing the armatures on the above lines this can be easily done.

For low-voltage windings and very good commutating qualities soft quality carbon brushes may be used; for 200-volt windings a medium quality brush will give good results, and for high voltage commutators hard carbon brushes will ensure good commutation. There are, of course, a great many methods used by designers for predetermining the commutation qualities of a machine. The following method has been used by the author for several years, and has been found to give very accurate results:—

Once we know the factors that must be taken into account to determine the relative value of the armature magnetic field, the whole problem becomes an exceedingly simple one. At first sight it may appear that the diameter of the armature should be taken into account, but after carefully investigating the subject it seems that we need only consider the armature ampere-turns per pole, and the length of the armature core, in order to arrive at a satisfactory basis for calculation. The E.M.F. induced in a short-circuited coil opposing commutation may then be said to be propor-

* This is advisable whether they are in a separate building or not. One serious objection to the placing of the switchboard at the end of the building is the concentration of leads running to the board, the practical impossibility of avoiding crossings of cables, and the fact that the width of the building limits the possible extension of the switchgear.

* [Illustrated in *The Electrician*, Vol. LI. p. 238.]

† A similar arrangement has been adopted by Messrs. Sargent and Lundy for the new stations at Boston and Chicago (see Fig. 4), where Curtis turbines are being installed. The authors have independently adopted it at Carville, where Parsons turbines are in use.

‡ Abstract of a Paper read before the Liverpool Engineering Society on March 23rd. Printed with the permission of the Council of the Society.

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tional to the armature ampere-turns per pole, the number of turns per commutator part, the speed of the machine in revolutions per minute and the length of core.

Let δ be a function of this E.M.F, then $\delta = ATp. \times T \times L \times R \times K$, where ATp = armature ampere-turns per pole, T = armature-turns per commutator segment, R = revolutions per minute at which the armature is running, L = gross length of armature core in inches, $K = 1$ for lap-wound armatures and $p/2$ for wave-wound ones, with two sets of brushes.

After examination of a large number of machines, the author has found that the above formula holds good for machines of all sizes, and has not found any correction necessary for abnormal conditions.

For slotted armatures δ may be given a limiting value of 60×10^6, and a figure as high as 80×10^6 will give sparkless commutation if a hard quality carbon brush be used, and a large brush lead is not objected to. The author prefers to limit δ to 50×10^6 to 60×10^6, which with "S" quality carbon brushes as made by the Le Carbone Company will give perfectly sparkless commutation with fixed position of the brushes. If the sparking figure be kept within the above limits, one need not trouble about the ratio of air-gap ampere-turns to armature ampere-turns to ensure a fixed brush lead; in fact, with properly shaped pole tips one may reduce the length of the air-gap to that necessary mechanically, without in any way changing the commutating qualities of a machine.

A small four-pole dynamo was experimented upon some time since with a view to testing these ideas, and though the tests were not carried out very thoroughly, yet the results obtained may be of interest. The machine had an armature 13in. diameter. There were three turns on the armature per commutator segment and the winding was a wave one. It was separately excited and driven by belt, the load consisting of the usual test room resistances. The field coils were first excited with the normal current, and the armature was run up to a speed of 820 revs. per min. The current through the armature was 38 amperes and the voltage across the brushes 500 volts. The number of armature ampere-turns per pole with this current through the windings was 1,985. Length of armature core 8·25in. From this data δ was found as follows:—

$$\delta = 1{,}985 \times 3 \times 8{\cdot}25 \times 820 \times 2 = 80{\cdot}6 \times 10^6.$$

The magnetic flux per pole was $2{\cdot}18 \times 10^6$ lines, and this field required 2,240 ampere-turns per pole to drive it across the air-gap and through the teeth. The ratio between ampere-turns required for one air-gap + teeth and armature ampere-turns per pole was, therefore, 1·13. With 38 amperes through the armature the commutation was found to be very poor, the brushes being very sensitive and sparking badly unless shifted, when the load was varied. A sparkless position could be found for all loads, but it was impossible to run with fixed lead. The brushes were of "S" quality, Le Carbone make.

Resistances were next inserted in the field circuit, and the shunt current reduced to 0·5 ampere. The current through the armature was kept at 38 amperes, as in the previous test, and the machine was run up to a speed of 500 revs. per min. The magnetic flux per pole was $1{\cdot}24 \times 10^6$. The sparking figure was, therefore,

$$\delta = 1{,}985 \times 3 \times 8{\cdot}25 \times 500 \times 2 = 49{\cdot}2 \times 10^6.$$

The commutation of the machine was now found to be excellent, and the brushes were not at all sensitive. With a fixed load of 38 amperes through the armature, the brushes could be rocked round the commutator through a wide angle without showing any signs of sparking, and with fixed brush lead sparkless commutation was obtained with a load varying from open circuit to about 50 amperes. The current was not increased beyond this load. The air-gap + teeth ampere-turns required for this value of flux was 1,180. Some further tests bearing on the question of the effect of the ratio between field ampere-turns and armature ampere-turns were also carried out. The machine was a four-pole generator, manufactured by the Sandycroft Foundry Co. (Ltd.) of Chester, designed for a load of 75kw. at 210 volts when driven at a speed of 480 revs. per min. The full-load current was, therefore, 357 amperes, the armature current being 368 amperes. The following are the particulars of the machine:—

Length of core, 11¼in.; number of conductors on armature, 392; number of commutator segments, 196; turns per segment, 1; type of armature winding, lap.

The commutator of this machine would run absolutely sparklessly under any conditions of the test with the brushes on the neutral points. The brushes used on the test were of "Z" quality, the contact density being 40·3 amperes per square inch, with a load of 300 amperes.

In designing continuous-current machines, δ makes a very good starting point taken in conjunction with the maximum number of commutator segments it is mechanically practicable to use.

We may deduce some useful formula from δ

$$\delta = ATp.T.L.R.K.;$$

but $T = 60 \times 10^8 \times E./2F.R.Y.K.$, where E = internal E.M.F. of armature; F = magnetic flux per pole: Y = number of segments in commutator.

$$\therefore \quad TR = 30 \times 10^8 \times E./F.Y.K. \text{ and } \delta = 30 \times 10^8 \times ATp.L.E./F.Y.$$

For a given machine $A.Tp/F.$ will be about constant, therefore the sparking will be proportional to the volts per commutator segment.

Let Ec = volts per commutator segment, = P.E./Y, where P = number of magnet poles.

Then the maximum permissible number of volts per segment for a given value of δ will be given by

$$\text{Max. } Ec = F.\delta.P./30 \times 10^8 ATp.L. \quad . \quad . \quad . \quad . \quad \text{(i.)}$$

Taking $\delta = 60 \times 10^6$, we have max. $Ec = F.P./50L.ATp.$

For an armature of a given diameter and length the capacity of the machine in watts per revolution will be fairly closely known to a designer. For the watts generated by an armature we may write: $\text{Watts} = N.F.R.A./60 \times 10^8$, where N = total number of conductors on the armature and A = current of machine.

$ATp = N.A./2P.^2$ for a lap-wound machine.

$$\therefore \quad \text{Watts} = P.^2ATp.F.R./30 \times 10^8;$$

$$\therefore \quad ATp.F = 30 \times 10^8 W./P.^2R.; \quad . \quad . \quad . \quad . \quad . \quad \text{(ii.)}$$

where W = watts generated by armature.

From equation (i.) $F = 30 \times 10^8 Ec.ATp.L./P.\delta.$

From equation (ii.)

$$F = 30 \times 10^8 W./P.^2R.ATp. = 30 \times 10^8 W.r./P.^2ATp.,$$

where Wr = watts per revolution.

From these equations can be found the maximum permissible number of armature ampere-turns per pole for a given value of δ.

$$\text{Max. } ATp = \sqrt{\delta.Wr./P.Ec\ L.}$$

It has been found that for values of δ of 50×10^6 to 60×10^6 or thereabouts, carbon brushes of "S" quality will give excellent results. For values of 25×10^6 to 40×10^6 or thereabouts, "Z" quality brushes are preferred, and for values 20×10^6 and less, "X" quality brushes will ensure perfectly good commutation. The author has recently used the last-mentioned quality brushes on a 100-volt generator where δ came out at 18×10^6, the contact density of the brushes being about 80 amperes per square inch.

Table I.—*Test on "Sandycroft" Four-pole 75kw. Dynamo.*

Volts.	Amperes.	Field current. Amperes.	AT_a/AT_p.	Revs. per min.	$\delta \times 10^{-6}$.	Remarks.
145·0	300	2·3	0·82	475	19·7	Absolutely sparkless, brushes on neutral point
115·0	300	1·5	0·57	550	22·8	Do. do. do.
50·0	300	0·5	0·26	580	24·0	Do. do. do.
12·5	200	..	0·14	600	16·6	Do. do. do.
15·0	290	..	0·11	580	23·3	Do. brushes on 1·8° backward lead
15·0	300	..	0·11	580	24·1	Barely visible sparking, 5·5° backward lead
50·0	280	..	0·28	580	22·4	Do. 7·28° do.
20·0	300	0·3	0·13	560	23·3	Absolutely sparkless, brushes on neutral point
16·5	300	0·2	0·12	560	23·3	Do. do. do.
20·0	300	0·2	0·13	560	23·3	Do. brushes on 8·2° backward lead
20·0	280	0·2	0·14	560	21·7	Occasional sparking, 11·8° backward lead
30·0	290	0·3	0·19	560	22·5	Do. 11·8° do.
40·0	280	0·4	0·24	560	21·7	Do. 11·8° do.
50·0	300	0·5	0·18	560	23·3	Absolutely sparkless, 2·3° forward lead
34·0	300	0·5	0·2	550	17·8	Do. 2·3° do.
12·0	235	0·2	0·13	560	18·2	Do. 2·3° do.
13·0	250	0·2	0·1	680*	23·5	Do. 2·3° do.
5·0	210	0·2	0·096	560	16·2	Do. 5·9° do.

* Vibration prevented speed being increased above this point, the machine being on temporary foundations. AT_a = air-gap ampere-turns.

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The result was excellent. The brushes mentioned above are of the Le Carbone Company's make.

Commutator Losses.—Consulting engineers often specify a maximum value for the current density at the contacts of carbon brushes and commutator irrespective of the voltage and speed at which a machine may be running. This often results in the commutator losses being greater than need be. Investigations into tests of contact resistances of carbon brushes will show that for any given peripheral speed at which a commutor may be running there will be a certain current density at the contacts of the brushes which will give a minimum value to the commutator losses.

For brushes of the above-mentioned make the contact resistance per square inch is approximately as follows:—

For "S" quality brushes, with densities of 20 amperes per square inch or above, $0{\cdot}187\sqrt{1/D}$; for "Z" quality brushes, with densities of 40 amperes and above, $0{\cdot}09\sqrt{1/D}$, where D = current density in amperes per square inch. The contact resistance of "X" quality brushes appears to vary a good deal more than either of the other qualities with the pressure applied to the brushes. It may be considerably reduced by increasing the pressure on the brushes, and it will generally be found that the pressure must be considerably greater than is usual with "S" and "Z" quality brushes in order to benefit very much by their use. The gain in reduction of contact resistance by increased pressure of the springs will be a good deal more than the increased loss due to friction.

Dealing first with "Z" type brushes, and taking the pressure applied to the brushes at 20 oz. per square inch and the coefficient of friction at 0·3, tangential pull per square inch = 0·375lb.

The watts lost due to friction will be, friction watts per square inch = $0{\cdot}0085p$, where p = peripheral speed in feet per minute at surface of commutator.

The total watts lost per square inch of contact surface—*i.e.*, (C^2R + friction) watts will be

$$\text{Total watts per square inch} = 0{\cdot}09D^{\frac{1}{2}} + 0{\cdot}0085p. \quad . \quad . \quad \text{(iii.)}$$

If C be the total armature current, total contact surface = $2C/D$.

$$\therefore \text{ Total watts lost} = W = C(0{\cdot}18D^{\frac{1}{2}} + 0{\cdot}017pD^{-1}).$$

Differentiating W with regard to D and equating to zero, $0{\cdot}09D^{-\frac{1}{2}} = 0{\cdot}017pD^{-2}$;

$$\therefore \quad D^{\frac{1}{2}} = 0{\cdot}189p. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(iv.)}$$

Therefore density for minimum losses = $0{\cdot}88p^{\frac{1}{2}}$.

From equation (iii.) C^2R loss per square inch = $0{\cdot}09D^{\frac{1}{2}}$; but $D^{\frac{1}{2}} = 0{\cdot}189p$.

$$\therefore \quad C^2R \text{ loss per square inch} = 0{\cdot}09D^{\frac{1}{2}} = 0{\cdot}017p.$$

From (iii.) friction loss per square inch = $0{\cdot}0085p$.

We therefore see that in order to reduce the commutator losses to a minimum the contact surface of the brushes should be so chosen that the loss due to friction is half that due to C^2R at the contacts.

It can be shown in the same way that the total watts lost per square inch at contact surfaces of "S" quality carbon brushes = $0{\cdot}187D^{\frac{1}{2}} + 0{\cdot}0085p$; total watts lost = $C(0{\cdot}374D^{\frac{1}{2}} + 0{\cdot}017pD^{-1})$.

From this we deduce, as before, a value of D for minimum commutator losses $D = 0{\cdot}202p^{\frac{1}{2}}$,

And, as before, this shows that for minimum losses the loss due to friction should be half that due to C^2R loss.

Alternating-current Machines.

In order to emphasise the importance of a clear understanding as to the resultant magnetising ampere-turns produced by the currents flowing in the several windings of a polyphase machine, it may be pointed out that the voltage regulation of a generator depends more upon the demagnetising effect of the armature than upon the inductance of its windings. Again, the performance of an induction motor as regards its power-factor and maximum torque depends upon the demagnetising effect of the rotor windings, though in this case, of course, without the inductance of the stator and rotor windings there would exist no demagnetising effect, whereas in a generator, if the windings be imagined to be non-inductive, an external inductive load will produce a demagnetising current in the armature windings.

It has been very clearly shown by Eborall, by means of a vector diagram, that the resultant magnetising force in a three-phase armature is equal to 1·5 times the magnetising force of one phase. It can also be proved analytically that this is the case, and the fact that on this basis it is possible to calculate the no-load current of an induction motor with great accuracy is probably the best proof of all.

When making inductance tests on windings having but a few turns per coil the P.D. required is often very small. The resistance of the contacts may then easily lead to considerable error, and it is therefore advisable to use a method of calculating L from the test readings, not requiring an accurate knowledge of the resistance of the circuit. The following formula is a good one to use:—

$$pL = \frac{\sqrt{(\text{apparent watts})^2 - (\text{true watts})^2}}{C^2},$$

when $p = 2\pi\sim$, L = coefficient of self-induction in henrys, C = current in the winding.

The value of the power-factor and the overload capacity of a motor is almost entirely governed by the demagnetising component of the rotor current. At no-load this is practically nil, but as the torque is increased it grows with it, slowly at first, until the load is reached at which the power-factor of the machine has its highest value. After this load has been passed the rotor magnetising component increases more rapidly until, when the motor is developing its maximum torque, it attains the same value as the component of the rotor current with which it is in quadrature.

This demagnetising current depends upon three things: (*a*) The coefficient of leakage of the stator windings; (*b*) the coefficient of leakage of the rotor windings; (*c*) the ohmic resistance of the stator windings. Instead of using coefficients of leakage the author finds it simpler to work out the coefficient of mutual induction between the stator and rotor windings, and then to estimate the coefficients of self-induction of the stator and rotor windings.

First, let it be assumed that the stator windings are non-inductive and possess no ohmic resistance. The rotor lagging current can be calculated by the ordinary method as applied to any circuit possessing both inductance and resistance, the periodicity, of course, depending upon the slip of the rotor. It will be obvious that the resistance of the rotor windings will not affect the lagging rotor currents, as the periodicity of the currents would be increased with any increase of the rotor resistance owing to the greater slip necessary. If we now consider a motor, both the stator and the rotor windings of which possess inductance, the conditions are changed. The stator winding is still supposed to have no resistance. The inductance of the stator winding has to be neutralised in the motor itself, and this is effected by a magnetic field, which is linked with both stator and rotor windings, and though it neutralises the stator inductance, it unfortunately increases the lagging current in the rotor windings.

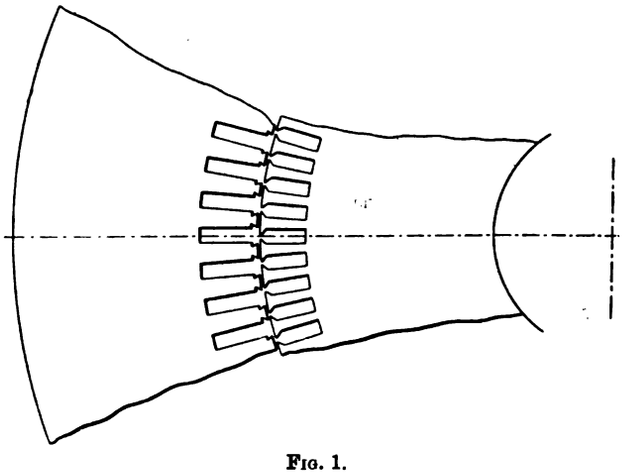

Fig. 1.

Finally, let the stator windings possess resistance as well as inductance. Now the rotor is to a certain extent shielded from the stator inductance by the resistance of the stator windings which assists in neutralising the inductance. The neutralising flux is consequently reduced and with it the demagnetising component of the rotor current.

In order to show more clearly the effect of the demagnetising component of the rotor current upon the performance of a motor, a small machine has been worked out, and values of power-factor, slip and demagnetising rotor currents, have been tabulated. The machine is a standard three phase induction motor built by the Sandycroft Foundry Co., and the stator motor stampings are shown diagrammatically in Fig. 1.

The following are the particulars:—

Full load	20 B.H.P.
Synchronous speed	750 revs. per min.
Voltage between terminals	220
Periodicity	25 ~ per second
Outside diameter of stator	25½in.
Bore stator	15 1/16in.
Gross axial length of stator and rotor	7in.
Type of stator slots	Open
Number of stator slots	72
Wires per stator	6
Type of rotor slots	Open 1/16in. at periphery
Number of rotor slots	84
Wires per rotor slot	2

In working out the following particulars, the ratio between the number of stator and rotor turns has been considered as unity.

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This, of course, does not affect the results obtained, as the number of ampere-turns will not be altered in any way.

Torque, lbs. ft.	Slip of rotor.	Stator magnetising current.	Rotor demagnetising current.	Power-factor.
	Per cent.	Amperes.	Amperes.	Per cent.
36·2	1·1	12·0	0·32	64·1
67·5	1·85	12·8	1·22	84·1
100·5	2·7	14·2	2·75	90·4
146·0	4·1	18·2	7·0	92·6
189·0	5·96	23·2	12·57	93·2
227·0	7·05	28·1	17·22	92·8
282·0	9·65	40·15	29·8	91·25
356·0	13·05	59·2	48·5	88·5
386·0	15·2	75·0	65·6	86·1
400·0	22·2	109·0	100·4	79·0

In conclusion, I should like to express my thanks to Messrs. the Sandycroft Foundry Co. (Ltd.) for permitting the use of data and tests relating to machines of their manufacture, and also to Mr. Edward Comerford for carrying out the tests and for his assistance generally.

EDDY CURRENTS IN CABLE SHEATHS.*

BY M. B. FIELD.

(Concluded from page 14.)

APPENDIX I.

DISTRIBUTION OF INDUCTION AND EDDY CURRENTS IN A LONG IRON PIPE, ENCLOSING AN ALTERNATING CURRENT.

Let $\Gamma_c = \Sigma\Gamma_i \sin(p_i t + e_i)$ stand for the Fourier's series representing the current in the cable, the summation being extended to all components of the current of differing frequencies. $p_i = 2\pi i n$, where n is the fundamental frequency. Thus Γ_0 is the amplitude in amperes of the fundamental term, and Γ_i the amplitude of the term involving the frequency in. The epochs denoted above by the general expression e_i will not affect the following considerations.

Let B_x denote the induction at x in lines per square centimetre.

Let A_x denote the current density in amperes per square centimetre of the longitudinally flowing current at x.

Let L be the mean circumferential length of pipe, assumed to be the length of all the magnetic lines within the pipe, which will be more and more nearly true as the diameter of the pipe is made large in comparison with the thickness.

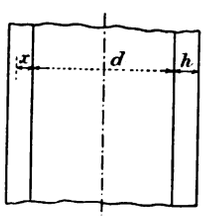

FIG. 13.

Let h be the thickness of pipe wall in centimetres.

Let d be the internal pipe diameter in centimetres, then $L = \pi(d+h)$.

Let c_x denote $L\int_0^x A_x dx$, or the total current in amperes flowing longitudinally in the hollow cylinder bounded by the interior surface of the pipe and a coaxial surface passing through x.

Let v be the P.D. between two planes 1cm. apart normal to the pipe axis.

Let μ be the mean permeability.

Let η stand for $4\pi\mu/10$.

Let m_i stand for $0{\cdot}000199\sqrt{\frac{\mu i n}{\rho}}$.

Let ρ be the specific resistance (electrical) of iron.

Let P_i stand for $\frac{\Gamma_i m_i}{L}\sqrt{\frac{\cosh m_i h - \sinh m_i h}{\cosh m_i h + \cos m_i h}}$.

B_x, c_x, A_x and v are all time functions, and may, therefore, each be expressed as a Fourier's series; we shall, accordingly, denote the amplitude of the term involving the frequency in as $\overline{B}_{xi}$, c_{xi}, &c.

There are two special cases for consideration—

1. Where the pipe is laid in dry concrete or dry earth, so that no eddy currents leak out or leave the pipe.

2. Where the pipe is laid in wet soil, or where the ends are for any other reason at the same potential. These two cases are represented by the conditions

(1) $c_h = 0$. (2) $A_h = 0$.

The differential equations of the problem are

$$10^8\rho\frac{d^2A_x}{dx^2} = \eta\frac{dA_x}{dt}; \qquad \eta A_x = \frac{dB_x}{dx}.$$

From which the following are readily deducible :—

Case I.

(1) $A_x = \Sigma P_i\left\{\epsilon^{m_i x}\sin(p_i t + m_i x + \phi_i) - \epsilon^{m_i(h-x)}\sin(p_i t + m_i(h-x) + \phi_i)\right\}$,

where ϕ_i is related to e_i.

From which we may write

$$\overline{A}_{xi} = \frac{\Gamma_i m_i}{L}\sqrt{\frac{2(\cosh m_i(h-2x) - \cos m_i(h-2x))}{\cosh m_i h + \cos m_i h}}.$$

The eddy-current losses per centimetre length of pipe expressed in watts are

$$\frac{L\rho}{2}\Sigma\int_0^h(\overline{A}_{xi})^2 dx = \frac{\rho}{L}\Sigma\Gamma_i^2 m_i\frac{\sinh m_i h - \sin m_i h}{\cosh m_i h + \cos m_i h}.$$

(2) $B_x = 10^8\rho\Sigma\frac{P_i m_i}{p_i}\left\{\epsilon^{m_i x}(\sin - \cos)(p_i t + m_i x + \phi_i) + \epsilon^{m_i(h-x)}(\sin - \cos)(p_i t + m_i(h-x) + \phi_i)\right\}$.*

From which we may write

$$\overline{B}_{xi} = \frac{\Gamma_i\eta}{L}\sqrt{\frac{\cosh m_i(h-2x) + \cos m_i(h-2x)}{\cosh m_i h + \cos m_i h}}.$$

(3) $v = -\rho\Sigma P_i\left\{\sin(p_i t + \phi_i) - \epsilon^{m_i h}\sin(p_i t + m_i h + \phi_i)\right\}$.

(4) $c_{h/2} = \Sigma\frac{\Gamma_i}{\sqrt{\cosh m_i h + \cos m_i h}}(\sin - \cos)(p_i t + \frac{m_i h}{2} + \phi_i) - \Gamma_c$.

From which we see that if h be sufficiently great, the current flowing longitudinally along the inner skin and back along the outer skin of the pipe, is at every instant equal to the current in the cable, the direction being such as to produce zero resultant magnetisation in the centre of the pipe wall.

Case II.

The expressions for A_x and $\overline{A}_{xi}$ are manifestly derivable from the corresponding expressions in the first case by writing $2h$ instead of h, whence the eddy-current loss in watts per centimetre length is

$$\frac{\rho}{2L}\Sigma\Gamma_i^2 m_i\frac{\sinh 2m_i h - \sin 2m_i h}{\cosh 2m_i h + \cos 2m_i h}.$$

Similarly B_x and $\overline{B}_{xi}$ are derivable from the previous corresponding expressions by making the same substitution as above, and so on.

In the case of thick pipes of correspondingly larger diameter, so that we may still, without sensible error, consider all magnetic lines within the pipe as of equal length, we have for the watts per centimetre length of pipe

$$\frac{\rho}{L}\Sigma\Gamma_i^2 m_i. \quad \ldots\ldots\ldots \text{(Case I.)}$$

$$\frac{\rho}{2L}\Sigma\Gamma_i^2 m_i. \quad \ldots\ldots\ldots \text{(Case II.)}$$

It is interesting to observe in this connection that if we have a circuit made up of two single-phase cables laid parallel to one another, each in a separate pipe, which pipes are practically insulated (*e.g.*, as when laid in dry concrete), then, by electrically connecting the two pipes together at each end, we halve the hysteresis and eddy-current losses in them.

Or if we consider the three-phase case already alluded to, where three single-core cables were drawn through three separate pipes, we should again halve the hysteresis and eddy losses in the pipes by electrically connecting them at either end. When the pipes are thus connected we have case II., when separated, case I. It will be observed that the eddy currents induced by each cable, flowing, let us say, up the interior surface of the pipes and back along the exterior surfaces, together form the equivalent of a three-phase six-line-wire eddy current system. As soon as we connect the pipes together at either end, we do the equivalent of grouping three of the return line wires. But we know in a three-phase system no current would flow back along this common wire, hence we see in a very simple manner that we should halve the eddy C^2R loss, and with it the hysteresis loss, in the manner above described.

APPENDIX II.

In the following the magnetic fields due to various systems of straight parallel conductors are considered, it being assumed that the conductors are circular in section, and that the distribution of current over the cross-section of each conductor is a function of the distance from the axis of the conductor only. Our ground for this assumption has already been explained.

Case I.

Two parallel conductors, with current flowing up and down the other. We have $r_1/r_2 = \text{constant} = z_i$ for all points in the ith line of force.

In polar co-ordinates we have

$$z_i^2 = \frac{\sigma^2 + r_3^2 - 2\sigma r_3\cos\phi}{(\sigma+b)^2 + r_3^2 - 2(\sigma+b)r_3\cos\phi}.$$

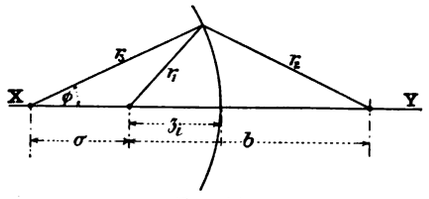

FIG. 14.

If we write $z_i^2(\sigma+b) = \sigma$, or $\sigma = z_i^2 b/(1-z_i^2)$, z_i is independent of ϕ, hence we see that the ith line of force is a circle whose radius is $z_i b/(1-z_i^2)$.

* "A Theoretical Consideration of the Currents induced in Cable Sheaths, and the Losses occasioned thereby." Paper read before the Institution of Electrical Engineers on April 14th.

* In this appendix the form $(\sin - \cos)\alpha$ has been employed for the sake of brevity for $\sin\alpha - \cos\alpha$.

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the centre being situated on the axis XY. It is sometimes convenient to express this in terms of the intercept 3_i.

It is, $$\text{Radius} = \frac{3_i(b-3_i)}{b-2_{3_i}}.$$

It is to be observed that the law $\frac{2c}{10}\log\frac{r_1}{r_2}=k$ only holds true for those portions of the lines of force external to the conductors. If we take a point inside the conductor at a distance r_1 from the centre, the total number of lines within the conductor which surround the point is $\frac{c}{10}\left(1-\frac{r_1^2}{\beta^2}\right)$, where β = the outside radius of the conductor, c being, as before, the current in amperes. For points inside the conductors we have, therefore, in the two-conductor case

$$\left.\begin{aligned}+\frac{c}{10}\left(2\log\frac{r_2}{\beta}+1-\frac{r_1^2}{\beta^2}\right)\\ -\frac{c}{10}\left(2\log\frac{r_1}{\beta}+1-\frac{r_2^2}{\beta^2}\right)\end{aligned}\right\}=k,$$

which enables us to construct the complete field of force both inside and outside the conductors.

Case II.

Three parallel conductors carrying currents c_1, c_2, c_3, where $c_1+c_2+c_3=0$ at every instant.

We have for external points

$$-\frac{1}{5}(c_1\log r_1+c_2\log r_2+c_3\log r_3)=k.$$

If we take a particular case, and write $c_1=-2c_2=-2c_3$, we have

$$-\frac{c_1}{5}\log\frac{r_1}{\sqrt{r_2r_3}}=k.$$

The line of force which runs out to infinity, separating the positive from the negative fields of force, is given by the condition $k=0$, or $r_1^2=r_2r_3$.

For points inside the conductors we have

$$\left.\begin{aligned}-\frac{c_1}{10}\left(2\log\frac{\beta}{\sqrt{r_2r_3}}-1+\frac{r_1^2}{\beta^2}\right)\\ -\frac{c_1}{10}\left(2\log\frac{r_1}{\sqrt{\beta r_3}}+\tfrac{1}{2}-\frac{r_2^2}{2\beta^2}\right)\\ -\frac{c_1}{10}\left(2\log\frac{r_1}{\sqrt{\beta r_2}}+\tfrac{1}{2}-\frac{r_3^2}{2\beta^2}\right)\end{aligned}\right\}=k.$$

We may express the E.M.F. induced at any point of the sheath of a three-core cable as

$$\frac{1}{5}\left(\frac{dc_1}{dt}\log\frac{r_1}{r_3}+\frac{dc_2}{dt}\log\frac{r_2}{r_3}\right)10^{-8}\text{ volts.}$$

If c_1 and c_2 are sine functions of amplitude $\bar{c}$, and differing in phase by the angle $\frac{2\pi}{3}$, the amplitude of the E.M.F. is

$$\frac{2\pi\sim\bar{c}}{5}10^{-8}\sqrt{\left(\log_\epsilon\frac{r_1}{r_3}\right)^2+\left(\log_\epsilon\frac{r^2}{r^3}\right)^2-\log_\epsilon\frac{r^1}{r^3}\log_\epsilon\frac{r_2}{r_3}},$$

r_1, r_2, r_3 being the distances of the point in the sheath from the centres of the conductors.

The integral of the current density over the sheath is zero, for if Δ be the mean diameter, τ the thickness, ρ the specific resistance, the integral of current density will be

$$\frac{\Delta\tau}{10\rho}10^{-8}\int_0^{2\pi}\left(\frac{dc_1}{dt}\log r_1+\frac{dc_2}{dt}\log r_2+\frac{dc_3}{dt}\log r_3\right)d\theta.$$

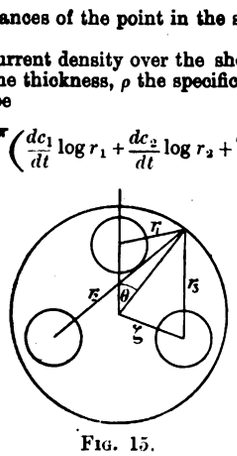

FIG. 15.

We can express r_1, r_2, r_3 thus,

$$r_1=\sqrt{\frac{\Delta^2}{4}+\zeta^2-\Delta\zeta\cos\theta};$$

$$r_2=\sqrt{\frac{\Delta^2}{4}+\zeta^2-\Delta\zeta\cos\left(\theta+\frac{2\pi}{3}\right)};$$

$$r_3=\sqrt{\frac{\Delta^2}{4}+\zeta^2-\Delta\zeta\cos\left(\theta+\frac{4\pi}{3}\right)}.$$

But $$\int_0^{2\pi}\sqrt{\left(\frac{\Delta^2}{4}+\zeta^2-\Delta\zeta\cos(\theta+\psi)d\theta\right)}$$

is evidently independent of ψ; hence, assigning the value j to this integral, we may write the integral of current density over the whole cross-section of the sheath as

$$10^{-8}\frac{\Delta\tau j}{10\rho}\frac{d}{dt}(c_1+c_2+c_3),$$

which is evidently zero. Similarly, the integral of current density taken merely round the periphery of the sheath is likewise zero.

The bearing of this theorem on the Paper has already been pointed out.

Case III.

Two-phase cable, consisting of two circular cores enclosed in a sheath forming the common conductor.

For external points we have

$$\frac{2c}{10}\log\frac{\sqrt{r_2r_3}}{r_1}=k,$$

and for internal points (except for points inside either conductor), we have

$$\frac{2c}{10}\log\frac{\sqrt{r_2r_3}}{\Delta/2},$$

and so on.

If the current in, say, the right-hand core is zero, in the outer c, and in the left-hand inner $-c$, then the external field of force is that due to two conductors at the points j_1 and j_2 respectively, while within the magnetic lines are concentric circles with centre at j_1.

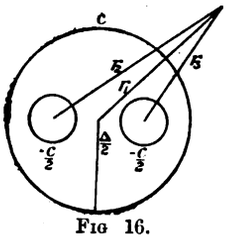

FIG. 16.

The line separating the positive from the negative field will therefore be 1, 2, 3, 4, 5, being a straight line externally and an arc of a circle of radius $\Delta/2$ internally.

In dealing with systems of circular conductors we usually find that the nucleus of the field of force (or the point enclosed by the maximum number of lines) is displaced from the centre of the conductor.

For example, in the two-core case the positions of the nuclei are determined by the value of r_2 that renders

$$2\log\frac{r_2+b}{\beta}-\frac{r_2^2}{\beta^2}$$

a maximum.

This is $$r_2=\pm\sqrt{\beta^2+\frac{b^2}{4}}-\frac{b}{2}$$

Whereas if the current in each conductor be in the same direction which occurs in the two-phase case already considered

$$r_2=\pm\sqrt{\frac{b^2}{4}-\beta^2}-\frac{b}{2},$$

b being the distance between the centres of two conductors.

Cores of other than circular cross-sections: In dealing with cables having segmental-shaped cores, or any shape other than circular, we must use the expression $\frac{1}{A}\Sigma\delta A\log_\epsilon r$ instead of merely $\log_\epsilon r_1$, &c., as above; that is to say, instead of merely taking the whole current in the core as concentrated at the axis, and taking the log of the distance from the core-centre to the point in question, we must consider elements of area separately, taking the sum of the logarithm of the distance multiplied by each little element of area, divided by the total area of cross-section A. It is interesting to observe that from this follow immediately the two geometrical theorems that in the case of a circle, the area of cross-section multiplied by the log distance from centre to any external point is equal to the integral of each element of area multiplied by the log of its distance from the point in question, the integration being extended over the whole area. Secondly, the circumference multiplied by the log distance from centre to external point, equals the integral round the circumference of each element of length multiplied by log its distance from the point in question. The corresponding relations in the case of internal points are similarly self-evident.

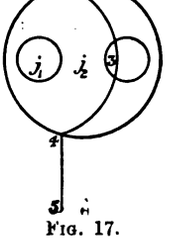

FIG. 17.

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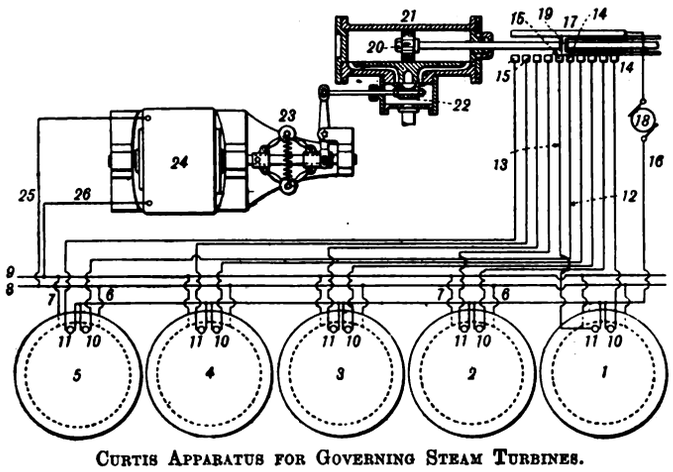
ELECTRIC GOVERNING OF STEAM TURBINES.*

A simple means of governing a series of steam turbines has been devised by Charles G. Curtis of New York, which does away with the multiplicity of valves leading to the buckets of each turbine.

The controlling element of the apparatus is a centrifugal governor, which may be mounted upon or driven from the shaft of the first turbine of the battery, or, in case the turbines are used to drive alternating-current generators, this centrifugal governor may be driven by a synchronous motor connected with the 'bus bars to which the dynamos are connected. This centrifugal governor serves to open and close a valve admitting water, oil, or other suitable liquid to opposite ends of the cylinder, in which moves a piston, and the piston by its movement opens and closes directly or indirectly and in proper order the valves controlling the supply of steam to the turbines. The general scheme of the apparatus is clearly shown in the accompanying diagram.

The controlling valves of the several turbines are operated by the governing apparatus, so as to govern the turbines progressively in the following manner:—Enough of the valves of the first turbine are opened in succession as the load increases to produce the full-load condition of the dynamo driven by that turbine. As the load increases further the controlling valves of the second turbine are opened successively until the full-load condition of the dynamo driven by that turbine is reached, and so on, for the third, fourth and any greater number of turbines which the battery may contain. After the full-load condition of all the dynamos of the battery has been reached the governing apparatus puts on part of the overload on the first turbine and then successively on the other turbines of the battery until all the dynamos are carrying the same amount of the overload, when a further fraction of the overload is added, first



CURTIS APPARATUS FOR GOVERNING STEAM TURBINES.

to the first turbine and then to the second turbine, and so on, and this operation of adding the overload to the turbines in succession fractionally is repeated until the full overload condition is reached. Instead of having the control of each turbine divided between a number of valves, both for the full-load condition and for the overload condition, the number of valves for each turbine may be reduced and the regulation for each turbine made dependent to a greater extent upon the throttling action of the valves. This may even be carried to the extent of providing only two valves for each turbine, one for the full-load and one for the overload, each of these valves controlling the admission of the steam to a large number of sections of the sectional nozzle. In this case the governing apparatus will act to first open the full-load valve of the first turbine, depending upon the throttling action of the valve at intermediate positions to control the turbine for less than full load. The governing apparatus will then in the same manner open the full-load valve of the second turbine, and so on, until the full-load valves of all the turbines of the battery are open. For the overload the governing apparatus will apply the overload fractionally to the turbines by first partially opening the overload valves of the turbines in succession and then returning to the first turbine and opening the overload valves in succession still further, and so on, until the overload valves of all the turbines are entirely open. The loss in efficiency which will result from depending upon the throttling action of the valves will not be very great in the case of a battery containing a number of turbines, since the effect produced by throttling will be for most of the time confined to a small fraction of the whole effect.

Referring to the diagram, 1, 2, 3, 4 and 5 represent turbine units, together with alternating-current dynamos connected by wires to the 'bus bars 8, 9. Magnets 10 and 11 control the valves of the turbines. For simplicity of illustration only two of such magnets are shown for each turbine, the magnets 10 controlling the full-load valves and the magnets 11 controlling the overload valves. The magnets are connected by separate wires, 12 and 13, with the separately insulated contacts 14, 15, while a return wire, 16, common to all the magnets, is connected with a plate, 17, and includes a source of direct current, 18. A contact plate, 19, having a length equal to all of the contacts, slides over the contacts and the plate 17. The contact plate 19 is carried by the rod from the piston which moves in the cylinder. The piston is moved in one direction or the other by liquid under pressure admitted to opposite sides of the cylinder and exhausted through suitable entrance and exhaust ports controlled by a valve, 22. The valve is moved by a centrifugal governor which is driven by a synchronous motor connected by wires with the 'bus bars 8, 9. As already suggested, the centrifugal governor may be mounted on the shaft of the turbine.

It will be understood that the usual switches are placed in the several circuits for opening and closing them, and also that the steam supply pipes leading to the turbines will be provided with the usual throttle valves for turning on and off the steam. When the turbines are not running these throttle valves will be closed and the switches will be opened, the piston will stand at the left-hand end of the cylinder, and the plate 19 will cover all the contacts 14 to 15. To start up the plant the circuit to the magnets 10, 11 will be closed, thus opening all the turbine valves controlled by the various branches of that circuit. Steam will then be turned on the first turbine by opening its throttle. When the dynamo operated by the turbine has acquired the proper speed it will be connected with the 'bus bars and the circuit to the synchronous motor will also be closed. The motor will at once acquire the speed of the dynamo and will operate the centrifugal governor, which will move the valve 22 to the right and cause the piston to move to the right until the contact plate 19 covers the proper number of contacts.

Assuming that the throttles of all the turbines are open and that all the dynamos are connected with the 'bus bars and are turning, the operation of the governing apparatus will be as follows:—Starting with a light load on the first dynamo, it is assumed that contact plate 19 rests only on the contact 14 at the extreme right, thus opening the full-load valve of the first turbine. As the load is increased the first dynamo will reduce in speed, and this will cause the synchronous motor to reduce in speed, causing the governor to move the valve 22 to the left, opening the right-hand end of the cylinder to the liquid pressure and the left-hand end of that cylinder to the exhaust. The piston will be moved slowly to the left, drawing the contact plate 19 upon the second contact 14 and opening the full-load valve of the second turbine. This will cause the second turbine and the dynamo driven by it to take a part of the load, and the synchronous motor will regain its speed and will move the valve to a central position, covering both pressure ports to the cylinder. As the load further increases a similar sequence of operations will take place, and the contact plate 19 will be drawn further to the left, covering in succession the contacts 14 connected with the full-load valves of the third and subsequent turbines. A still further increase of load will cause a continued movement of the contact plate to the left, so that it will cover in succession the contacts 15 and will successively open the overload valves of the several turbines. The reverse operation takes place as the load decreases.

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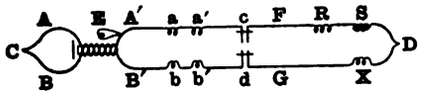
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E FOURNIER D'ALBE.]

Use of the Differential Telephone.—W. Duane and C. A. Lory have improved the differential telephone method of measuring inductance, and have succeeded in reducing the error to $\frac{1}{30}$ per cent. Two coils AA′ and BB′ are wound side by side on the bobbin. These coils are adjusted so as to have equal inductances and resistances, and so that the magnetising effect of a current flowing through one coil from A to A′ is exactly annulled by that of an equal current flowing through the other from B to B′. A variable inductance standard S is joined in series with coil AA′, and the coil of unknown inductance X in series with coil BB′. A non-inductive variable resistance R is inserted in series with S or X according as the resistance of X is greater or less than that of S. The two entire circuits are then joined in parallel and an alternating E.M.F. is applied to the branch points C and D. By varying R and S values can be found easily such that no sound is heard in the receiver.



When this is the case the two parallel currents must be equal to and in phase with each other, and therefore the inductance of X must be equal to that of S. The apparatus is portable and stable, accurate, easily manipulated and uninfluenced by the heating effects. Only one standard is required, and it is not necessary to know the value of any resistances. The disadvantage is that the inductance to be measured must lie within the range of the standard.

[DUANE and LORY, *Physical Review*, April, 1904.]

The Ether and Double Refraction.—D. B. Brace quotes some experiments to disprove the validity of the FitzGerald-Lorentz contraction hypothesis to explain the negative results of the Michelson-Morley experiment of interference between two rays, at right angles and parallel respectively to the earth's motion. The experiments were conducted by an extension of Rayleigh's method, using a system rotating about a vertical axis, and working with either glass or water. A heavy beam was pivoted between the floor and ceiling so as to carry a trough with its horizontal axis intersecting the pivotal axis. This system could be rotated continuously so as to bring it into any desired position. The trough was 413cm. long, and built of thick planking so as to give stability to the polarising and mirror systems which it carried. Sunlight was so thrown into the trough as to keep its path the same whatever its position. The results were negative in every case. The experiments were repeated during the early part of February, 1904, when the earth's orbital velocity conspires approximately with that of the solar system in space. The conditions were quite as favourable as before, but no effect could be detected. The author concludes that the contraction hypothesis cannot explain the negative results of the interference experiments. Either the ether moves with the embedded matter, or the effect of the relative motion on the intermolecular forces and the possible consequent relative change in dimensions are very small.

[D. B. BRACE, *Philosophical Magazine*, April, 1904.]

N′-rays.—J. Meyer has discovered some new sources of the extinguishing rays called by Blondlot N′-rays, and has obtained rays of a higher penetrating power than heretofore. If a screen with patches of phosphorescent calcium sulphide is placed in the receiver of an air pump and the pump is worked, the phosphorescence decreases, being restored as soon as the pressure is restored. The same thing takes place if the screen is placed outside instead of inside the receiver. An incandescent lamp through which no current passes, or a vacuum tube, are powerful sources of N′-rays, the strain of the glass under atmospheric pressure being sufficient to account for their production. These rays are not absorbed by a slab of wood 10cm. thick, or a sheet of oxidised lead 1mm. thick and folded so as to be traversed by the rays eight times, or by a glass vessel 10cm. thick filled with pure water. The only bodies capable of intercepting these rays appear to be platinum 1mm. thick and "opal glass" 3mm. thick. In studying the refractive index of the rays by means of an aluminium prism, the author observed that the aluminium stored the rays in great quantity, and gave them out again for the next 24 hours. Ordinary and crown glass store them for a short time, and lead, copper and pure water do not store them at all. An aqueous solution of sodium hyposulphite remains a magazine of N′-rays for a long time. The hand itself stores them for a few minutes, probably owing to the salts of the perspiration. The rays are refracted by glass, copper and aluminium, and may be diffracted by a grating.

[J. MEYER, *Comptes Rendus*, April 11, 1904.]

Physiological N-rays.—M. d'Arsonval, in a report communicated to the Academy of Sciences, deals with the numerous claims of priority set up Audollent, Baraduc, Darget and others with regard to rays other than heat rays emanating from the human body. He points out that most of the authors dealt with had employed photographic methods for recording such radiations, whereas the rays described by Blondlot and Charpentier have no effect upon the photographic plate. None of them discovered the fact that the rays in question increase the luminosity of a phosphorescent body, and may be conducted along a wire, retaining their wave-length and refractive index in the process.

[D'ARSONVAL, *Comptes Rendus*, April 11, 1904.]

Chemical Application of N-Rays.—A. Colson is of opinion that the N-rays are capable of being utilised as a delicate chemical reagent of considerable value. Some chemical reactions are the source of N-rays, while other and very similar ones are not. In preparing zinc hydrate the result is the same whether the zinc sulphate is added to the caustic potash solution or the latter is added to the former. Now, when the dilute potash is added to the sulphate the reaction gives rise to N′-rays, which diminish the brightness of a phosphorescent screen, whereas the reverse process does not give rise to the rays. The author finds that this evolution of rays is accompanied by the formation of a basic salt, which is only formed as long as the zinc sulphate is in large excess. Calorimetric tests show that the formation of this basic salt gives rise to a greater quantity of heat than the formation of the zinc hydrate without such an intermediary stage. A similar reaction is observed in the case of copper sulphate.

[A. COLSON, *Comptes Rendus*, April 11, 1904.]

Double Refraction.—The explanation of double refraction requires that in three directions at right angles to each other either the density of the body, or its elasticity, or its dielectric constant, should have different values. If the latter assumption is made it may be supposed that a number of conducting particles are embedded in a non-conducting medium. Lampa has made calculations bearing upon the case of conducting ellipsoids embedded in a non-conductor, or conducting spheres distributed with different frequencies in three directions. F. Braun now deals with another alternative. It is that a number of bricks are embedded in a medium of smaller dielectric constant, all the bricks being oriented in the same manner. Such a combination must show double refraction on the condition that it behaves like a homogeneous medium towards the incident wave system. If a block of the medium be placed in a uniform electric field, the potential energy of the system will be at a minimum when the longest axes of the bricks are parallel to the lines of force. Hence the capacity of the condenser and also the dielectric constant will have their maximum value in the same direction. The author constructed a grating of bricks of fireclay, 6cm. by 12cm. by 24cm. each, the area of the grating being 1 sq. metre. Ten such gratings placed one behind the other gave one nearly complete rotation of the plane of polarisation. The difference of the refractive indices was about 0·22, or larger than the difference between the ordinary and extraordinary rays in calcspar. The wave-length used was 68cm., emitted by a Righi polariser.

[F. BRAUN, *Physikalische Zeitschrift*, April 15, 1904.]

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TRADE UNIONS AND TRADE DISPUTES.

A somewhat lengthy debate took place in the House of Commons last Friday on the motion by Mr. PAULTON, Member for Bishop Auckland, that the Trade Unions and Trade Disputes Bill be read a second time. The Bill has a threefold object and consists of an equal number of clauses. The first clause, if made law, would make it legal for a person or any number of persons to assemble at or near a house for the purpose of obtaining or communicating information by peaceful means, or for the purpose of "peacefully persuading" any person to work or abstain from working. By the second clause it is provided that no act performed by any combination of persons in aiding or promoting a trade dispute shall furnish ground for action unless the same act, if performed by an individual, rendered that individual liable. The third clause seeks to make it impossible to bring an action against a trade union or association for damages sustained by any person or persons by reason of the action of a member or members of the union or association.

As a rule, it is not our policy to deal with matters concerning party politics in our leading articles; but on this occasion we do not hesitate to make an exception in commenting on a Bill which, if made law, would have a vast and, it is to be feared, anything but beneficial influence on the manufacturing industries of this country, and particularly on that great industry with which we are more intimately concerned —engineering. The first clause of the Bill, although by no means the most important, is alone sufficient to condemn it, and it is not surprising that the Prime Minister, Sir A. HICKMAN and Col. PILKINGTON treated it unsparingly. Mr. PAULTON, in moving the second reading, said it was unwise and dangerous to prohibit workmen from using peaceful methods of conducting a strike effectively, as it would almost excite men to defy an unjust law and to "resort to methods of terrorism." It is quite apparent, however, that the remedies suggested by the Bill would tend rather to encourage than to discourage the employment of violent methods during a strike. Certainly, an excited crowd of strikers awaiting the arrival or departure of "blacklegs" near the works would be the very best way of instilling terror into the minds of those who were sufficiently cowardly or courageous to continue work, and the chances of such a crowd remaining in merely an "excited" condition are exceedingly remote. The second clause of the Bill would simply modify the existing

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definition of "conspiracy" for one particular section of the community. As Mr. BALFOUR pointed out, an act performed by an individual may assume totally different proportions when performed by a number of persons; it is, in fact, a totally different action. Judges may have varying views as to what may constitute conspiracy, but it is useless to employ this fact as an argument, as was done by the supporters of the Bill.

The third clause is the true *raison d'être* of the Bill, and only too clearly betrays the anxiety with which the trade unions contemplate their financial liabilities. Most workmen, in contributing to trade union funds, do so primarily with the idea that their money is to be used mainly for redistribution at times when there is lack of work and for other purposes from which the workman may derive direct benefit; the organisation of strikes and the remuneration of permanent officials of the unions, however, runs away with much money that might otherwise be devoted to these more charitable uses; and, finally, recent legal decisions have shown that, by the injudicious action of trade union organisers, the whole of the funds may be drawn upon for the compensation of employers who have suffered heavy pecuniary loss by illegal actions on the part of the unions. The fact that the whole funds of the union are not devoted to fighting purposes may be accepted; but it is not sufficient to absolve such institutions from ordinary responsibilities, similar to those borne by other corporations in the country. Moreover, in spite of the plausible statistics which were introduced into the debate, there is not a shadow of doubt that exceedingly large sums have been spent, not only for the purposes of prolonging strikes, but also in heavy legal expenses, such as those involved by the Taff Vale and subsequent similar cases. The third clause of the Bill seeks to relieve the unions of this last obligation, and it is to be hoped most sincerely that nothing will ever induce any Government, whether Conservative or Radical, to allow such a measure to become law. It is not to be assumed that we advocate the payment of legal and similar expenses from money collected for provident and benefit funds, but we are most strongly of the opinion that trade unions should be compelled to accept complete responsibility for the actions of their members. However, as pointed out by Mr. CRIPPS and the ATTORNEY-GENERAL, the unions have the remedy in their own hands, and there is no necessity whatever for legislation. They are at liberty to appoint trustees to take charge of their "benefit" money, and so ensure that it cannot be used for any other purpose—not even for strike pay. This simple procedure would protect the "benefit" money from loss through actions brought to recover damages owing to the behaviour of a member or members. But it would effectually destroy the efficacy of the unions as a fighting force, for the major part of the funds being securely set aside for other purposes, there would then be insufficient reserve for the institution of strike campaigns.

To recapitulate: the Bill, if passed, would constitute a serious menace to personal rights and liberties, in that it would permit the assembly of large bodies of men for the purposes of "peaceful persuasion," which would inevitably degenerate into rank intimidation and, in all probability, end in actual physical violence. It would also relieve trade unions of a responsibility for the good behaviour of their members, which they should, in common fairness, be compelled to bear. We are, therefore, all the more surprised that the Prime Minister, although opposing the Bill personally, did not throw the whole weight of the Government against it, and thus prevent the waste of more time upon the consideration of a measure the passing of which, even in a modified form, would be most prejudicial to the industrial interests of the country.

REVIEWS.

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Die Gleichstrommaschine. By Prof. E. ARNOLD. Vol. II. Construction and Design. (Berlin: Julius Springer.) 18m.

A review of the first part of Prof. Arnold's treatise on continuous-current dynamos (dealing with the theory) appeared in *The Electrician* for August 29, 1902 (p. 753), and now the second part, which is concerned principally with the construction, design, testing and operation of such machines, is before us. The two volumes form, without doubt, the most complete treatise on the subject which has yet appeared in any country, and it is to be hoped, in the interests of the industry, that an English translation of both will be eventually available.

The first part of the volume now under consideration deals with the proper dimensioning of the component parts of direct-current machinery from the mechanical point of view, with the whole question of slot insulation, and with the construction of formers and the execution of armature windings generally. The subject is treated in a very thorough and practical manner, and is illustrated by a large number of excellent sketches drawn to scale, and by no less than 30 complete designs of modern machines of all sizes taken from the best European and American practice. The tabulated data for the machines, together with the scale drawings given for most of them (assembled together at the end of the volume in the form of plates), constitute one of the most valuable features of the book, for the examples are not only well chosen, but they relate to some of the best machines actually built during recent years, and hence are of real value. Too often the elaborate calculations and examples found in works on dynamo design relate to machines of obsolete pattern, or of the "freak" class, but the author of this work has successfully avoided all designs of a misleading character.

Of the various formulæ and calculations given by the author in this part of the book, covering the design of shafts, bearings, binding wires, pulleys, &c., it may be said that while somewhat too elaborate for general use (for most designers follow a few simple rules in such matters) they will prove useful as a check on figuring of a more simple character, where special cases have to be dealt with. It is to be regretted, however, that the subject of turbo-dynamos is barely touched upon, and from this point of view the author's discussion of commutator and brush-holder construction, armature winding and balancing can hardly be considered as adequate.

The second part of the book is taken up with the calculation and electrical design of dynamos, the author's treatment being based upon the theories (especially with regard to commutation) established in the first volume. This treatment is certainly too elaborate for everyday work, the experienced designer taking many short cuts where the author devotes many pages of detailed calculation; this is especially noteworthy in the sections dealing with the design of the armature (from the commutation point of view) and the pre-determination of the no-load characteristics. But it may be safely asserted that before a designer reaches the stage at which short cuts and approximations may be made when figuring out a given design, he has got to be thoroughly acquainted with the whole of the contents of this part of the book. The author shows step by step how the electrical design of a direct-current dynamo is built up, based upon a modern theory of commutation, and upon the orthodox views with regard to temperature rise; references to permissible current densities and permissible flux densities are conspicuous by their absence, the treatment being throughout on a scientific basis, and entirely free from rule-of-thumb methods.

We do not think, however, that the author has done sufficient justice to several classes of direct-current machine which designers have to deal with in everyday practice of the present time. Mention of turbo-generators has already been made above, and for this class of machine the author's control formula for the sparking limit would be of little use; the same remark applies to reversible boosters and even to railway motors. All these machines are more or less neglected, and also that much-used but (with designers) unpopular machine—the generator built for lighting and tramway use, with the

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same rating when working on the shunt at 460–480 volts as when working compounded at 500–550 volts. For all these special classes of machine the designer will certainly find the groundwork of his requirements in the two volumes of this work, but he will find no record of experience in them to assist him to overcome a particular difficulty with which he may be confronted.

Sufficient stress has hardly been laid by the author on the enormous influence of improved ventilation on the output of dynamo machinery. It is probably in this direction alone that improvements may be looked for in the future in the direction of obtaining a better utilisation of the material than is obtained at present, and much more might have been said by the author with profit to the reader.

In the third part of the work (which deals in the completest possible manner with all matters relative to the testing of dynamos) will be found the particulars of some original researches carried out by the author, concerning the theory of commutation and the eddy current losses in the armature conductors. The results of the former in particular, when taken in conjunction with the theory of commutation given very fully in the first volume, are of considerable interest and value.

The remaining portions of this work deal adequately with a number of important matters connected with the subject, such as the starting of motors, the speed regulation of motors, large and small (including the special arrangements for winding engines), the operation of three-wire systems, series transmissions, &c., as far as the machines are concerned, and with other matters of interest to the designer and user of the continuous-current machine. The treatment is of a thoroughly practical character throughout, clear and to the point.

The Common Sense of Municipal Trading. By Bernard Shaw. (London: Archibald Constable & Co.). 2s. 6d.

That this is a brightly and cleverly written little brochure goes without saying. But it is more than that, it is one which deserves the serious attention of anti-municipal traders. To "the virulence and prevalence of private spirit in our commercial civilisation," to quote the words of the author, with its outlook on life limited by dividend-earning considerations, is due, without a doubt, the birth and rapid growth of municipal trading, and it is well for those who are responsible for the virulence and prevalence complained of to see themselves as others see them.

The author eschews the statistical method of gauging the advantages and disadvantages of municipal trading, and he is right. Firstly, because this method is fatal to municipal trading, of which he is an advocate; secondly, because there are gains and losses which are incalculable; thirdly, because the public have had a surfeit of figures. The total outcome of any given commercial operation may be divided roughly into visible and invisible results, and figures can deal only with the former results, which are not infrequently the less important. The author is, for instance, talking sober sense and not paradoxes when he states that "private companies can and do make large profits out of sweated and demoralised labour *at the expense of the ratepayers*; and these very profits are often cited as proofs of the superior efficiency of private enterprise."

A great point is made of the alleged fact that the benefits of private enterprise are merely incidental, whilst those of municipal enterprise are inherent. But admitting the point to be proved, which we are very far from doing, what does it matter whether benefits are incidental or inherent so long as they exist. The root objections against municipal trading are simply these: "There is," to again quote Mr. Shaw's own phraseology, "no magic in the ordeal of popular election to change narrow minds into wide ones, cowards into commanders, private ambition into civic patriotism, or crankiness into common sense"; secondly, "the cardinal difference between private and municipal enterprise for the capitalist is that investment in the one is *voluntary*, whilst investment in the other is *compulsory*"; and thirdly, the probable deadening and demoralising effect of the municipalisation of industry on the national character. Mr. Shaw attaches more importance to the unseen results of municipal activity than to balance-sheets; so do we. And that is why we commend his book to the statistically minded.

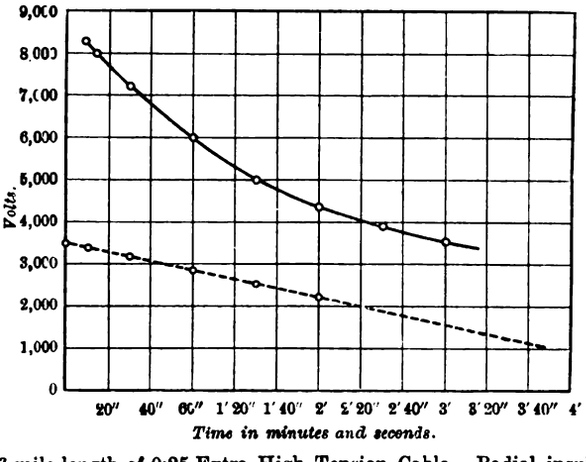
CORRESPONDENCE.

DANGER OF ELECTROSTATIC SHOCKS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The unfortunate accident at Bow has certainly given rise to an interesting discussion and to a fairly wide divergence of opinion as to the possible effect and value of a static charge. The results of some experiments made since my last letter may be of interest.

A length of three-quarters of a mile of 0·25 sq. in. concentric cable built for a working pressure of 10,000 volts was taken for the tests. The insulation resistance between cores was 600 megohms, and the capacity of the length 0·238mfd. An electrostatic voltmeter was connected directly across the cable, and a pressure of 10,000 volts alternating applied. This pressure was switched off many times, with a view to observing the maximum volts left upon the cable in the form of a static charge. The highest observed reading of many dozens was 8,300 volts 10 seconds after disconnection. (No reading sooner than this was possible owing to the swing of the voltmeter needle.) The value of the charge dropped with great rapidity at first, and afterwards much more slowly, the readings being: 8,300 volts 10 seconds after disconnection, 6,000 volts at the end of one minute, 4,400 volts after two minutes, 3,500 volts after three minutes. Accurate readings lower than this were not possible with the voltmeter used, but the shape of the curve indicates that at the end of five minutes a charge would remain of well over 2,000 volts.



¾-mile length of 0·25 Extra High Tension Cable. Radial insulation: ⅛ inch. Insulation resistance: 600 megohms. Capacity: 0·238 microfarads. Full line curve = Charged with 10,000 volts, alternating. Dotted line curve = Charged with 3,500 volts, continuous current.

Now, as to the possibility of a charge building up; the cable mentioned above, with a static charge of 5,000 volts upon it, resulting from an alternating supply, was earthed for the shortest possible time by flashing a wire at high speed across the terminals. It was found from many experiments that the highest value remaining afterwards was 400 volts. The same cable with the same static charge—viz., 5,000 volts—was taken and short-circuited for two minutes, the highest remaining charge after this being found to be only 0·8 volt. These tests go to show (1) that a dangerous charge may often be present in a cable five minutes after the high-pressure alternating current has been switched off. (2) That a very perfunctory earthing is all that is necessary to reduce the voltage to a safe limit, and that no "creeping up" of voltage occurs after earthing.

Mr. Duddell in your last issue, in disagreeing with a statement of mine in a previous letter, remarks that he has often found on switching off a cable that it is charged to the maximum volts of the alternating wave. I do not see how this is possible, because on switching off there must be some sort of an arc at the break, and this must lower the potential. Certainly it seems clear that, so short a time as 10 seconds after disconnection, no higher static charge than 8,300 volts can be left by 10,000 R.M.S. volts, the wave

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having practically a sine form. It is interesting to observe that in the experiments referred to above, it was found that a higher voltage was left on the cable when the circuit was interrupted by a rapid air break than when broken under oil. Mr. Duddell says that a capacity of 10mfd. to 12mfd. charged to 1,500 or 2,000 volts might well give a fatal shock; this is agreed, but would there be enough energy to give a "flash and report"?

If it is, as Mr. Duddell suggests, that the voltmeter is worked through a transformer, would not the primary winding of this transformer have dissipated any static energy that might have been present, seeing that the attendant had removed six fuses before receiving the shock? The curves obtained on Mr. Duddell's oscillograph show that in spite of the high resistance of its circuit, it suffices to dissipate the static charge to practically zero potential within a time equivalent to 1½ to 2 periods after switching off.—Yours, &c.,

Prescot, April 25. G. H. NISBETT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I find it difficult to believe that the quantity of electricity stored electrostatically even in a long cable, can give a fatal shock when discharged through the body of a full-grown man in normal health. Far less do I believe that fatal results would ensue from the residual charge manifesting itself after a cable has been disconnected from an alternating-current system, and momentarily discharged.

In the case of the remarkable accident at Bow, one naturally asks whether the unfortunate victim were in a normal state of health, for, if not, it cannot be positively asserted that there was any inherent danger in the electrical conditions obtaining at the time of the accident, any more than the firing of a percussion cap could be said to be a danger to life *per se*, even though in some particular instance it might have so startled some one suffering from heart weakness as to bring about his death.

It must be admitted that the question whether a shock will prove fatal or not is determined by (1) the current strength passing through the body, (2) the duration of the shock, (3) the path traversed by the current. That the time element is important is, I think, indicated by the fact that, while the shock from a small Leyden jar charged to a high potential is not dangerous, contact with a live 'bus bar at a lower potential may prove fatal. In the first case, the *initial* current is determined by the P.D. of the jar coatings and the resistance of the body; it may, therefore, quite well be greater than in the second case, but owing to the short duration of the current, dangerous effects are not experienced. It is thus reasonable to suppose that, not only must the current strength be considered, but also the number of ampere-seconds or coulombs discharged through the body.

A capacity of 5mfd. would represent a very long cable, and this charged to a potential of 14,000 volts (*i.e.*, the crest of a 10,000-volt wave) would store 7×10^{-2} coulombs of electricity. While these are somewhat extreme figures, it must be remembered that there are many authentic cases of shock which have not proved fatal, where, as far as one can judge, a larger quantity of electricity than 7×10^{-2} coulombs must have passed through the body.

[The fact that the capacity of a Leyden jar is concentrated whereas that of a cable is distributed, may constitute an important factor in determining the relative severity of the shock, since it is conceivable that the discharge from a concentrated capacity would be so instantaneous as to be confined to the conducting portions of the body nearest to the skin, whereas the discharge from a distributed capacity of equal amount might penetrate to vital organs.]

With regard to these residual charges, or those which gradually make their appearance after the cable has been momentarily discharged, I believe I am correct in my idea that the time intervals required for the "soaking-in" and "soaking-out" of a charge are of the same order of magnitude. If a steady voltage be applied to a cable, a charge will often continue to soak-in for many minutes, after which, if the cable be momentarily discharged and left to recover, a residual charge will appear, but the potential of the cable will not rise to its initial value before it was discharged. It follows, therefore, that the "soaking-in" effect which could take place in a hundredth part of a second would be exceedingly small. But whatever "soaking-in" effect does take place when a cable is connected to an alternate-current supply must be reversed each cycle. In each half cycle the quantity which had "soaked-in" during the previous half cycle must have "soaked-out" before an equal quantity of electricity of opposite sign "soaks-in"; at no instant, therefore, can there be a greater residual charge than that which can "soak-in" in the time occupied by a half cycle, or one hundredth of a second if the frequency be 50. This will be a very small charge, and it is reasonable to suppose that if the cable cores were connected to earth for only one second no residual charge could subsequently manifest itself.

To my mind, neither the initial nor residual discharge could be accompanied by such manifestations of considerable energy as the report indicates when referring to the marks of burning and singeing on the face and hair of the unfortunate victim.

I might, perhaps, mention a case of a cable becoming unexpectedly charged which came under my notice a few years ago. The end of a disconnected cable was brought into a switch pillar of a tramway system, and supported in mid-air by a piece of string tied to a terminal mounted on the marble slab of the pillar. The cable end was taped, and the terminal from which it hung was not connected to any circuit, although some switches mounted on the same marble slab were alive. The cable was found to be charged, and on being discharged it regained its charge in about 15 seconds. This happened again and again, and it was discovered that it was being charged from the live switches through the leakage path via marble, string and insulating tape. At first sight this seems very remarkable, but if it be considered what a small quantity of electricity is required to charge such a cable, it becomes evident that this may quickly take place through a very high resistance. For example, if the capacity be ⅓mfd., then it is easy to show from the law of the charging current of a condenser that, provided the insulation of the cable be otherwise perfect, it will become practically fully charged through a resistance of 3 megohms in less than five seconds. In the case of alternate-current systems such charges are not likely to appear if the insulation of the cable ends be in good condition, but in dealing with high-tension continuous-current systems, I think it is a point to bear in mind.—Yours, &c.,

Manchester, April 23. M. B. FIELD.

THE OUTPUT COEFFICIENT OF INDUCTION MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have perused with much interest the abstract, published in your journal, of the discussion which followed the reading of Mr. Hobart's Paper ("The Rated Speed of Electric Motors as Affecting the Type to be Employed") before the Institution of Electrical Engineers on March 10th. It is not my intention here to comment on this important Paper. I would only draw your attention to the question of the output formula for induction motors. There is no doubt that the only useful and suggestive formula is the old $D^2LR\phi$, which, as pointed out by Mr. Esson, is by no means an empirical one.

It is, however, of the utmost importance to know the nature of the coefficient ϕ. I have endeavoured to find its expression by an *analytical combination* of the fundamental formulæ used in induction motor designs.

Let me call R = revs. per min.; D = stator core in centimetres; L = effective length of iron in centimetres; d = air-gap in centimetres; p = number of poles; f = frequency; A = air-gap surface given by $\epsilon\pi DL/p$, where ϵ is a coefficient depending on the teeth openings; P = volt-amperes absorbed at full load; e = voltage per phase; i = primary full-load current; i' = magnetising current; η = efficiency of the machine; $h = i'/i$; a_t = amps.-conductors per centimetre of core peripheral length; m = number of phases; n = number of conductors per phase; $\mathbf{N}$ = flux in megalines; $\mathbf{B}$ = maximum induction in the gap; σ = leakage factor; c = Behrend constant in the formula $\sigma = dpc/\pi D$; ρ and χ are the two well-known coefficients in the formulæ $e = \rho \mathbf{N} nf 10^{-2}$ and $i' = 2{\cdot}5.10^6 \mathbf{N} pd/\chi A nm$.

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If we remember that $\mathbf{B} = 1{\cdot}57\mathbf{N}\ 10^6/\mathrm{A}$, and that $\rho/\chi = 2{\cdot}5$ for any kind of winding, we get, after some transformation,

$$P = 8 \times 10^{-8} \epsilon \mathrm{DL} df\, \mathbf{B}^2/h.$$

Now, if we introduce the condition that the motor must work with the maximum power factor possible, and we remember the Behrend formula and the relation $h = \sqrt{\sigma/(1+\sigma)}$, which can be written, with very little inaccuracy, $h = \sqrt{\sigma}$, we arrive finally to the formulæ :

$$P = 0{\cdot}215 \frac{\epsilon \sqrt{\sigma}}{c} \mathbf{B}^2 \mathrm{D}^2 \mathrm{LR}\ 10^{-8},$$

$$a_t = \frac{1{\cdot}59}{\chi c} \sqrt{\sigma} \mathbf{B}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The B.H.P. is given [$\cos \phi_{max}$ being $= 1/(1+2\sigma)$], by

$$\text{H.P.} = 2{\cdot}9 \times 10^{-12} \frac{\eta \sqrt{\sigma}}{1+2\sigma} \frac{\epsilon}{c} \mathbf{B}^2 \mathrm{D}^2 \mathrm{LR}.$$

This formula speaks too clearly to need any comment ; the designer of asynchronous motors will find in it the explanation of many facts he has observed in practice.

The coefficient which Mr. Esson calls ϕ is (referring to centimetres instead of inches) :

$$\phi = 2{\cdot}9 \frac{\eta \sqrt{\sigma}}{1+2\sigma} \frac{\epsilon}{c} \left(\frac{\mathbf{B}}{1{,}000}\right)^2 10^{-6},$$

and we see that it is determined when we fix—first, the leakage constant c ;* second, the leakage factor, which depends almost entirely on c and on the number of poles, the ratio d/D being, for mechanical reasons, almost constant ; third, the induction in the gap, which is limited by the difficulty of making room for the copper around the stator periphery (see formula 1), or, more frequently, by the fact that we cannot allow too high an induction in the teeth ; fourth, the efficiency η ; and fifth, the coefficient ϵ for the slot openings. The output coefficient, then, does not depend on the slip or on the number of conductors in the rotor, &c., as Mr. Esson stated, and it is not a function increasing always with the rotor diameter.—Yours, &c.,

Birmingham, April 18. N. PENSABENE

ROYAL COMMISSION ON LONDON TRAFFIC.

THE POST OFFICE TELEPHONE CABLES.

The sittings of the Royal Commission on London Traffic were resumed on Thursday, April 21.

Sir ROBERT HUNTER, Solicitor to the Post Office, dealt with the powers of the Postmaster-General with reference to the construction and maintenance of telegraphs under the streets of London. These powers were derived from the Telegraph Acts, and were the powers conferred by Parliament upon the old telegraph companies in 1863, subject to certain extensions and modifications in favour of the Postmaster-General sanctioned by subsequent legislation. The Postmaster-General consequently did not exercise or claim to exercise any powers in the streets of London by virtue of any Crown prerogative, although, in some respects, the fact of his being a Crown officer might affect any action taken against him by local authorities who alleged that their streets were unduly intefered with. At the same time, the procedure which the Postmaster-General was compelled to adopt by the Telegraph Acts was much more cumbrous and tedious than that which was applicable to gas, water and other companies, and much delay arose in obtaining the consent of the road authorities even if that consent was finally given. It was impossible that any new work such as laying telegraph and telephone main cables could be undertaken without abundant notice to the road authorities. With regard to the telephone system in London, this had been laid down in such a manner that the only necessity for breaking up a street now was in the case of connecting new subscribers. These connections, however, were not direct from the main cable in the roadway but from service cables running along the pavement and they therefore involved the opening of the footway for a short time over a very limited space. The National Telephone Co. had no power to break up the streets of London without the authority of the Postmaster-General. Speaking generally from his knowledge of the way in which the Postmaster-General exercised his wayleave powers, every care was taken to reduce interference with traffic to a minimum and to consult the views of the local authorities. The Postmaster-General used the roads only for the public service, and would be always glad to co-operate in solving the problem of supplying the numerous accessories of civilised life which the population of a town expected to enjoy in so far as these affected the special interests entrusted to him.

Mr. JOHN GAVEY, Engineer-in-Chief to the Post Office, said he had superintended the provision of telephones for London and had designed the plan upon which the work had been carried out. The scheme was on a scale to provide for the wants of London for some time, and, together with the City, Mayfair, West Hampstead, Westminster and Kensington districts, underground ducts had been constructed for nearly 60,000 subscribers. For the purpose of laying the main work of the telephone system it had been necessary to take up most of the principal streets of London, and from 1899 to 1901 the interruption to traffic caused by these operations was no doubt considerable. The work had been so constructed, however, that new main cables could be drawn into the ducts through the manholes constructed in the roadway without breaking up or in any way disturbing the roadway itself. The same thing applied in connection with the service cables. The Post Office used the subways of the London County Council as far as possible, but in Queen Victoria-street and on part of the Thames Embankment the subways, large as they are, were filled to so great an extent with gas and water mains that there was not room for the telephone cables, and it was necessary to open the roadway to lay ducts. With a view to minimising the interference to traffic as much as possible, certain arrangements had been come to between the Post Office department and the Corporations of London and Westminster. Every care was taken to minimise the obstruction of traffic in the streets, and now that the main telephone works were laid, he thought the amount of interference with traffic caused by the Postmaster-General's telephone operations would be trifling. It has been suggested that all Post Office work involving the opening of streets should be carried out at night, and that the work of different undertakings should be carried out simultaneously. With regard to night work, although the Postmaster-General was willing, it would be quite impossible to confine telephone operations to the night. Apart from the ordinary difficulties there were many electrical ones. In dealing with working wires it would be impossible to make any tests in the night time to Post Offices (which would be closed) and to subscribers or private wire renters and similar places. Difficulties would also arise in connection with the staff, as the higher grade engineers must be on duty in the daytime for other purposes and could not, therefore, also be at work at night. With regard to the other suggestion, so far as the Post Office was concerned this was just as inapplicable as that of carrying out work by night. The attempts of the Postmaster-General to carry out his work simultaneously with other undertakings had not met with success. For instance, at the commencement of the construction of the main telephone works, the Charing Cross Electric Lighting Co. were also about to commence extensive works, but no co-operation on their part could be obtained in the matter of simultaneous working. He concurred in the view of Sir Robert Hunter, that the Postmaster-General always desired to use the streets with a minimum of inconvenience to those using the streets for other purposes, and would always be willing to co-operate with local authorities in every endeavour to advance the public interests as far as possible in every respect.

Friday, April 22.

Mr. ALFRED WILLIS, a director of the Baker-street and Waterloo Railway Co., and formerly connected with the South Eastern Railway Co., said that he had come to the conclusion that it was now too late in the day for Parliament or any other tribunal to lay down a general scheme for providing railway accommodation and traffic facilities within the Metropolis. The only course open at present was to see how far the schemes already existing and those projected would meet the reasonable requirements of the travelling public and to make the best of them. His opinion of the great outcry against the congested street traffic was that this was due to the development of electric lighting and telephone enterprise in London. In addition to this there were various street widenings being made, and when these matters had settled themselves somewhat the congestion would not be so great as at present. Relief could also be looked for in the future when he anticipated that a great deal of the goods and passenger traffic on the surface of streets would be maintained by motor traction. He failed to see that the construction of tube railways would in any way reduce the number of omnibuses in the streets as there must always be a demand for quick short-distance in-and-out traffic which could not be met by tube railways. He was against tramcars being admitted into the City, but thought the requirements of the Metropolitan traffic would be substantially met by the existing and projected tube railways in conjunction with the omnibus services, especially if the omnibus companies introduced motor traction. He saw many objections to the so-called general schemes as, after all, what really governed these matters was what financial return was likely to be gained. Perhaps something might be said for co-ordinating the various schemes submitted from time to time for suburban traffic, and if this was done a great and appreciable effect would be noticed upon the daily traffic to and from London. In discussing Parliamentary procedure witness laid stress upon the effect of the local veto, and if a really good extra-mural tramway service was desired this veto would have to be swept away. There should be absolute free trade in tramway services with mutual running powers over the different systems, leaving it to Parliament to decide as to what extent this principle should be acted upon in particular cases. His opinion was, however, apart from the veto, that if tramway development in the suburbs was left to municipal enterprise many promising schemes would be shelved and the public would be kept waiting. He thought the best way to systematise schemes relating to London and suburban traffic was that all bills should be referred automatically by Standing Order to a new tribunal. This tribunal might be formed by an amalgamation of lay members of the Railway and Canal Commission and the Light Railway Commission, with the addition of a traffic expert and a first-class

* See Hobart, "Electric Motors, Traction and Transmission," March, 1904.

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engineer, or it might be set up as a new department within the Board of Trade. The function of this tribunal should be the examination of each scheme in order to ascertain how far it conformed with the general principles which the Commission should lay down, and also to settle all points of minor importance.

Mr. H. T. SCOBLE, an associate of the Surveyors' Institution, spoke with regard to the transference of factories from congested town areas to suburban rural districts and gave some details of a Paper which he had contributed to the Surveyors' Institution upon this subject.

PARLIAMENTARY INTELLIGENCE.

TOTTENHAM COURT ROAD TRAMWAY.

LONDON COUNTY COUNCIL TRAMWAYS AND IMPROVEMENTS BILL.

Mr. Compton Ricketts' Committee of the House of Commons commenced consideration of this bill on Wednesday.

Mr. ERSKINE POLLOCK, K.C., who appeared for the promoters with Mr. Moon, K.C., and Mr. du Cane, said the bill was of an omnibus character and he proposed to deal with it by sections. The first part was the 5 furlongs 9 chains of tramway down Tottenham Court-road. The line commenced in the Hampstead-road near Tolmers-square, the present terminus, and would be projected onwards across the Euston-road and continue down the Tottenham Court-road, terminating at the end immediately behind a street refuge. It would be double track. The width of Hampstead-road at the present terminus was 35ft, but powers had already been obtained for widening it to a uniform width of 80ft. Tottenham Court-road was at present 42ft. wide. The proposal was to run a line on either side of the refuge at the end of Tottenham Court-road and to have the lines with 20ft. between centres all along the road owing to electric light standards and cab stands. The Oxford-street end of Tottenham Court-road was very wide, forming a bell-shaped thoroughfare varying from 54ft. to 68ft. The terminus at Hampstead was a very important one, as four lines of tramways converged and terminated there. But a very considerable number of passengers who patronised these lines desired to go further towards Oxford-street, and from this point of view a line such as was proposed would confer enormous benefit upon the workers of London. With regard to the road authorities, practically speaking, it could be said that the St. Pancras Borough Council, which owned the road as far as Percy-street, was strongly supporting the bill, whilst the Holborn Borough Council, which owned the remainder of the thoroughfare, was opposing. There was no scheme for widening Tottenham Court-road, but no difficulties were encountered in the matter of statutory road width between Hampstead-road and Percy-street. From that point it would be impossible to get the statutory width for a distance of about 680ft. only. The Charing Cross, Euston and Hampstead Railway opposed the tramway on the ground of competition. Petitions from frontagers had also been deposited.

Mr. T. H. W. IDRIS, mayor of St. Pancras, gave evidence in favour of the bill by instruction of the Borough Council.

Mr. MAURICE FITZMAURICE, chief engineer to the London County Council, was next called, and dealt at length with the widths of the road throughout the entire distance of the proposed tramway. There would be a 2½-minute service, and there were many instances in London where a similar service was carried on with much less width. The cost of the construction of the tramway was estimated at £28,500, and the lines would be worked on the conduit system. The northern lines, which were leased to the North Metropolitan Tramways Co., would fall into the hands of the Council in 1910, but the Council had the power to electrify all the northern lines at any time. If this course were not adopted before 1911, the new lines would probably be worked by horses by the tramway company.

Cross-examined by Mr. BAGGALLAY, K.C., for the Holborn Borough Council, Witness admitted that at certain points of the route the statutory width between the rails and the kerb would not be obtained, but he failed to see that this was any disadvantage to the tramway cars.

Mr. FREDERICK PURCHASE, an alderman of the St. Pancras Borough Council and a member of the Board of Guardians, spoke in favour of the scheme.

Yesterday the CHAIRMAN announced that, after the most careful consideration both by the Committee themselves and with the Local Government Board, the line through the part of Tottenham Court-road where the statutory width could not be obtained would not receive the consent of the Committee. This decision was solely in view of the character of the thoroughfare, This would not prejudice the prospects of the bill as regards the remaining two-thirds of the street however. What the promoters would have to do now was to decide upon some spot north of the narrow portion, somewhere between Francis-street and Percy-street, where a suitable terminus could be arranged.

After some discussion and objections by the opponents as to proceeding with the measure further that day, it was decided to adjourn at once until Monday.

METROPOLITAN DISTRICT RAILWAY BILL.

THE ZONE SYSTEM OF FARES.

A Committee of the House of Lords, of which Lord Camperdown is Chairman, considered this bill on Tuesday. There is no opposition to the preamble, but several petitioners are seeking the insertion of special clauses.

Mr. FREEMAN, K.C., for the promoters, detailed the objects of the bill. The first point dealt with is an extension of time for the construction of the Earl's Court–Mansion House deep-level electric railway. A small portion of this line had been utilised in connection with other works of the company, but for the remainder an extension of time until August, 1906, was asked for. The chief reason for the delay was that, until the scheme for the electrification of the District lines generally was completed, it would be very difficult to decide in what manner the deep-level line should be utilised. Clause 22 proposed to give the company power to introduce what were known as "zone" fares. About 50 per cent. of the new fares would be at 2d., 32 per cent. at 3d., and 15 per cent. at 4d. and the remainder at 5d. It was anticipated that the loss incurred upon the cheaper fares would be covered by the profits on the long-distance passengers. The bill also asked, in view of the altered conditions of traffic during recent years, upon the Inner Circle, to restrict the amount of luggage carried by passengers travelling at "zone" fares to 28lb.

Formal evidence having been given in proof of the preamble,

The CHAIRMAN announced that the bill might proceed.

On Wednesday clauses were gone into. The London County Council petitioned for a clause in respect of workmen's fares to be applied to the Earl's Court–Mansion House deep level line, but this the Committee refused.

Mr. DICKINSON, on behalf of the Fulham Borough Council, objected to the proposed schedule of zone fares, insisting that a great increase in the short distance fares would be the result. He also sought a larger limit of luggage than 28lb.

Mr. FREEMAN, K.C., on behalf of the promoters, offered to make certain concessions, so as to include another station in Fulham which would receive the benefit of the 2d. fare. With regard to luggage, he refused to modify the company's proposals.

For the London County Council's opposition on these points, Mr. HARPER, statistical officer to the Council, produced a number of tables to show that there would be a larger number of fares increased than the company had indicated over the single journey. With regard to the return fares and the season rates, for which no tickets would be issued, the increase would be still more noticeable.

After further discussion,

Mr. TALBOT, on behalf of the London County Council, stated that the District Company had no need to come to Parliament in order to introduce a system of zone fares, except so far as any increase was concerned. Looking at the matter generally, the County Council failed to perceive any material advantage to the public in the proposals of the company.

Mr. FREEMAN, for the promoters, replied that at present no railway company was bound to issue return or season tickets, and that in this respect he was not evading any of his liabilities. The District Company, in putting forward these fares, &c., did so with the object of giving the public a quick service, and the Committee would have to weigh up the advantages and disadvantages of the new and the old.

Eventually the Committee found the preamble of the bill proved with the addition of a proviso that the company should run two trains in each direction every day, stopping at every station, upon which a first-class passenger might carry 120lb. of luggage and a third-class passenger 60lb. of luggage free of charge. An application by the Fulham Borough Council for further concessions was not granted.

GAS COMPANIES AND ELECTROLYSIS.

BARNET GAS AND WATER CO.'S BILL.

In our issue for April 15 we mentioned that application was being made for the insertion of a clause in the above bill giving the company special protection with regard to damage to its mains by electrolytic action. The clause reads as follows:—

"If any injury or damage occur to the mains, pipes or works of the company by fusion or electrolytic action, caused by any electric currents generated or used by any county borough or district council or any other body, company or person for the purpose of electric traction or electric lighting or other analogous purposes, such council, body or person shall make full compensation to the company for any such injury or damage."

On Friday last week, a Committee of the House of Commons, presided over by Capt. Jessel, having disposed of the other portions of the bill, dealt with this clause.

The promoters called

Mr. J. G. NEWBIGGING, chief engineer to the gas department of the Manchester Corporation. He said there were some 2,000 miles of gas-pipes in Manchester, and many instances of electrolytic damage had been caused through the working of the electric tramways. The attention of both the Gas and Water committees at Manchester had been drawn to this matter, and he was a member of a committee of Corporation engineers which had been appointed to consider the matter in 1900. [Witness here produced many samples of gas pipes showing distinct "pitting."] It was generally said that a tramway worked under the Board of Trade regulations ought to be safe, but the Manchester tramway lines which had produced the injury shown upon his samples of pipe were worked under these conditions. At Manchester the Electricity committee so realised the possibilities of electrolysis that it had agreed to pay for any damage so caused. His contention was that when the Board of Trade regulations were first drawn up very little knowledge on the subject was available, and that they were based largely on theory.

Cross-examined by Mr. HARPER, on behalf of the Middlesex County Council, which has a system of electric tramways in course of construction, Witness admitted that he had never been to the Board of Trade and made a complaint. This was because at Manchester the Corporation owned all the undertakings, and an arrangement had been come to between them. If any actual inconvenience to the service was occasioned he should then make such an application. As to the possibility that the Manchester tramways were not working strictly within the limits defined by the Board of Trade regulations, he said that no independent inspection

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had been made to ascertain this, but the returns showed that the system was being conducted according to the regulations. The Manchester soil was not unusually conducive to electrolytic action. He knew of no case in which a clause similar to the present one had been included in a water bill unless by agreement. The degree of the damage caused depended upon the amount of current, the soil conditions, and the length of time during which the current was passing through the metallic substance. He was not aware that both the Board of Trade and the Light Railway Commissioners had refused to allow this clause to be inserted in the Middlesex light railway orders. With regard to electrolytic action caused by leakage from electric lighting mains at Manchester, trouble was usually experienced with the high-tension distributing cables, but unless the insulation absolutely broke down there was very little danger from electric lighting mains.

By Mr. SNOWDEN, for the Finchley Urban District Council: He was aware that the Finchley Urban District Council had an electric lighting undertaking, but did not know that in the Council's order there was a very stringent clause as to the position of mains having regard to electrolysis. Assuming that the Finchley Urban District Council had already laid its mains, and the water company afterwards placed some pipes so that electrolytic damage followed, he maintained that the Council should make compensation to the company. He did not consider the terms of the clause too wide.

Mr. SNOWDEN contended that, with the present wording of the clause, the company could claim compensation even if the damage were caused by its own negligence.

In answer to Mr. CROOKS, a member of the Committee, Witness stated that the chief of the electricity department at Manchester did not deny that electrolytic damage was caused.

Mr. CROOKS: What you have done in Manchester as to payment for the sake of peace and quietness, you now seek to make the common law of the land?—Yes.

The CHAIRMAN: Have you not your remedy by the common law?—No, Sir, because Parliament has authorised the tramways to be worked under the Board of Trade regulations.

Mr. CROOKS: You are asking us to give you powers beyond those contained in the Board of Trade regulations?—Yes, because we have found by experience that the regulations are not effective.

The CHAIRMAN: Is there any precedent for this in a water bill?

Mr. LLOYD, K.C., for the promoters: No. It is quite a novel proposition to ask to have it inserted in a water bill.

The CHAIRMAN: I do not think that we can grant you the clause.

A LONDON SUBURBAN TRAMWAY REJECTED.

When Mr. Compton Ricketts' Committee of the House of Commons resumed consideration of the London, Camberwell and Dulwich Tramways Bill on Friday last week,

Mr. ERSKINE POLLOCK, K.C., for the London County Council, stated that the committees of the Council concerned with this tramway had met the day before and it was decided to advise the Council to purchase the whole undertaking in August next under the terms of the Tramways Act—*i.e.*, upon "old iron" terms.

The CHAIRMAN: Would it be of any use if you were to confer with the promoters on this point?—I do not think so.

The case for the Camberwell Borough Council was then proceeded with, a large number of local witnesses testifying as to the undesirability of the line down Rye-lane.

On Monday the CHAIRMAN announced that the Committee had visited Rye-lane on Friday evening, and had carefully examined the thoroughfare.

Mr. J. W. BURCHELL, solicitor and parliamentary agent for the bill, was then called and related the circumstances under which he had received his instructions to prepare the notices, &c., for the bill. The Westminster Syndicate had arranged to find the necessary money for this, and had since acquired a large proportion of the tramway company's shares. The Westminster Syndicate was also now prepared to assist in finding the capital for the electrical equipment of the tramways.

Mr. A. T. MOORE, chairman of the Camberwell Borough Council's Highways committee, said that, in the opinion of the Council, not 5 per cent. of the Dulwich residents would use these lines. In his opinion, the whole of Rye-lane should be widened throughout to a road width of 40ft. and a footway width of 12ft.

Mr. LEWIS COWARD, K.C., in addressing the Committee on behalf of the Camberwell Borough Council, commented upon the difficulty which had been encountered as to a clear idea of the position of the Westminster Syndicate, and he was not convinced that the transactions between the Syndicate and the company had been satisfactory. In urging that the widenings proposed by the tramway company were not sufficient, he maintained that the Borough Council since 1895 had been perfectly consistent in its attitude in this matter.

The opposition of the London County Council was then taken.

Mr. J. A. BAKER, chairman of the Highways committee, stated that in 1903, when some portions of the company's lines were purchasable by the London County Council, the matter had been carefully gone into, but it had been decided that the lines should not be purchased, since, for tramway purposes, they were considered non-existent. Since the bill had been before this Committee, however, the Highways committee, after further consideration, had passed a resolution to the effect that they would recommend the Council to purchase the lines in August this year on what were known as the Bramwell terms. This was done with the object of considering whether some portions of the lines could not be utilised as an extension of the Council's own system in that district. With regard to clause 33 of the bill, which proposed a variation of the period and terms of purchase as defined in the Tramways Act, he maintained that there was no precedent for this, and pointed out that, in view of the fact that in 1911 the County Council would become the owners of every mile of tramway within the County of London, they had committed themselves to an expenditure of several millions for electrical equipment.

On Tuesday, Mr. J. A. BAKER was cross-examined, and reiterated his views that the tramway down Rye-lane with the widenings suggested by the promoters would absolutely spoil the district.

Mr. MAURICE FITZMAURICE, chief engineer to the London County Council, considered that an eight minutes' service would be the quickest that could be maintained.

Mr. ERSKINE POLLOCK, K.C., then addressed the Committee on behalf of the London County Council, and stated that the promoters were asking for concessions with respect to purchase, &c., that had never before been asked for or granted in a tramways bill affecting the County of London. The actual promoters, he contended, were not the London, Camberwell and Dulwich Tramways Co., but the Westminster Syndicate, and if the latter at any time stopped the supplies the undertaking would practically come to an end.

Mr. H. LLOYD, K.C., in replying for the promoters, commented upon the treatment which the company had received at the hands of the Camberwell Borough Council.

The CHAIRMAN said that he did not think the Committee had been treated quite frankly by the promoters as regarded the Westminster Syndicate.

Mr. LLOYD replied that the promoters had not anticipated that the question of finance would be raised by the petitioners against the bill, but the promoters were quite willing to insert a provision in the bill to pay off all creditors, and leave the company a reasonable amount of working capital. He admitted that there was no precedent for an extension of the the terms of puchase to 30 years even if the purchase were carried out on the basis of the "old iron" terms, neither could he produce a precedent for the acquisition of a tramway undertaking at the end of its statutory period as a going concern.

After a short deliberation,

The CHAIRMAN said the Committee had come to the unanimous decision that the preamble of the bill was not proved.

ILFORD URBAN DISTRICT COUNCIL BILL.

ENDEAVOUR TO OBTAIN THE "BERMONDSEY" CLAUSE.

This bill came before a Committee of the House of Lords, presided over by Lord Clifford of Chudleigh, yesterday.

Mr. WEDDERBURN, K.C., who appeared for the promoters, said that the bill sought authority to carry out certain street improvements and to make further provision in respect of the electricity undertaking. The Ilford Gas Co. opposed the latter portion of the measure. Originally it had been proposed to construct and work electric tramways, but this portion had been struck out of the bill at the instance of the ratepayers. The Gas Company's opposition was in respect of the insertion of what was known as the "Bermondsey" clause, and this being so, he proposed first to call formal evidence in proof of the preamble. This having been done, the case for the Gas Company was gone into.

Mr. SQUAREY, for the Ilford Gas Co., pointed out that the bill proposed to borrow £10,000 for the purpose of supplying electrical fittings on the hire-purchase system, and his company being a large ratepayer in the district, thought it unfair that competition of this character should be carried on by the local authority without some protection to the gas company that there should be no call upon the rates in respect of such trading. What he asked for was, therefore, the insertion of a clause in the bill to the effect that the Council should, once in every year, so adjust its charges for electrical energy, that the receipts for that year should cover the estimated expenditure.

Evidence for the Ilford District Council was then called.

Mr. W. C. C. HAWTAYNE, the consulting electrical engineer to the Council, said that it was proposed to borrow £10,000 at once, and also to have the power to borrow any subsequent sums as the Council felt desirable from time to time. Power to borrow money for this purpose had been given to other local authorities, and in this respect nothing unusual was being asked for.

Cross-examined by Mr. SQUAREY: He maintained that the Ilford Council kept its accounts in a similar manner to all local authorities, and that sufficient had been put by for depreciation, &c. The Ilford undertaking showed a profit after the second year of working.

Evidence in support of the proposal having also been given by the Mayor of Ilford and the borough accountant,

The Committee adjourned.

BELFAST TRAMWAYS BILL.

SEVERE CONDITIONS IMPOSED.

The Earl of Camperdown's Committee of the House of Lords considered this bill on Wednesday.

The Hon. J. D. FITZGERALD, K.C., for the promoters, said that this was a promotion by the Belfast Corporation to enable them to acquire the undertaking of the Belfast Street Tramways Co., and also to authorise the construction of additional tramways. Terms had been agreed between the Corporation and the tramways company, and there was no opposition from that quarter. The company had been authorised by an act in 1872. The Tramways Act of 1870 did not apply to Ireland, but in the Belfast Street Tramways Act of 1872 provisions for the purchase of the undertaking by the local authority similar to those in the Tramways Act of 1870 were included. The lines were thus purchasable in 21 years from 1872, or at the end of any subsequent seven years. Accordingly, these powers became exercisable in 1893. In the previous year, however, an agreement was arrived at between the Corporation and the company by which the Corporation agreed to suspend for a further period of 14 years the exercise of its powers of purchase, and the company agreed to pay an

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annual sum to the Corporation as a consideration, as well as to institute a schedule of fares which would be satisfactory to the Corporation. That agreement was sanctioned by Parliament in 1893, and the powers consequently would lapse in 1907. Belfast was now practically the only large town in the United Kingdom, outside London, which had horse tramways. The Tramway company obtained powers some years ago to work the tramways electrically, but during the negotiations with the Corporation, a very considerable difficulty arose on account of the near approach of the expiry of the term of the company. Therefore, it was considered advisable that the Corporation should hasten the period of purchase and the agreement which was scheduled to the bill was arrived at. Briefly, the terms of this agreement were, that the Corporation should take over the lines on Jan. 1 next, upon the same terms as if they had been purchased in 1907. During the period between Jan. 1 next and August, 1907, however, the Corporation would pay to the company a sum representing the profits which the company would have made during that period, and this sum would be calculated upon the net profits of the company for the past five years. Practically the only opposition was from the three railway companies which had termini in Belfast.

Yesterday, Mr. McCORMACK, chairman of the Law Committee of the Belfast Corporation, was called, and confirmed the opening statement by Mr. Fitzgerald. The present debt of the Corporation was £1,716,000, which, however, was not much more than one year's ratable valuation—viz., £1,500,000. The Corporation also owned the gas and electrical undertakings as well as the markets, all three of which were carried on at a profit. He considered that the tramways would be carried on at a profit also.

Mr. BAGGALLAY, K.C., for the Great Northern Railway Co. of Ireland, said that the point of his opposition was that the Corporation should be placed under an obligation to charge such fares upon the tramways that there would be no call upon the rates, to which the railway companies contributed very largely.

Mr. McCORMACK, continuing, said that the horse tramway company had always paid 6 or 7 per cent.

The CHAIRMAN: Have you any objection to the clause asked for by the railway companies being inserted in the bill?—I do not think the Corporation would care to be tied in this matter.

Continuing, Witness said that the clause in question had been granted in one or two cases, notably Aberdeen and Dundee.

By Mr. S. ROMAN, K.C., for the Belfast and County Down Railway Co.: There was a clause in the bill giving the Corporation powers to lease the line or to enter into working agreements and for the supply of electrical energy outside the borough. The amount contributed to the rates by all the railway companies in Belfast was £15,000 out of a total of £1,500,000.

Mr. T. H. MINSHALL, the electrical engineer who has advised the Corporation with respect to this bill, was then called on the technical question, but the Chairman interposed that this point was not challenged by the opposition. Witness said he objected to the clause proposed by the railway companies in as much as it would prevent a manager experimenting with fares with the object of ascertaing what fares would be remunerative and what would not.

Mr. BAGGALLAY then addressed the Committee for the Great Northern Railway Co. of Ireland, and asked that the clause with respect to the supply of electrical energy and working agreements should be struck out of the bill, except in so far as this concerned the Cavehill and Whitewell tramways, as these did not compete with him. With regard to the clause as to the charging of fares so that the lines should not be a burden upon the rates, he maintained that it would be an easy matter for the Corporation accountant to prepare a sort of budget each year and to thus fix fares which would meet the anticipated expenses.

Mr. S. ROMAN, K.C., addressed the committee to the same effect on behalf of the Belfast and County Down Railway Co., except that he asked for the clause as to working agreements to be struck out of the bill altogether.

The CHAIRMAN then stated that the bill might proceed, but that the preamble would be subject to the consideration of clauses, including those asked for by the railway companies.

After considerable discussion upon clauses, it was decided to amend the bill in the following manner:—The Corporation should not have the power to enter into working agreements with or to supply electricity to any tramway undertakings not authorised at the passing of this Act. Further, clause 60 was amplified to the extent that the Corporation shall, after the end of the first 12 months' working, so arrange the fares to be charged upon the tramways that the receipts for the ensuing year shall cover the estimated expenditure. This clause is identical with the one already in the Aberdeen Corporation Act.

The preamble of the bill was then declared proved.

OTHER ELECTRICAL BILLS.

The *Great Northern and City Railway (Extension of Time) Bill* came before the unopposed Committee of the House of Lords on Tuesday and was reported for third reading. The bill has already passed through the House of Commons (see *The Electrician*, March 11, p. 832).

The *Shipley Urban District Council Bill*, which is proceeding as an unopposed measure, has been reported for third reading in the House of Lords. The bill is of an omnibus character and includes provisions for the extension of the area in which the Council may supply electrical energy so as to include Baildon.

In the *Corbridge Gas Bill* which was before the unopposed Committee of the House of Lords on Tuesday, and was reported to the House for third reading, clause 71 reads as follows:—"The company may, if they think fit, under the provisions of the Electric Lighting Acts of 1882 and 1888, make application for a provisional order for licence to supply electrical energy for public and private purposes, and may apply their funds for the purpose of such application."

The *Hampden Gas Bill* which has already passed the House of Commons unopposed has also been reported for third reading in the House of Lords. This bill contains the following clause:—"The company, if they think fit, may, under the provisions of the Electric Lighting Acts of 1882 and 1889, make application for a provisional order or orders to produce and supply electricity for public and private purposes, and may apply their funds for the purpose of such application."

In the House of Lords on Thursday last week the *Torquay Tramways Bill* was read a second time.

In the House of Commons on Friday last week, the *Tyneside Tramways and Tramroads Bill* was read a second time. On Monday the *Wolverhampton Corporation Bill* was read a second time and the *Preston, Chorley and Horwich Tramways Bill* a second time.

The *Plymouth Corporation Bill* was before the unopposed Committee of the House of Commons on Wednesday. The proposals in the bill are for the purpose of borrowing money to meet outstanding balances and an overdraft upon the bankers amounting to £190,000 which has been incurred in respect of the various undertakings of the Corporation. Before the Committee would pass the measure, however, it decided that the Tunbridge Wells audit clause should be inserted. This clause provides for a Local Government Board audit, and was inserted by the Committee after conference with the Local Government Board.

COOPER'S HILL COLLEGE.

In the House of Commons on Wednesday, Mr. BRODRICK, in reply to a question by Sir M. Bhownaggree, said that it had been decided to close Cooper's Hill College owing to the fact that efficient candidates for the Indian Public Works Department could be provided by other engineering colleges with less cost to both the department and the candidates. The ctual date of closing the college had not been fixed.

WEIGHTS AND MEASURES (METRIC SYSTEM) BILL.

A number of petitions from Scottish Parliamentary Burghs have been deposited in the House of Lords in favour of this Bill. The Select Committee which has the measure under consideration has arranged to resume its sittings early in May.

LARGE OIL-COOLED TRANSFORMERS.

On p. 138 of Vol. LII. of *The Electrician* appeared an article on oil-cooled transformers built by the Allgemeine Elektricitäts-Gesellschaft. Those transformers ranged in size from 1kw. to 50kw., and now the company is issuing a second pamphlet dealing with single-phase and three-phase current transformers ranging

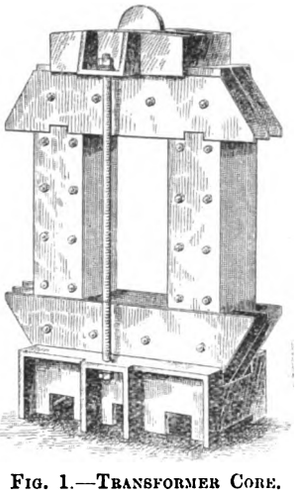

FIG. 1.—TRANSFORMER CORE.

from 50kw. to 500kw. in capacity. The general remarks with regard to the advantages of oil-cooling, the insulation and the construction in general, which were fully set forth in the former article, apply equally to the larger types. The core is built up of steel stampings in the manner indicated in Fig. 1, the bolts being insulated to prevent eddy-current losses. Well-ribbed pieces of cast iron of the form shown in the illustration are used for firmly clamping together the different parts of the core, the design being such that practically no eddy-currents are set up in them. In the smaller types the low-voltage winding, consisting of a cylindrical bobbin sub-divided into a number of coils, is generally placed next to the core, but in the larger sizes it lies generally on the outside. The radial distance between the high-tension and low-tension windings increases with the voltage. This space is filled in with insulating material. Conductors carrying currents in excess of 100 amperes are sub-divided. Additional cooling-surface is provided for the larger sizes of transformers (from

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about 150kw. upwards) by flat side tanks, which are connected at the bottom and top to the transformer shell by connections of ample size. The oil in these ribbed side tanks is more rapidly cooled than in the main tank, and, becoming consequently more dense, it sinks and sets up a continuous circulation of oil. Figs. 2 and 3 show the rise of temperature with the time. All connections are brought in through the lid. Strong porcelain insulators are used, and the lower part of them is made to dip into the oil

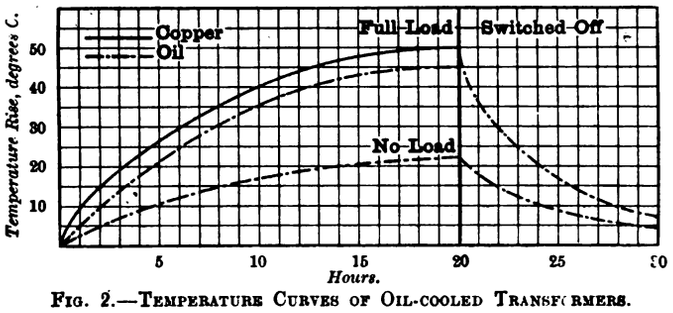

FIG. 2.—TEMPERATURE CURVES OF OIL-COOLED TRANSFORMERS.

when voltages higher than 10,000 volts are dealt with. Particulars of some two dozen standard patterns are given in the booklet. Standard voltages are: 10,000, 20,000 and 30,000 volts. The efficiencies at full-load and with power-factor unity are given as ranging from 96·3 per cent. for the smallest type designed for a pressure of

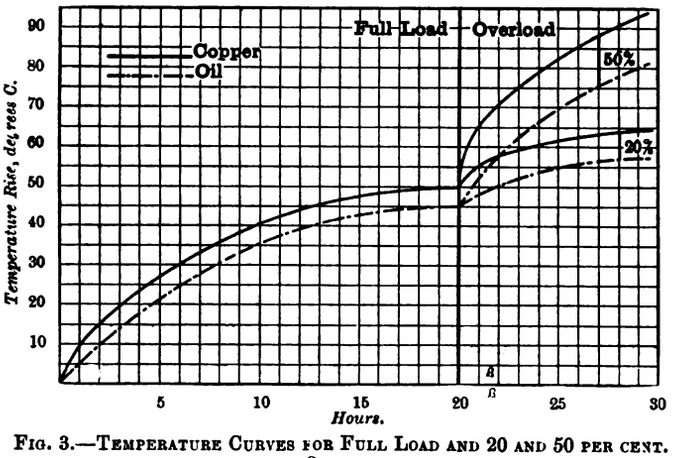

FIG. 3.—TEMPERATURE CURVES FOR FULL LOAD AND 20 AND 50 PER CENT. OVERLOAD.

30,000 volts up to 98·2 per cent. for the 500kw. size built for 10,000 volts. The foregoing figures are based on a frequency of 100 cycles per second and star connection, Both the drop in voltage and the no-load losses of these transformers are small. While the former vary between 1·7 and 0·95 per cent. the latter range from 1·8 to 0·9 per cent. only.

MANCHESTER CORPORATION TRAMWAYS.*

BY J. M. McELROY.

The Permanent Way.—When the lease of the lines to the tramways company was coming to an end, and the question of the introduction of mechanical traction was under consideration, the point was raised as to the suitability or otherwise of the existing rails for the new form of traction. A thorough examination of the whole of the track was made, and a report was presented to the Corporation showing clearly that not only were the rails too far worn, but the joints were not nearly strong enough for mechanical traction. The Corporation thereupon determined to reconstruct the permanent way of the entire system, and the work has been carried out by the tramway department's own staff. The new section of rail adopted for the work weighs 102lb. to the yard, and its general dimensions, compared with the old section, are as follows—viz.:—

	Old Section.	New Section.
Depth	7in.	7in.
Base	7in.	7in.
Tread	$1\frac{9}{16}$in.	2in.
Width of groove	$\frac{13}{16}$in.	$1\frac{3}{16}$in.
Depth of groove	$\frac{13}{16}$in.	$1\frac{1}{16}$in.
Guard	$\frac{9}{16}$in.	$\frac{5}{8}$in.

* Abstract of Paper read before the Manchester Local Section of the Institution of Electrical Engineers, February 16th.

The fishplates are 24in. long and $\frac{7}{8}$in. thick, and are pierced for the reception of six bolts. In our rail specification we call for the usual drop and tensile tests, and we require, as is necessary nowadays for mechanical traction, rails with a high percentage of carbon. We specify not less than 0·50 nor more than 0·65 per cent. For our curve track we use rails with a $1\frac{1}{4}$in. groove and a guard 1in. wide. On sharp curves the groove soon wears to $1\frac{1}{2}$in. and $1\frac{3}{4}$in. The wheel flanges wear away the guard of the rail very rapidly. The road-bed in most of our main thoroughfares is exceptionally good, and all that we found it necessary to do was to lay a concrete trench 18in. wide and 6in. deep under the rails, and this has proved quite satisfactory. We laid the rails direct on the concrete bed, and packed them well with chippings and cement packing, grouting the bed afterwards. The straight track rails are tied to gauge every 10ft. by tie-bars. On curves the tie-bars are placed closer. The paving between the rails and for the 18in. margins has—with one or two exceptions—been laid with 6in. Welsh granite setts. The paving has been grouted with pitch grouting. This grouting is undoubtedly the best if the work is carried out in fine weather, but in wet weather it is somewhat defective. Under the conditions, however, which prevailed in Manchester—where the traffic was allowed to run over the track almost immediately it was laid—cement grouting was quite out of the question The special track work for the junctions was obtained from America. When we began the reconstruction work the most difficult problem we had to face was how to re-lay the important junctions in the city without causing serious public inconvenience. To enable us to solve this problem the Americans came to our aid. An enterprising United States firm offered to send their engineer over here to take the surveys and make the necessary plans, and they undertook to supply the special track work for the junctions in such a condition that all we had to do was to fix the same in position in the streets. At the time I speak of no firm in this country were in a position to undertake this work, and consequently orders to the extent of £80,000 were placed by the Manchester Corporation in America. One or two British firms are now in a position to undertake this class of work, and we have placed some orders with them. The laying of all the important junctions in the city was done on Saturday nights and Sundays. The work at each junction was commenced at, say, 11:30 on Saturday night—after the last car had gone—and by six o'clock on Sunday evening the whole of the junction was laid and paved up. All the curves at the junctions and elsewhere are spiralised, thus ensuring easy running of the cars. The points and crossings are provided with hardened steel renewable centres. Each joint has been bonded by two copper bonds fixed *over* the fishplate and one copper bond *under* the fishplate—*i.e.*, between the fishplate and the web of the rail. The bonds are of the ordinary "Chicago" and "Crown" types.

The wear and tear of the rails, especially at the junctions, is very great. Our estimate of the average life of the track is 10 years. In arriving at this estimate we include all roads—those of light as well as those of heavy traffic. We have had some little trouble, in common with other towns, with the setts rising at the sides of the rails on a few routes. The remedy is to anchor the rails or to use a deeper rail. Personally, I favour the adoption of a 9in. rail. A rail of this depth could be embedded in concrete to the extent of 2in. to $2\frac{1}{2}$in., and this would prevent any "creeping" or movement of the rail, which is the cause of the setts lifting. The life of the rails is measured by the life of the joints. The fish-joint adopted in Manchester—where the rails are butted up close and no expansion joints allowed—is as satisfactory as a built-up joint can be made, but recently we have been looking into the question of so-called "continuous" rail joints. The advantages to be gained by the adoption of a satisfactory "continuous" rail joint are:—(1) It increases the life of the rails; (2) it decreases the wear and tear of the rolling stock, and (3) it gives a safer and more satisfactory rail return.

The Overhead Equipment.—The overhead equipment is almost entirely span-wire construction with side poles. Our experience is that, except for very wide roads, the span-wire system is the best.

The poles we have used for our span-wire construction are of mild steel built up in three sections. They are 31ft. long when complete. The dimensions of each pole are as follows—viz., the first section has an external diameter of $7\frac{5}{8}$in. and is 17ft. long, the thickness of metal being not less than 0·5in., and the weight per foot not less than $37\frac{1}{2}$lb. The second section has an external diameter of $6\frac{5}{8}$in., and is 9ft. 6in. long, the thickness of metal being not less than 0·45in., and the weight per foot not less than $30\frac{1}{2}$lb. The third section has an external diameter of $5\frac{9}{16}$in., and is 7ft. 6in. long, the thickness of metal being not less than 0·4in., and the weight per foot not less than 22lb. The sections are shrunk together while hot and under pressure. The smaller sections are inserted into the larger to the extent of 18in. Larger poles are used for feeder poles and for junction work. The usual deflection and drop tests are called for in our specifications. The trolley wire is of hard-drawn copper, 0·4in. in diameter. We specify that the weight per mile of wire must not vary more than 3 per cent. from 2,557lb. The wire

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must be supplied in 1-mile lengths, without joints or splices. The conductivity of the copper must not be less than 98 per cent. of Matthiessen's standard. The span-wire is galvanised steel stranded wire $\frac{7}{16}$ S.W.G. We have adopted triple insulation throughout the whole of our overhead construction—namely, an insulator bolt at each ear, with globe strains, and Brooklyn strains at each span-wire terminal. In consequence, we are well protected against leakage. The frogs are of the movable type—worked by the point boys. The section insulators are carefully anchored.

Guard wires are a source of trouble to us, but happily, the Corporation has recently come to an agreement with the National Telephone Co., and the result is that all telephone wires—except the Post Office wires—are being placed underground, and most of the guard wires will, therefore, in a short time, find their way to the scrap heap.

The Rolling Stock.—We have three types of cars at present in service. The first type is a double-deck single-truck car, seating 45 passengers and weighing, when empty, about 8 tons, and when fully loaded a little over 11 tons. The second type is a double-deck, double-truck car, seating 71 passengers, and weighing, when empty, slightly under 11 tons, and when fully loaded about 15¾ tons. The third type is a single-deck, double-truck car, seating 48 passengers, and weighing, when empty, slightly over 11 tons, and when fully loaded about 14½ tons. The first type—the small double-deck cars—we use on most routes for what we call our "all-day" services. The second type—the large double-deck cars commonly known as "bogie cars"—we use mainly for "part day" services—that is, the extra services we put on at the "rush hours." The third type—the single-deck cars—were obtained for use on the circular route on which the bridges are too low for double-deck cars. We have a wider rocker and a narrower waist panel than is usual. This gives the cars a neater appearance than they would otherwise have.

We have not adopted the reversed stairway. The roof is of the Monitor type. The inside roof is of bird's eye maple veneer, the inside framing of teak and the panels of sycamore. The bottom framing is of thoroughly seasoned English oak, the corner side pillars, window rails, &c., are of teak, and the external panels and mouldings are of mahogany. The car bodies are strongly built. We had an inspector practically living with them during the whole time they were under construction. The trucks for the small cars are of two well-known types—Brill and Peckham. The bogie trucks are of the maximum traction type. In some, we have the pony wheels leading. In others we have the driving wheels leading. We prefer the latter. When the pony wheels leads there is a tendency for the truck to leave the track at curves. We have had trouble with bogie cars coming off the track. One of the principal causes has been a defect in the points. When the pin at the heel of the points becomes loose, and the front bogie passes over it, there is a tendency for the toe of the point to be moved from its position before the hind bogie reaches it, and, if this occurs, the hind bogie the wrong track. We are, however, remedying this defect in the points by an apparatus which will hold the points at the toe. Generally speaking, our experience of maximum traction trucks—used as they are in a city with no severe gradients—is not at all unfavourable. The wheel base of our single trucks is 5ft. 6in. This is 6in. less than is usual in other towns. Our reason for adopting this length of wheel base is the shortness of the radii of some of our curves. The minimum radius is 35ft., measured from the track centre line. The wheel base of the bogie trucks is 4ft.

All the wheels we have used, until recently, have been chilled cast iron. During the past few months, however, we have been experimenting with steel-tyred wheels, and these have given very good results. We get a far greater mileage out of them, we get better "braking" effect and we get no "flats" on the wheels. The putting of "flats" in wheels in a large system like ours is a serious and annoying matter. They are, of course, in most cases, caused by careless motormen. Wheel "flats" are a great annoyance to the travelling public, and more particularly to the residents along the lines of route. The depth of the wheel flange is ½in., and the wheels are pressed on the axles so as to allow a ¼in. clearance over the track gauge. There is a clearance between the bottom of the wheel flange and the bottom of the rail groove, on new rails, of ⅝in., thus allowing the head of the rails to wear down to the extent of ⅝in. before the wheel flange touches the bottom of the groove. When the latter event happens we consider the rails require renewing. The car equipments are of two types—the British Thomson-Houston and the Dick-Kerr. We have 305 cars equipped with the former and 137 with the latter. Each small car is furnished with two 25 H.P. motors and each bogie car with two 35 H.P. motors. They are single reduction four-pole motors, enclosed in strong water and dust-proof steel frames. In our specifications we stipulate for the usual insulation and efficiency tests. We demand an efficiency of 82 per cent. The controllers are of the ordinary series-parallel type. The trolley standards are of the internal spring type, and are fixed 15in. from the longitudinal centre line of the car. The trolley heads are of the swivelling type and are provided with a spring which keeps the wheel in line with the boom. The panorama destination indicators we are now adopting for all our cars contain the names of 80 different routes, so that each car in the sheds may be turned on to any route. We adopted, at the commencement of our system, what is termed the "cow-catcher" life-guard, and the statistics show that it has been, on the whole, successful in its operation. In compliance, however, with the wishes of the Board of Trade we have discarded the "cow-catcher" in favour of the "swinging-gate" or "trigger" life-guard, which is now used on almost all the tramway systems in the country. In most instances where persons are knocked down and killed by cars the life-guard is not called into service at all, the persons being fatally injured, generally on the head, by being thrown on to the hard pavement. The best life-guard is a good brake. Our cars are equipped with the ordinary hand brakes and rheostatic brakes, which answer their purpose very well. On the Stockport route, where we have the worst gradient, we run cars equipped with the Westinghouse magnetic track brake. We are equipping 100 cars with "dry" seats of the thin lath type. This seems to be the best in the market, taking all points into consideration. The only way, however, to induce passengers to ride outside in wet and inclement weather is to cover the tops of the cars. We are fitting up some cars with top covers as an experiment. We have, however, several low bridges to contend with.

The following is an abstract of the discussion on the above Paper:—

Mr. COWAN (chairman) said he was interested in electric welding and would like to know if Mr. McElroy had had any trouble with expansion of the rails in hot weather?

Dr. RHODES said that with 1¼in. groove and 5ft. 6in. wheel base 36ft. radius was the least allowable, and yet Mr. McElroy stated that there were some only 35ft. How was this? The overhead construction was somewhat mixed in some places, and he doubted if triple insulation was always universal. A reversed stairway allowed a heavier load on the top deck but running was not so steady. Maximum traction trucks were suitable for Manchester, but in hilly districts four motor bogie trucks were the best. Guards of the "cow-catcher" type he considered unsatisfactory, as they often rose 6in. or 7in. from the track, and it was likely that a victim would be under the guard in many cases. The hanging-gate type favoured by the Board of Trade was certainly the most satisfactory. He strongly disapproved of wheel brakes and steel tyres. Some form of track brake should be adopted.

Mr. GILES (Blackburn) said that the explanation of the 35ft. radius was that Dr. Rhodes was thinking of 1¼in. groove when it was really 1⅜in. Grooves could be made wider still with advantage. He considered section insulators as strong as any other part of the line. He did not consider a wider rocker and narrower waist panels very great advantages. As for Mr. McElroy's dry seats of the lath type, he thought a snowstorm would change his mind about them.

Mr. ACHESON (Rochdale) thought that grooves must be wide for smooth working. He had found trailing frogs quite satisfactory. Section insulators were stronger than the rest of the line construction, in his opinion. He noticed that in Manchester they were anchored 6ft. apart and strained to the side poles. The Board of Trade regulations stipulated vertical anchorings to save trouble if the trolley came off. He thought it a mistake to do away with the hand-wheel, and challenged the statement that B.T.-H. motors were dust and dirt-proof.

Mr. TAITE (Salford) congratulated Manchester on the arrangement come to with the telephone company. Covered tops were the only remedy for outside accommodation.

Dr. BOWMAN said that the continuous rail did not suffer by expansion, because the rail being buried for the most part did not get hot, and there was no expansion.

Mr. MOORE (Manchester) was of the opinion that the single-section pole had many advantages. He had noticed that many section insulators were placed half-way up hill in Manchester; this was good for the Electricity committee, but bad for the tramways department. He recommended wattmeters on cars.

Mr. McELROY, in reply, said that the rails were buried, butted close, and there was no expansion. Curves of 35ft. radius had a check rail and 1in. groove; after wear this became 2in., and it was a pity they were not allowed to make it that size at first. The Board of Trade stipulated 1¼in. grooves, but rails were put down with 1½in. The question of life-guards was difficult; he thought people getting in front must be hurt, but their object was to hurt them as little as possible. Board of Trade regulations with regard to anchoring section insulators could only be regarded as suggestions, and the method adopted in Manchester was the most convenient. He thought centre poles were an obstruction. Current consumption per car-mile was for single-track cars 0·9 unit, and for double-track cars 1·4 units. "Thermit" welding was being used largely owing to its convenience. Electric welding was unwieldy and more suitable for new work. They had a very elaborate system of examination for the overhead construction to insure safety. In the city the sanitary department kept snow off the track, and the tramways department only ran salt waggons. For the suburbs there were seven snow ploughs.

Telephone Operators.—It is stated that the British Post Office Telegraph Department has under consideration the question of substituting female for male operators for working the telephone service at night when the time comes for the Department to take over the National Company's undertaking.

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LEGAL INTELLIGENCE.

Macartney, McElroy & Co. (Ltd.) v. Brighton Corporation.

This case came before Mr. Justice Grantham and a special jury last week in the High Court. Plaintiffs sought to recover an amount alleged to be due for work done and materials supplied by them as contractors to the Corporation for laying electric tramways in Brighton.

Mr. LUSH, K.C., in his opening for plaintiffs, said a contract was entered into between the parties on Jan. 15, 1901, for constructing permanent way and wood-paved carriage ways and crossings in connection with the first portion of the Brighton electric tramways for £101,515. 19s. 5d. The engineers under the contract were Mr. F. J. C. May (borough surveyor of Brighton) and Mr. T. B. Holliday, the electric tramways engineer to the Corporation. A portion of the work was the construction of the permanent way, including macadam margins between the tracks and the kerbs where no wood paving was laid, while another portion consisted of the laying of the wood-paved carriage ways on either side of the tracks where wood paving was to be laid. Under the first portion (A) plaintiffs claimed £1,316. 16s. 8d., and on the second (B) £14,625. 9s. 1d. The charges in (A) were made up of a mass of details relative to extras, and in (B) were for excavation, concrete and floating required to be executed by the plaintiffs as a foundation for wood paving, plaintiffs urging that these items were not included in the prices quoted in their tender, and that they were to be paid for as extras under the provisions of the specification. The defendant Corporation contended that all the matters were covered by the tender.

The jury having expressed the view that it was advisable that the portion under (A) should be referred to arbitration, it was agreed to leave this portion for the present.

Mr. LUSH said if he recovered £14,600 under (B) his clients would waive the other item rather than go to costly arbitration. Plaintiffs complained that defendants' engineers had refused to measure up work done on the engineers' instructions in carrying out the construction works, or to allow the plaintiffs' charges for work done on the instructions of the engineers after such work had been measured up by the engineers or their assistants. Further that the said engineers had wilfully certified that the works were completed on a date long subsequent to that at which they were in fact completed, had been passed by the Board of Trade and were actually opened to the public. An important point (urged Mr. Lush) was that defendants' engineers, in making out their certificates of the progress of the works, always allowed plaintiffs for excavating, concreting and floating until September, 1901, when they ceased to do so by direction of defendants. Up to September, 1901, defendants paid £21,000 to plaintiffs on the basis said to have been agreed upon between plaintiffs and the engineer, Mr. May—viz., that the excavating, concreting and floating were to be paid for separately. He submitted, with regard to the suggestion of delay on the part of plaintiffs in the execution of the work, that that was defendants' own fault. An important letter, written at a critical period of the relations between the parties, was missing, and he suggested that this had been destroyed.

Mr. J. A. McELROY gave detailed evidence in support of counsel's opening statement.

Mr. FLETCHER MOULTON, K.C. (for the Corporation) submitted that, as a matter of law, there had been nothing put forward that entitled plaintiffs to go beyond the legal interpretation of the written contract, and asked the judge's ruling to that effect.

Mr. Justice GRANTHAM said he considered the written contract bore plaintiffs' interpretation.

Mr. JOHN F. MACARTNEY then gave evidence.

Mr. F. H. CARTER, assistant tramways construction superintendent for plaintiffs, said he attended to the measurements and the invoices. A question arose between himself and the engineer's (Mr. May) assistants as to whether measurements of the excavating, &c., should be super or cubic measurements. They submitted that the measurement should be cubic, and said it would be impossible to measure it super because the ground was uneven and varied in depth. Witness agreed to that measurement, and from that time always measured up the excavation done under (B) by cubic measurement, and in the invoices set it out as cubic measurement. It was agreed that this system of measurement should apply to both (A) and (B).

The evidence of the superintendent engineer to plantiffs (Mr. J. F. Kerwin), who is abroad, was taken on commission and read.

Mr. FLETCHER MOULTON, for the Corporation, said the work under the contract required the superintendence of two officials, the tramways engineer and the borough surveyor, the former looking after the tramways and the latter after the roadways. He contended that when the Corporation asked for tenders the logical construction was that they wanted a price for all the work that was necessary to create the streets and a price for all the work that was necessary to create the tramways, and that the amounts of such tenders represented what the contractors were prepared to do all those necessary works for. Were plaintiffs to have the advantage of quoting a low figure, and so securing the contract through that low figure, and then to be allowed to charge large extra sums for excavating and concreting, essential parts of the work? That would be unfair, not only to the Corporation, but to other tenderers. He submitted the contract awarded to plaintiffs was for all work necessary to make the tramways and roadways, and that the parties were bound by the contract. The Works committee entered into the contract under the impression that £102,487. 14s. 5d., the total amount of the tender, was the amount plaintiffs were willing to do the whole of the work for. The granting of the certificates prior to September, 1901, as mentioned was due, he submitted, to a mistake on the part of Mr. May's subordinates. As soon as Mr. May discovered that mistake he stopped it. If people entered into a contract they were bound by it. It must be shown that both sides meant to enter into a different contract, and that their blunder was the same, before a contract could be rectified. It would be an absolute absurdity that Brighton Corporation, or any similar body, should dream of tendering for other than the whole of the work comprised in such a contract, and he urged that the contract was a contract to do for the sum named therein the work as specified, which described not only the wood blocks and putting them in place, but also the preparation of the concrete bed on which the blocks were put.

His LORDSHIP asked if the bills of quantities of the Corporation contained any reference to the preparation for laying the wood blocks.

Mr. MOULTON said the bills of quantities for (A) were taken out in detail and for (B) were an overall price per square yard. Both forms of tender were quite common. In (B) the whole of the work was included in the price per square yard.

His LORDSHIP said it was remarkable that he could find nowhere in the bills of quantities anything for the roadways outside the tramways. It was most unfortunate that the language used in the bills of quantities and the specification was most misleading, and they knew that plaintiffs were misled.

Mr. MOULTON: Then they were the only tenderers who took that view.

Ald. W. SENDALL, J.P., chairman of the committee, said the specifications for the tramway work were prepared by Mr. Holliday, and for the wood-paved carriage ways by Mr. May. The committee considered it imperative that both sections should be executed by one contractor. Plaintiffs' tender was the lowest, and was practically the same as the total of the surveyor's estimates for the work to be done. The committee had no idea they were accepting a tender for anything less than the whole of the work.

Judge GRANTHAM: You had before you, when you considered the tenders, the figures of the contractors and also the estimates of Messrs. May and Holliday. When you saw that plaintiffs' tender for the wood was £23,991 and that all the other tenders were from £7,000 to £10,000 more (representing 33 and 50 per cent.) did you ask Mr. May the meaning of it?

WITNESS replied that the committee did not do so. They added the two together, and finding they were practically the same as their own estimate, they accepted plaintiffs' tender. It was also not very much below the next tender. He admitted that an entry in the committee's minutes, dated July 12, 1901, "the undermentioned accounts were submitted, examined and referred to the Finance committee," and among these accounts were Messrs. Macartney, McElroy & Co.'s first instalment on account of their contract under (B). They left the examination of the accounts for the preparation of the certificates to Mr. May, and they acted entirely upon his advice in the matter.

The FOREMAN OF THE JURY: Is there a sub-committee of the Works committee?—Yes, and the members of this sub-committee go through the bills a quarter of an hour before the meeting.

By Mr. LUSH: Looking at the plaintiffs' tender, is it not manifest that the persons who signed that tender were tendering only for the wood?—That may have been their construction. It certainly was not our view at any time until our attention was directed to the matter latter. Then the fact that our responsible officers who had prepared the specification were of a contrary opinion to Mr. McElroy, and the fact that nine of the 10 contractors read it in the same light as did our own officers, guided us in our decision.

Mr. Justice GRANTHAM: But you have admitted that you thought the 13s. 9d. (a figure quoted) was only for the wood. Do you still say you think plantiffs should not be paid because you relied upon Mr. May, who knew a mistake had been made and did not tell you of it?—The matter had been decided. He agreed that if the specification did not demand the making of the concrete bed, then plaintiffs out to be paid.

Councillor E. A. SMITHERS corroborated Ald. Sendall, and said the committee accepted plaintiffs' tender as an inclusive one. Individual members of the committee did not look into the tenders.

Ald. W. BOTTING, J.P., supported the evidence given by the two previous witnesses.

Mr. F. J. C. MAY, borough surveyor, said he drew up a number of plans and sections and reported to the Corporation in 1900 upon the tramway scheme and the wood paving of the outside margins of the roads. The margins, consisting of a strip of wood paving 18in. on each side of the tramway track, belonged to the tramways, and the outside margins were between that and the kerb, and belonged to his department. In August, 1900, he prepared an estimate, on the same area that he afterwards put in the specification, for the construction of wood-paved 'carriage-ways in a number of streets through which the trams were to run. It amounted to £35,701. 1s. 8d. He quoted 17s. 10d. as an inclusive price for excavating, concreting, floating, and for hard wood blocks. He prepared a specification and bills of quantities and submitted them to the Works committee in Nov., 1900, and on the same day Mr. Holliday presented his specification, &c., relative to the tramway tracks, and witness afterwards incorporated the two in the document on which the tenders were afterwards made. As far as his experience went, it had been the invariable practice to give an inclusive price per square yard in estimating for wood paving a road. It was easy to tender in that way. The area of the wood paving was given as 38,732yd., the depths were stated, and all that was necessary to enable a person to estimate was that the superficial area of the wood paving should be measured by the 15in. depth of excavation, the 5in. for the concrete, and the 1in. for the floating, the super. area being exactly the same in each case. If the excavation proved to exceed the 15in. allowed, it was added to the contract price; if less, it was deducted from it. It had always been his practice, in order to allow for contingencies, to specify a greater depth than what was likely to be the actual. He had carried out several contracts for Brighton on precisely the same terms,

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He was present when the tenders were opened, and remembered there were remarks made as to the great difference between some of the tenders. He thought the total of plaintiffs' tender was a fair price for the work. He believed he subsequently read the whole of the totals of the other tenders to Mr. McElroy. Mr. McElroy said his firm were very anxious to have this Brighton contract. He had no interest whatever, either in keeping the contract in plaintiffs' hands or in taking it away. In none of the interviews with Mr. McElroy did he agree to his suggestion that the specification only applied to the wood blocks, or that the specification could mean that it was only the wood blocks that were included in the price quoted.

Mr. F. J. TILLSTONE (town clerk of Brighton) said he did not know there was any difference of opinion about the contract until Mr. Macartney called upon him. He had considered the contract with a view to ascertaining its true construction, and came to the conclusion that the real meaning of the contract was that the contractors were not to be paid for the excavating, concreting, and floating, and he accordingly advised the Council that the contract was an inclusive one. He had not been consulted in the construction of these contracts. He did not know that Mr. May altered the form of tender for (B) by striking out part of it before submitting it to Mr. Macartney. He certainly did not know that Mr. McElroy had told Mr. May that the tender was not an inclusive one.

Mr. MAY, recalled, explained his mode of certifying, and said that in certifying he invariably set out the total amount of the contract and the balance. When he found that, owing to an error on the part of his assistant (Mr. R. Smith) a larger amount had been certified for than was due to the contractors, he communicated with Mr. Macartney, and only agreed to sign the next certificate on that gentleman giving him a pledge to complete the work. Mr. Macartney said he saw the difficulty he (witness) was in, but urged that he should raise the question as to the meaning of the contract. He (witness) was astounded, and told Mr. Macartney he had never heard of any question of difference as to the interpretation of the specification. If Mr. McElroy had given him the least inkling that they construed the specification differently from what it was intended by witness to be construed, he should have reported this to the town clerk in order that it might have been brought to the notice of the Works committee.

Mr. Justice GRANTHAM, addressing counsel, said: I think I ought to call your attention to a matter I think neither of you appear to have noticed. I asked some time ago for the original agreement prepared for this contract. My object was to see whether it was prepared by a solicitor. I found it was not. I looked at it to see what it was, and I found it was altered in a very remarkable way. The original draft runs thus: "And it is hereby agreed that the price per super. yard of any work which shall be paved with red gum shall be at so much per yard super." These words are struck out, and the following is inserted: "And it is hereby agreed that the price for providing and laying red gum wood of the description affixed." It looks to me as if the words were struck out intentionally, to show that they were only intended to supply the wood.

Mr. LUSH (to Witness): Why did you strike out that clause?—Because I did not think it was necessary. I do not think it was misleading to strike it out because the tenderers did not see it.

The jury at this point intimated that they were agreed as to the question of fact. They were of opinion that the contractor under the tender was only to provide for the wood blocks and not for the excavation, concreting, and floating, and that both parties signed the contract on the assumption that the tender was for the wood only, and that plaintiffs were to be paid for excavating, concreting, and floating.

Up to this point the case had lasted up to Wednesday. Yesterday (Thursday) Mr. Fletcher Moulton first addressed the jury, and was followed by Mr. Lush, who, in reviewing the evidence, said corporations were protected by the fact that they could only contract under seal. Whether or no Mr. Moulton's argument as to the absence of a seal would protect them against the consequences anybody else would be exposed to was a question of law, but the only questions that need trouble the jury in this particular case were questions of fact. He asked them to say that the Works committee agreed to pay 12s. 7d. per yard super. for the wood, and nothing more. He did not think the Works committee were to be let off so lightly as Mr. Moulton thought, because their minutes showed that invoices, in which plaintiffs claimed the right to be paid for excavating, &c., independently of the price quoted for the wood, were examined and approved, and the minutes of the Finance committee stated that those accounts had been approved by the Works committee He had asked members of the Works committee if they understood that 12s. 7d. should only cover the cost of supplying the wood and laying it, and they said "Yes." He was told Mr. Buckwell, a member of the committee, said that morning that when they passed the resolution of Jan. 4 the cost of the wood was understood to be 12s. 7d.

Mr. Justice GRANTHAM said it was clear that Mr. R. Smith (Mr. May's assistant) agreed, on behalf of Mr. May, that the figure for excavations, &c., should be 7s. 1½d. He quite agreed with Mr. Moulton as to the legal aspect of the case. It was a serious question as to the meaning of the contract. If the Corporation had been in the habit of employing a solicitor he would not have allowed them to enter into such a contract. They trusted their borough surveyor, and when the question arose he should have gone to them and asked for instructions. It was for the jury to say whether this version was correct or not. He did not agree with Mr. Moulton that it was a lump contract. The lump sum was simply arrived at by adding the figures together. Mr. May knew the cost of the wood was practically 13s. 9d., and defendants must have had a fairly good idea beforehand. He did not like to use a hard term, but if, knowing that, they tried to force Mr. McElroy into a contract for which he had made no provision (that is, if they knew he was only tendering for the wood, and they thought they would make him do the other work for the same figure), it required rather a nasty word to describe their action.

In answer to questions put by his Lordship, the jury found that both plaintiffs and defendants believed the contract price for wood only was 12s. 7d., that they had acted throughout on the basis that it was so, that defendants had paid plaintiffs £9,281. 2s. 1d. for excavating, concreting and floating under contract (B) (this being in addition to the price of the wood), that it was not practicable to estimate the amount of excavation under (B) from the materials given in the form of tender and plans, that defendants left to Mr. May the authority to act for them in carrying the contract into effect and that he did so act, and that the price plaintiffs were entitled to for excavating, concreting and floating was 7s. 1½d. per yard.

His LORDSHIP said he hoped to arrange an early day for considering the questions of law. The matter is to be mentioned to-day (Friday).

Maxwell v. British Thomson-Houston Co. and Others.

In the King's Bench Division on Saturday Mr. Justice Kennedy further considered this matter.

Mr. ROSKILL, K.C., said the case came up again in connection with third party procedure by the defendants, the British Thomson-Houston Co., against their sub-contractors, R. W. Blackwell & Co. (Ltd.) The action was originally tried before his lordship at Leeds in 1901 (see *The Electrician*, March 29, 1901, and Feb. 7, 1902). Plaintiff (Miss Maxwell) was travelling in June, 1899, on the outside of a horse-drawn tramcar while the tramways were being reconstructed for electric traction, and some workmen working on a high platform fixing the overhead service allowed an iron rod to project. This caught plaintiff and severely injured her. The B.T.-H. Co. were held liable to pay £850 damages and costs, and the company went to the Court of Appeal, which upheld the verdict. The company, having brought in Messrs. Blackwell as third parties, now claimed that they, as sub-contractors, were liable to indemnify them.

Mr. SCOTT FOX, K.C., for Messrs. Blackwell, stated that his lordship and the Court of Appeal held that, though the Corporation and their contractors had got his clients to do the work, it was their business to see that sufficient precautions were taken against injury to the public, and that they having that obligation on them had not fulfilled it. Now they said that under the contract with the sub-contractors his clients were liable to indemnify them for the damages and costs awarded to plaintiff. The appellants had to show a contract for indemnity. And even if that was proved his clients would only be liable for the damages and costs of the first trial, because they refused to have anything to do with the appeal which was a luxury the Thomson-Houston Company insisted upon in the hope of getting rid of their liability.

After discussion as to whether the indemnity clause in the contract covered all risks or was limited to accidents arising from faulty construction and bad material,

His LORDSHIP held that Messrs. Blackwell were responsible for the damages and costs awarded to plaintiff, but not for the costs of the appeal.

Stay of execution was granted.

Downer v. Clarke.

At Watford County Court last week plaintiff sought to recover £90. 0s. 6d. from Mr. R. Clarke, engineer, for electric wiring work at St. Pancras Receiving Homes.

For plaintiff, Mr. M. A. ROBERTSON stated that a Mr. Gray Hill had the contract for the work, and he sub-contracted with defendant for part of the work. Mr. Clarke sub-contracted with plaintiff for the wiring of the building. All the work had been carried out in substantial and workmanlike manner. There were certain deviations from the specification because it was found impossible to carry it out, seeing that the work had to be done in accordance with the rules of the St. Pancras electric lighting department. The mains leading from the gates to the building were not laid, as the St. Pancras authority desired to, and they did actually, carry out the work. If plaintiff had fulfilled the requirements of the first clause of the specification he submitted he was entitled to payment for it.

PLAINTIFF said he agreed to do the electric wiring for £108, in accordance with a specification, and received an order to do the work, which he had carried out. If the work was carried out according to the first part of the specification, the latter part was useless, as it was not in accordance with the rules of the St. Pancras authority, who preferred to run service mains from their mains in the street right into the building which was to be lighted. He consequently allowed them to do it, and would now have to pay for it. Witness was directly under the architect, but the contract was between himself and defendant. Defendant raised no objection until the account was overdue.

Mr. A. E. PRIDMORE, architect for the work, said he was satisfied the work had been properly done. The clerk of the works was also satisfied with it.

Mr. AULAGNIER stated that he inspected the wiring on behalf of a fire insurance company, and found it satisfactory.

DEFENDANT said he had a sub-contract on the work in question, and no variation had to be made without the architect's written order. The steel conduit tubes, wood troughs and asphalt, the four junction boxes with water-tight covers and the main cables themselves had not been supplied by plaintiff. The main switchboard had also not been supplied, and a portion of the wires in the building were not in steel conduit tubes, but in wood casing. The cost of laying the main cable was about 5s. per foot, and that had been charged to St. Pancras Guardians. The specification intended that the cables should be laid so that the wires could have been drawn out if necessary and fresh ones put in. That, however, had not been done. The Guardians had had an electric pump put in the building, and he believed that the present mains were put in from that, and Mr. Downer had simply tapped it. Plaintiff applied for payment, and witness told him that he had not had certificates for the work, but

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paid him £25. The amount paid into court (£50), together with what had been paid to plaintiff, was sufficient for the work which had been done.

Mr. C. J. FERGUSON, electric light and telephone engineer, stated that he had inspected the work. On the main cable there were no inspection boxes, and it was, therefore, not in accordance with specification. Some of the wires were placed in wood casing, which should have been condemned by the insurance office. The switches were of inferior quality, and the main switchboard was not there at all.

His HONOUR gave judgment for defendant, with costs from time of payment into court. The £50 was ordered to be paid out to plaintiff.

Forman v. Moffat Town Council.

Sheriff-substitute Campion recently heard an action by Mr. W. J. G. Forman, C.E., against defendants for £78. 15s. for work done in preparing a scheme for the electric lighting of Moffat, and gave judgment for plaintiff for £37, but as this sum had been tendered by defendants, plaintiff had to pay costs.

Sheriff-principal Fleming heard last week an appeal by plaintiff against this decision, which his Lordship confirmed.

MARYLEBONE ELECTRIC LIGHTING.

At the meeting of the Borough Council last evening the report of the delegates appointed to negotiate with the Metropolitan Electric Supply Co. with the view to an arrangement between the two bodies as to future working of the electricity undertaking in Marylebone was presented. This report set out chronologically the steps taken with a view to a compromise, and shows that (supplementing the proposals made by the company, set out in *The Electrician* for Feb. 5, p. 622, and which were rejected by the Council), the company, in a letter dated April 19, 1904, made the following alternative offers to the Council:—

1. For the supply of current in bulk.
2. For a lease of the Marylebone undertaking.

Supply of Current in Bulk.—In consideration of the Council taking from the company the whole of the current required in the borough the company are prepared to accept ¾d. per unit for the quantity supplied in excess of that represented by two hours' average daily supply during each quarter of the maximum demand made upon the company in the quarter, the said two hours' average daily supply being charged at 3d. per unit; the average price of the whole of the current supplied in any one year not to exceed 1·70d. per unit.

The supply to be given for a period of 27 years from Jan. 1, 1905, with the right to either party of claiming a revision of price at the end of 9 and 18 years, the revised price to be settled, failing agreement, by arbitration in the manner provided in the agreement of May 8, 1901.

As part of this arrangement the company will be prepared, if required, to provide and fit up in any sub-station to be erected by the Council in St. John's Wood or in the existing generating stations at Manchester-square or Rathbone-place (if the Council remove the steam plant and adapt those stations for transforming purposes), such motor-generators as the Council may require, together with all necessary switchgear, balancers, starting machines, cable connections, and travellers, for the sum of £7. 10s. per kilowatt. In this way, the contemplated outlay by the Council of from £280,000 to £300,000 on a 9,000kw. generating station, with the necessary machinery and trunk mains, would be reduced to £41,000 for all the additions necessary to bring up the capacity of the existing transforming plant in the borough to 9,000kw., subject only to the cost of altering the present buildings. . . . If desired, the directors will have plans prepared, and name an inclusive sum for which they will undertake to alter as well as equip these two stations, in which sum will also be included, if the Council wish it, the cost of erecting a sub-station in St. John's Wood on a site to be provided by the Council.

Lease of the Marylebone Undertaking.—As an alternative to the offer of a bulk supply, the directors are prepared to accept a lease for the same period of 27 years, on terms which will relieve the Council of all charges for interest and sinking fund (except in respect of costs) which will devolve upon them during the currency of the lease under the pending bill as amended in Committee of the House of Commons, subject to the company having power at any time to terminate the lease on two years' notice in the event of another order being granted and confirmed by Parliament. These charges the directors understand to be—

1. Interest, at a rate to be agreed, on £1,212,000 payable under the award, and on capital expenditure in 1902, 1903 and 1904, estimated at £150,000.
2. Sinking fund on a 3 per cent. basis in respect of the above-mentioned sums, repayable in 35 years from January 1, 1908.

The directors are strongly of opinion that the costs of the arbitration should not be capitalised, and that each party should bear its own costs. They are, therefore, prepared to return to the Council the amount which has been paid to them under taxation.

The company would also provide all the capital required for the business in Marylebone during the lease, subject to repayment on its termination, less 1½ per cent. per annum from the several dates of expenditure. As bearing upon the question of depreciation, it must be borne in mind that the plant which depreciates most—the steam generating plant—is outside the area, and will be maintained at the sole expense of the company.

On this proposal Mr. Arthur Wright and Messrs. Price, Waterhouse & Co. were

Unanimously of opinion that the terms of the offer of a bulk supply of current by the company are in no way likely to commend themselves to the Council, nor would the proposed lease be acceptable unless the company withdrew the following conditions:—(1) The power at any time to terminate the lease on two years' notice in the event of another order being granted and confirmed by Parliament; (2) the company's objection to the costs of the arbitration being capitalised.

A further letter was sent to the company asking whether it was absolutely the company's final decision to insist upon a terminable lease and upon the non-capitalisation of the costs of the arbitration.

The directors regret they are unable to alter their views on the two points mentioned. They believe that the condition with regard to competition is as much in the interests of the borough as of the company. It is extremely unlikely that any attempt will be made to establish competition, but if it were the company would be better able to protect the property of the Council if the Council had an immediate instead of only a deferred pecuniary interest in the matter, which interest, it may be pointed out, would extend also to the additional capital expended on the undertaking by us during its currency, less only the agreed rate of depreciation. As regards costs, their capitalisation would add nothing to the earning power of the undertaking, and the directors consider that they should be dealt with in such a manner as not to throw any burden upon future earnings.

As there thus appeared to the delegates to be no further possibility of compromise, the Electric Supply committee, in their report to the Council, state that, after careful consideration, they recommend:—

That the Council resolve that the proposals of the Metropolitan Electric Supply Co., contained in their letter of April 19, be not accepted, and that the company be informed accordingly; and that the Council order the Electric Supply committee to proceed with as little delay as possible to have the necessary plans and specifications prepared to carry out the Council's resolution of March 12, 1903, as follows:—"Resolved that the Council be recommended to authorise the expenditure during the next two years of £400,000, exclusive of the cost of site, for the purpose of erecting a generating station and purchasing the necessary plant and machinery, and for the finishing of the conversion to a continuous-current supply of the districts not yet completed by the Metropolitan Electric Supply Co. (Ltd.), provided that the sum can be raised by loan."

The Chairman of the Electric Supply committee (Mr. E. R. DEBENHAM) now moved the adoption of this recommendation. They had (he said) given the matter careful consideration, had had the best possible advice, and had come to the conclusion that the acceptance of the company's offer was not possible, as it would practically mean a loss of something like £36,000 in all per annum to the ratepayers. Under Mr. Wright's scheme, if the work could be commenced at once, it was hoped that they would be in a position to supply all the current required by Oct. 1, 1905. There was no reason why the Council should not carry out the scheme.

Councillor E. R. ELGOOD supported, as did also Sir T. Brooke Hitching, and Councillors Cornwallis West, Sands, Straus, Lea-Smith, J. Lewis, Dr. Fletcher Little and Anglim.

Ald. WHITE opposed the recommendation, and suggested the acceptance of the company's second alternative.

After a long discussion the Committee's recommendation was adopted by 49 to 1.

The Electric Supply committee further reported that application would be made to Mr. Justice Buckley in the High Court to-day (Friday) for a further extension of time for the completion of the purchase by the Council of the Metropolitan Electric Supply Co.'s Marylebone undertaking.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An experienced electrical draughtsman, accustomed to continuous and alternating work and designing large switchboards, and able to superintend installation work, is required by Messrs. Henry Lea & Son, 37, Bennetts-hill, Birmingham. See advertisement.

Aldershot Urban District Council require an assistant electrical engineer at a commencing salary of £80 per annum. Applications to the clerk (Mr. W. E. Foster) by May 2. See advertisement.

Poplar (London) Borough Council require a clerk accustomed to keep costs accounts in a public electricity undertaking and with experience in analysing wages and stores. Applications to town clerk (Mr. Leonard Potts), Council offices, High-street, Poplar, London, E., by noon May 6. See also advertisement.

Derby Corporation Tramways committee require a chief motor instructor and car shed superintendent. Salary £2. 10s. per week. Applications to the town clerk (Mr. G. Trevelyan Lee), Tennant-street, Derby, by 17th inst. See also advertisement.

An estimating and corresponding clerk is wanted with special knowledge of telegraph and telephone installations, insulator work and overhead power lines. See advertisement.

Exeter Council require a shift engineer for their electricity station. Applications to town clerk (Mr. Geo. R. Shorto) by May 4.

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An assistant lecturer and demonstrator in engineering is required at Merchant Venturers' Technical College, Bristol. Salary £170, which may rise to £220. Applications to Registrar by April 30.

Mr. S. E. Britton, A.M.I.C.E., the burgh electrical engineer at Motherwell, N.B., has been appointed borough electrical engineer at Chester, in succession to Mr. F. Thursfield. In addition to the names given in our last issue, Mr. A. Dimmack, the chief assistant at Chester, was included in the short list of those from whom the final selection was made.

Mr. Britton served his apprenticeship with Messrs. Crompton & Co.; in 1895 he entered upon an engagement with the Southampton Electric Light and Power Co; in 1899 he was appointed resident engineer at Barking; and since December, 1900, he has been burgh electrical engineer at Motherwell.

Mr. W. Evans, an inspector of Halifax Corporation tramways, has been appointed traffic superintendent to Leicester Corporation tramways department.

Preston Tramways committee recommend the Corporation to appoint Mr. J. F. Simpson of Blackpool chief assistant engineer and manager of the department.

West Ham Corporation have appointed the chief assistant, Mr. Eustace, mains superintendent.

Mr. F. W. Courtenay Clark, late manager of the River Plate Electricity Co., has been appointed assistant manager and accountant to La Capital Tramways Co., Buenos Ayres.

Mr. John W. Hame of Wigan has been appointed by York City Council as chief assistant electrical engineer.

Adelaide (South Australia).—The Municipal Council have resolved that "in view of the dissatisfaction with the present tramway system, the Government should purchase the lines with a view to their electrification and ultimate municipalisation."

Amsterdam.—The conversion of the tramlines from horse to electric traction, which has been a work of great difficulty owing to the peculiar lay-out of the city and its numerous canals and bridges and the narrow streets in the ancient parts of the town, is nearly completed, and the electricity supply works are now in full operation. The conversion of the tramways has greatly increased the receipts. £750,000 has been expended on these lines up to the present, and traffic receipts are estimated at about £170,000 for the past year.

Argentina.—The Grand National Tramway Co. have commenced reconstructing their track for electric traction.

Juan A. Rossi has obtained a concession for electricity supply at La Rioja.

Agar, Cross & Co. are to construct electricity works at Rio IV.

The proposal by the Mayor of Buenos Ayres for the erection of large municipal electricity works has been reported upon unfavourably by the Finance and Public Works committees who consider that it would be more satisfactory to arrange for public and private lighting either by the Compañia Alemana Transatlantica de Electricidad or by a contractor to be decided upon by open tender.

Argentina.—An American syndicate, represented locally by Mr. Hugo Gruning, propose to construct electric tramways in Rosario to connect all the railway stations by way of thoroughfares not yet provided with tramways. There is also a project on foot for connecting the camp towns in the province by electric tramways.

Barnet.—The North Metropolitan Electric Power Supply Co. have consented to the Council having power to take over their second provisional electric lighting order at the expiration of 14 instead of 21 years.

Bispham.—The Council have appointed a committee to consider the question of electricity supply.

Blackpool.—The accounts of the tramways department for the year ended March 31 show total expenditure £270,000. Revenue was £42,000, and after paying expenses, sinking fund and interest the net profit was £56.

Bridlington.—The Council are recommended to lay electric lighting cables in 18 additional thoroughfares at an estimated cost of about £1,200.

Croydon.—The Corporation have decided to include in next year's omnibus bill further powers for electricity supply, including authority to wire consumers' premises, and to supply electric motors and fittings on hire, &c.; also to supply electricity in bulk or otherwise to any person or authority outside the borough boundary.

At the last meeting of the Council, some extensions of the electric lighting mains were authorised, and it was also decided to employ Nernst lamps in place of the present electric incandescent lighting in two thoroughfares.

Deptford (London).—The Council are to invite tenders from six firms for wiring and plain fittings for the new Town Hall and municipal buildings. The consulting engineers (Messrs. Medhurst and Lloyd) estimate the cost at £710. The draft general conditions, drawings and specifications for (1) the provision of steam dynamos and booster, (2) alteration to battery, (3) switchboard and connections and (4) steam piping has been submitted, but consideration of same has been postponed. Messrs. Medhurst and Lloyd have received instructions to prepare a specification for the provision of internal telephones.

Dundee.—The Electrical committee considered on Monday a proposal to increase the salary of the borough electrical engineer (Mr. H. Richardson). It was proposed that, in view of the likelihood of Mr. Richardson being appointed to a similar position at Chester, an addition of £100 be given.

Bailie Machon and Mr. Speed deprecated any addition, but it was stated that, owing to the present transition stage of the works in connection with the re-laying of the street mains, it would be false economy to run any risk of a change in the engineership. Ultimately, and after a division, it was decided to submit to the Council a unanimous recommendation to sanction the increase.

The Tramways committee have instructed the clerk to defend an action brought by a dairyman named Cumming for £50 damages, who alleges that, "while driving his horse and milk-van along Overgate, the animal suddenly collapsed, throwing him out, overturning the milk cans and injuring the horse, and that the accident was due to an escape of electric current from a defective main."

On Monday the Tramways committee considered the report by Mr. Richardson on the proposals to utilise the head of water at Lintrathen for generating electric energy.

Mr. Richardson reported he had gone carefully into several different schemes, and the only three which really merited detailed attention were the following:—*Scheme 1.*—Tapping the River Isla above Reckie Linn and running a flume or canal to below the Slug of Auchrennie. Of the three schemes, this gave the least power, and could be helped by the overflow from Lintrathen. *Scheme 2.*—Running a canal, tunnel or flume from above the Reckie Linn and rejoining the Isla. This would give a very heavy fall and more power than scheme 1. *Scheme 3.*—Tapping the River Isla at the Kirkton of Glenisla and running a canal or flume to a point below dyke ends on the River Melgum, running into Loch Lintrathen and increasing the storage power of that loch and then discharging therefrom to a low-lying point on the River Isla. This would give the greatest power of the three schemes. No. 1 was the cheapest, but gave rather too little power and would require considerable storage. No. 2 involved a capital cost in excavating and tunnelling that would be out of all proportion to the advantages. No. 3 would give plenty of power, but the cost of earthworks, together with the cost of greatly increasing the storage power of Lintrathen to an extent which would take full advantage of the water supply, involved an expenditure which he thought was prohibitive.

In the course of the discussion it was stated that to generate electrical energy on anything like an adequate scale would involve an expenditure of not less than £120,000. At much lower cost, it was said, current could be generated.

The committee resolved to postpone consideration of the project.

Ealing.—The Council have received sanction to borrow £25,000 for electrical purposes, £19,576 for 23 years and the remainder (£5,424) for 30 years.

The Council have decided to apply for sanction to a further loan of £20,000, about £10,000 for a new steam alternator and condensing plant, and the remainder for extensions of the mains, &c.

Electrical Fitters for the Navy.—A number of additional electrical fitters are about to be entered in the electrical engineers' department at Devonport to fill vacancies, &c.

Electricity in Australian Collieries.—The G. Weymouth Proprietary (Ltd.) are supplying the Jumbunna Coal Co., Gippsland, Victoria, with a 160 H.P. three-phase generator coupled to Belliss engine for winding, pumping and lighting.

Exeter.—Plans and specifications for the projected electric tramways have been submitted by the city electrical engineer (Mr. H. D. Munro) to the Tramways committee, who will recommend the Council to invite tenders.

Farnworth.—For the year ended March, 1904, the receipts of the electric tramways were £7,485. 17s. 10d. for 242,524 miles run, or 7·4d. per car-mile. 1,532,293 passengers were carried at an average fare of 1·17d. The current consumed per car-mile was 1·30 units. Working expenses were £4,849. 13s. 3d., interest £1,841. 10s. 5d., sinking fund £1,174. 19s. 5d., and rent of Kearsley track £1,400—total expenditure £9,266. 3s. 1d. (equal to 9·17d. per car-mile), and £1,780. 5s. 3d. in excess of receipts. Repairs and maintenance cost £682. 14s. 9d. (0·70d. per car-mile), the chief item under this head being rolling stock £528. 9s. 11d. Current (charged at ½d. per unit to relieve undertaking of loss occasioned by bad weather and poorness of trade) is represented by £660. 13s. 7d. (0·65d. per car-mile), wages £2,260. 9s. 9d., and various materials, &c., £100. 11s. 4d., bringing the total traffic expenses to £2,361. 1s. 1d. (2·19d. per car-mile), from which has been deducted £146. 17s. received for advertising. Cleaning and overhauling cars cost £677. 18s. 7d. (0·69d. per car-mile), management, legal expenses, &c., £193. 10s. 4d. (0·19d.), insurance and general establishment charges £151. 12s. 1d. (0·15d.), rents, rates and taxes £268. 19s. 10d. (0·26d.) The tramways capital expenditure stands at £43,695. 12s. 1d. The Council's lines will eventually be connected to those of Salford Corporation and the South Lancashire Company.

The total capital expenditure of the electricity department is now £36,064. 5s. 5d. The receipts for the past year included

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£2,149. 19s. 7d. from private consumers for lighting and motive power (253,905 units), public lamps £726. 5s. (49,794 units), tramways £675. 13s. 10d. (324,333 units), motor hire £204. 3s. 10d., meter rent and sundry receipts £258. 8s. 11d.—a total (less £218. 15s. 5d. receipts on capital account) of £3,795. 15s. 9d., showing a surplus of £31. 18s. 6d. after deduction of expenses (£3,763. 17s. 3d.). The lamps connected are equivalent to 7,787 8 c.p., motors 10,360, and radiators 198, compared with 5,148, 6,797 and 99 respectively at close of previous year.

Finchley.—The electrical exhibition organised by the Council was opened on the 20th and closed yesterday (Thursday). There was a good number of exhibitors of electric light fittings, motors, lamps, &c.

Fireproofing Wood.—The German timber journals contain particulars of a new process of fireproofing wood, the invention of Herr Gautsch, of Munich. Under this process timber is placed in a vacuum whereby the cells are freed of air, and the wood is then impregnated under pressure with a solution of sulphate of ammonia and borax ammonia. The process is said to render timber fireproof and proof against decay.

Folkestone.—Mr. C. H. Merz has reported favourably on the adoption of the overhead system for the proposed electric tramways if Lord Radnor's objection to overhead wires can be overcome. As an alternative he advises the "G.B." surface contact system.

Forthcoming Books.—Messrs. Harper & Bros. have nearly ready a work dealing with the "Theory of Starters and Regulators for Electric Machines," by Rudolph Krause, translated by Messrs. Kinzsbrunner and West.

Gillingham (Kent).—At present there are 169 consumers, representing a total of over 10,000 8 c.p. lamps, connected. The Electric Lighting committee have requested the resident engineer (Mr. A. D. Chalmers) to erect various electric light standards and to make some experiments with Nernst lamps. The engineer has been instructed to carry out, where practicable, all new works himself, buying materials direct from manufacturers.

Grays.—During the past year the receipts from private consumers of the electricity department were £1,681 and from street lighting £923, a total of £2,604. Working expenses were £1.518, and interest and sinking fund charges £1,159, leaving a deficit of £73. There are 221 street lamps. The chief engineer (Mr. E. D. Long) who advises early consideration of the question of extensions, estimates there will be a profit of £312 at the end of the present year on the basis of the old rates charged for electrical energy, but this excess is expected to be reduced by £175 by the reduction of charges reported in our last issue.

Greenock.—The Electricity committee recommend the Corporation to increase the salary of the electrical engineer (Mr. J. A. Robertson) by £100 per annum.

A show room is to be fitted up for exhibiting electric light fittings, &c., by the electric wiring and fitting department. It has been decided to purchase the "free" wiring installations in the district of the National Electric Construction Co. for £382.

Hanley.—The accounts of the electricity department for 1903 show a total expenditure of £83,014. 3s. 4d., an increase of £1,074. 12s. 7d. for the year. £75,009 has been raised by loans, and the balance (£8,005. 3s. 4d.) represents an overdraft. The receipts from sale of electric current were £11,982. 8s. 8d., from public lighting £2,242. 7s. 10d., meter rental, &c., £363. 4s. 5d., and sale and repairs of other apparatus £246. 7s. 4d. Generation expenses amounted to £4,239. 10s. 6d., cost of distribution £866. 19s. 7d., repairs and maintenance of public lamps, &c., £400. 12s. 10d., rates and taxes £742. 10s., management expenses £1,034. 6s. 5d., and, with insurances, &c., the total was £7,327. 7s. 5d., leaving gross profit £7,507. 0s. 10d. to meet interest on loans (£2,161. 19s. 3d.) and on overdraft (£392. 19s.), sinking fund instalment £2,148. 4s. 5d., amount of loans paid off £361. 5s. 10d. £2,356. 10s. 11d. was applied in relief of local rate, leaving £194. 18s. 11d. to be carried forward, against £108. 17s. 6d. last year. 960,991 units were generated, 639,824 were supplied to private consumers, 172,214 to public lamps and 23,611 used on the works. There are 311 public lamps, representing 55,339 32-watt lamps, and the total maximum supply demanded was 775kw. The works costs and total costs were 1·50d. and 2·04d. per unit respectively, compared with 1·72d. and 2·29d. in 1902. The average price obtained per unit was 2·56d. for public lighting and 4·49d. for private use.

Infirmary Lighting.—Surbiton Board of Guardians have decided to apply for sanction to a loan for the electric lighting of the infirmary buildings.

Kingston-on-Thames.—An inquiry was held here recently into the application of the Council to borrow £15,850 for electric lighting extensions.

The town clerk (Mr. H. A. Winser) gave statistics as to population, rateable value, &c., and supplied particulars of the existing electric lighting loans. Technical evidence was given by the borough electrical engineer (Mr. J. E. Edgcome) and by the consulting engineer, Mr. H. Burstall (Messrs. Burstall and Monkhouse). The latter said the proposed extensions were absolutely necessary to satisfy the demand. Last year they were only just able to scrape through the winter. The proposed expenditure would suffice for the next three years at the normal rate of progress.

There was no opposition.

King's Lynn.—The Council have received sanction to a further loan for electric lighting.

Lancaster.—The Council have increased the salary of the borough electrical engineer and tramways manager (Mr. W. A. Tester) by £50 per annum.

Launceston.—In the draft agreement with Messrs. Crompton & Co. for the erection and maintenance of electricity works there is a clause providing for a yearly payment, and this the Board of Trade object to. The Lighting committee are taking counsel's opinion.

Lecture.—A lecture on "Electro-Mechanism as Applied to the Simplification of Weaving Machinery" was recently delivered at Manchester by Mr. T. B. A. Carver before the British Association of Managers of Textile Works.

Mr. Carver said his object was to prove that there was in textile machinery a very wide field for the application of electro-mechanics. It had been demonstrated that electric power transmission was the simplest means of transmitting energy from the point of generation to the point of consumption. Electric driving was particularly adapted for weaving machinery. Mr. Carver described his invention for the displacement of Jacquard cards by an electrical machine for transferring the pattern from zinc cylinders to the cloth, and also an electric loom which he has devised jointly with a co-worker.

Leicester.—The Town Council on Wednesday adopted the recommendation of the Electric Light committee to increase the salary of the engineer and manager of the gas and electric lighting undertaking (Mr. A. Colson) from £1,250 to £1,500 per annum, the increase to be charged to the electric lighting department.

The opening of the municipal electric tramways has been provisionally fixed for May 18.

Light Railways.—The Board of Trade have, after modification, confirmed the Kent and East Sussex Light Railway (General Powers) Order 1904, amending the Colne and Tenterden Light Railway Order, 1899.

The Stretford Light Railways and the West Manchester Light Railways (New Lines, &c.) Orders have been submitted to the Board of Trade for confirmation. Objections by 14th inst.

The Midland Railway Co. notify that they intend to proceed forthwith with the construction of the Burton-Ashby light (electric) railway, for which Mr. C. H. Gadsby is consulting engineer.

Last week the Board of Trade heard objections to the confirmation of the Bideford, Westward Ho! and Appledore Light Railway order:—

The promoters (British Electric Traction Co.) were represented by Mr. Sydney Morse, and Mr. Wedderburn, K.C., appeared for Bideford Corporation, who objected to the order.

Mr. WEDDERBURN contended that where Parliament had granted certain powers no one except Parliament could dispose of those rights. There was no objection to the Appledore extension, but Bideford Corporation objected to the erection of two loop sidings at the Bideford end of the line, and the promoters could not do that without the consent of Bideford Corporation.

Mr. MORSE said that the promoters did not ask the Board to overlap the Act of Parliament. What they asked was the specific grant of powers to make a particular siding as to which notice had been given to everyone concerned. It was a matter entirely within the jurisdiction of the Board. Col. Yorke had reported that backing a train on a public thoroughfare was dangerous, and that it would therefore be advantageous to the public and the company to have a loop on the broad quay.

Mr. S. SELLON gave evidence as to the necessity of the loop, and said it would be a serious thing to allow traffic to continue without the loop.

Major PRINGLE, in reply to Sir Herbert Jekyll, said he did not consider it safe to have more engines on a train than were necessary to work it, because there was danger of the couplings parting or of the engine following coming into collision with the carriages if brought to a sudden stop.

Decision was reserved.

London County Council.—At Tuesday's meeting loans for electric lighting were made to Battersea £10.249, Stepney £17,650 and £40,000.

St. Marylebone Electric Lighting Bill.—The Parliamentary committee reported that substantial alterations to meet the Council's objections had been made in this bill.

Savoy Hotel.—Plans for the proposed electrical installation at the new wing of the Savoy Hotel have been approved, subject (among others) to a condition "that a quarterly inspection be made by a properly qualified electrical engineer and a copy of his certificate be sent to the Council."

Tramways.—The Highways committee reported that they had not yet decided the system of traction to be adopted for the tramways acquired from the South London Tramways Co. It was decided to acquire a site at East-hill, Wandsworth, for a sub-station for working a portion of the Council's tramways.

London Local Authorities and the Telephone.—A conference of representatives of local authorities in the London telephone area will be held at the Guildhall, E.C., on May 18 to consider the

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proposed purchase by the Postmaster-General of the undertaking of the National Telephone Co. The Lord Mayor will preside.

Manchester.—An inquiry will be held on Thursday into the application of the Corporation to borrow another £135,000 for electricity supply extensions.

Motor Omnibuses.—At the meeting of Thomas Tilling, Limited, last week, the chairman said the directors had set aside £1,000 for experimenting with motor buses, as they thought they had found a vehicle which would answer their purpose.

Municipal Insurance.—"The Municipal Journal" states that the Municipal Mutual Insurance (Ltd.) proposes to establish a North of England branch (with head offices at Bradford) for the counties of Yorks., Lincs., Notts., Derby, Cheshire and the English counties north thereof.

Municipal Telephony.—It is reported that the result of the first year's working of the Portsmouth municipal telephone department, after setting aside £1,500 for interest and sinking fund, is a profit of £1,225 upon a capital expenditure of £29,000.

Hull Telephone committee have authorised the laying of wires to Hessle, Cottingham and Beverley, within the municipal telephone area. The chairman of the committee (Mr. Brown) stated at the last meeting that he considered a satisfactory arrangement had been made with the Postmaster-General at the recent conference in London with respect to the purchase by the Government of the telephones. The interests of municipalities had been safeguarded by the promise that they should be heard before the purchase was effected.

Municipal and County Engineers.—The annual conference of the Eastern District of the Incorporated Association of Municipal and County Engineers was held at Grimsby on Saturday. Among the Papers read was one by the borough electrical engineer (Mr. W. A. Vignoles) on the "Grimsby Corporation Electricity Works," and at the close of the meeting the members inspected these and the refuse destructor works, &c.

New South Wales Tramways.—The revenue of the tramways of the New South Wales Railway Department for the March quarter amounted to £209,279, against £199,789 for the corresponding period last year. The expenditure was £163,773, against £156,987 last year.

Penang.—The municipal electricity works will be opened shortly and current will be supplied on the maximum demand system.

Peru.—On Feb. 17 last the first electric tramway operated in Peru was inaugurated. The line runs from Lima to Chorrillos, and is 8 miles in length. Another line is shortly to be opened connecting Callao with Lima. This line will have a double track and be 10 miles in length.

Portsmouth.—Recently the Corporation engaged Messrs. Kincaid, Waller, Manville and Dawson to prepare a report on the condition of the electricity works. This report (prepared by Mr. E. Manville) has now been submitted to the Council, and is a lengthy document. The report states that there are two points in which existing arrangements are particularly weak, the first and more important being the inadequacy of the supply of condensing water (to which the electrical superintendent, Mr. W. S. Foale, recently drew attention), and the second, the absence of a duplicate steam supply to the two newer turbine units. The report suggests that a fresh intake and discharge pipe should be installed. The cost of the alterations and additions to condensing plant, piping, &c., is put at about £5,000.

The Electric Lighting committee last week considered the question of insuring the electricity station buildings. At present the committee take all risks, but the subject has, we understand, been referred to a sub-committee for further consideration.

Preesall.—The Council is considering an electric lighting scheme submitted by Mr. Oswin E. Hansom.

Presentation.—The staff and workmen of York electricity works have presented the chief assistant engineer (Mr. A. J. Beckett) with a smoking cabinet on his departure to take up the position of borough electrical engineer at Bridlington.

Rowley.—The Board of Trade have sanctioned the borrowing of £28,000 by the Council for the construction of an electric tramway from Old Hill to Blackheath.

Runcorn.—The District Council decided on Tuesday to accept the offer of the Mersey Electric Supply Co. (Ltd.) to take over the Runcorn electric lighting order, 1899, the company to repay all expenses incurred in obtaining the order. The maximum price for electricity for private lighting is to be 6d. per unit and for power 2d., and the Council are to have option of purchasing the undertaking at the end of 14 years on payment of the capital expended plus 20 per cent.

Russia.—In 1902 the Odessa Port committee presented a report on harbour improvements, and proposals for the expenditure of about £25,000 for a more complete system of electric lighting have been approved. The harbour improvements include the erection of port elevators and the extension and alteration of lines of railway into the port.

It is proposed to construct a connecting railway between Sevastopol and Yalta (a town which adjoins the Imperial estate of Livadia). It is probable that the line will be an electric one.

The Municipality of Theodosia are discussing the question of the better lighting of the streets and open spaces. It is said that at present electric lighting, although favoured, has been ruled out of the contest on the ground of expense.

St. Pancras.—The Prudential Assurance Co. having informed the Borough Council that they are not prepared to make further advances at 3⅜ per cent., the Council have asked the London County Council to loan them £19,000 for electric lighting extensions for 42 years at 3¾ per cent.

Scarborough.—Trial trips have been made on the local electric tramways, and the date of the opening has been provisionally fixed for May 6.

Shipley.—For the year ended March 31 the income of the electricity department was £5,200, expenses £3,137, leaving £2,063 for interest and sinking fund.

Southend-on-Sea.—The borough electrical engineer (Mr. W. E. J. Heenan) reports that there are now 34,703 8 c.p. lamps connected to the mains, an increase of 138 per cent. for the year. Units sold show an increase of 60 per cent. and generation costs have decreased 17 per cent. The number of passengers carried on the light railways during the year was 3,421,601, against 2,750,823 last year, an increase of 24·4 per cent.

Southwark (London).—The Council have petitioned the Local Government Board to legalise payment by municipal authorities of the annual subscription to the Incorporated Municipal Electrical Association and the reasonable expenses of delegates attending the yearly convention.

Stettin (Germany).—The increasing export trade from this port is materially assisted by the fairway between Stettin and Swinemünde being now completely lighted during the night by electric beacons and buoys, making the fairway available throughout the 24 hours. The exact plan showing the lighthouses, beacons and buoys lighted by electricity is to be exhibited at the St. Louis Exhibition.

The articles of export from Stettin in 1903 included 345 tons of "electric engines." These exports have increased from nil in 1901 and 176 tons in 1902.

Stourbridge.—The Council are negotiating with the Midland Electric Power Distribution Corp. as to terms for the supply of electricity in bulk.

Surbiton.—The new electric lighting station at Tolworth was officially opened on Wednesday last week. A description of the works appeared in *The Electrician* at the time of the informal opening of the station some few months ago.

Sydney (Australia).—The new municipal electricity supply works are to be opened next month. Experiments are being made with Lahmeyer long-burning arc lamps for street lighting.

Technical Education in Germany.—The Locomotive Drivers' Association of Saxony has succeeded in interesting members of the Dresden City Council in a scheme for the establishment of a school for locomotive driver apprentices, in connection with the Dresden Technical School. Among the chief subjects to be taught are German, arithmetic, graphics and the mechanism of locomotives. The course is for one year, and is limited to apprentices "between 25 and 30 years of age" employed in the Dresden car shops.

Telephones in Nova Scotia.—A new long-distance telephone line (292 miles) has recently been opened between Halifax and Sydney (N.S.). The Nova Scotia Telephone Co. now works 2,246 miles of line, requiring 790 miles of poles, for their long-distance service. The total mileage of telephone lines in the province is 7,136 and the number of telephones 3,260, Halifax requiring 1,801. Over the company's service last year 14,000,000 messages passed. The long-distance service takes in Truro, Amherst, Bridgewater, New Glasgow and Windsor-Sydney. Throughout the province there is one telephone for every 88 inhabitants, in Halifax one to every 27. The average number of calls per day per instrument in Halifax is 11, the average throughout the province being 10. Three minutes' conversation on the long-distance line costs $1.25 in the daytime and 65 cents between 6 p.m. and 8 a.m.

Tunbridge Wells.—The Tradesmen's Association have passed a resolution against the Council disposing of the municipal electricity undertaking.

U.S. Telegraphic Anniversary.—On May 1 the 60th anniversary of the dispatch of the first message over a telegraph line in the United States will be commemorated.

U.S. Government Telegraph Cable Contract.—The London "Daily Telegraph" states that Gen. Greely has awarded a contract for the manufacture and supply of about 625 miles of submarine telegraph cable to a New York firm. The cable is to connect Sitka (Alaska) with Fort Liscum (Prince William Sound), and will be laid during the ensuing summer by the c.s. "Burnside."

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Venezuela.—A steamer, the "Lumbador," belonging to the Venezuelan navy, has recently laid a sub-aqueous telegraph cable, about 10 miles in length, between Bella Vista and the city of Altagracia. It is stated that the cable was made in the United States, and was laid by American engineers.

Wandsworth (London).—The Board of Trade have allowed the appeal of the County of London Co. against one of the conditions (viz., that the whole width of the tar-paved footpaths should be retopped) upon which the Council approved the laying of certain mains.

Warrington.—An inquiry was held here on Tuesday into the application of the Council for permission to borrow £5,000 for electric lighting extensions.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Lords Commissioners of the *Admiralty* are prepared to receive proposals from persons willing to submit for competitive trial range-finders, both large and small, for naval use. Conditions, &c., will be furnished to bona fide inventors or manufacturers of such instruments on application to the Director of Navy Contracts, Admiralty, London, S.W. Full descriptions of the range-finders proposed must be sent in by June 30, and inventors whose proposals may be approved for trial must produce the necessary instruments complete, with instructions for use, within six months of date of notification. Further particulars are given in an advertisement.

Bermondsey (London) Borough Council invite tenders for plant and connections required in the utilisation of exhaust steam for heating purposes and water connection between the artesian well pump and overhead tank. Specifications, &c., from the Town Hall, Spa-road, London, S.E., and may also be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller, Manville and Dawson), 29, Great George-street, Westminster, S.W. Tenders to the town clerk (Mr. Fredk. Ryall) by noon May 9. See also advertisement.

Walthamstow District Council require tenders for supply of tramcars. Contractors must tender for whole of work specified. Twelve of the cars are to be delivered within three months and 20 within six months from date of acceptance. Specifications, &c., from the consulting engineer (Mr. J. Enright), 68, Lincoln's Inn-fields, W.C. Tenders to Mr. C. Sydney Watson, clerk and solicitor, Town Hall, Walthamstow, by 5 p.m. May 20. Further particulars are given in an advertisement.

Canterbury Lighting committee invite tenders for one Lancashire or dry-back marine boiler, superheater and steam pipes, one 300kw. steam dynamo, switchboard and connections, and extensions to economiser. Specifications, &c., may be inspected at the offices of the consulting electrical engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, London, S.W., and can be obtained there after May 4. Tenders to the town clerk (Mr. Henry Fielding) by 10:30 June 1. An advertisement contains further particulars.

The Electrical committee of *Bristol* Corporation invite tenders for one 750kw. to 1,000kw. single-phase turbo-alternator. Specifications, &c., from the city electrical engineer (Mr. H. Faraday Proctor), Temple Back, Bristol, to whom tenders by noon May 16. See also advertisement.

Neath Corporation invite tenders for the supply and laying of electric light mains, feed pillars and switchboards. Drawings and specifications may be inspected at the offices of the consulting engineer (Mr. H. T. Sully), Scottish Widows'-buildings, Bristol, or of the borough engineer (Mr. B. M. Jenkins), Gwyn Hall, Neath, from either of whom specifications, &c., may be obtained. Tenders to the town clerk (Mr. Edwin C. Curtis) by May 16. See also advertisement.

Stoke-upon-Trent Corporation invite tenders for electricity meters, demand indicators and house services and cutouts. Specifications, &c., from the chief engineer (Mr. P. J. S. Tiddeman). Tenders to the town clerk (Mr. John B. Ashwell), Town Hall, Stoke-upon-Trent, by 5 p.m. May 13. See also advertisement.

Aberdeen Electric Light committee invite tenders for supply and erection of mild-steel coal bunkers, together with coal and ash conveyor of the endless-chain bucket type, and accessories. Specifications, &c., from the city electrical engineer (Mr. J. Alex. Bell), to whom tenders to the electricity works, Milburn-street, Aberdeen, by noon May 14. See also advertisement.

Glasgow Corporation invite tenders for main cables, electricity meters and carbons for 12 months from May 31. Specifications, &c., from the chief engineer (Mr. W. A. Chamen), 75, Waterloo-street. Tenders to the town clerk (Mr. James G. Munro), City-chambers, Glasgow, by 23rd prox. See also advertisement.

Glasgow Corporation also invite tenders for supply and erection of four sets of 800kw. dynamo panels. Tenders to town clerk (Mr. J. G. Monro) by May 9.

Glasgow Corporation also invite tenders by May 9 for cast-iron joint-boxes.

The Clyde Navigation Trustees, *Glasgow*, invite tenders by noon 23rd prox. for a number of 4-ton electric wharf cranes.

May-Oatway Fire Appliances (*Ltd.*), 92 and 94, Paul-street, London, E.C., invite tenders for wiring the installations set out in an advertisement. Tenders by May 4. Electrical contractors willing to make a speciality of fire-alarm signalling, with direct brigade connection, should communicate with the company.

The Council of the Metropolitan Borough of *Hammersmith* invite tenders for the supply of two 1,500kw. turbine or slow-speed engine generating sets with condensers, and high-pressure steam boilers with superheaters capable of evaporating 40,000lb. of steam per hour. Tenders to the Town Hall, Broadway, Hammersmith, by 4 p.m. May 18.

Dublin Lighting committee invite tenders for the supply and erection of a steam-generating three-phase extra high-pressure set of plant, consisting of Belliss engine and condensing plant combined with 1,500kw. Dick-Kerr, E.C.C., Oerlikon, Westinghouse, Lahmeyer or A.E.G. alternator, steam and exhaust piping and extension to switchboard. Tenders to the chairman, 3, Corkhill, Dublin, by noon May 9.

Poplar (London) Borough Council invite tenders for supply of of cables and supply and erection of a battery. Tenders to the town clerk (Mr. Leonard Potts), Council Offices, High-street, Poplar, by 9 a.m. May 7.

Kilmarnock Corporation invite tenders for tramway permanent way construction, excavations, concrete foundations, steel rails, fish-plates, and special work, paving, &c. Tenders to the town clerk (Mr. W. Middlemas) before noon May 17.

The Metropolitan Borough of *Hackney* invite tenders for electricity supply mains (feeders and distributors). Tenders to deputy town clerk (Mr. W. A. Williams), Town Hall, Hackney, N.E , before 4 p.m. May 26.

London County Council require tenders for switch-gear as set out in our last issue (p. 34). Tenders to Mr. G. L. Gomme, County Hall, Spring-gardens, S.W., by May 17.

Cleckheaton District Council invite tenders for one 350kw. steam generator. Tenders to the clerk (Mr. J. Armitage), Town Hall, Cleckheaton, by May 2.

Salford Corporation require tenders by 4 p.m. May 16 for 20 tramcars and two rail-cleaning and watering cars.

Tenders are wanted by May 25 by the *Manchester* Dock and Warehouse Extension Co. for 20 movable electric cranes.

Ayr District Lunacy Board invite tenders by May 20 for engines, boiler, pump, dynamos, switchboard, wiring and mains, building, &c.

The Magistrates of the City of *Utrecht* (Holland) invite tenders for the supply and laying of a complete cable network, consisting of feeding and distributing mains, joint boxes, service boxes and other accessories. Tenders on prescribed forms, and addressed to the Magistrates of the city, must be delivered before May 31. Specifications and forms of tender at the town clerk's office, Town Hall, Utrecht, on payment of 1s. 4d.

TENDERS RECEIVED AND ACCEPTED.

Battersea Borough Council have accepted the tender of Babcock and Wilcox for the supply and fixing of extension pipe work and ejector condenser at the electricity works at £1,119; that of W. T. Glover & Co. for cable to connect the main switchboard at £86. 11s.; that of Callender's Company for cables, &c., for stock at schedule prices (estimated at £2,624) and street boxes (estimated at £518. 16s. 8d.); that of the Walsall Electrical Co. at £179. 5s. for providing an additional panel to the main switchboard; that of the General Electric Co. for 100 arc lamp globes at 6s. 9d. each; and that of Belliss and Morcom for the purchase from the Council of a disused engine and dynamo at £170.

For the supply of plant for the electric working of Southwark tramways the London Council have received the following tenders:

Three Motor-generators.

Dick, Kerr & Co. (*accepted*) (delivery 12 weeks)	**£5,150**
British Thomson-Houston Co. (20 weeks)	4,837
British Westinghouse Co. (12 weeks)	5,492

Switchboards.—Mr. B. Thomas' tender to supply and erect at schedule rates under existing contract an additional low-tension switchboard at Elephant and Castle sub-station has also been accepted.

London County Council have decided to expend £15,000 on high and low-tension cable required in connection with the reconstruction for electric traction of certain short lengths of tramways in Southwark and Bermondsey, and offers of Siemens Brothers & Co. and the British Insulated and Helsby Cables (Ltd.) to supply, deliver and lay such cables at schedule rates under their existing contracts with the Council have been accepted.

Messrs. Ernest Scott and Mountain have obtained contracts for electrical pumping installations for the Consett Iron Co., Blackhill, the Weardale Coal, Coke and Steel Co., Croxdale, and for an electric hauling and pumping installation for the old Silkstone Colliery, near Barnsley.

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The British Westinghouse Co. have obtained a further order from Bury Corporation for Westinghouse magnetic brakes for 25 cars (12 single truck and 13 bogie), all mounted on Maguire trucks. This order covers all the cars not already fitted with magnetic brakes.

Dundee Town Council have accepted the tender of Messrs. Chamberlain and Hookham for the supply of electricity meters, and that of R. L. Ireland & Co. for 4,000 tons of coal (Lassodie mill dross) for the Dudhope electric power station.

The Secretary of the Army Council has placed a contract with Geipel and Lange for 51 Geipel steam traps. This is the third repeat order for the Royal Gunpowder Factory, Waltham Abbey, and makes a total of 147 Geipel traps in use there.

Messrs. Wm. Beardmore & Co., Glasgow, have secured the contract for the supply and erection of a number of large Oechelhauser (1,000 H.P. and 2,000 H.P.) gas engines (for driving Siemens electrical generators) for the Johannesburg municipal electricity works.

Woolwich Borough Council have placed an order with the British Thomson-Houston Co. for 12 months' supply of B.T.-H.-Edison incandescent lamps.

Keighley Corporation have accepted the tender of the British Thomson-Houston Co. for eight double-deck cars, equipped with two G.E. 58-6 turn motors and B 18 controllers.

The secretary of the Army Council has placed an order with the Sir Hiram Maxim Electrical and Engineering Co. for the supply of electric telescope lamps mounted in ebonite sockets.

Siemens Brothers & Co. have secured an order for electric pumping plant to the value of £2,151 for the New Golden Gate Gold Mining Co., Matthinna, Tasmania.

Stepney Borough Council have let the contract for the extensions to the generating station building to Mr. B. E. Nightingale at £12,921.

Lancaster Council have accepted the tender of R. W. Blackwell & Co. for the construction of a new tramway route and the doubling of a portion of the existing track for £10,189.

Lincoln Corporation have accepted the tender of Bruce Peebles & Co. for a 220kw. steam generating set.

St. Helens Cable Co. have received an order from Broughty Ferry Corporation for Dialite insulated cables.

Faversham District Council have accepted the tender of H. S. Tett & Co. for wiring the town hall.

West Ham Corporation has placed an order with R. W. Blackwell & Co., at £75, for a tower waggon for overhead equipment repairs.

Loughborough Town Council have accepted the tender of A. Faulks for the erection of electricity station buildings at £4,365.

BUSINESS NOTICES.

Mr. John Roberts, chief electrical engineer to Durban (Natal) Corporation, is in London, and will be able to see callers at the offices of the Corporation agents, Messrs. Webster, Steel & Co., 5, East India-avenue, London, E.C., between the hours of 10 a.m. and 4 p.m.

Mr. Cecil E. Lugard, who has for several years been chief of the electrical department of Ashmore, Benson, Pease & Co., has entered into practice as a consulting electrical engineer at Field's-buildings, Middlesbrough.

Messrs. Ernest Scott and Mountain have decided to remove their works to Gateshead, where they have acquired about 7 acres formerly occupied by Black, Hawthorn & Co. and later by Chapman, Furneaux & Co.

LIQUIDATIONS, BANKRUPTCIES, &c.

The Cleveland and Durham County Electric Power Co. (Ltd.) is being wound up voluntarily, and Mr. G. D. Prince, 5, Great George-street, London, S.W., is liquidator. This company was a promoting syndicate, and the incorporated company (Cleveland and Durham County Electric Power Co.) is carrying on the undertaking.

In the bankruptcy of C. M. Downie, electrical engineer, 4, Bloomsbury-street, W.C., and 28, Heathville-road, Crouch Hill, N.W., London, the first meeting of creditors will take place on May 3 at Bankruptcy-buildings, London, W.C, and the public examination on June 9 at the same place.

Sale by Auction.—Mr. Henry Sherley-Price (of Wheatley Kirk, Price & Co.) has been appointed by the Court to sell by public auction in one lot as a going concern, at the Mart, Tokenhouse-yard, London, E.C., early in May, the extensive freehold and well-equipped car-building works known as the Castle Car Works, Hadley, near Wellington, Salop, together with the whole of the fixed plant and machinery and trade connection. Particulars and further information from the receiver and liquidator (Mr. H. D. Eshelby, F.C.A., of Messrs. Harmood, Banner & Son), 24, North John-street, Liverpool; of Messrs. Gribble, Oddie, Sinclair and Johnson, solicitors, 38, Bedford-row, London, W.C., or of the auctioneers, 46, Watling-street, London, E.C., and Albert-chambers, Albert-square, Manchester. See also advertisement.

Plant, &c., for Sale.—An electric lighting installation, suitable for country house, is advertised for sale on another page. The plant consists of a J. & P. dynamo (50 amps. 135 volts), an 11 H.P. Priestman oil engine, a battery of 58 E.P.S. cells, &c., and is being removed to make room for a larger one. Applications to Messrs. Plenty & Son, Newbury, Berks.

Taunton Corporation invite tenders for the purchase and removal of a steel Paxman Economic steam boiler, with two furnaces for evaporating 4,400lb. of water per hour at 140lb. per square inch. Forms of tender and particulars from the borough electrical engineer (Mr. E. B. Thornhill), St. James'-street, Taunton. Tenders to the town clerk, Mr. C. H. Kite, by Saturday, May 14. See also advertisement.

A 12in. spark-induction coil, with Nodon valve and transformer, are for sale by Mr. T. Scott Anderson, Royal Exchange-buildings, Sheffield. See also advertisement.

About 300yds. of 19/16 cable, a new earth indicator, field rheostat, &c., are advertised for sale by Messrs. T. E. Evans & Co., 126, Bute Docks, Cardiff.

Messrs. Hooker and Harris, Retreat-place, Hackney, London, have for sale some electric lighting plant. See advertisement.

Mr. J. Light, Wolverhampton, has for disposal a Robey steam engine, suitable for driving a dynamo. See advertisement.

Dowson gas plant, capable of producing 12,000 cubic ft. per hour from anthracite, and suitable for about 140 B.H.P. gas engine, is advertised for sale on another column.

The "Journal."—Part 165 of the "Journal" of the Institution of Electrical Engineers is now ready, price 5s. Particulars of the contents are given in an advertisement.

Catalogues, &c.—With a view to providing a cheap and reliable automatic cut-off switch for shop windows, lamp signs, &c., the Electrical Co., Charing Cross-road, London, W.C., has placed upon the market an automatic switch consisting of an ordinary alarm clock in combination with an ordinary S.P. switch. The clock goes for 24 hours with one winding, and can be so set as to automatically switch off the current at any desired time. This class of apparatus enables shopkeepers to keep their business premises illuminated after business hours for any length of time previously decided upon.

A neat post card illustration of "Taunton" plant is issued by Newtons Limited of Taunton.

The British Westinghouse Co. have issued a new "special publication" entitled "A Reconstructed and Enlarged Central Station," describing the Meriden Electric Light Co.'s station, Meriden, Col., U.S.A.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from April 20 to 26, with the ports of destination:—

Africa—Alexandria, £187; Cape Town, £473; Delagoa Bay, £531; Durban, £1,516 (including £469 telegraph material); East London, £509 (including £142 telegraph material). *Argentina*—Buenos Ayres, £176 (telegraph material). *Australasia*—Auckland, £318; Brisbane, £31; Cairns, £200; Hobart, £22; Melbourne, £40; Otago, £933; Perth, £79; Sydney, £1,535 (including £220 telegraph material); Wellington, £35. *Azores*, £271 (telegraph material). *Belgium*—Brussels, £250. *Ceylon*—Colombo, £89 (including £64 telegraph material). *China*—Shanghai, £825 (including £40 telegraph material); Tientsin, £26. *Germany*—Hamburg, £420. *Gibraltar*, £57. *Greece*—Piræus, £20. *Holland*—Amsterdam, £60; Rotterdam, £100. *Hong Kong*, £414 (including £20 telegraph material). *India*—Bombay, £155; Calcutta, £218 (including £65 telegraph material). *Japan*—Kobe, £268; Nagasaki, £648; Tokyo, £419; Yokohama, £239. *Portugal*—Lisbon, £245 (including £165 telegraph apparatus). *Straits Settlements*—Penang, £558; Singapore, £20 (including £68 telegraph material). *Sweden*—Gothenburg, £175. Total £12,242 against £7,107 in the corresponding week last year (April 22 to 28).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

January 23, 1904.

1,725 F. W. HAYWARD and R. C. FOX. Norwich. Electrical transmitting cables.

1,727 J. GARDNER. Manchester. Wireless telegraphy and appliances.

1,785 H. G. NICHOLSON. Conductors for the trolley system of electric traction.

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1,794 F. Hope-Jones and C. L. Sumpter. Electric clocks.
1,799 W. H. Mordey and G. C. Faicker. Electricity meters.
1,800 Van Raden & Co. (Gulcher-Accumulatoren-Fabrik G.m.b.H., Germany). Electric mining lamps.

January 25, 1904.

1,846 G. Eason. Switches.
1,847 J. Stratton and E. A. Claremont. Manufacture of cables and the like.*
1,848 E. S. Seymour and E. A. Claremont. Covering of cables.*
1,851 P. C. Hewitt. Obtaining a flow of current in one direction from an alternating source. (Date applied for, Feb. 3, 1903, date of application in U.S.)*
1,860 F. R. Boardman. Working electric railway or tramway service.
1,863 J. S. Cunnington. Incandescent lamp holder and combined switch.
1,878 T. L. Carbone. Arc lamp. (Date applied for, Aug. 22, 1903, date of application in Germany.)*
1,884 Stothert and Pitt and W. Pitt. Electric cranes.

January 26, 1904.

1,952 F. Parker. Automatic device for cutting off current when line wire breaks.
1,964 A. W. Sharman. Production and application of electric oscillations.
1,968 B.T.H. Co. (G.E. Co., U.S.) Motor-control systems.
1,973 C. Adams-Randall. Telegraph systems.*

January 27, 1904.

2,035 F. H. Royce and E. A. Claremont. Manchester. Methods of protecting a booster or generator.*
2,055 W. Cowell and A. Cowell. Burnley. Trolley pulleys and heads.
2,060 O. Siegert. Burglar alarm applicable to locks.
2,063 H. Nehmer. Static electrical machines for lighting gas, &c.
2,066 J. T. Armstrong and A. Orling. Electric receiving apparatus for telegraphic and other purposes.
2,093 M. Leblanc. Systems of excitation for induction machines. (Date applied for, Jan. 23, 1903, date of application in U.S.)*
2,096 A. F. Berry. Apparatus for distribution of alternating currents.
2,097 A. Spencer. Tools or appliances for maintaining permanent way of electric railways.
2,098 Cie. pour la Fabrication des Compteurs et Matériel d'Usines à Gaz. Induction meters. (Date applied for, Feb. 26, 1903, date of application in France.)*

January, 28, 1904.

2,119 T. Jones, jun. Glasgow. Electric tramway cars and other vehicles.
2,141 A. G. Witherby. Applying electricity and light for curative purposes.
2,152 J. Raschen, G. C. Clayton and United Alkali Co. Electrolytic cells.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

2,928 Luppinger. Electric tramway systems.
5,150 Sanders. Contact breakers for induction coils and the like.
5,170 Carolan (G.E. Co., U.S.). Electric-motor control systems.
5,289 Carolan (G.E. Co., U.S.). Rotary fans for cooling dynamos, &c.
5,292 Carolan (G.E. Co, U.S.). Electric train-control systems.
5,494 Raworth. Electric motors and regulating devices for electric vehicles.
5,561 Porsche. Dynamo-electric machines.
5,891 Portalier. Batteries. (Date applied for Sept. 13, 1902.)
5,913 Karslake. Trolley rope guard for tramcars.
6,494 Carolan (G.E.Co., U.S.). Means for controlling the division of load between synchronous electric motor-generator sets.
6,723 Dawson and Dawson. Electric ignition for internal combustion motors.
6,784 Le Blanc. Voltage regulators for charging storage batteries.
7,141 Carolan (G.E. Co., U.S.). Alternating-current motors.
7,142 Carolan (G.E. Co., U.S.). Electric metering systems.
7,387 Turner and Isherwood. Standards and supporting devices for trolleys.
7,676 Wilson. Telephonic systems and disposition of apparatus therefor.
7,910 Hartley and Greenwood. Apparatus for automatically operating track and conductor switch points of electric tramway systems.
7,966 Graham. Telephonic apparatus.
8,292 Stelzes and Typewriting Telegraph Corp. Typewriting telegraph receiving instruments.
9,324 Parsons. Electromagnets and armatures for use with bells, &c.
9,382 Edwin Charles Stevens and Percy Herbert Stevens, exors. of the late John Sanders Stevens, dec., Charles George Major, Edwin Charles Stevens and Percy Herbert Stevens. Electric lifts.
9,807 Carolan (G.E. Co., U.S.). Emergency brakes for vehicles.
9,809 Carolan (G.E. Co., U.S.). Detecting high voltage in circuits and apparatus.
10,251 Wokes and Street. Purifying air and generating ozone by electricity.
10,388 Sedgwick and Smith. Electric ignition of miners' and other lamps.
10,413 Polson. Automatic fire alarms.
10,630 Eckstein and Brooker. Microphonic transmitter.
11,000 and 11,001 Reynolds. Electric crucible furnace.
11,002 Reynolds. Melting steel and the like in electric furnaces.
12,578 Gessmann. Dry battery for use with hat or head bands.
13,937 Fisher. Electric apparatus for therapeutic use.
16,294 Beck. Arc lamps.
16,583 Monnier. Electric railway and vehicles for transporting letters and other light loads at high speeds.
17,721 Beaumont. Coin-freed electricity meters.
18,754 Faller. Semi-automatic telephone systems.
21,208 Cie pour la Fabrication des Compteurs et Materiel d'Usines à Gaz. Alternate current meters. (Date applied for, Dec. 16, 1902.)
22,673 Müller. Regulating dynamos, motors and like machines.
23,120 Bijur. Storage battery plates.
23,574 Shoemaker. Wireless signalling systems.
24,310 A.G. "Magneta" Electrische Uhren ohne Batterie und ohne Contacte. Magneto-electric machines. (Date applied for, Jan. 20, 1903.)
25,047 Bloxam (Goffin). Brackets for telegraph and like posts.
26,174 Howorth (Everhart and Dossert). Couplings of electric cables.
26,274 A.G. Brown, Boveri & Cie. Ventilating dynamo electric machines. (Date applied for, Dec. 16, 1902.)
26,659 Masson. Magneto-electric ignition for internal combustion engines.
26,849 Fairweather (Stromberg Carlson Telephone Mfg. Co.). Telephone systems.
26,961 McCullough. Switching mechanism for double filament lamps. (Date applied for, Dec. 10, 1902.)
27,213 Heinrich. Winding moving coils for electrical measuring instruments.
27,392 Revilliod. Electricity meter. (Date applied for, Dec. 15, 1902.)
27,574 Foster. Brush and commutator for internal combustion engines.
27,576 Roos. Magneto-electric ignition for internal combustion engines.
27,585 Walker. Casings for wires and lamp holders, wall plugs and the like for use therewith.
27,733 Hearson (Adolf Bleirchert & Co.). Electric suspended railways.
27,825 Soc. des Accumulateurs Chelin. Electric lamp, particularly for miners' use. (Date applied for, Aug. 3, 1903.)
28,055 Soc. Française d'Incandescence Par le Gaz (Système Auer). Arc lamps. (Date applied for, Dec. 22, 1902.)
28,057 Wheatley (Attwood Electric Co.). Solutions for use in galvanic batteries.
28,232 Sabat. Coin-freed apparatus for electricity supply.
28,290 Fessenden. Wave telegraphy.
28,291 Fessenden. Receivers for electromagnetic waves. (Date applied for, April 9, 1903.)
28,365 Robertson. Trolley arms for electric traction.

1904.

114 Duflos. Sparking plugs for internal combustion engines. (Date applied for, Jan. 7, 1903.)
758 Heys (Ammon). Process for insulating conductors.
768 Stephens and Timmerman. Furnaces for extracting metals, making carbides, &c.
1,187 Elieson. Accumulator plate.
1,279 Johnson (Brown and Tredway). Pipes or conduits for use under ground.
1,296 Postans. Electrical ignition for internal combustion engines.
1,307 Moscicki. Condensers.
1,308 Moscicki. High-tension condensers.
1,349 Fairweather (Arnold Magnetic Clutch Co.). Electromagnetic clutch, speed varying and brake mechanism.
1,599 Ryffel. Galvanic batteries.
1,714 Pieper. Electrical signalling apparatus.
1,847 Stratton and Claibmont. Manufacture of cables and the like.
1,848 Seymour and Claremont. Apparatus for covering cables.

COMPANIES' MEETINGS AND REPORTS.

Indo-European Telegraph Co. (Ltd.)

The thirty-seventh ordinary general meeting was held on Wednesday under the presidency of Mr. C. Holland (in the absence of Mr. Tritton, who had met with an accident).

The SECRETARY having read the notice and the auditors' report,

The CHAIRMAN said: The alterations made at the recent London Conference in the Regulations annexed to the International Telegraph Convention do not materially touch this Company's interests, but certain reductions in the tariffs will affect the Company's receipts to some extent. I do not think the Company's revenue will be seriously affected. Our Chairman informed you at our last general meeting that there was a falling off in our receipts for the year 1902 amounting to £18,735, brought about by the reduction in the rate to India. We have, I am glad to say, decreased this loss in 1903 by £4,789, owing to an increase in the traffic exchanged with South Russia and India. The increase in Indian traffic is satisfactory, but I do not altogether hold the view that the lowering of the rate has brought about this increase, which should be attributed partly to the improved trade of the country. It is with satisfaction that the Directors announce in the report that the terms of an agreement have now been arranged with the Postmaster-General and the Imperial German Post Office for the leasing of land wires in this country and submarine cable wires between this country and the German coast. We expect to have the detailed agreement very shortly. The lines of the Company have worked well during the year, and the direct Wheatstone working, which has proved so successful between London and Teheran, has now been extended to Manchester and Liverpool. Merchants and pressmen in these towns fully appreciate the fact that their telegrams are received without re-transmission from Teheran, a distance of 4,000 miles. Re-transmissions always add to the possibility of error, and accurate transmission is essential. The amount of £12,394 was, as our report informs you, released under the Arbitration Award, and must be looked upon as a windfall; it had accrued during the years 1901

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and 1902, and does not belong to this year's revenue. The Directors hope, therefore, that the shareholders will take the view that this is, literally speaking, a golden opportunity for placing the officers' retirement scheme upon a sound basis, and will adopt the recommendation of the Directors and appropriate this sum for the trust now proposed to be created. Last year at our general meeting the scheme was approved in principle by the shareholders, who voted £5,000 towards its formation. Since that time it has taken definite shape, and has been in operation since Oct. 1, 1903. It would take too long to place the details before you; but the main principle underlying the scheme is that, on reaching the age of 55, coupled with 25 years' service in the Company, a member of the staff becomes eligible for retirement upon half-pay. This half-pay would be continued during his lifetime, so long as the Company carries on business. Upon liquidation of the Company it will become necessary to make provision for the continuance of his half-pay by the purchase for him of an annuity. It is to the purpose of purchasing such annuities that the Directors wish to apply sums voted by the shareholders, and they have decided that the only satisfactory way to attain the desired result is to form a trust fund outside the Company's assets, and to hand over to this trust fund the sums already voted, or to be voted. The telegraph service, gentlemen, is a hard service, and the Directors feel it their duty to think of the future of their staff, who have served the Company faithfully during so many years, and will, we hope continue to do so. I will now turn to the financial aspect of the report. There is an increase of £4,789 in the revenue, and I have already explained how this increase has been brought about. The increase in expenditure amounts to £4,541, and is accounted for mainly by an increase this year of maintenance charges (which last year were under the average) and by the cost of a considerable purchase of telegraph poles for stock. The dividend absorbs £14,875, and to this amount is added the bonus—£17,000—making a total of £31,875. The Directors propose to add £15,000 to the equalisation of dividends fund, to apply an additional sum of £10,000 to the depreciation of reserve fund securities—necessitated by further shrinkage of values, and to carry forward £16,365 to the credit of 1904 after payment of the dividend and bonus. With regard to the outlook for 1904, I have already informed you that the further reductions in tariffs agreed to at the International Telegraph Conference, which come into force on July 1 next, are likely to cause a decrease in the revenue, but I do not anticipate that the accounts for 1904 will show any serious diminution of receipts. I now ask you to turn your attention to the balance-sheet. At the close of the present year, 1904, our whole undertaking, so far as the Russian section is concerned, passes to the Russian Government under the concession, and becomes absolutely their property. You will see in the balance-sheet that this section stands in our books at the sum of £313,285. 5s. 5d. It will consequently be necessary to write off this item altogether; this will be done by charging it to the reserve fund. The only item then remaining to represent the original cost of construction will be £25,244, book value of the Persian section. The issued capital of the Company, £425,000, will then be represented by over £570,000 of first-class investments, for we have invested an additional £25,000 since Jan. 1, 1904. The Board of Directors may, I think, congratulate the shareholders and themselves that the policy they have adopted has been one of long-continued and rigorous application of the sinking fund principle, and I may be pardoned, perhaps, if I add, comparing great things with small, that its rigorous application in national finance is of the highest importance to the State. The equalisation of dividends fund will now stand at £30,000, and in view of the many adverse possibilities inseparably connected with an undertaking such as ours, may perhaps require further strengthening. I now move the adoption of the report and accounts, and the payment of the dividends set out therein.

Mr. W. S. ANDREWS seconded the resolution, which was carried unanimously.

The retiring Directors, Mr. J. H. Tritton and Mr. John Von Berenberg Gossler, were then re-elected, as were the retiring auditors, Messrs. C. F. Kemp, Sons & Co.

A vote of thanks to the Chairman and Directors, and the staff, was carried unanimously.

After the Chairman had replied, an extraordinary meeting was held at which a series of resolutions were proposed giving the Directors power to alter the Articles of Association to meet the requirements of the proposed "Retirement Fund."

In seconding the resolutions proposed by the Chairman, Mr. G. VON CHAUVIN said: The scheme which you have elaborated has, I have no doubt, been worked out with the care and business-like acumen which has been characteristic of the management of this Company. It is a question which has weighed considerably on a good many telegraph men. In your remarks you said that a telegraphist's life is a very hard one. I have never myself been a telegraphist, but I have been connected with the executive working of submarine telegraphy for over 25 years, and I can, from my personal experience, very fully endorse the remarks which have fallen from the Chairman to-day. A telegraph operator soon ceases to be in his prime, and the extraordinary competition which not only pervades nowadays the whole of the commercial world, but all those who cater for the necessities of commercial life—the transport of goods, the transport of persons, and the transport of words and intelligence—makes the lot of the men who have to work these things harder and harder. Time and again I have had under consideration schemes which I wanted to suggest to my employers on the other side of the Atlantic, and a good many of the suggestions made would have been willingly and gladly accepted if there had not been some insuperable legal difficulties in the position in the United States. Fortunately, in this country no such difficulties stand in the way. I am extremely pleased to think that the Directors are putting before us a scheme which is not only a right, a just, and a proper one, but which, putting it on a very low basis, is really to the best interests of the shareholders. It is right and proper that the men who devote their energies, the flower of their life, and the best and most active years of their existence—sometimes under not too agreeable circumstances, in distant climes, away from their homes where they may have difficulties in finding the means of educating their children and the comforts they have been accustomed to—should be able to look forward to some better fate than that of being cast off, like old clothes, when their work is done.

The CHAIRMAN put the motion, which was at once carried unanimously, and the proceedings terminated.

AIRDRIE AND COATBRIDGE TRAMWAYS CO.—At the meeting yesterday (Thursday) the directors' report for 1903 was presented, and stated that a contract has been entered into with the British Electric Traction Co. for the construction and electrical equipment of 3 miles 3 furlongs 3·58 chains of tramways authorised by the Airdrie and Coatbridge Tramways Act, 1900, and the Coatbridge Tramways Order, 1901, and for the provision of a car depot and rolling stock for working the tramways. The total capital expenditure to Dec. 31 amounts to £31,697. 18s. 2d.

CALCUTTA ELECTRIC SUPPLY CORP. (LTD.)—During 1903 2,044,681 units of electrical energy were sold, compared with 1,552,775 in 1902. The gross revenue was £47,139, compared with £35,124; working costs £25,552, compared with £21,990. Net result of year's operations, after making provision for future maintenance and repairs, a profit of £21,587, compared with £13,133. Exchange is calculated at 1s. 4d. per rupee. At the end of the year 1,379 houses, representing an equivalent of 121,878 8 c.p. lamps, were connected, compared with 965 and 80,765 in 1902. Capital expenditure during the year was £87,116 (£4,730 on freehold land and buildings, £13,308 on machinery and tools, £55,850 on mains, £5,554 on meters, and £6,611 on electrical instruments, switchboards, &c), bringing the total capital expenditure to £382,770. £8,500 has been set aside for renewals, and £2,574. 4s. 10d. expended, leaving £5,925. 15s. 2d. to be added to £9,352. 7s. 4d. of this account. To the net profit of £21,587. 5s. 5d. there has to be added £1,077. 16s. 3d. from 1902, making an available balance (after deducting interim dividend, interest and income tax) of £13,932. 15s. 10d. A final dividend at the rate of 8 per cent. is recommended, making 7 per cent. for year. £2,482. 15s. 10d. is carried forward. Orders have been placed for the equipment of the new station in the northern part of the town of Ultadanga, and for a generating station at Howrah.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The report for the half-year ended Dec. 31 states that the total receipts were £18,643. 11s. 3d., and expenses were £5,809. 19s. 10d., leaving £12,833. 11s. 5d., added to £6,137. 8s. 3d. from last account, or a total of £18,970. 19s. 8d. £5,000 had been added to reserve, which now stands at £155,000. Preference dividend absorbs £3,000, and the directors recommend a dividend at the rate of 5 per cent. per annum on the ordinary shares, tax free, the balance (£6,970. 19s. 8d.) being carried forward. The Cienfuegos-Santiago 1875 cable became interrupted on Dec. 21. The Mexican Telegraph Co.'s steamer "Mexican" was hired for its repair, but the operations were unsuccessful. The directors have now entered into a contract with Hooper's Telegraph and India Rubber Works (Ltd.) for a new cable to be laid between these points. The applications to the United States Government for payment of the claim for the cost of repairing the damage done to the cables during the Spanish-American War, and to the Cuban Government for payment of the subsidy for the coast cables, are still under consideration.

EASTERN EXTENSION AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended Dec. 31 shows gross receipts £265,259. 15s. 5d., against £267,553. 9s. 5d. for the corresponding half-year of 1902. Working expenses, including £33,400. 4s. 9d. for maintenance of cables, absorb £142,419. 1s. 10d., against £121,869. 11s. 10d. for the corresponding period of 1902, leaving £122,840. 13s. 7d. From this is deducted £4,473. 6s. 4d. for income tax, £12,512. 17s. 5d. for debenture interest, &c., leaving as net profit £105,854. 9s. 10d. Adding £71,036. 8s. 3d. from previous half-year, the available balance is £176,890. 18s. 1d. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is proposed to distribute another of like amount on 5th prox., making (with interim dividends paid for first half-year) a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for 1903. The balance (£41,890. 18s. 1d.) has been carried forward.

Further cable renewals have been carried out during the half-year under review, and the cost (£10,854. 18s. 2d.) has been charged against reserve. The further contract with the Netherlands-Indian Government for laying additional short cables in the Java seas has been satifactorily carried out.

The directors deemed it advisable that a representative of the board and the general manager should make a tour of inspection of the company's stations abroad and in the colonies, and, accordingly, the Hon. George Peel and Mr. F. E. Hesse left London in November for that purpose.

The register of transfers will be closed from 27th inst. to May 4 inclusive.

GRAVESEND AND NORTHFLEET ELECTRIC TRAMWAYS CO. (LTD.)—The revenue for 1903 amounted to £12,977; after deducting expenses (including £1,130 for interest) the profit was £3,305. Adding £938 from previous account and deducting preference dividend, the directors recommend placing to reserve and renewals fund £1,000 and a dividend of 3 per cent. on the ordinary shares. Capital expenditure to Dec. 31, £122,077.

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LEAMINGTON AND WARWICK ELECTRICAL CO. (LTD.)—The report for 1903 states the gross receipts were £6,739. After deducting expenses (including repairs, maintenance and interest) the profit was £1,810. An interim dividend of 2 per cent. was paid in November, and the directors now recommend placing £700 to depreciation and reserve, and that a dividend be paid at the rate of 5 per cent. on the ordinary shares, making 7 per cent. for the year. Capital expenditure during the year in connection with reconstruction of lines and equipment for supply of electricity was £9,860, of which £7,243 was for generating plant and machinery, £2,076 in laying mains, and £420 for legal expenses, &c. Tenders are being invited for building the power house and offices and the work of reconstruction and equipment of the lines will be proceeded with as quickly as possible.

ORIENTAL TELEPHONE AND ELECTRIC CO. (LTD.)—At the meeting on Wednesday the chairman (Sir Auckland Colvin) said steady progress had been made by all the subsidiary companies in Egypt, Rangoon and Singapore. The lines approved by the Egyptian Government would cover 3,500 miles, and they expected shortly to receive another order for a further extension. In Hong Kong also the business was extending rapidly. The Straits Government had conceded a new licence for 31 years.

PETERBOROUGH ELECTRIC TRACTION CO. (LTD.)—The revenue from Jan. 24 (when a portion of the lines was opened for traffic) to Dec. 31, 1903, was £7,833. 18s. 8d., and the profit, after deducting expenses, was £2,185. 18s. 5d. After the 6 per cent. preference dividend has been paid, £500 placed to depreciation and reserve, and a dividend paid on the ordinary shares of 2½ per cent., there is £791. 1s. 10d. to be carried forward. The total capital expenditure at end of year was £60,706. 2s. 9d. The Board of Trade have approved the assignment to the company of the undertaking authorised by the Peterborough and District Light Railway order, 1900.

RIVER PLATE ELECTRICITY CO. (LTD.)—At the meeting on Friday the chairman said the net revenue upon the running of the business in Argentina was £13,565, that sum representing a full year's work at the La Plata and Tucuman stations, and three months' at the Buenos Ayres station. The latter station was purchased by the German company in the early part of the year, and, therefore, the company was only entitled to the profits for three months ended March 31. Depreciation had been allowed on machinery of £801. The directors had proceeded upon the definite plan of charging 2½ per cent. for depreciation upon the book values of the machinery. As to the prospects of the company in Tucuman, there was a question whether the company should continue to do the public lighting, as the municipality had asked for great concessions.

SUBMARINE CABLES TRUST.—The report of the trustees for the financial year to April 15, 1904, states that the revenue amounted to £24,592. 19s. 6d., and the expenses to £1.169. 18s. 8d., leaving £23,413. 0s. 10d., added to £117. 18s. 9d. from the last account, making £23,530. 19s. 7d. After providing £19,314 to meet payment of coupons, £4,156. 2s. has been transferred to redemption fund, leaving £60. 17s. 7d. to be carried forward. Thirty-six certificates have been redeemed since last report by purchase in open market, costing £4,156. 2s.

TELEPHONE CO. OF EGYPT (LTD.)—The report for 1903 states that, after paying debenture interest, the balance was £9,516. Including £2,634. 17s. 11d. from 1902, the balance is £12,151, and the directors recommend a dividend at the rate of 7½ per cent. per annum on the preferred shares (less tax), absorbing £5,799, to transfer £4,000 to reserve, and to carry forward £2,351. During the year 133 additional provincial lines were completed on behalf of the Government, and further installations of 393 have been contracted for, which are now in construction. The demand for exchange telephone lines in Cairo and Alexandria continues satisfactory, the net increase for the year being 260 lines. A number of private lines have also been erected. The working of two trunk line circuits between Cairo and Alexandria, which commenced on May 1 last, has resulted in a small profit, after paying all expenditure.

WILLANS AND ROBINSON (LTD.)—An extraordinary general meeting was held on Wednesday to appoint Messrs. G. W. Anderson and J. C. Peache as additional directors. Mr. Mark Robinson presided and moved the appointment of Mr. Anderson at a remuneration of £250 per annum. An amendment that the remuneration of the new directors should be deducted from the fees paid to the existing board was carried. When this amendment was put as a substantive motion the following words were added:—"But it is declared that this is only an expression of the opinion of this meeting, and not a binding direction to the board." A resolution for the appointment of Mr. Peache was afterwards carried on a show of hands, and was followed by a proposition fixing his salary at £2,000 per annum with a contingent share of profits. The resolution was carried with two dissentients; but a poll was demanded, and this will be taken at Cannon-street Hotel on May 11.

YORKSHIRE (WOOLLEN DISTRICT) ELECTRIC TRAMWAYS (LTD.)—The gross receipts for 1903 were £18,626. 2s. 1d. Deducting expenses (including repairs and maintenance and interest on loans) the profit was £5,184. 12s. 1d. A dividend of 4 per cent. on the ordinary shares absorbs £1,540. 13s., and the balance is carried forward. A portion of the company's lines commenced running on Feb. 18, 1903, and since that date further portions have been opened. The total route mileage of line now working is 17¼, including 3 miles authorised by the Batley Corporation Tramways Order, 1900, which are being worked by the company under lease. The total capital expenditure amounted to £289,870. 7s. 9d., of which £130,442. 13s. 4d. was incurred during last year.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (April 21, 1904). Price of silver 25⅝d. per oz. (April 28). Consols 88 5/16—89 1/16 for money, 88 5/16—89 1/16 for account; 2½ per cent. annuities 88¼—88¾ (April 28). Consols Pay Day, May 5; Stocks and Shares Continuation Days, May 10 and 23; Ticket Day, May 11; Pay Day, May 12; Mining Share Carry-over Days, May 9 and 24.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—Subject to audit the directors recommend payment of the 6 per cent. preference dividend for 1903, placing £7,000 to general reserve, £6,500 to depreciation reserve and carrying forward £3,057. 11s. 5d.

CENTRAL AND SOUTH AMERICAN TELEGRAPH CO.—The receipts for 1903 were $1,072,134, compared with $1,002,572 in 1902. Operating expenses were $405,296, against $388,031. $620,710 was expended in repairs and improvements. A dividend of 6 per cent. has been declared, and $140,592 carried forward.

DEUTSCH UBERSEEISCHE ELEKTRICITATS GESELLSCHAFT (BERLIN).—For the past year a dividend of 6 per cent. is recommended, compared with 3 per cent. in 1902.

INDIA RUBBER, GUTTA PERCHA AND TELEGRAPH WORKS CO. (LTD.)—It is announced that an issue of £100,000 second mortgage 4½ per cent. debentures of £100 each is being made at par. The issue is offered exclusively to existing share and debenture-holders in the company.

METROPOLITAN RAILWAY CO.—At the meeting of the Board yesterday Col. J. J. Mellor resigned his position as chairman and Sir Charles M'Laren, Bart., M.P., was elected in his place. Col. Mellor remains a director.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—This company is offering to its shareholders 17,991 5 per cent. preference shares of £5 each at 10s. premium, and a similar number of £5 ordinary shares at £1 premium.

NORTH STAFFORDSHIRE TRAMWAYS CO. (LTD.)—The net profit for the year 1903 is £4,895. 7s. 11d. After payment of the 6 per cent. preference dividend, a 5 per cent. dividend on the ordinary shares will be paid.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)—The amount of electricity sold for the quarter ended Lady Day is returned at 2,330,724 units, estimated to produce £37,388, against 2,063,412 units, which produced £33,358, for the corresponding period of last year.

SOUTH LONDON ELECTRIC SUPPLY CORP. (LTD.)—The amount given in our last issue (p. 38) as the sum realised for the units of currents sold for the Lady-Day quarter should have been £18,600, not £18,000.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed May 5 a special settling day in, and have granted a quotation to, provisional certificates (fully and partly-paid) of a further issue of £1,000,000 4 per cent. debenture stock of the *National Telephone Co. (Ltd.)*, and have also ordered to be quoted a further issue of £89,593 4 per cent. debenture stock of the same company, and £3,599,268 5 per cent. profit-sharing secured notes (fully-paid certificates) of the *Underground Electric Railways Co. of London (Ltd.)* Application has also been made to the committee to allow a further issue of 2,000 fully-paid £5 shares of the *Hove Electric Lighting Co. (Ltd.)* and a further issue of 5,015 fully-paid 4½ per cent. £5 cumulative preference shares of the *Metropolitan Electric Supply Co. (Ltd.)* to be quoted.

THOMAS PARKER (LTD.)—Mr. Thomas Parker has resigned his position as a director of this company and is succeeded by Mr. James Underhill. Mr. Parker is about to take up permanent residence in London as consulting electrical engineer to the Metropolitan Railway Co. in connection with the conversion of that line to electric traction.

TRAMWAYS AND LIGHT RAILWAYS ESTATES CO (LTD.)—The revenue for 1903 was £1,433. 1s. 4d., and the expenses £873. 4s. 3d., leaving profit £559. 17s. 1d. The directors recommend a dividend of 4 per cent. for the year.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON.—Messrs. Speyer & Co. and Messrs. Blair & Co. offer privately $10,000,000 worth of 5 per cent. bonds of this company at 96½.

URBAN ELECTRIC SUPPLY CO. (LTD.)—An issue of £200,000 4½ per cent. first mortgage debenture stock is being made by this company at 98 per cent. The authorised share capital of the company is £500,000, of which £400,000 has been issued in £150,000 preference and £250,000 ordinary shares of £5 each. The present issue of debenture stock is a specific first charge on the statutory electric lighting and tramway undertakings now owned by the company and the freehold and leasehold land and buildings held in connection therewith. No mortgage or other charge is to be created ranking pari passu with or in priority to this debenture stock, except such further debenture stock ranking pari passu with this issue as may be issued from time to time in accordance with the articles of association of the company. The stock under this issue will be payable at par in July, 1940, or may be redeemed in whole or in part earlier at £105 per cent. at six months by the company. In the event of the company's voluntary liquidation before 1940, the stock will be payable at 105 per cent. Interest is due April 1 and Oct. 1 in each year, and the stock will be transferable in multiples of £1. The abridged prospectus will be found set out on another page of this issue. The subscription list opened on Tuesday last and closes on or before Monday next. Copies of the prospectus and forms of application can be obtained from the bankers, from the brokers, or at the offices of the company, Broad Sanctuary-chambers, Westminster, London, S.W.

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WEST COAST OF AMERICA TELEGRAPH CO. (LTD.)—The directors' report for the year ended Dec. 31 last shows that the gross receipts amounted to £35,707. 13s. 5d., against £34,293. 18s. 1d. in 1902, an increase of £1,413. 15s. 4d. Working expenses were £28,381. 5s. 3d., compared with £24,295. 5s. 2d., an increase of £4,086. 0s. 1d., largely due to cost of repairing cables. After providing £6,800 for interest, there is a balance of £526. 8s. 2d. (adding £571. 3s. 1d. brought forward), making £1,097. 11s. 3d., which is carried forward.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

BRITISH ELECTRIC SEPARATING CO. (LTD.)—Reg. April 20, capital £20,000 in £1 shares (4,000 deferred), to acquire business carried on by the British Electric Separating Co. (Ltd.) and to carry on business of strippers of tin from tin plate, scrap, and other articles coated with tin (by means of electricity or otherwise), electro-depositors of metals, &c. First directors H. A. Leaver (managing), J. R. Leaver, J.P., B. Dickinson, C. E. Perry and W. R. Renshaw. Reg. office, New Cut-road, Swansea.

ELECTRO PEAT-COAL CO. (LTD.)—Reg. April 20, capital £130,000 in £1 shares, to carry on business of peat-coal, peat-fuel, peat-charcoal and fibrous peat (with or without use of electric treatment or minerals or chemicals), paper and millboard manufacturers, workers of and dealers in mineral substances, &c., and to adopt agreements between L. F. Kelly (for the company) and W. C. Johnson (trading as Johnson and Phillips) and between A. E. Whalley and L. F. Kelly. First directors, the Earl of Mayo, H. Allen, J. Macgregor, Col. T. A. St. Quintin, Sir L. Falkiner and R. Walker. [Applications for an issue of 105,000 shares were invited this week.]

LODGE ELECTRIC LIGHT AND POWER CO. (LTD.)—Reg. April 22, capital £3,000 in £1 shares, to acquire the business carried on by Mr. H. Lodge as the Lodge Electric Lighting Co., and to carry on the business of an electric light and power company. First directors H. Lodge (man.) and J. L. Langford. Reg. office, Central-buildings, North John-street, Liverpool.

RUBBER RECLAMATION CO. (LTD.)—Reg. April 26, capital £10,000 in £1 shares, to acquire patents and rights relating to the reclamation and manufacture of rubber, and to carry on the business of manufacturers and reclaimers and dealers in indiarubber and guttapercha and manufacturers of and dealers in resin, sulphur, beeswax, gum, gum shellac, &c. First directors T. M. Thom, G. Merrylees and T. L. Livingston. Reg. office, Balfour House, Finsbury-pavement, London, E.C.

STATUTORY RETURNS.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—According to return to March 25 the capital is £400,500 in 74,000 ordinary and 6,000 preference shares of £5 each and 500 founders' shares of £1 each, of which 44,436 ordinary, 6,000 preference and 500 founders' shares have been taken up. £5 per share has been called up on 37,770 ordinary and 6,000 preference shares and £218,850 has been received. £33,830 is considered as paid on 6,666 ordinary and 500 founders' shares. Mortgages and charges, £150,000 debenture stock and £800 buildings.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORP. (LTD.)—In return to Feb. 17 the capital is given as £2,100,000 in 130,000 preference, 130,000 ordinary, 80,000 City Undertaking preference and 80,000 City Undertaking ordinary shares of £5 each, of which 70,000 preference, 70,000 ordinary, 80,000 City Undertaking preference and 70,000 City Undertaking ordinary shares have been taken up. £5 per share has been called up on 70,000 preference, 70,000 ordinary and 80,000 City Undertaking preference shares and £1,100,000 has been received. £350,000 is considered as paid on 70,000 City Undertaking ordinary shares. Mortgages and charges, £400,000 4 per cent. debenture stock and £400,000 City Undertaking 5 per cent. debenture bonds.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The return to March 23 gives the capital as £1,200,000 in 40,000 preference and 80,000 ordinary shares of £10 each, of which 40,000 preference and 70,595 ordinary have been taken up. £1,105,950 has been paid. Mortgages and charges, £700,000.

CRYSTAL PALACE DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The return to Feb. 18 shows capital of £75,000 in £1 shares, of which 47,859 have been taken up. £1 per share has been called up and paid on 2,859 and 45,000 are considered as fully paid. Mortgages and charges, £60,000.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—In return to April 5 the capital is £95,000 in 13,000 ordinary and 6,000 preference shares of £5 each, of which 12,931 ordinary and 6,000 preference have been taken up. £5 per share has been called up and £95,655 has been received. Debentures, £30,000 (redeemable 1914).

MORTGAGES AND CHARGES.

WOKING ELECTRIC SUPPLY CO. (LTD.)—Issue on April 9 of £950 4½ per cent. debentures, part of series created Nov. 2, 1899, to secure £25,000 charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £22,000.

WOLVERHAMPTON DISTRICT ELECTRIC TRAMWAYS (LTD.)—Trus deed, dated April 11, to secure £100,000 debenture stock (with power t issue further stock, ranking pari passu therewith, up to half issued capital), has been registered. Property charged, company's undertaking and property, present and future. Trustees, Electric and General Investment Co.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 28	1,230	+ 302	47	56,516	+ 11,544
Airdrie	,, 15	186	...	10	1,889	...
Ayr Corporation	...	...	...	...	...	...
Barnsley	,, 15	148	— 108	15	2,362	— 176
Barrow	,, 15	136	+ 66	10	1,514	+ 911
Bexley District Council	,, 21	202	...	28	4,560	...
Birkenhead	,, 24	1,023	+ 88	...	...	...
Birmingham Corporation	,, 23	258	...	15	4,619	...
*Birmingham Tramways Co.	,, 23	5,450	+ 650	16	82,855	+ 4,680
*Blackburn Corporation	,, 22	889	+ 83	4	3,794	+ 104
Blackpool Corporation	,, 21	556	+ 183	3	2,585	+ 66
Blackpool and Fleetwood	,, 23	313	+ 18	17	3,984	— 326
Blackp'l, St. Anne's & Lytham	,, 21	297	+ 297	25	4,424	+ 3,845
Bolton Corporation	,, 24	1,794	+ 42	4	6,591	— 252
Bournemouth Corporation	,, 20	1,165	+ 215	3	3,878	+ 461
*Bradford Corporation	,, 23	3,925	+ 628	4	13,801	+ 1,091
Brighton Corporation	,, 24	844	+ 118	3	3,189	+ 6
Brisbane Tramways	Mar. 9	2,341	— 186	10	22,787	— 397
*Bristol Trams & Carriage	April 22	5,076	+ 599	22	101,768	+ 3,788
*Buenos Ayres & Belgrano	...	...	...	...	...	...
Burnley Corporation	,, 23	1,095	+ 303	4	4, 84	+ 395
Burton Corporation	,, 24	318	...	38	12,639	...
Calcutta Tramways Co.	,, 23	a33,353	+ a3,685	17	a586,538	+ a31,655
Camborne-Redruth	,, 25	97	...	25	2,707	...
Cardiff Corporation	,, 16	1,885	— 94	8	6,668	+ 80
	,, 23	1,945	+ 805			
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 23	6,538	— 535	17	117,980	— 1,078
Chatham & Dist. Lt. Rys.	,, 21	572	+ 160	16	8,353	+ 1,449
City & South London Rly.	,, 24	2,778	— 193	17	52,422	— 1,864
Cork Electric Trams Co.	,, 21	442	+ 5	16	6,346	— 185
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 15	495	+ 32	15	6,989	+ 954
Dover Corporation	,, 23	195	+ 10	4	746	— 46
Dublin & Lucan Railway	,, 24	127	+ 33	17	1,632	+ 81
Dublin Southern District	,, 22	1,081	+ 247	¶17	70,685	+ 788
Dublin United	,, 22	3,885	+ 152			
Dudley—Stourbridge	,, 15	725	— 464	15	11,446	+ 884
Dundee Corporation	,, 20	832	+ 80	...	...	...
East Ham Council	,, 23	754	+ 166	3	2,566	+ 220
Gateshead & Dist. Trams	,, 15	884	— 90	15	13,035	+ 618
Glasgow Corporation	,, 23	14,935	+ 1,642	47	639,625	+ 59,289
Glossop	,, 23	105	...	16	1,582	...
Gravesend—Northfleet	,, 15	224	— 48	15	3,318	+ 497
Gt. Northern & City Rly.	,, 23	915	...	10	9,378	...
Greenock & Port Glasgow	,, 15	564	+ 11	15	7,075	+ 694
Halifax Corporation	,, 13	1,202	— 674	8	4,226	— 89
	,, 20	1,851	+ 284			
Hartlepool Tramways	,, 15	246	— 40	15	3,763	+ 344
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 23	2,026	+ 389	3	7,080	+ 497
Ilford District Council	,, 23	467	+ 122	3	1,626	+ 100
Ilkeston Corporation	,, 20	149	...	23	2,883	...
Ipswich Corporation	,, 23	408	...	3	1,529	...
Isle of Thanet Co.	,, 23	428	+ 41	...	...	...
Kidderminster & District	,, 15	97	— 88	15	1,508	— 93
Kirkcaldy Corporation	,, 20	281	...	8	1,674	...
Lanarkshire Trams Co.	,, 21	766	...	16	9,357	...
Leeds Corporation	,, 23	5,532	+ 645	4	23,269	+ 1,480
Liverpool Corporation	,, 16	9,964	+ 156	16	158,547	+ 3,116
*Liverpool Overhead Rly.	,, 24	1,618	— 13	17	26,360	+ 142
*London County Council	,, 16	10,465	+ 1,465	§2	25,829	+ 5,127
Lowestoft	,, ...	...	...	...	...	...
Manchester Corporation	,, 23	11,700	+ 869	3	35,194	— 219
Mersey Railway	,, 23	1,429	+ 377	16	23,325	+ 5,784
Merthyr	,, 15	197	— 88	15	2,966	+ 178
Middleton	,, 15	266	— 200	15	3,981	+ 89
Nelson Corporation	,, 24	116	+ 57	4	462	+ 215
Newcastle-on-Tyne Corp.	,, 23	3,488	+ 611	16	55,774	+ 7,225
Newport (Mon.)	,, 23	464	+ 175	3	1,676	+ 848
Oldham, Ashton & Hyde	,, 15	498	— 193	15	7,569	— 526
Oldham Corporation	,, 10	1,189	...	...	...	...
	,, 17	1,180				
Perth (W. A.) Elec. Trams.	,, 22	1,275	+ 127	16	22,056	+ 2,917
Peterborough	,, 15	127	— 78	15	1,775	— 259
Poole and District	,, 15	293	— 122	15	3,711	— 56
Portsmouth Corporation	,, 25	1,774	+ 371	†4	6,621	+ 564
*Potteries	,, 15	1,593	— 82	15	24,760	+ 1,841
Reading Corporation	,, 14	595	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 15	93	— 108	15	850	+ 88
Salford Corporation	,, 25	3,881	+ 745	4	14,364	+ 546
Sheerness	,, 13	45	— 177	15	704	— 177
Sheffield Corporation	,, 25	4,556	+ 514	§4	19,640	— 157
*Southampton Corporat'n	,, 21	949	+ 85	...	...	...
Southend Corporation	,, 20	277	+ 51	3	877	+ 68
Southport Tramways	,, 15	286	— 149	15	3,841	+ 231
S. Staffordshire Trams.	,, 15	782	— 865	15	11,341	+ 176
Stockport Corporation	,, 22	531	+ 262	3	1,518	+ 483
Sunderland Corporation	,, 24	1,170	+ 150	3	4,059	— 115
*Swansea Trams	,, 15	504	— 86	15	7,067	+ 201
Taunton Trams	,, 15	51	— 27	15	786	— 61
Tynemouth and District	,, 15	225	— 154	15	3,246	— 210
Tyneside Trams Co.	...	...	...	...	...	...
Wallasey District Council	,, 23	680	+ 83	†4	2,340	+ 13
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 21	754	...	8	3,559	...
Weston-super-Mare	,, 13	61	— 81	15	479	— 39
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 15	327	— 235	15	5,174	— 288
Worcester	,, 15	248	+ 86	10	2,580	+ 1,040
Wrexham	,, 15	149	+ 7	15	1,569	— 84
Yorkshire Woollen District	,, 15	588	+ 233	15	7,939	+ 3,830

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., April 27.	Rate per Cent. Yielded.	Dividend Due	Business Week to April 27		Share	Last Dividend	Name.	Price Wed., April 27.	Rate per Cent. Yielded.	Dividend Due	Business Week to April 27.	
						High-est.	Low-est.							High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.						**TELEPHONES.**		£ s. d.			
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4½—5½	4 17 7	April, Oct	5⅛	4⅞	5	2/0	Chili Telephone (fully paid)	4⅝—5¼	5 14 3	August ..	..	..
St.	6%	Do. Permanent 6% Deb. Stock	127 —132	4 11 11	..	..	..	St.	6%	National Co. Pref. Stock	103 —105	5 14 10	..	104	103⅝
St.	3½	Auckland Elec. Trams 5% Deb. (red.)	98 —100	..	..	..	..	St.	5%	Do. Def. Stock	88 —91	5 10 10	..	90½	86½
10	10/0	Barcelona Tramways Ord.	6 —8	6 5 0	..	..	..	10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 —12	5 0 0	Feb, Aug	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..	10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	..	..
St.	4½	Do. 4½% Deb. Stock (red.)	90 —95	4 14 9	..	..	..	5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5¼	4 15 3	Feb, Aug	5⅛	5⅛
100	5%	Do. 5 per Cent. Debs.	95 —98	5 2 0	..	97	..	St.	3½	* Do. Deb. Stock 3½ per Cent. (red.)	97 —99	3 11 5	June, Dec	..	..
1	..	Bath Elec. Trams Pref. Ord.	¾—1	..	..	..	..	St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101 —103	3 18 9	..	102⅜	..
1	..	Do. 5% Cum. Pref.	¾—1	..	..	..	..	1	0/7½	Oriental	⅛—1⅛	6 6 8	April, Oct	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	2⅛	2	1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	..	4	..	5	3/0	United River Plate	5½—6	5 16 8	July.....	5⅝	..
St.	4½	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	..	..	5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5½	4 15 3	June, Dec	..	..
10	8%	Bristol Tramways and Carriage Ord.	18 —19	4 4 2	Feb, Aug	..	..	St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 —105	4 15 8	June, Dec	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 18 0	..	..	..			**ELECTRICITY SUPPLY.**					
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..	1	..	Blackheath & Greenwich Dist. Ord.(f.p.)	⅝—¾	..	..	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	98 —101	5 18 9	..	..	..	1	0/8½	Do. 7% Cum. Pref.	1 —1½	5 12 0	..	..	..
St.	5%	Do. Pref. Ord. Stock	99 —102	5 0 0	..	101½	100½	St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & coun.)	115 —120	3 15 6	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10⅝	5 11 7	..	10⅝	10⅝	10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102%—104%	4 6 7	..	..	..	10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..	10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
10	6/0	British Electric Traction Ord.	9½—9	3 17 9	..	9⅛	8⅞	St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	9½—10½	5 17 0	Feb, Aug	10⅛	9½	St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	102 —105	4 7 8	..	..	..
St.	5/0	Do. 5 per Cent. Perpetual Debs	114 —117	4 6 0	..	115½	..	5	5/6	Brompton & Kensington Elec. Sup. Ord.	10½—11½	4 5 1	..	11	10½
5	3/0	Buenos Ayres and Belgrano Ord.	2⅜—2⅞	5 3 9	..	2⅛	2⅛	5	3/6	Do. 7 per Cent. Pref.	10½—10⅞	3 5 1	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5⅛—5⅜	5 4 4	..	..	..	5	3/0	Calcutta Electric Supply Ord.	6⅞—7½	4 9 8	..	7⅛	..
5	3/0	Do. "B"	4⅜—5½	5 14 4	..	4⅛	4⅞	St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 —109	3 13 8	..	..	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	106	..	5	4/0	Charing Cross & Strand Electric Sup.	7½—7⅞	5 3 3	Feb, Aug	7⅞	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	4 19 6	..	..	..	5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 5 9	Feb, Aug	5⅜	5⅜
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	98 —100	5 0 3	..	..	..	5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅜—5	4 10 0	..	..	..
								5	1/7	Do. Do. (1903)	4½—5	..	..	4⅝	..
5	3/6	Calcutta Tramways	6⅞—7½	4 2 8	..	7⅛	6⅞	St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 10	..	103⅜	103
100	4½%	Do. 4½% 1st Deb. Stock (red.)	107 —109	4 3 7	..	107¾	..	5	3/6	Chelsea Electric Supply Ord.	6½—6⅝	4 1 5	March ..	6⅝	..
1	1/0	Cape Electric Tramways Shares	1⅜—2⅜	8 0 0	..	2	..	St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 3 1	Jn, Dec ..	..	..
St.	4%	Central London Ordinary Stock	92 —95	4 4 2	June, Dec	95	93½	10	5/0	City of London Electric Lighting Ord.	10½—10⅝	4 13 0	Feb, Aug	10⅝	10⅞
St.	4%	Do. 4 per Cent. Pref. Stock	98 —101	3 19 9	..	..	..	10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St.	4%	Do. Deferred Stock	85 —88	4 11 3	..	..	..	St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec ..	..	..
100	4%	Do. 4 per Cent. Debs.	110 —113	3 10 9	..	..	..	St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	100½	..
5	2/6	City of Birmingham Trams. 5% Cm. Pf.	4½—5	5 0 0	..	..	..	10	4/0	County of London & Brush Prov. Ord.	7 —8	5 0 0	..	7⅛	7½
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..	10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	..	..
St.	2%	City and South London Rly. Con. Ord.	49 —52	4 11 4	Feb, Aug	51	49	St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106 —109	4 2 11	..	..	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 8	Feb, Aug	..	..	St.	27/6½	Do. Second Deb. Stock Prov. Certs.	100 —103	..	..	100½	100
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..	5	3 6	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 8	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	..	..	St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 8 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	..	..	10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	101 —104	4 18 1	..	..	..	5	5.0	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
10	6 0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..	St.	..	I of W. Elec Lt. & Power 4½% Db St. (red.)	102 —104	..	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..	1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅛—¼	..	..	..	..
5	6/0	Electric Lgt. & Tract. of Aust. 6% Cm. Prf.	1½—2½	12 0 0	..	..	..	5	7/0	Kensingtn & Knghtsbdge Ord.	11½—12½	4 16 0	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 —97	5 3 1	..	..	..	5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
10	..	Gt. Northern & City Rly. Prf. Ord. (4%)	5½—6½	4 12 2	..	6⅜	..	St	4%	Kensingtn. & Knghtsbdge Ord. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..	3	..	London Electric Supply Ord.	1 —1⅛	..	..	..	..
10	10%	† Imperial Tramways Ord	18 —19	5 5 3	Mar, Sept	..	..	5	3/0	Do. 6 per Cent Pref.	4½—5	6 0 0	..	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..	St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 —98	4 2 11	Mr, Jn, S, D	96½	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	103 —110	4 1 10	Jan, July	..	..	10	9 6	Metropolitan Electric Sup. Ord.	18 —19	4 12 1	April, Oct	19¼	18¾
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..	5	1/4½	Do. 4½ per Cent. Cum. Pref.	5½—5⅝	4 3 9	..	5⅜	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..	St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec ..	..	..
10	1½	†Liverpool Overhead Railway Ord.	4⅛—4⅜	2 16 5	Feb, Aug	..	..	St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —98	3 11 9	..	..	..
10	5%	† Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..	100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
St.	4%	† Do. 4 per Cent. Deb.	99 —101	4 0 0	Jan, July	..	..	10	6.0	Notting Hill Electric Ord.	12½—13½	4 8 11	March	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11½—11¾	4 5 2	..	11⅞	11⅝	100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 18 5	..	..	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	101 —103	3 18 5	..	101⅛	..	5	4/0	Oxford Electric Ord.	5½—6	5 8 4	March ..	..	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..	St.	4%	Do. 4% Deb. Stock	96 —99	4 0 9	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	12	..	1	..	Rand Electric	¾—1	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..	100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	98 —101	4 9 1	April, Oct	..	..
1	..	Metropolitan Electric Trams Def	⅛—¼	..	..	..	..	5	9 6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	14⅞	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	..	..	..	5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	8⅞	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..	St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 5 0	..	..	..	5	4/0	Smithfield Markets Electric Sup. Ord.	3 —3½	5 14 3	..	..	..
5	..	New General Traction Ord.	½	..	..	..	..	St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1 —2	..	May	..	..	5	3/0	South London Electric Supply Ord.	3⅛—3⅝	4 0 0	..	3⅝	3⅜
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 —102	4 18 0	..	..	..	5	2/6	Urban Electric Supply Ord.	4⅜ 4½	5 2 6	..	4⅜	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..	5	2/6	Do. 5% Cum. Pref.	4⅜—5	5 0 0	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..	5	7/0	Westminster Electric Supply Ord.	12½—13½	5 0 0	Mar, Sept	13⅛	12¾
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 —106	4 5 11	..	..	..	5	2/6	Do. 5 per Cent. Cum. Pref.	6½—6⅝	3 14 0	..	6⅝	6⅛
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..			**ELECTRIC MANUFACTURING &c.**					
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	¼—½	10 0 0	..	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..	1	..	Aron Electric Meter 6% Cum. Pref.	⅜—½	..	Mar, Sept	..	..
St.	3%	Waterloo and City Ord.	89 —92	3 8 4	June, Dec	90	..	5	4/0	British Insulated & Helsby Cables Ord.	5⅜—6⅛	6 8 0	July, Feb	..	..
		TELEGRAPHS.						5	3/0	Do. 6 per Cent. Pref.	5½—5⅝	5 4 4	Jan, July	..	..
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	..	..	St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —106	4 5 9	..	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..	St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..	5	3/0	British Westinghouse 6% Pref.	3⅞—4½	7 1 2	..	3⅝	..
St.	12/6	Anglo-American	49 —52	5 12 4	F, My, Ag, N	..	..	St.	4%	Do. 4 per Cent. Mort. Deb. Stock	90 —93	4 7 0	..	..	..
St.	25/0	Do. Preferred	93 —95	6 1 0	F, My, Ag, N	94½	93	2	..	Brush Electrical Engineering	½—¾	..	March ..	..	..
St.	2/0	Do. Deferred	7½—7¾	1 5 10	F, My Ag, N	7⅞	..	2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	¾—1	..	Mar, Sept	1⅛	¾
100	£2	Commercial Cable Capital Stock	180 —190	4 4 2	Jn, Ap, Jy, O	..	..	St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	91 —93	4 6 3	Jn Ap, Jy, O	..	..	St.	4½%	Do. Perpetual 2nd Deb. Stock	72 —77	5 18 4	Jan, July	73½	60
10	7/0	Cuba Submarine Ord.	7½—8½	9 8 5	Feb, Aug	..	..	5	5/0	Callender's Cable Construction Ord.	10½—11½	6 10 5	Jan, July	10⅝	10⅜
10	10/0	Do. Preference 10 per Cent.	15½—16½	6 1 3	Feb Aug	..	..	5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5⅞	4 6 11	Jan, July	5⅞	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..	St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 3	Nov, May	104	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..	1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅜—½	6 17 2	..	..	..
St.	4½%	Do. 4½ per Cent. Deb.	99%—102%	4 9 3	Jan, July	..	..	St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
20	3/0	Direct United States Cable	10½—11	5 18 2	Ja, Ap, Jy, O	10¾	10½	1	0/7½	Ghadburn's Ship Telegraph Ord.	¾—1	8 0 0	March ..	..	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	98 —101	4 9 1	Jn, Dec ..	..	..	3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅜—2⅛	6 13 4	Jan, July	..	..
St.	25/0	Eastern Ordinary	122 —127	5 10 3	Ja, Ap, Jy, O	126	123	100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96 —99	5 2 0	Jan, July	98½	..
St.	17/6	Do. 3½ per Cent. Pref. Stock	85 —88	3 19 6	Ja Ap, Jy, O	88½	..	5	..	Dick, Kerr & Co. Ord.	7⅜—8½	..	..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104 —107	3 15 8	May, Nov	107	105½	5	3/0	Do. 6% Cum. Pref.	5 —5⅛	5 9 1	..	..	..
10	2/6	Eastern Extension	11⅞—12⅛	5 14 3	Ja, Ap, Jy, O	12⅜	12	St.	4½%	Do. 4½% Deb. Stock	102—10a	4 7 2	..	..	..
8	4%	Do. 4 per Cent. Deb. Stock	103 —106	3 16 0	Feb, Aug	104⅛	..	5	..	Edison & Swan United ("A" sh.) (£3 pd.)	½	..	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	99 —102	3 19 0	Feb, Aug	..	..	5	..	Do. (£5 paid)	½—1½	..	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%—104%	3 18 2	May, Nov	..	..	St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	..	..
10	5/0	Great Northern of Copenhagen	x7 —28	4 9 3	Jan, July	..	..	St.	5%	Do. 5 per Cent. 2nd Deb. Stock	74 —79	6 6 7	..	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —101	4 9 6	June, Dec	..	..	5	2/6	Edmundson's Elec. Corp. Ord.	5⅜—6⅛	5 12 0	H'lf-yearly	6	5⅞
25	12/6	Indo-European	42 —45	5 11 1	May, Nov	45	..	5	3/0	Do. 6 per Cent. Cum. Pref.	5⅜—6	5 0 0	..	5⅜	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec.	..	..	St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 5 2	..	..	..
10	2/0	West African Telegraph Shares	5 —6	1 18 4	..	..	..	2	1/2½	Electric Construction Co.	1⅛—1⅜	6 71 2	Jan, July	1⅛	1⅛
25	..	West Coast of America	¼—⅜	..	..	..	..	2	2/9½	Do. 7 per Cent. Cum. Pref.	2⅝—3	4 13 4	July	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 10	Jan, July	..	..	St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
10	..	West India and Panama	⅝—¾	..	May, Nov	⅞	⅝	1	..	Electrolytic Alkali Ord.	⅛—¼	..	..	..	..
10	8/0	Do. 6 per Cent 1st Pref.	5⅛—6⅛	9 12 0	May, Nov	6⅜	5⅜	1	7%	Do. 7 per Cent. Cum. Pref.	¾—1	..	..	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	..	..	St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 8	..	..	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 18 4	Jan, July	..	..	10	5/0	General Electric (1900) 5% Cum. Pref.	9½—9¾	5 2 6	..	9⅝	9⅛
10	3/0	Western Telegraph	12½—12¾	5 9 10	Mr, Jn, O, D	12⅝	12⅜	St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 17 9	June, Dec	..	..	5	9.0	Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99 —102	3 19 5	..	..	..	5	2/3	Do. 4½ per Cent. Pref.	5 —5⅛	4 1 10	Feb, Aug	5⅛	..
		FINANCIAL, INVESTMENT, &c.						St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..	..
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —6⅛	5 9 1	..	..	..	10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 7	Feb, Aug	19⅜	18⅜
10	2/0	Globe Telegraph and Trust	⅞—¹⁵⁄₁₆	4 6 6	Ja Ap Jy O	9⅛	8⅞	100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 5	Mar, Sept	..	..
10	3/0	Do. 6 per Cent. Pref.	12¼—12⅝	4 14 2	Ja Ap, Jy, O	12⅝	12⅜	10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
10	4/0	Reuter's	6⅝—7⅛	5 6 8	April, Oct	..	..	10	36/0	Telegraph Construction & Mainten'ce.	34 —37	6 9 10	Mar, July	37	35
100	6%	Submarine Cables Trust (Cert.)	117 —122	4 18 4	April, Oct	120	..	100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
								5	..	Williams and Robinson Ord.	2½—3½	..	Apr, Oct	3⅛	..
								5	..	Do. 6 per Cent. Cum. Pref.	3⅛—4⅛	..	Apr, Oct	4⅛	3½
								St.	4%	Do. 4 per Cent. 1st Mort. Debs.	90 —95	4 5 9	May Nov	..	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

THE sequel to the Isle of Wight litigation, in which a Miss KNIGHT successfully sought an injunction to restrain the Isle of Wight Electric Light and Power Co. from working a gas engine station at Ryde, is the purchase of the lady's lease by the defendant company. As the law stands at present this course is practically the only one open to an undertaking which transgresses the law of nuisance, and its chief disadvantage appears to lie in the fact that the vendor can demand practically any price, and the purchaser can either complete the contract or break off negotiations. Unfortunately, the shadow of an injunction precludes all possibility of pursuing the latter course, and there is no statute yet in existence which compels the parties to refer the matter to arbitration. As we announced last week, a conference organised by the St. Pancras Borough Council is about to make an attempt to get the law altered in this respect; all they will have to do now is to obtain sufficient support for the new Government Electric Lighting Bill, which we publish in full on another page, in order that the Government may be induced to push it through this session.

THIS new Electric Lighting Bill is practically the same as the one which was introduced last year late in the session,—too late for it to be passed. We trust that it will meet with better success this year, as it is designed to effect reforms in the existing law of electricity supply that are much needed. The very first clause of the Bill gives the Board of Trade power to grant Provisional Orders authorising the compulsory purchase of land, subject to the provisions of the Land Clauses Act, and Clauses 4 and 6 give still more important discretionary power to the Board of Trade. In certain circumstances, the Board is authorised to exclude the 42 years' purchase clause from a new Provisional Order, and the most important provision of all is one by which the Board may, if it think fit, grant a Provisional Order to a company even if the Local Authority has withheld its assent to the application. Clause 2 enables an undertaker to lay cables to a generating station outside its own area by obtaining powers by Provisional Order instead of under special Act as hitherto. Clause 3 deals with "bulk" supply, Clause 5 with supply from a joint committee or board of Local Authorities, and Clause 7 relates to applications for revision of tariff. This last clause, if adopted as it stands, would prove troublesome, as it would make it necessary for the Board of Trade to hold every five years, at the request of but twenty consumers, an inquiry into the tariff charged by an electricity supply company. Clause 8 corrects the present rule as regards the certification of meters by the Board of Trade; Clause 9 specifies that electric lighting accounts are to be made up to March 31st in each year unless cause is shown to the contrary. Clause 10 is similar to the "stand-by supply" clause introduced in many private Acts, and Clause 11 would remove a difficulty which has sometimes occurred in the case of a transfer of powers under a Provisional Order.

THE St. Louis Exhibition, which is to beat all records,—for size at any rate,—was opened on Saturday, and it goes without saying that most, if not all, of the exhibits were in an unfinished condition. It has been an open secret that British manufacturers were anything but clamorous to exhibit their products, and the catalogue issued by the Royal Commission is conclusive evidence on this point. The fact is that our own manufacturers have much to lose and nothing to gain by sending their wares for the world's free inspection. First, there is the cost of transportation and the expenses incurred during the term of exhibition; but, there is the much more serious question as to the advisability of giving foreign engineers an object lesson which, partly owing to England being a Free Trade country, they are so eminently able to turn to good

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account. There is, therefore, small cause for regret that the British exhibit of electrical machinery is so small, especially as there is every reason to believe that the Empire will be adequately represented in other directions.

THE Royal Commission on London Traffic is still hearing evidence, and goes over much old ground. Last week, for instance, Mr. CUNINGHAM and Mr. DEVONSHIRE put forward no new facts, but the clear manner in which they gave their evidence must have done much to impress the Commission as to the eminent suitability of the tube railway and the trolley tramway for dealing with the heavy metropolitan passenger traffic. Of the few longer routes for which fast speed communication has not yet been authorised, that from Hammersmith to the City, along the south side of Hyde Park, via Piccadilly, the Strand and Fleet-street, is one of the most important. Two years ago there were three schemes promoted for this route, one of which was the extension of the Central London Railway into a flat loop, described by Mr. CUNINGHAM in his evidence last week. This extension, if it had been sanctioned then, would now be approaching completion, but unfortunately it was thrown out by the House of Lords in favour of a more ambitious scheme, including through connection from Hammersmith to Palmers Green and Waltham, in the north of London, via the City, a scheme which had to be abandoned before it reached the House of Commons owing to a disagreement between the promoters—the Pierpont-Morgan group and the London United Tramways.

AS a fine piece of engineering work, the London County Council tramways on the slotted conduit system demand respect and approval, but nevertheless the overhead trolley system should still be regarded as the more important one. Owing to the extremely high cost of construction of the conduit system, it should only be employed in such places where the erection of overhead lines is out of the question. This should not have been the case, however, in the greater part of the London County Council network to the south of the Thames, and some of the Borough Councils on the north of the river are forcing the Council to deal with their tramways in the same manner. This is narrow policy on the part of these local authorities, for not only would they get their electric tramways sooner if they consented to the trolley system, but the adoption of this more economical method would save money to their ratepayers, who also pay a rate to the London County Council. As is seen in the report of Lord WELBY'S speech at the London County Council on Tuesday, published on another page, it is not only the difference in actual cost that has to be considered—and this is serious enough—but the cost of adopting the conduit system is also considerably enhanced by the extreme dislocation it occasions to the traffic on the existing lines of tramway, and the consequent loss of revenue.

THE inventive genius of the American engineer is well shown by the names he devises for new forms or uses of machines and tools. It is true that brevity and suggestiveness rather than elegance mark some of these inventions. "Booster" is a case in point and, despite protests, the uncouth word is firmly established among us. In our respect for our neighbour's pipes—and for the law—we have applied the booster to the reduction of potential difference in tramway rails, giving the machine so applied the ponderous name of "negative booster." Across the Atlantic, this use of the booster is yet a novelty—but the name is ready. "Crusher" is the short, sweet and expressive title. Yet there is no reference in the report of the Mosely Commission to the superior instruction in philology or literary grace of which this fact is another proof.

A CONVENIENT summary of the suggestions so far put forward to account for the puzzling phenomena of comets tails, appears in this year's report of the Council of the Royal Astronomical Society. We gather from the report that the first definite theory aiming at an explanation of the existence and behaviour of comets' tails was given in 1882 by FITZGERALD, who showed that the Maxwellian light-pressure exerted by solar radiation on the molecules of a gaseous cometary envelope might be the cause of the observed curvatures of the appendages. FITZGERALD himself, in *The Electrician* of December 14, 1900, noted the difficulty which arises from the small absorption of radiation by gases, and ARRHENIUS suggested, for some such reasons, that condensed particles of matter should replace the molecules of FITZGERALD'S hypothesis. This modified hypothesis was minutely investigated in 1901 by SCHWARZSCHILD, who calculated the repulsion exercised by the sun's total radiation on a single particle, and compared that force with the sun's gravitational attraction. He estimated that, on particles of the most favourable size, the radiation pressure might reach a magnitude about 20 times the gravitational attraction.

AS a matter of fact, astronomical measurements indicate a solar repulsive force about 40 times the attraction of gravitation. Thus, with the most favourable postulates, the Maxwellian light-pressure theory has not yet afforded a complete explanation of the main phenomena. Perhaps a single principle may never suffice to account for the complex effects observed. Such events as the protrusion of quickly-moving jets of luminous matter and the remarkable variations in the nucleus, coma and appendages, recorded in HUSSEY'S recent photographs, may arise from internal actions not directly due to solar radiation. Nevertheless, several speculative physicists have lately propounded distinct self-contained theories. Thus, FESSENDEN thinks the tail may consist of particles carrying negative electricity which move under solar gravitation, nuclear electrostatic attraction and the electrical repulsion of a negatively-charged sun. J. J. THOMSON has suggested that the sun's ultra-violet radiation disengages from the nucleus negative ions which are repelled by radiation pressure. This supposition seems to require the existence in solar radiation of Hertzian waves; a type of radiation as yet undetected at the earth's surface, because, possibly, of its absorption in the upper layers of our atmosphere. Lastly, BOYS is responsible for the suggestion that radio-active substances in the nucleus may give rise to charged atmospheres

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which move in the electrostatic field of the sun—a notion which accords to some extent with BARNARD'S photographic evidence of the extraordinary variety in quantity and in motion of the matter emitted from the nucleus.

WE have found occasion recently to refer to the attitude adopted by opponents of the electrical industry before Parliamentary Committees. Two instances have occurred again during the past week to which we feel bound to draw attention. The most important, perhaps, is that of the Crystal Palace Gas Co., who, in a Bill with which the Beckenham Urban District Council had no connection whatever, sought to impose upon that authority the "Bermondsey" clause. Originally, the Crystal Palace Gas Co. also endeavoured to secure the electrolysis clause which was refused to the Barnet Gas Co. a week ago. This, however, was removed from the Bill at a very early stage, a fact not surprising when it is remembered that last session, when the Beckenham Tramways Bill was before the House of Lords for third reading, this very electrolysis clause was deleted from the Bill after a full discussion in the House. The Crystal Palace Gas Co. were the petitioners in this case also. The "Bermondsey" clause, however, was allowed to remain in the Gas Company's Bill this session until, evidently, it was found that a strenuous opposition would be made to it, and it was only deleted at the last moment. The other matter to which we refer is the insertion of the "Willesden" clause, a modification of the "Bermondsey" clause (see *The Electrician*, Vol. LI., p. 255), in the Ilford Urban District Council Bill, at the instance of the Ilford Gas Co. The facts of the case were reported in our Parliamentary columns last week, and the decision is given this week. The results are not likely to be serious at Ilford, as it is not a new undertaking, but it is to be regretted that another precedent should be made for the insertion of a clause which may do considerable harm to the electricity supply industry.

IN referring to the telegraphic competition between the "All-British" Pacific cable and the cables worked by private enterprise, Sir JOHN WOLFE BARRY, at the half-yearly meeting of the Eastern Extension Australasia and China Telegraph Co., called attention to the tactics which have been adopted in the endeavour to capture traffic for the former. In spite of the assurance given by the Colonial Secretary in 1899 to the effect that the primary object of the new cable was not competition, it appears that energetic canvassers are employed in the capitals of Australia, and that, in addition, all un-routed telegrams, both in Australasia and Great Britain, are forwarded by the Postal authorities via the Government cable. It is by no means certain that such a practice is not an abuse of the monopoly granted to various Post Offices for other purposes, and, in all fairness, the "un-routed" messages from England to Australia should be divided between the two routes, either equally or in the same ratio as the in-coming messages.

House Wiring in South Africa.—We learn that the Cape Town Local Section of the Institution of Electrical Engineers has called the attention of fire insurance companies and architects as well as consumers themselves to the necessity of improving the standard of house wiring work in South Africa.

Tramways and Light Railways Association.—The meeting called for to-day (Friday) at the Society of Arts, when a discussion upon "Running Powers" was to have taken place, has been postponed to a later date, of which due notice will be given by the secretary.

Royal Society.—Among the Papers down for reading yesterday was "A Note on the Action of Radium on Micro-organisms," by Dr. A. B. Green.

The "black" conversazione of the Royal Society will take place on Friday next, May 13th, at Burlington House.

Staffordshire Iron and Steel Institute.—The annual meeting of the Staffordshire Iron and Steel Institute was held at the Station Hotel, Dudley, on Saturday afternoon. The following were elected officers for the ensuing year:—

President, Mr. H. B. Toy; *Vice-President*, Mr. Walter Jones; *Treasurer*, Mr. James Piper; *Secretary*, Mr. W. H. Carder. *Other Members of Council*, Messrs. W. Somers, W. Brooks, R. Edwards, R. Buchanan, H. Pilkington and W. B. Rubery.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
Beissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Dakar—Conakry	April 11, 1904 ..	May 2, 1904

Cable Fire in a London Street.—The daily newspaper reports concerning a slight fire which occurred on the Charing Cross and Strand Electricity Supply Corporation's network in Furnival-street, London, were grossly inaccurate. We are informed that the trouble was due to a leak on a service line which caused a small amount of smoke to come through a pavement-box cover. On opening up, the fault was found in a cast-iron service box in the brick chamber and no damage whatever occurred outside the cast-iron box. A number of fire engines and horse escapes arrived on the scene, but even the latter were not required.

An Improved Tape Perforator.—The *Australian Mining Standard* reports that Mr. John Gell, of the New Zealand Postal Department, has been granted leave of absence for the purpose of visiting England to introduce his new telegraph tape perforator. It appears that the instrument, which is for use in conjunction with Wheatstone senders, is in the form of a typewriter, and that the depression of keys corresponding to the required letters automatically effects the correct perforation and spacing of the tape. Our contemporary asserts that the saving in time which may be effected by the use of the new machine will be very considerable, a speed of 72 words per minute having been attained. The instrument may be worked by compressed air or electricity.

Wireless Telegraph Notes.—A Reuter telegram from St. Petersburg, published in Tuesday's newspapers, states that the Japanese, knowing that the Russians have been intercepting wireless messages, tried a clever ruse to deceive and harass the Russians. For several nights in succession they sent messages purporting to come from the Japanese Admiral ordering preparations to be made for landing, for sending fireships into the harbour, for attacking with submarines, and so forth.

The *Review of the River Plate* publishes the following statement:—"The Marconi Wireless Telegraph Co. has made an offer to establish a station in Argentina to be in communication with Italy. They ask for a monopoly and a heavy yearly subvention. Both of these causes should be sufficient for the offer to be rejected. The working of the company between Canada and England has not been such a commercial success as to warrant the Argentine Government spending a single cent on such a scheme."

Notes on Radium.—According to *Nature*, some experiments by Prof. A. Stefanini and Dr. L. Magri on the influence of radium on the electric spark lead to the following results:—For discharges between two spheres, or between a positively charged point or sphere and negative disc, the discharge is facilitated by radium for short sparking distances and impeded for longer ones. If the disc is positive and the sphere or point negative, the discharge is impeded at small sparking distances

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within a limited interval; in general the effect is nil. For certain sparking distances between a sphere and disc it is possible for radium to impede or facilitate discharge according to which electrode is positive.

New Cut-outs and Switches.—An interesting demonstration of electrical switch gear was given yesterday by Messrs. Cowan and Andrews. Experiments were made with early types of cut-out releases to show why they have failed in practice, and with a continuous-current cut-out release whose action was not seriously impaired by any fall of potential. Demonstrations were also given of an alternating-current discriminating cut-out; of an apparatus for automatically isolating a faulty feeder, even though the potential at the sub-station end fell to zero; and of a novel time-element device having a time lag inversely proportional to the magnitude of the load. A model of a highly ingenious system of remote control extra-high-tension switch gear was also exhibited. Messrs. Cowan and Andrews will repeat the demonstrations to-day, and we hope to publish a full description of the various apparatus next week.

Royal Institution.—The annual meeting of the members of the Royal Institution was held on Monday afternoon, Sir James Crichton-Browne, M.D., treasurer and vice-president, in the chair. The following gentlemen were unanimously elected as officers for the ensuing year:—

President: The Duke of Northumberland. *Treasurer:* Sir James Crichton-Browne. *Secretary:* Sir William Crookes. *Managers:* Dr. Henry E. Armstrong, Sir William Abney, Mr. Shelford Bidwell, Sir Alexander Binnie, Mr. J. H. Balfour Browne, K.C., The Hon. Sir Henry Burton Buckley, Sir Thomas A. De la Rue, Bart., Dr. J. A. Fleming, Sir Victor Horsley, Lord Kelvin, Dr. Ludwig Mond, Sir Owen Roberts, Sir Thomas Henry Sanderson, Sir Felix Semon, and Mr. H. W. Spottiswoode. *Visitors:* Dr. J. Mitchell Bruce, Mr. J. B. Broün-Morison, Dr. F. Clowes, Dr. Mackenzie Davidson, Mr. W. B. Gibbs, Mr. Francis Fox, Mr. C. E. Melchers, Mr. R. Mond, Mr. J. Callander Ross, The Hon. Walter Rothschild, Mr. Maures Horner, Mr. A. A. Campbell Swinton, Mr. J. J. Vezey, Dr. G. Johnstone Stoney and Mr. G. P. Willoughby.

Glasgow Local Section of the Institution.—The fourth annual report of the committee of the Glasgow Local Section of the Institution of Electrical Engineers is to be submitted to the general meeting of the section on Tuesday next. The numerical strength of the section shows a gross increase of 19 in the 12 months and a net increase of four. At the April meeting the committee submitted their list of office-bearers, for the next session, to the members, and as no further nominations have been received, the office-bearers for 1904-1905 are as follows:—

Past Chairmen, Lord Kelvin, Prof. Magnus Maclean, Henry A. Mavor, W. A. Chamen; *Chairman*, Robert Robertson; *Vice-chairman*, Prof. Francis G. Baily; *Hon. Secretary and Treasurer*, E. George Tidd; *Ordinary Members of Committee*, Prof. A. Gray, M. T. Pickstone, Wm. W. Lackie, J. M. M. Munro, John Macfee, Sam Mavor, A. W. Stewart, E. T. Goslin (*Representing Associate Members*), J. R. Stothert (*Representing Associates*).

Newcastle Local Section of the Institution.—The annual general meeting of the Newcastle Local Section of the Institution of Electrical Engineers will be held in the Chemical Lecture Room, Durham College of Science, on Monday next at 7:30 p.m., when the report for the past session will be read and the election of officers and committee for the ensuing session will be made. In pursuance of Article 45 of the Articles of Association of the Institution of Electrical Engineers, the following have been nominated by the present committee for election, and any fresh nominations should reach the secretary of the Newcastle Section not later than May 2nd:—

Chairman, E. Eugene Brown; *Vice-chairman*, Dr. W. M. Thornton; *Past Chairmen*, A. W. Heaviside, J. F. C. Snell, John H. Holmes and Gerald Stoney; *Committee*, Geo. Ralph, Wm. Cross, H. L. Riseley, A. L. E. Drummond, A. E. Le Rossignol, James Pigg, Charles F. Proctor, *C. S. Vesey Brown, *Walter A. Clatworthy, *W. McLellan and *J. F. Lamb; *Hon. Secretary*, Wm. D. Hunter. * Denotes new members proposed.

Wiring Rules of the Fire Underwriters' Associations of Australia.—A revised set of wiring rules has just been issued by the Fire Underwriters' Associations of New South Wales, Victoria, Queensland, South Australia, Western Australia and Tasmania. These rules embody the regulations drawn up by the Institution of Electrical Engineers, and also contain a few special provisions which have been added so as to meet the different climatic and other conditions. It is provided that the circuits of a traction system employing an earthed return must, in no circumstances, be taken into, on, or through any building for light or power purposes, save in the case of the buildings belonging to the system. Owing to the high temperature at times in certain States the maximum current for rubber-covered wires must not exceed the permissible maximum given in the column of the Institution of Electrical Engineers' table for wires exposed to high external temperatures. No conductor may be insulated with pure rubber as sole dielectric, and, if the dielectric consist of vulcanised indiarubber, the conductor must be protected in an approved manner from the action of the vulcanisation. Flexible wires, where exposed to mechanical injury or to the action of flies and other insects, must be protected to the satisfaction of the inspector. Unless under special circumstances, and with the approval of the inspector, no conductors will be allowed to pass through party walls separating two risks. In all damp or other situations where contact between switches and earth can be easily made, no lighting switches will be allowed in which any part of the cover or handle is of metal, unless such metal cover or handle is efficiently and permanently connected to earth.

Opening of Gloucester Tramways.—The Gloucester Corporation tramway system, comprising some 5 miles of double track and 4 miles of single track, was formally opened on Tuesday, May 3rd. The routes, which aggregate about 9 miles, traverse very level ground, the maximum gradient being 1:25, and the sharpest curve has a radius of 40ft. Girder rails, weighing 90lb. to the yard, are employed, and they serve, in conjunction with special return feeders, as a return path for the current. Hard-drawn copper wire (gauge 0) is the material used for the overhead construction. It is suspended from bracket arms, and side trolleys are employed. The equipment of the line was carried out by the British Electric Equipment Co. Vulcanised bitumen feeders of Messrs. Callender & Co.'s make are laid along the side of the road in cast-iron troughs, filled in with bitumen. These cables have a copper section of 0·15 sq. in. and 0·25 sq. in. respectively. Thirty double-deck single-truck cars, holding 41 passengers each, have been built for the Corporation by the Brush Company, and Messrs. Dick, Kerr & Co. Both hand and electric brakes are provided. The gauge of the track is 3ft. 6in. Power is obtained from the Corporation's electricity department, the pressure being 550 volts. Halfpenny fares have been instituted, as well as special rates for workmen and school children. Mr. Walter J. Bache is resident electrical engineer, Mr. E. Edwards is tramways manager and Messrs. Robert Hammond & Son and A. Dickinson & Co. were consulting engineers to the scheme.

Accumulator Traction in Germany.—According to *Elektrische Bahnen*, a full-gauge accumulator car has been running regularly since March 17th between Dresden and the suburbs Cossebaude and Mügeln. The vehicle consists of two single-truck cars, which are permanently connected together by a flexible joint. Four 27 H.P. four-pole motors transmit their power to the axles by gearing, the ratio of reduction being 1:2·21. The two motors on each car are permanently connected in series and form one group. A wheel base of 4 metres (13ft. 1¼in.) has been chosen, and the wheels have a diameter of 1 metre (3ft. 3½in.). A magnetic and a hand brake are provided. The former consists essentially of four solenoids, which actuate the 16 brake shoes by means of a suitable link arrangement. Each solenoid exerts a pull of from 500kg. to 600kg. (1,100lb. to 1,330lb.). The overall length of the car is 18·9 metres (62ft.), and its weight 44 tons. It is built to travel at a speed of 45km. (28 miles) per hour. Each car has a passenger compartment, measuring 20ft. by 10ft. by 8ft. 4in., and altogether 98 passengers are provided for. Stored away in a number of wooden cases, lined with vulcanised indiarubber, are 184 double accumulator cells, the capacity of each being 430 ampere-hours, when discharged at 140 amperes. These cells are placed underneath the seats, which run lengthwise. At the charging station provision is made to charge the battery in series from the tramway supply (480 volts), but means are also provided on the car for splitting up the battery into sections, so that, if necessary, a lower charging voltage may be used. The mean voltage of the battery, when discharging, is 365 volts. In addition to

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8 16c.p. electric lamps, the car is equipped with a few oil lamps. Three doors, two at each end and one at the junction of the two single-truck cars, give access to the interior.

Traction Plant at King's College, London.—The electrical engineering department of King's College, which is under the control of Prof. Ernest Wilson, has recently been augmented by the acquisition of a complete trolley car equipment supplied on exceedingly reasonable terms by Messrs. Dick, Kerr & Co. The equipment consists of a Brill under-truck complete with two pairs of 30in. wheels, brake hangers, shoes and all the electrical accessories. There are two 500-volt series motors, each of which has a normal rating of 37 B.H.P. at 435 revs. per min. The weight of each motor complete is 1,976lbs., and the specification provides for a drawbar pull of 1,640lbs. at the tread of a 30in. wheel, with a temperature rise of 75°F. after one hour's run. Each armature has an outside diameter of 14½in. and the gear ratio is 69/15. The controllers are of Messrs. Dick, Kerr & Co.'s magnetic blow-out pattern, and have emergency brakeing contacts, &c. There is also a circuit-breaker, together with a Garton lightning arrester, rheostats, switches, &c. The trolley pole is 15ft. 16in. in length, and is fitted with a Wilkinson insulated head. A new extension to the existing electrical engineering department, being built by the college authorities, is a spacious apartment 80ft. in length by 25ft. in width and about 25ft. in height. This extension is to be fitted with a Tangye 4-ton overhead travelling crane, and there is also to be a special testing pit 30ft. long by 7ft. wide and 4ft. deep. The truck will stand over this pit, and every possible facility will therefore be available for making tests towards determining efficiency, torque and the allocation of losses in the motors and gearing. A special feature will be the separation of friction from other losses and their determination. The truck and motors arrived at the college separately, but the whole equipment has been erected and wired by the students of the department.

Serious Subway Fire in New York.—In *The Electrician* for April 8th, p. 973, there appeared a note relating to a fire which had occurred in the excavation for the rapid-transit tunnel at the south-west corner of Broadway and Fulton-street in New York city; details of this fire are given in the issue of the *Electrical World* of New York which has just reached us. The site of the fire is described as the spinal cord of the city's underground communications, and the effect not only paralysed local facilities but also suspended for the time being important lines of communication to all parts of the United States and Canada. To make way for the subway structures the contractors had removed the usual protecting manhole provided for the conductors, and had massed the cable thus exposed in a most inextricable tangle. To protect these cables from damage they were wrapped with burlap coverings and surrounded with woodwork. One of the cables which had been damaged was being repaired by a telephone splicer, who employed the usual pot of heated paraffin, melted lead and gasoline stove. For some unaccountable reason the paraffin took fire and flame was immediately communicated to the burlap about the cable and to the woodwork. The heat generated for the time being was intense. The burlap took fire and melted off the lead covering of 22 large telephone cables, containing 5,250 pairs of wires, eight Western Union cables carrying important telegraphic circuits, five postal telegraph cables carrying wires of equal importance, a burglar-alarm cable, a cable of the American District Telegraph Co., a cable of the New York Stock Quotation Co., a city fire-alarm telegraph cable, several circuits of the public telephone system and some other circuits of a miscellaneous nature. The short-circuiting of the telephone wires overloaded the ringing generators and storage batteries of the Cortlandt-street central office. This resulted in the operation of the circuit-breakers. By this means not only were the wires in the cables actually injured thrown out of service, but all of the wires entering at Cortlandt-street, coming in through cables from other directions, were rendered inoperative. In addition to this, a mass of trunk wires extending from the Broad, John and Cortlandt-street offices and going to points north were made useless. To render the Cortlandt-street office inoperative took just 10 minutes. All the other offices were intact, but communication between the three offices mentioned was cut off to all points north and communication between these three offices themselves was also cut off. Included among these injured cables was one of the Pupin cables which had just been laid to replace the overhead west side line so recently removed. The interruption of this cable cut off long-distance communication with points in the east, including New Haven, New London, Providence, Boston and other New England points. Important Buffalo and other up-State wires were also thrown out of service. The confusion which this produced in the business community of New York can hardly be described. Large commercial houses, newspaper offices and other large concerns tried in vain to find a substitute for the telephone. Some of them went temporarily out of business. To meet this emergency the resources of the New York Telephone Co. were not found wanting, but it was impossible to employ in the very limited area where the damage occurred more than 25 men at a time. Within an hour and a-half of the accident all the long-distance wires in the Pupin cable were restored to service. By afternoon the damaged local wires began to operate and at nightfall 800 of the damaged trunk lines were in successful operation and 200 of the subscribers' lines were restored. By the morning of Thursday a still further increase in the number of wires was reported and by Thursday night the entire telephone system was again working. The accident called attention to the inestimable value of the New York telephone service, and served to bring to public attention in the most sensational manner the utter paralysis of business which would result were the entire telephonic and telegraphic system suspended.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, May 6th.

PHYSICAL SOCIETY.

8 p.m. Ordinary Meeting at the Royal College of Science, Exhibition-road, South Kensington. [The change of date from May 13th to May 6th has been made owing to the Royal Society having chosen the former date for the annual conversazione.] Agenda: (1) "An Experiment with Lubricating Oil," by W. A. Price; (2) "Some Instruments for the Measurement of Large and Small Alternating Currents," by W. Duddell; (3) Exhibition of Apparatus from the National Physical Laboratory.

MONDAY, May 9th.

INSTITUTION OF ELECTRICAL ENGINEERS: NEWCASTLE LOCAL SECTION.

7:30 p.m. Annual General Meeting at the Durham College of Science, when the report for the past session will be read and the election of officers and committee for the ensuing session will be made.

FARADAY SOCIETY.

8 p.m. Meeting in the Library of the Institution of Electrical Engineers, 92, Victoria-street, S.W. Papers to be read: (1) "Studies in Viscosity," by C. E. Fawsitt; (2) "The Electrolytic Oxidation of Anthracine," by A. Fontana and F. Mollwo Perkin.

TUESDAY, May 10th.

INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.

8 p.m. Meeting at 207, Bath-street, Glasgow. Agenda: (1) Report of Committee; (2) "Corporation Telephones," by A. R. Bennett (adjourned discussion); (3) "Electric Hauling Machinery for Collieries and Allied Purposes," by Maurice Georgi (reply to discussion).

THURSDAY, May 12th.

THE JUNIOR INSTITUTION OF ENGINEERS.

6 p.m. Visit to the works of the Great Northern, Piccadilly and Brompton Railway.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting at the Society of Arts, John-street, Adelphi. Conclusion of discussion on Messrs. Merz and McLellan's Paper on "Power Station Design," if necessary. Paper to be read: "The Steam Turbine as Applied to Electrical Engineering," by Messrs. Parsons, Stoney and Martin.

FRIDAY, May 13th.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.

8 p.m. Meeting at the Royal College of Science. Messrs. Merz and McLellan's Paper on "Power Station Design," read in London, will be discussed, following which M. J. H. Dowling will describe a small magnetic separator for iron filings.

ROYAL SOCIETY.

9 p.m. Conversazione at Burlington House, Piccadilly.

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THE ST. LOUIS EXHIBITION.

On Saturday afternoon the St. Louis Exhibition was opened by President Roosevelt, who pressed a golden button in Washington and thus set the exhibition machinery in motion. Everything passed off successfully, and the weather was all that could be desired. It is said that the public interest in the exhibition is very feeble in New York. *The Times* correspondent affirms that the "ivory city" of St. Louis surpasses the "white city" of Chicago, and that certain of the buildings are exquisitely proportioned and gracefully decorated, and are likely to surprise European architects. Japan's national exhibit is more nearly complete than any other, France is far behind and Germany is not much better. Russia has withdrawn her exhibit since the commencement of the war. Altogether, 50 foreign Governments have provided elaborate displays and 19 of these have erected national pavilions.

The *Western Electrician* of Chicago states that the first meeting of the International Electrical Congress reception committee of the American Institute of Electrical Engineers was held in New York on March 24th, at which the following itinerary for the tour of the European visitors was proposed and accepted. The details of the tour were thoroughly discussed, and while there was a feeling that it would be a severe tax upon the visitors, it was difficult to see how the trip could be curtailed without omitting some desirable and important features. Ladies are expected, and special arrangements will be made to ensure their comfort. The foreign guests of the Institute are expected to arrive in New York previous to September 3rd. After this date the itinerary will be as follows:

Sunday, Sept. 4, 1904—**New York City**: Steamer ride up the Hudson River. *Monday, Sept.* 5: The visitors will inspect points of engineering interest in New York city. In the evening there will be a reception under the auspices of the American Institute of Electrical Engineers. *Tuesday, Sept.* 6—**Schenectady, N.Y.**: The party will be received and entertained by the General Electric Co. at Schenectady. *Wednesday and Thursday, Sept.* 7 *and* 8—**Montreal, Canada**: Reception at McGill University, Montreal, and visits to the important power transmission plants in the vicinity. *Friday, Sept.* 9—**Niagara Falls, N.Y.**: Visit to the Falls and the important power houses and electrical industries of the locality. *Saturday, Sept.* 10—**Chicago, Ill.**: Visits to important power houses and local points of interest. *Sunday, Sept.* 11—**St. Louis, Mo.**: To be spent in St. Louis. *Monday, Sept.* 12—Opening of the International Electrical Congress at 10 a.m., with joint sessions of all of the sections. *Wednesday, Sept.* 14—Special joint session between the American Institute of Electrical Engineers and the British Institution of Electrical Engineers, to which all foreign guests are invited. *Sept.* 13, 14, 15 *and* 16—Sessions of the various sections of the Congress each day from 9 to 12 a.m., and from 1:30 to 4:30 p.m. *Saturday, Sept.* 17—Closing general sessions of all sections of the International Electrical Congress. *Monday, Sept.* 19—**Pittsburg, Pa.**: Reception and entertainment by the Westinghouse Company, and visits to important and interesting local industries. *Tuesday, Sept.* 20—**Washington, D.C.**: Inauguration of the National Bureau of Standards at Washington and visits to places of local interest. *Wednesday, Sept.* 21—**Philadelphia, Pa.**: Visits to important power houses and points of interest. *Thursday, Sept.* 22—**Boston, Mass.**: Visits to power houses, Harvard University, Massachusetts Institute of Technology and places of local interest. *Friday, Sept.* 23—Unassigned.

As an executive committee of the general reception committee the following have been selected:—Messrs. F. J. Sprague, J. J. Carty, J. C. Barclay, Calvert Townley, H. W. Leonard, I. B. Stillwell, George G. Ward, E. H. Mullin, H. G. Stott, J. G. White, F. W. Jones, J. W. Lieb, jun. The following were elected chairmen of the local reception committees:—New York, Mr. T. C. Martin; Schenectady, Mr. E. W. Rice, jun.; Montreal, Prof. R. B. Owens; Niagara Falls, Mr. George W. Davenport; Chicago, Mr. Samuel Insull; St. Louis, Lieut. W. V. N. Powelson; Pittsburg, Mr. Charles F. Scott; Washington, Mr. O. T. Crosby; Philadelphia, Mr. J. B. McCall; Boston, Mr. C. L. Edgar.

The *Electrical World* of New York states that the following Papers are promised for Section A—the section on "Theory"—of the Congress, of which Prof. E. L. Nichols is chairman and Prof. H. T. Barnes secretary:—

Prof. Dr. Paul Drude, "Metallic Conduction"; Prof. Dr. W. Jaeger, "Electrical Standards"; Sir Oliver Lodge, F.R.S., "Ions"; Prof. H. Nagaoka, "Magneto-striction"; Prof. Dr. J. J. Thomson, F.R.S., subject to be announced; Prof. J. S. Townsend, F.R.S., "The Theory of Ionisation by Collision"; Mons. J. Violle, "Secondary Standards of Light"; Mr. C. T. R. Wilson, F.R.S., "Condensation Nuclei"; Prof. P. Zeemann, "Magneto-optics." Prof. H. T. Barnes, "The Mechanical Equivalent of Heat as Measured by Electrical Means"; Dr. Carl Barus, "Atmospheric Nuclei"; Dr. Louis A. Bauer, "The State of Our Knowledge Regarding the Earth's Magnetism"; Prof. D. D. Brace "Magneto-optics"; Prof. H. S. Carhart and G. W. Patterson, jun., Ph.D., "The Absolute Value of the Electromotive Force of the Clark and Weston Cells"; Prof. C. D. Child, "The Electric Arc"; Dr. K. E. Guthe, "Coherer Action"; Prof. E. P. Lewis, "Electrical Discharges in Gases"; Prof. L. T. More, "Electrostriction"; Prof. E. Fox Nichols, "The Unobtained Wave Lengths Between the Longest Thermal and the Shortest Electric Waves yet Measured"; Prof. E. L. Nichols, "Standards of Light"; Harold Pender, Ph.D., "Magnetic Effect of Moving Charges"; Dr. M. I. Pupin, "Electrical Theory"; Dr. Edward B. Rosa, "Alternating-current Measurements"; Prof. E. Rutherford, "Radio-active Change"; Prof. J. C. McLellan, "Radio-activity of the Atmosphere"; Prof. J. Trowbridge, "Electrical Discharge in Gases"; Prof. A. G. Webster, "Electrical Theory."

Acceptances of membership in the Congress number over 1,300 up to the present time, and 150 Papers have been promised in all. The following societies have all promised to hold conventions at St. Louis during the Congress week, and to hold conventions with one or more sections of the Congress:—The American Institute of Electrical Engineers, American Physical Society, American Electro-Chemical Society, American Electro-Therapeutic Association, International Association of Municipal Electricians. The British Institution of Electrical Engineers has also arranged to co-operate under some plan, the details of which have not yet been determined. The following bodies have promised to co-operate by sending delegates:—The Société Internationale des Electriciens, National Electric Light Association, Association of Edison Illuminating Companies. Co-operation is expected from various other societies.

The official catalogue of the British Section at the Exhibition has been issued by the Royal Commission, and it appears that very little British electrical machinery is being exhibited. A perusal of the catalogue does not reveal the existence of a single dynamo or motor, although instrument makers will occupy considerable space, and there will also be a few telegraph and telephone exhibits. Further particulars in regard to the exhibitors will be found in our Trade Notes columns.

POWER STATION DESIGN.*

BY C. H. MERZ AND WM. McLELLAN.

(Continued from page 53.)

The designs of the Carville works† and those shown in Figs. 5 and 6 are typical of the three possible arrangements so far as relative positions of engines and boilers are concerned. Fig. 3 may be considered most suitable for power stations up to 5,000kw. The arrangement shown in Fig. 6 with the double row of boilers has been extensively adopted both in this and other countries. It has, however, many objections—it is difficult to allow for unlimited extension, and the steam and feed piping are considerably longer than in other arrangements. For all power stations of over 5,000kw. capacity, especially stations for power supply (which must be designed for large extensions) the authors consider the arrangement as at the Carville works or that shown by Fig. 4 the best and most flexible. It may be specially noted how this design facilitates an alteration in the size of units without upsetting the general arrangement of the station, as the extension boiler houses may be longer.

The arrangement of the auxiliary plant (including in this term all piping and cable connections) is a most important factor in the design of the engine room. A design which probably originated on the Continent, and which is carried out there extensively, has also been largely adopted in this country—*i.e.*, the provision of a basement to contain all pipes and auxiliary machinery. Experience has shown this to be an extravagant method, affecting adversely both capital and running costs. It is also expensive in running wages, as unless the plant be allowed to run with practically no attention, more men are required, and it is expensive in repairs on account of the difficulty of providing lifting tackle and the necessity of working entirely with localised artificial light. Against these objections the only advantage is a clean engine-room floor. Various arrangements have been adopted by engineers to avoid the inherent defect of installing the auxiliary apparatus in the basement. The provision of wells or pits instead of a basement in the main engine room has been frequently adopted, and though this arrangement hardly gets over the difficulty with regard to piping, it certainly reduces the supervision and attention required.

The turbine, on account of the small floor space which it occupies, has simplified matters immensely, as with it all apparatus can

* Abstract of a Paper read before the Institution of Electrical Engineers on April 28th.

† Illustrated in *The Electrician*, Vol. LI., p. 238.

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easily be put on the one floor, or (as is desirable on account of increased efficiency) the condenser may be placed directly *below* the turbine ;* in the latter case, the turbine, as it requires little or

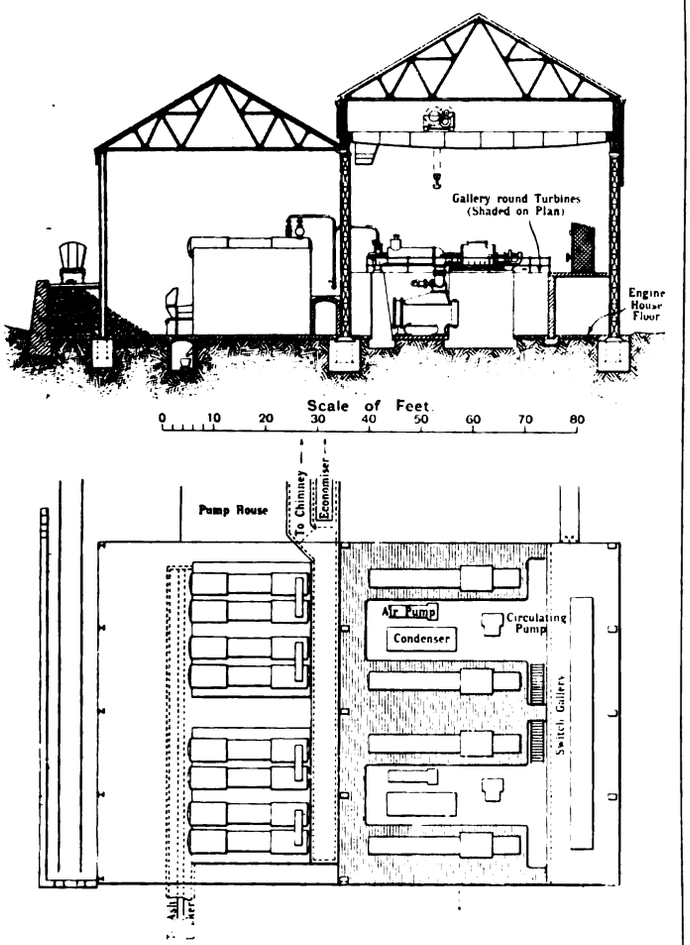

FIG. 5.—DESIGN OF POWER STATION, WITH SINGLE ROW OF BOILERS.

no attention, can be left to run by itself at a higher level with merely a gallery round it. The auxiliary apparatus, requiring, as it does, much more attention, can then be put on what may be regarded as the main floor. Both arrangements allow of all apparatus being conveniently handled by the main crane—though neither provides that perfect-looking engine room which is a feature of many Continental stations.

* The General Electric Co. of America are developing their Curtis turbine with a condenser in the base of the turbine itself, which at once secures this advantage. In the case of small units it is an advantage to provide a condenser for each pair of sets, as in this way at light loads the advantage of a high vacuum is obtained.

3. SPARE PLANT AND THE RATING OF PLANT.

The whole question of spare plant and its proportion to the output of the station is an important one in design—as also is that of securing the correct relative capacity of the various pieces of apparatus making up a complete unit: the boiler, the engine, the generator and the switch gear. On the one hand, if the various components in the station which make up a complete unit have different degrees of reliability, or if some require more overhauling and inspection than others, then obviously different margins of spare plant are required. Again, while every piece of apparatus may be said to have one point at which it works at maximum economy, overload capacity is generally obtainable at small expense, though possibly by some sacrifice of running economy.

In a gas engine, as the economical rating coincides with the maximum rating, both peak and breakdowns can only be met by installing additional plant. In the case of a steam station, if the load under normal (not peak) conditions is equal to the economical rating of one machine only, then it is clear that while it might be possible to take care of the peak with the overload capacity of that machine, an additional unit is essential to allow for periodical overhaul and to guard against failure through the breakdown of a unit section.

The three factors to be met by the installation of machines having an overload capacity and by the provision of spare machines are: (1) the peak, (2) periodical overhaul, (3) breakdowns. Whether any or all of these factors are best met by additional plant or by overload capacity depends on the number of units installed and on the relation between the peak and the overload capacity procurable; but in any case it seems to us important to take the overload capacity into consideration in designing a station, and to consider it a feature in design—not merely a casual advantage which may happen to come in useful. We attach 12 typical load curves, one for each month of the year 1903 for the Neptune Bank power station (Fig. 7). As a matter of fact, if we take the year in question and consider the normal load as 100, the peak load is 100 per cent. higher, or 200. The total number of units sent out of the station while the load was at or below normal (100) was more than 80 per cent. of the total number of units sent out during the year. In other words, if this 100 per cent. peak is represented by 100 per cent. extra plant, the 100 per cent. of extra plant only turned out a proportion of the balance of 20 per cent. of the total units.

While, therefore, it is important that the plant should operate economically at normal rating, it is of equal importance that it should have a uniformly high overload capacity. Little regard need be paid to the running costs at the peak, as the resulting fractional increased coal consumption is far more than balanced by the saving in capital charges.* The steam turbine lends itself admirably to dealing with large overloads, as by means of a by-pass admitting high-pressure steam to the low-pressure section of the turbine the capacity of the turbine can be increased 50 per cent., though this is, of course, accompanied by a certain drop in economy. Standard designs of alternators can be built without excessive cost to stand

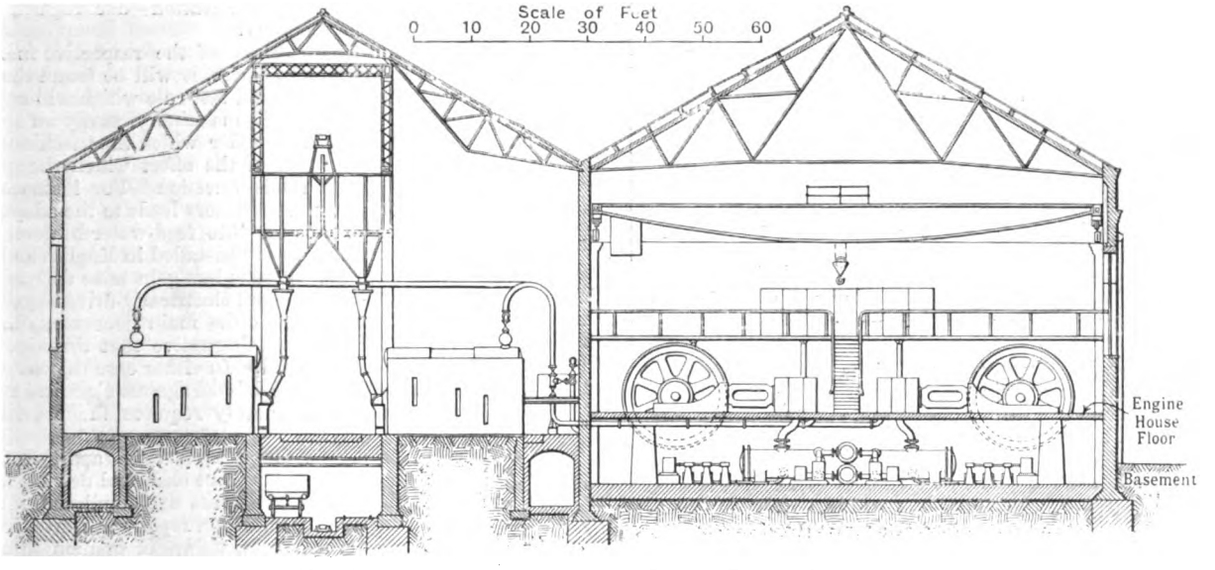

FIG. 6.—GENERATING STATION, WITH DOUBLE ROW OF BOILERS.

* It does not follow that even the fuel costs must necessarily be increased by forcing the plant at the peak. In the case of a very short peak, such as is formed by the load of works which shut down at five o'clock overlapping the lighting load, the all day economy of the boiler house may be actually improved, due to the fewer boilers kept under steam. On account of possible low steam pressure, however, this is only safe with proper induced draught, giving ample margin for forcing.

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an overload of 50 per cent. for two hours. If, therefore, the boiler plant has a similar range of elasticity, the peak can be met by simply forcing all plant beyond its economical production point, and by doing the same in the engine room if any of the units are out of commission for overhaul. There is no great difficulty in securing that the boilers shall have the necessary elasticity even under natural draught, but under mechanical draught the solution is easy. In fact, the adoption of artificial draught improves the control of the boiler-house plant so enormously under ordinary conditions that it is, in our opinion, desirable to instal it, apart altogether from the question of emergency output.

Apart from actual personal experience, it is only by comparing one station with another that an engineer can hope to improve his design, so far as low capital cost is concerned. It is, therefore, important that the basis of comparison should be fair and uniform, but it is not a particularly simple problem to define what this uniform basis should be. It is evident, for instance, that for all practical purposes a station containing, say, four steam turbines, each of a normal economical rating of 2,500kw., is of larger capacity than a station containing two turbines each of a normal economical

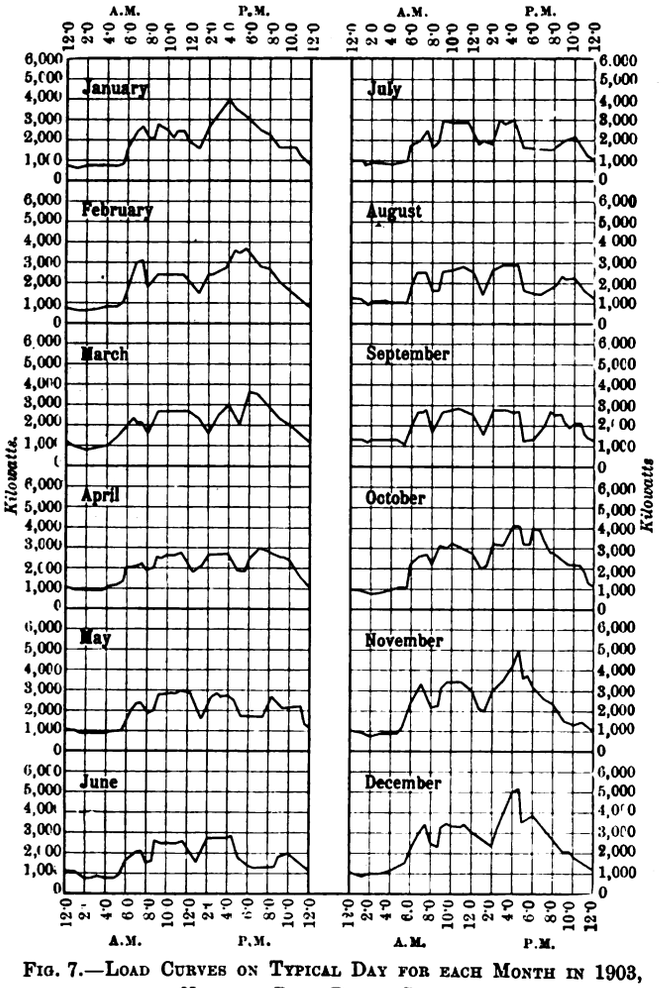

Fig. 7.—Load Curves on Typical Day for each Month in 1903, Neptune Bank Power Station.

rating of 5,000kw., while these steam stations are respectively of larger capacity than a gas-engine station containing four units of 2,500kw. normal economical rating, or two units of 5,000kw. normal economical rating. There are eight different ways in which a station may be rated :—

1. On the basis of the maximum *possible* load which the station is capable of dealing with continuously, making no allowance for spare plant.

2. On the basis of the maximum *economical* load which the station is capable of dealing with continuously, making no allowance for spare plant.

3. On the basis of the maximum *possible* load which the station is capable of dealing with continuously, *less an allowance for spare plant.*

4. On the basis of the maximum *economical* load which the station is capable of dealing with continuously, *less an allowance for spare plant.*

5. On the basis of the maximum *possible* load which the station is capable of dealing with *for a short period*, making no allowance for spare plant.

6. On the basis of the maximum *economical* load which the station is capable of dealing with *for a short period*, making no allowance for spare plant.

7. On the basis of the maximum *possible* load which the station is capable of dealing *for a short period, less an allowance for spare plant.*

8. On the basis of the maximum *economical* load which the station is capable of dealing with *for a short period, less an allowance for spare plant.*

Of the above, No. 4 would seem, at first sight, to be the most reasonable—*i.e.*, rating the station on the basis of the maximum economical continuous output, making due allowance for spare plant. This would certainly be correct if we were dealing with load-factors of 100 per cent., as, of course, in such cases practically the only value of overload capacity is for dealing with a sudden emergency due to the failure of one of the running units. As, however, we are considering essentially a station for power supply where the load-factor over the year may be expected not to exceed 25 to 30 per cent., low cost of production will be facilitated by the engineer considering capital expenditure rather from the point of view of the most economical way of dealing with the peak-load, or in other words, if in estimating the capital cost he considers that the rating of the station is based on its maximum possible output for one or two hours—that is to say, on the basis of No. 5. The authors consider that by proper attention to spares and overload capacity the cost per kilowatt of maximum output of a power station can be reduced from 20 to 40 per cent., depending, of course, on the load-factor to be dealt with.

The selection of a suitable size for the generating units is a question which is intimately associated with that of spare plant and capital cost, more particularly where future extensions are taken into account. That the *number* of units should be kept as low as possible (especially with steam turbines) may be taken as axiomatic ; and this, of course, points to units of large size. On the other hand, a limit is set to this reduction in *number* by the following factors :—(*a*) The amplitude of load variation throughout the 24 hours, or at different seasons of the year. (*b*) The capital cost of spare plant. In general, a solution which meets (*b*) will also be consistent with (*a*).

(4) Auxiliary Machinery.

A careful analysis of the repair and labour accounts of any power station, especially one where steam turbines are installed, shows that a very large percentage of the items are accounted for by the auxiliary machinery and apparatus. When we also consider that they represent about 10 per cent. of the total power installed in the station, it is evident that, in order to fulfil the essential conditions we have laid down, it is worth while devoting considerable attention to the choice and arrangement of this apparatus. When a main unit is running, the whole of the corresponding auxiliary plant is operating at practically full load, whatever be the load on the main unit. As a consequence, the auxiliaries are responsible for about 15 per cent. of the total coal bill of the station—due regard, therefore, should be paid to their economy.

After making a careful balance-sheet of the respective merits of steam and electrically-driven auxiliaries, it will be found that it is impossible to lay down any hard-and-fast rule which will apply to all cases or to all classes of auxiliary machinery, partly on account of the widely-different conditions under which the machinery has to operate, and partly on account of the effect which the general design of the station has on this question. For instance, the American practice of omitting economisers leads to the adoption of steam-driven auxiliaries exhausting into feed-water heaters, while as economisers are almost universally installed in English and Continental practice it follows that there is less gain to be derived from exhaust steam-feed heaters.* To adopt electrically-driven auxiliaries either involves that the capacity of the main generating units be increased by 10 per cent., or as an alternative that this amount of special generat ng plant be installed. In either case the cost of the additional generating plant must be debited against electrical auxiliaries, as steam-driven apparatus merely requires the provision of the additional boiler capacity.

It will almost invariably be found that, even apart from the question of reliability, it is best to adopt electrical driving for the machinery in the boiler house. The units are small, and if steam driven wasteful of steam and expensive in repairs and attendance.

As to the circulating and air pumps, we are of opinion that here also electrical driving is preferable, save only in the case of stations having slow-speed reciprocating main engines, where the air pumps may with advantage be driven direct from the main sets. The circulating pumps have occasionally to be situated some distance from the station, in which case electrical operation is especially advantageous.

* In this connection it may be noted that the installation of economisers offers more attractions with mechanical draught than with natural draught; in the former case the temperature of the flue gases at the base of the chimney need not be considered, and as a consequence they may be deprived of more heat.

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The feed pumps are a more difficult problem. They operate at v riable speed, whereas all other auxiliary plant in the station operates at constant speed. In addition to this, steam feed pumps have for years been standardised—their first cost is low and their reliability high. They are needed even when the boiler fires are banked, and when no plant is running in the station; and though this last argument is admittedly not a weighty one, it would appear desirable to put down steam-driven feed-pumps for, at any rate, the first instalment of plant. That this system of having steam-driven feed-pumps at the commencements and electrically-driven feed-pumps for extensions has much to commend it is evidenced by the fact that it has been adopted in many cases, both in this country and abroad.*

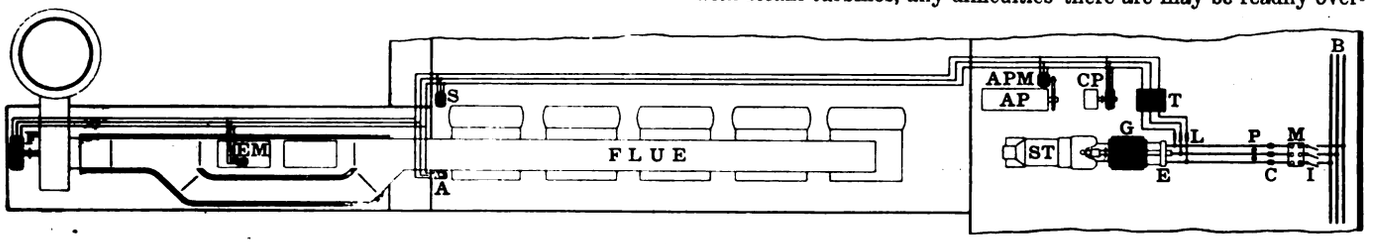

FIG. 8.—DIAGRAM SHOWING COMPLETE UNIT SYSTEM FOR OPERATING AUXILIARIES.

A Ash-handling Motor.	P Potential Transformer.	G Main Generator.	E Exciter. L Link Fuses.	E M Economiser Motor.
C Current Transformers.	A P Air Pump.	S Stoker Motor.	S T Steam Turbine.	M Main Oil-Switch.
F Fan Motor.	C P Circulating Pump & Motor.	A P M Air Pump Motor.	B 'Bus Bar.	T Transformer.

There are four obvious methods of driving electrically the auxiliary machinery:—

1. From the main 'bus bars.
2. From the main 'bus bars with a reserve battery.
3. From separate generating sets.
4. From separate generating sets, with the addition of a connection to the main 'bus bars to meet emergency conditions.

Of these (1) is the simplest method, the objection being that a total failure of supply stops not only the main units, but the auxiliaries—thus extending the duration of the failure owing to the necessity of again starting up the auxiliaries before the main units can be got under way.

The second alternative has the advantage that the auxiliaries can always be kept running even though the main plant be shut down. It is, however, more complicated than (1), particularly in an alternate-current station, as it involves the interposition of a motor generator between the 'bus bars and the battery.

The most flexible system is (3), especially when the station is of sufficient capacity to justify the erection of auxiliary generating units of reasonable size. There still exists the possible danger due to failure, this can either be met by the instalment of a battery or by taking current in emergency from the main 'bus bars on the lines of (4). This latter method offers many advantages, as it is preferable that the motors installed should be of the polyphase type.

If polyphase motors be adopted and if, as would appear desirable, steam feed-pumps are installed in the first instance, then as continuous current is required for excitation both the feed-pumps and exciters may be left out of consideration, and it is of less importance than it otherwise would be to guard against failure of the polyphase auxiliaries. It is therefore justifiable, with the ultimate adoption of (4) in view, to start the first instalment of a power station with polyphase auxiliaries operated through stationary transformers from the main 'bus bars, without, for the time being, providing any alternative source of supply, the separate generating unit for operating auxiliary plant alone would not be installed until justified by the load. In other words, method (1) may be adopted in the first instance with the idea of ultimately arranging for (4).

There is a further possible method—an extension of the complete unit system—which possesses many attractions, though, so far as we know, it has not been used anywhere. It consists in driving the whole of the auxiliaries from the particular main unit which they serve by connecting stationary transformers direct to the alternator terminals, these transformers being of sufficient capacity to operate air pumps, centrifugal pumps, stoker, induced draught fan, and even, if desired, feed pumps—all in permanent connection through a switch with the main unit. In starting up, the switches controlling air pumps and centrifugal pumps may be left in and the field of the main generator excited. These auxiliaries would then start up with the main machine, just as if they were mechanically coupled or geared to it. Flexible connections would be provided so that motors, feed pumps or induced draught fans could be used as spares for other sets, but normally each main unit would deal with its own auxiliaries and would be independent of all others. The chief advantages offered are simplification and consequent saving in switch gear, and also, we think, increased reliability. It will be seen that the 'bus bars are protected from any failure of the stationary transformer by the main machine switch (see Fig. 8).

We now come to the question of excitation—one which has always attracted considerable attention. Numerous attempts have been made to run each exciter from the main shaft of its own alternator, but this method has not been generally adopted, chiefly due to the fact that in any variation of speed this variation, and the variation of the exciting current, have a cumulative effect on the 'bus bar voltage, and this effect is heightened by the unstable nature of a small low-speed direct-current machine. The authors are, however, of opinion that with high-speed engines, and more particularly with steam turbines, any difficulties there are may be readily overcome, and that the simple arrangement of coupling the exciter to the end of the alternator shaft may be safely adopted.

The modern practice of operating all switch gear electrically almost necessarily involves the use of a small battery. It is convenient to utilise this battery to excite the fields of the direct-coupled exciters—it may also be used as a spare to meet the possible failure of one of the exciters. Such an arrangement

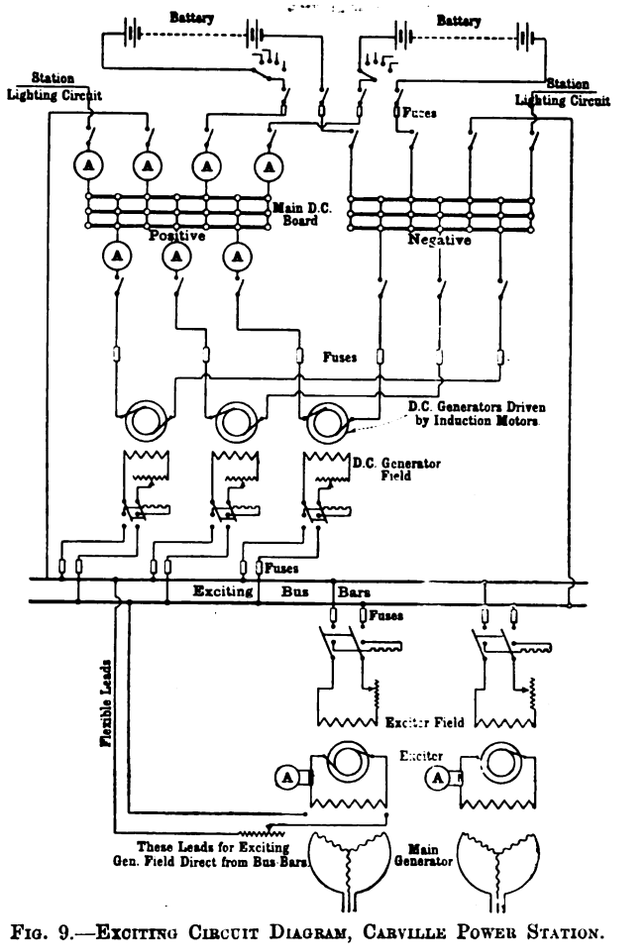

FIG. 9.—EXCITING CIRCUIT DIAGRAM, CARVILLE POWER STATION.

carried out is shown in Fig. 9. Here two batteries are installed, from one or other of which the exciter field current is normally supplied, but should an exciter break down the battery may be used for exciting the alternator direct. Two batteries are installed so that there may be no variation of exciting voltage while one is being charged, and the batteries, in addition to supplying current for excitation and for operating the electrical switches, can feed the emergency lighting circuits throughout the station.

(To be continued).

* The balance of advantages would still further lie with electrically-driven auxiliaries if it were possible to obtain efficient rotary feed and air-pumps. There is no inherent difficulty in designing the former, and they have been installed in various places.

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ALTERNATORS IN PARALLEL.*

BY H. BOHLE.

(Concluded from page 24.)

It will readily be seen from the preceding remarks that the asynchronous generator has several distinct advantages over the synchronous machines, not only as regards parallel working, but also considering cos ϕ. It has, however, one great disadvantage—the machine is too expensive, on account of the large amount of copper required for the rotor, and only in special cases will this type of generator be able to compete with the ordinary synchronous machines. Mr. Heyland has, however, vastly improved upon his earlier type, and his new type of compensated and self-exciting generator looks more like a synchronous machine, but it combines the good qualities of both machines, while the great disadvantage of the asynchronous generator—viz., its high price—is overcome.

A general diagram of this machine is shown in Fig. 55. For further details the articles of Kolben and Heyland, in the *Electrotechnische Zeitschrift* and *The Electrician*, 1903,† may be referred to.

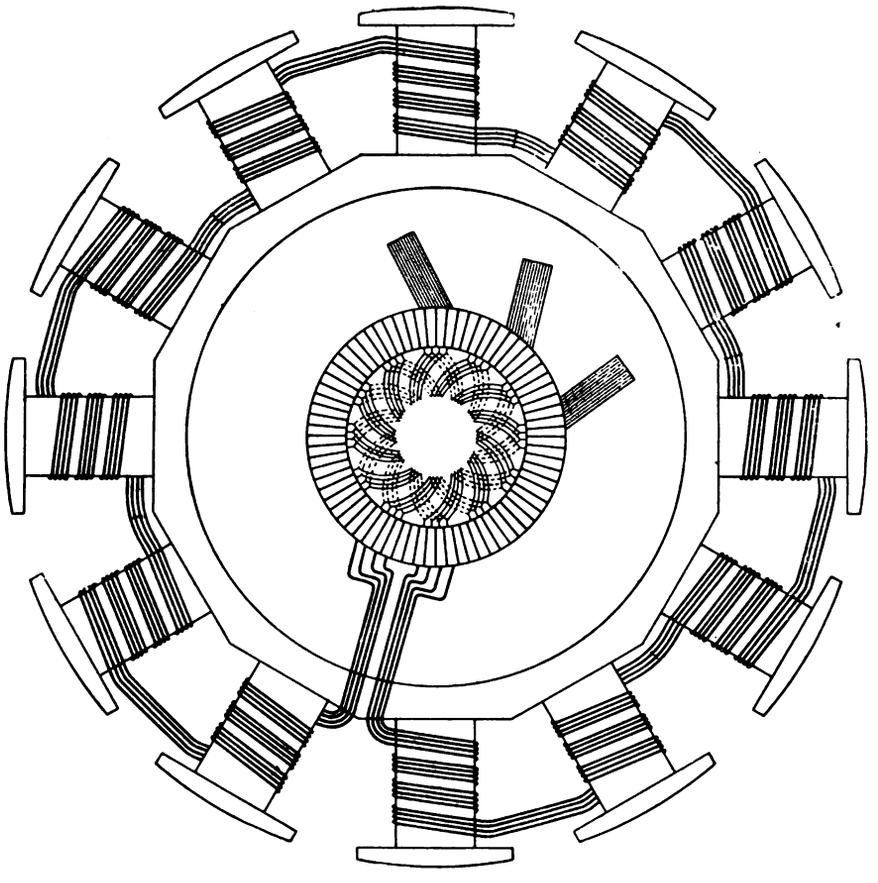

FIG. 55.

Now connect a synchronous generator in parallel with an asynchronous generator, see Fig. 56. (See "Asynchrone Generatoren," by C. Feldman.) Let SG be the synchronous generator, and AG the asynchronous machine, both being connected to the same mains. The impedance of the net between two wires, $I_p = \sqrt{r^2+(2\pi n_1 l)^2}$, where n_1 is the frequency of the stator current, r the resistance of the network between two wires, and l the induction coefficient. The power-factor of this circuit is r/I_p. With a terminal tension $E_T = E_m \sin 2\pi n_1 t$. I_p carries a current whose maximum value $C_{max} = E_m/I_p$, and whose instantaneous value

$$C = \frac{E_m r}{r^2+(2\pi n_1 L)^2} \times \sin 2\pi n_1 t - \frac{E_m 2\pi n_1 l}{r^2+(2\pi n_1 l)^2} \times \cos 2\pi n_1 t.$$

If, now, we connect to the same network an asynchronous machine (assume first a motor), the latter takes a current

$$C_a = \frac{E_m P}{P^2+Q^2} \times \sin 2\pi n_1 t - \frac{E_m Q}{P^2+Q^2} \times \cos 2\pi n_1 t,$$

and the current delivered by the synchronous generator

$$C_s = C + C_a = \left(\frac{r}{I_p^2} + \frac{P}{P^2+Q^2}\right) E_m \sin 2\pi n_1 t - \left(\frac{2\pi n_1 l}{I_p^2} + \frac{Q}{P^2+Q^2}\right) E_m \cos 2\pi n_1 t. \quad . \quad (35)$$

In this equation $P = R_1 + \frac{n_1 M_2}{(n_1-n_2)\Delta^2}$ where R_1 is the resistance of each stator phase, M the coefficient of mutual induction, and Δ the induction coefficient of rotor.

$$Q = 2\pi n_1 \frac{L_1 \Delta - M^2}{\Delta};$$

L_1 is the induction coefficient of the stator.

The first expression of equation (35) represents the watt current, the second the wattless current of the synchronous generator. The equation shows, further, that the synchronous generator supplies the total watt current, and the total wattless current for the network and asynchronous motor. Let the indice n represent watt components, l wattless components, then

$$\left.\begin{aligned} C_{sn} &= C_s + C_{an} \\ C_{sL} &= C_L + C_{aL} \end{aligned}\right\} \quad \text{and} \quad . \quad . \quad . \quad . \quad (36)$$

But now C_{an} becomes negative when n_2, the frequency of the rotor, becomes greater than n_1. If, therefore, the asynchronous motor is run at a higher frequency than that of the network it will supply watt current into the network, but the total wattless current is always supplied by the synchronous generator.

If there are several asynchronous generators with such regulation, so that with increasing velocity they give increasing energy into the network, they may be joined in parallel without troubling about synchronism. The fastest running asynchronous generator will supply the most energy, the machine running accidentally synchronously, none whatever. But the latter will supply all the wattless currents, and its drop will influence the whole network,

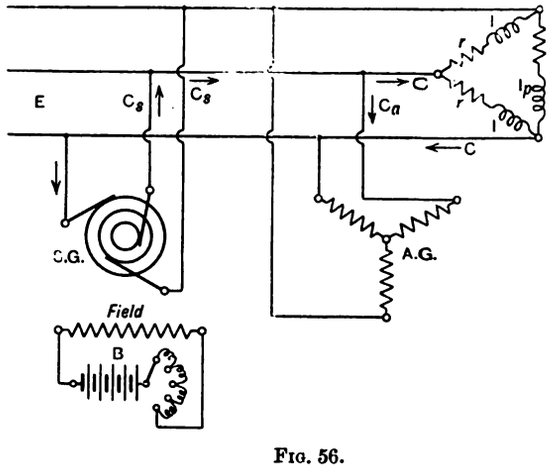

FIG. 56.

because the asynchronous generators draw their excitation, indirectly, from the network, and adjust their pressures accordingly.

Sometimes it may seem advisable to drive two alternators by one engine, synchronising on each occasion being then, of course, not required. The machines must be fixed upon a common shaft, in such a way that no synchronising currents will be produced. But this cannot be done by simple measurement, and one of the generators should be movable through a small angle, the exact synchronising position being found by trial. For this purpose the amperemeter, which will show the presence of any synchronising currents, must be studied, and the position of the inductor on the shaft should be altered, until the synchronising current has practically disappeared. The distribution of the load takes place by means of the exciter regulator, similar to direct-current generators. It is seen the proceedings are here extremely simple, but generally the arrangement is not a very economical one. If the load is fairly constant a single large set is preferable, but if the machines are only partly loaded for any length of time, two separate sets are more economical. To this must be added that, on account of load fluctuations, one or the other machine will tend to take up a leading or lagging position, but cannot do so, as both machines are fixed to the same shaft. The result will, however, be continual twisting of the shaft, which necessitates very large shaft dimensions.

* Paper presented at the Leeds Local Section of the Institution of Electrical Engineers, Jan. 21st. (See *The Electrician* of Jan. 22nd, p. 511.)

† *The Electrician*, Vol. LI., p. 969.

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The proceeding of switching alternators driven by gas engines into parallel, is even more difficult than in the case of steam-driven plants. This is partly due to the great speed variation, and to the fact that the coefficient of speed variation varies according to the load. This latter difficulty may be overcome by loading the incoming machine artificially, so that both machines have the same coefficient at the critical instant. An artificial load may be obtained by means of metal resistances, switched in step by step. For large machines this necessitates extensive resistances. A simpler way is shown by Dettmar (*E.T.Z.*, 1899), who uses a foucault brake, which acts upon the flywheel (see Fig. 57). The magnet is excited by direct current, the load being regulated by means of a regulating resistance. The heat produced by these currents is kept low by the air currents, especially as the proceedings last only a short time. On account of the artificial load, the regulator of the engine has a position which corresponds to the load, so that the machine will take over part of

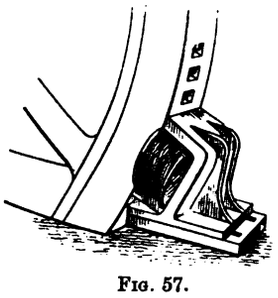

FIG. 57.

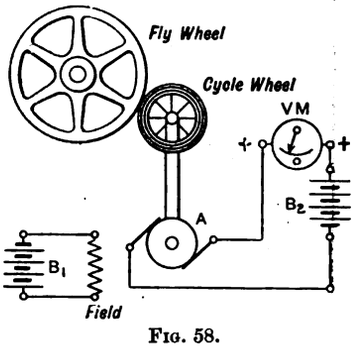

FIG. 58.

the load of the other machine immediately. The foucault brake acts at the same time as a damper, diminishing the mechanical fluctuations.

It has been shown above that the coefficient of speed variation plays a very important part as regards alternators in parallel. It may now be interesting to know how to determine this coefficient experimentally. This determination is the more difficult the smaller the coefficient. Let us, for instance, assume that a coefficient of about $\frac{1}{100}$ has to be determined with an accuracy of 10 per cent. This means we must determine the $\frac{1}{1000}$ part of the mean velocity. It will be obvious that this is not an easy matter, and that the apparatus used for the purpose must be extremely sensitive. A large number of methods have been invented to accomplish this purpose, but nearly all of them are more or less useless. It is essential that the apparatus has no sliding or elastic parts, and it must allow the elimination of changes in the time of the revolutions. The only measurements which have any claim to a fair

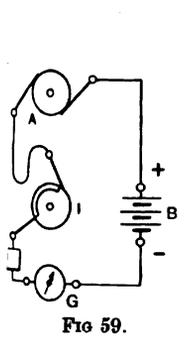

FIG 59.

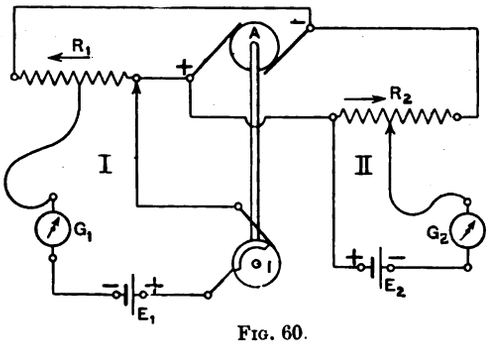

FIG. 60.

amount of accuracy are electrical determinations, and even these cannot be relied upon when the coefficient of speed variation is less than $\frac{1}{500}$.

A method which has been used in America by the engineers of the General Electric Co. is shown in Fig. 58. A cycle wheel is fixed on the shaft of a small direct-current generator. The rubber tyre is pressed against the flywheel of the engine, and the excitation of this generator is such that its E.M.F., corresponding to the mean speed, is equal and opposed to the pressure of a battery, B_2. Between the armature of the generator A and the battery B_2 is joined a Weston voltmeter, with a low reading scale. It will be evident that, if the flywheel rotated at a uniform speed equal to the mean, the voltmeter would show no reading; but, as the flywheel is rotating with a varying speed within a revolution, the voltmeter needle will oscillate, the amplitudes from the zero position being a measure of the variation of speed. A fair amount of accuracy has been claimed for this kind of measurement; but, if it is remembered that a direct-current generator of the most uniform speed will give oscillating pressures, due to short-circuiting of some of the coils when passing under the brushes, irregularities in the magnetic field and arrangement of the coils on the circumference of the armature, it will be obvious that the accuracy of the measurement will, after all, be low.

Another way is shown in Fig. 59 (Dr. R. Franke, *E.T.Z.*, 1901), which is an improvement on Fig. 58. The armature A and the indicator I are coupled to the engine, the indicator closing the circuit once in a revolution at a definite crank position, causing a deflection on the galvanometer G which is proportional to the instantaneous pressure at this instant, hence also to the corresponding angular velocity.

By bringing the brushes of the indicator into different positions, the circuit will be closed at a different time. This method would be very accurate, if the time of a revolution would not change, but, on account of this, the instantaneous velocity changes with each revolution, so that the pressures for the same brush positions are not constant at different times. To avoid this fault the arrangement of Fig. 60 may be employed; in which the influence of the changeable time is considered. Here the pressure of the armature A is closed by the high resistances R_1 and R_2. There are thus two circuits. On account of the drop in R_1 the back pressure E_1 (at the instant the circuit is closed) is compensated, say, by means of the

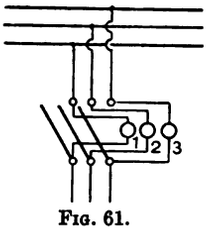

FIG. 61.

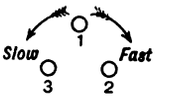

FIG. 62.

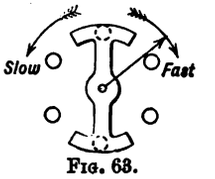

FIG. 63.

galvanometer G_1. The pressure E_2 is compensated similarly and, as shown, by means of galvanometer G_2, which should possess a periodic damping and a fairly large periodic time. Galvanometer G_2 shows therefore only changes in the number of revolutions, or, in other words, the changes in the time of a revolution. Observations must be made in circuit I at the time when the galvanometer G_2 shows no deflection, all observations will then correspond to the same time. It is seen that two persons are required to do the experiment, which requires a great deal of time and patience. Irregularities in the pressure, due to the construction of the experi-

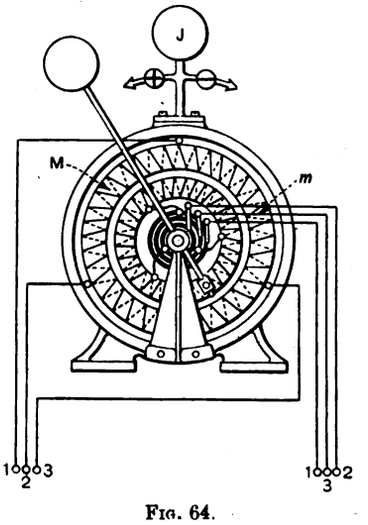

FIG. 64.

mental generator, must, of course, also be eliminated beforehand. Very small coefficients, that is to say those below $\frac{1}{200}$, cannot be determined.

To switch alternators in parallel phase lamps, or phase meters, are used, by means of which it can be seen when the machines are in synchronism. These lamps, or meters, do not, however, show whether the incoming machine is running too fast or too slow, and the engine driver has to find this out by trial. This is simple enough, but not always convenient, and a velocity meter would be better. If we connect between the contacts of the switch in Fig. 61 three lamps, they will glow in the succession 1, 2, 3, if the machine runs too fast, and 3, 2, 1, if the generator runs too slow. When the machine is in synchronism with the network lamp 3 is dark, and lamps 2 and 1 burn at half-full incandescence. If the lamps are arranged in a circle the succession of illumination may be marked by arrows (see Fig. 62). It is, however, not always easy to see the succession of illumination, and a pointer would be preferable. An apparatus which has this advantage has been constructed by

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Dr. G. Benischke. It consists of six iron cores, having suitable windings, arranged in a circle and connected up similarly to the lamps in Fig. 61. Above their poles a little armature is rotated which follows the magnetisation of the cores, the pointer showing the direction of rotation (see Fig. 63).

Another velocity meter is shown in Fig. 64. It consists of a fixed part, M, and a movable system, *m*. M is fed from the 'bus bars or from machine I., while the movable part *m* is fed from the incoming machine II. The connections of both parts are such that, as long as the machines are in synchronism, the fields caused in both windings rotate synchronously. A turning moment is only produced when the frequencies are different. The direction of rotation will be the same as that of the M field if machine II. is running below synchronism, and the direction will be opposed to that of the field if machine II. runs faster than I. (We have here similarity to an induction motor.) If, now, there is fixed upon the axis of the movable part a pointer with a signal disc, the man at the engine will be able to regulate his machine according to the direction of the moving pointer. When it passes slowly in front of the indicator disc I the machine will be in synchronism, and the switches may be inserted. + corresponds to fast and − to slow.

The oscillations, of which so much has been heard, may be studied by means of the apparatus shown in Fig 65. (This apparatus was shown by Prof. Görges, at the last meeting of the Verband Deutscher Electrotechniker.) A horizontal shaft is oscillated, by means of crank and connecting rod, from a lower

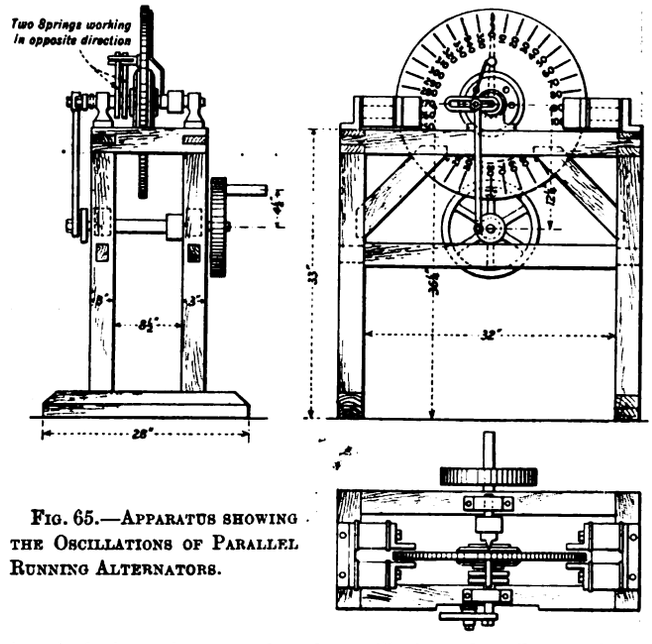

FIG. 65.—APPARATUS SHOWING THE OSCILLATIONS OF PARALLEL RUNNING ALTERNATORS.

lying shaft, in such a way that the oscillations describe nearly sine curves. The amplitude is shown by means of a pointer fixed to the shaft. Upon the oscillating shaft rests, by means of ball bearings, a heavy disc, coupled to the shaft by two clock springs. With the upper shaft fixed the disc will describe free oscillations when brought out of its position of equilibrium. A scale on the disc will show the amplitude of the oscillations. These oscillations may be damped by electromagnets near the circumference of the disc The damping can be regulated by connecting a regulating resistance in series with the magnet windings. Resonance may be obtained by rotating the lower lying shaft at such a speed that the times of free and forced oscillations become equal. Also interference of oscillations may be seen.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Starters and Regulators for Electric Motors and Generators." By Rudolf Krause. Translated by C. Kinzbrunner and N. West. (London and New York: Harper and Brothers.) 4s. 6d.

"Science Abstracts." April, 1904. Section A, Physics; B, Electrical Engineering. (London: E. and F. N. Spon.) 1s. 6d. each.

"Practical Enlarging." By J. A. Hodges. 6th edition. (London: Iliffe & Sons.) 1s.

"Clarke's Pocket-Book of Tables and Memoranda," by J. Wright Clarke. Fourth Edition (London, B. T. Batsford), 1s. 6d.

"Die Galvanoplastik." By W. Pfanhauser. Vol. XI. Monographien über angewandte Elektrochemie. (Halle: Wilhelm Knapp.) 4m.

"La Théorie de Maxwell et les Oscilliations Hertziennes: La Télégraphie sans Fil." By H. Poincaré.

TRAM-RAILS AND RAIL BONDING.*

BY PERCY S. SHEARDOWN.

When electric traction first came to the front it soon became obvious to the pioneers that more had to be done than simply equip cars with electric motors and controllers in place of the horse or mules which had previously been used, and among other things that very soon gave trouble was the car track as laid for horse haulage, and when we consider the changed condition of things this is not to be wondered at. One of the old type horse cars com plete weighed about 3 tons, and was pulled quietly over the track at an average speed of somewhere about 6 miles an hour. With the new order of things the weight of electric cars quickly increased from 8 to 12 tons, and carried a dead weight in the form of living passengers from 3 to 5 tons. The cars were propelled through the wheels at a speed which in the States quickly ran up to the vicinity of 15 to 25 miles an hour, and under these changed conditions it does not seem very strange that the old track work should com plain. It was not, indeed, so much the track as a whole that had to be re-designed as the supports at the ends of the rails or rail joints. The latest form of track for horse-car work comprised a girder rail of a weight as high as 60lb. or 70lb. per yard laid on a 6in. bed of concrete. This is more or less standard practice for electric tramway roads to-day, except that the weight of the rails has been somewhat increased and also the length of each section of rail; but trouble with joints immediately developed, the pounding action of the heavy cars travelling at a high speed causing the ends of the rails to become depressed, and this started matters rapidly from bad to worse, as wheels dropped into the ever-increasing depression. This to a large extent was got over by using heavier and more rigid fish-plates, which were more carefully fitted to the web and underside of the rail and allowing more bearing at these places. In many cases sole-plates also are used, being bolted or clamped on to the bottom flange of the girder rail, but the fish-plates still being held in position by large fish bolts and nuts. But as everyone who has had anything to do with bolts subject to any form of vibration is aware, there is always a tendency for the nut to slack back, and it occurred to a good many manufacturing concerns interested in this class of work, and also to many street railway engineers, that a solid form of joint or continuous rail should be most acceptable.

Some people may think it strange that such trouble should be met with in electric tramways when steam railroads carrying much heavier rolling stock and travelling at much higher speeds, and also using lighter rails and fish-plates, should be practically free from this trouble; but a small amount of consideration will show that the conditions are absolutely different. The difficulty is not in making a rigid joint with the ordinary fish-plates and bolts, but in keeping the fish-plates tight up to the rails, and on railways where the rails are not buried, this process of tightening up the bolts is continually going on. Added to this, the ordinary railway practice where the rails are fastened down to wooden sleepers laid on ballast, there is an amount of spring and go through a long section of truck which is quite absent in a 6in. or 7in. girder rail laid on a solid bed of concrete.

There have been many forms of solid or continuous rail joints thought out and patented, but the only three which have had any amount of use in practice are known as the Falk cast welded joint, the electric welded rail joint (with which is associated the name of the Johnson Company and later the Lorain Steel Co.), and more recently a system of producing a cast welded joint by a method known as the "Thermit" system. The Falk cast welded joint was first put to practical use in St. Louis, the operation being carried out by the Falk Mfg. Co. of Milwaukee in the year 1894, and during the following six years this process was very largely employed, over 600,000 joints being made by this company alone; and many of the large street railway companies in the States worked the process themselves under licence from the Falk Company. The method of proceeding was as follows:—

The "Falk" System.—This consists in casting an iron sleeve round the sides and bottom of rail joints, the rail ends being first placed firmly together. In cases where they do not absolutely touch, thin plates of steel are driven in between the heads of the rails before castiug. Before fixing the iron moulds, the sides and bottom of rail are cleaned. The cast iron used is of special chemical composition to give good results, and is run at a much greater heat than is used in making ordinary castings. The cast iron running into the iron moulds cools rapidly on the outside surface, thus causing a tremendous pressure to be exerted on the metal, which is still in its molten state, in contact with the web and foot of the rail. As the metal is poured in from one side and comes in contact with the web or thinnest part of the rail at its greatest heat, this part of the rail is brought to a white heat, and, owing to the pressure

* Paper read before the Dublin Local Section of the Institution of Electrical Engineers, April 14th.

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exerted on the molten cast iron, this is practically forced into the interstices of the steel, thus not only making a thoroughly good mechanical joint, but also ensuring a good electrical joint. Although not actually welded—as it would be impossible to weld cast iron to steel rails, the result obtained is practically equivalent to a weld, as, if the cast iron is torn away from the web of the rail it always brings away part of the rail with it. On examining a welded joint which has been sawn through, the section of the web of the rail can no longer be clearly distinguished, and it is impossible to say where the cast iron ceases and the web of the rail commences.

The cast iron must necessarily be melted close to where the work is being done, and for this purpose a regular outfit is required. The apparatus consists of a small cupola with the necessary steam engine or turbine fitted to a truck to be drawn by horses; also a sand-blast machine. The Falk Company claim that the sand-blast method of cleaning the rail ends was perfected by them in 1897, and state that this has proved to be the most satisfactory manner of getting the rail in condition for a perfect joint. This machine is operated by an electric motor driving an air compressor. This, at a pressure of about 20lb. throws a stream of sharp sand at a high velocity against the sides and bottom of the rail end, removing all scale and rust, and leaving the surface clean and bright and in perfect condition for amalgamation. In repairing the worn-out joints of old rails subsequent to the process of pouring the metal, various forms of clamps are used which regulate the amount of rise in the rail, reducing the surface to be dressed down to a minimum. After the joint is made, a special machine consisting of a flexible shaft grinder and an electric motor is put in operation, with the result that the finished job on old track presents, it is said, as smooth and even surface as can be produced. In addition to its strong mechanical construction, it is claimed that the electrical conductivity of the joint when cast welded in this manner is greater than the conductivity of the rail itself, and, from what I can learn, this is substantiated by evidence given from independent engineers who have had this system of rail-joint under their personal notice.

The section of the cast-iron joint is so designed as to have at least the same tensile strength as that possessed by the rail. The cast welded joints are generally about 14in. long, and the weight of the cast iron varies in accordance with the weight of the rails, from 70lb. to 140lb. per joint.

The next system to be described is the one being used on the Dalkey section of the Dublin United Tramway Co. at the present time.

The Lorain Steel Co.'s Method.—This method comprises three distinct operations. The machinery is mounted on self-contained cars of suitable design, each equipped with its own motors for locomotion. The running gear of these cars is provided with threaded axles, so that the machines can be used to weld track of different gauges. New rails may be welded either before or after the paving is in place, space being left at the joints to permit the entrance of the welder. In old rails the paving is lifted around the joints, and the fish-plates and bond wires being removed, the rail ends are then raised to the proper level.

In the welding process the first operation is that of the sand blast, by means of which all dirt, rust and foreign matter is removed from the rails at the places where the welds are to be made, and from the corresponding points on the bars used in making the joint. The apparatus for this work consists of a 10 H.P. motor driving an air compressor, a tank for the storage of air and a bin for holding a supply of sand. A sand mixer of the Tilghman type is also provided. By means of a hose and nozzle the operator directs the blast of air carrying the sand against the rail until all foreign matter has been removed. The bars are similarly treated, and the joint is ready for the actual operation of welding.

The apparatus for welding is carried in two cars coupled together by a special form of slip coupling which permits a sufficient range of movement for the car carrying the welder proper to be moved from one weld to another of the three welds necessary in making a joint without the necessity of moving the second car. The welder itself is hung from a bail on a crane extending out beyond the end of the car. This crane permits of lowering and raising so that the jaws of the welder can engage the sides of the rail, and also can shift the welder from one side to the other to engage both rails of the track. The crane is operated by friction clutches from a shaft in the car, which is kept running continuously by a 5 H.P. motor. This motor also drives a small rotary pump for regulating water through the water transformer and the faces of the contacts to keep them cool. After the water has passed through the welder it goes to a cooling tank on the top of the car. The welder itself is an alternating-current transformer, the primary winding of which consists of two coils in parallel of 44 turns each. The secondary winding is so made as entirely to enclose the primary coils, which are insulated with oil. On each side of the transformer and supporting it, but insulated from it, are the two large levers hinged together about two-thirds of the distance from the top, for transmitting the necessary pressure to the weld. These levers are connected to the top by a hydraulic jack. A hand pump for forcing the water into the jack is bolted to one lever. A pressure of 4,100lb. per square inch is obtained on the 3⅞in. diameter rams of the jack, the leverage on the arms increasing this, so that about 37 tons pressure is developed at the weld.

In making a joint flat rolled steel bars are used, having at each end a boss or projection on one side, which forms the contact point between the bars and the web of the rail, and confines the welded area to these sections. A flat strip of steel, ⅛in. thick and 1in. wide, is placed across the middle of the bars on the same side as the bosses. The bars are supported in the middle on small blocks and placed across the joint, so that the strip engages the web of both rails. The middle weld is a vertical one, and made the full width of the bar; the end welds are horizontal.

The welding train of two cars is moved up to a joint, the welder is swung into place and the jaws made to press against the bars on each side of the rail. The current is then turned on and flows from contact to contact through the bars and the rail web. By altering the pressure on the jaws the resistance of the several junctions is increased and the whole is soon brought to a welding heat. As soon as this stage is reached the current is cut off, and simultaneously the pressure is brought up to the full amount. Pressure is then lessened and the welder car moved back to bring the jaws opposite the first extremity of the bars. The same process is again followed here, except that when the final pressure has been applied it is held there and the weld permitted to cool under pressure until the metal is cooled sufficiently not to show any glow. The welder is then moved forward to the other end of the bar and the process repeated, after which the welder is raised and moved to the other side of the car to engage the opposite joint.

A remarkably tough weld is secured by holding the pressure after the weld is made. It will be noted that only the end welds are thus treated; as the centre weld is not subjected to the same stress it is not essential to have toughness there.

It has been found desirable to weld the end of the bars while the bars are in an expanded state. By making the centre weld first, and proceeding at once to the end welds without waiting to cool the centre weld under pressure the greatest elongation of the bars is secured. After the ends are welded and the bars cooled off they contract and exert a powerful pull to bring the abutting rail end together, thus closing the slightest opening and leaving practically no joint at all. It is at once apparent that this is an important consideration in the manufacture of a continuous rail, for if the abutting rail ends are not brought firmly together the metal in the head of the rail will have a chance to spread in service into the opening between the rails, and thus in time will cause a low spot in the rail head. Inasmuch as the bars are always in a state of tension, it follows that the rail itself enclosed between the bars is in a state of compression. Any contraction of the rail itself between the joints will be transmitted to the rail welds and it is, therefore, necessary to have these welds exceedingly tough to withstand the strain. The object of the centre weld is simply for vertical stiffness and to prevent any movement of the rail ends. The actual current used in welding is about 7 volts, and from 25,000 to 30,000 amperes.

In the car attached to the welder is carried a rotary converter for changing the direct current from the overhead wire to an alternating current. The direct-current side of the rotary will take current at from 325 to 600 volts from the wire, and by means of suitable regulating apparatus the voltage of the alternating side to the welder is kept practically constant at 300 volts. With regard to fluctuations of the line, with a line voltage of 500 about 225 amperes are required, or it takes about 125kw. to make a weld, the current being on about 2½ minutes to each weld.

The finishing operation in the process is grinding the head of the rail to true surface. In welding new rails there is little occasion for the use of these machines. In old track where the rail ends have been battered, the receiving rail is purposely welded higher than the other. The grinder is then used to grind out the inequalities in the head of the rail and bring it to true surface. The grinder consists of an emery wheel mounted on a carriage having two rollers which are about 4ft. apart. The carriage is let down on the rail so that the rollers roll along the head of the rail, the emery wheel being over the uneven portion of the joint. The carriage is connected with a motor on the car by a swing frame, thus enabling the operator to move the emery wheel backwards and forwards over the joint, while the car remains stationary. By means of a hand wheel, the emery wheel is gradually fed down, and it is moved forward and backward after the principle of a carpenter's plane, until the whole surface is brought to a true level. With the final operation of grinding the joint is left complete.

The work embraced in contracts undertaken by the Lorain Company in connection with electric welding includes the work of sand blasting the rails and bars, the supply of welding bars, the actual welding operations and the grinding of the rails afterwards to surface. The tramway authorities are required to remove the paving, take off the fish-plates and the old bond wires, and replace the paving after the operation is completed. It is of interest to note in this connection that by this process of welding it is not necessary to

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disturb the concrete bed of the rails in any way, and the facility and expedition with which the work is carried out certainly presents many advantages which tramway managers have not been slow to appreciate.

As a continuous process, working day and night, it takes about 13 minutes to complete a joint, and 80 joints in 24 hours is considered a fair average. The bars used are 1in. by 3½in., the length varying with the form of joint previously used. On new rails, where the ends are left blank especially for welding, the length is 18in., on old rails the bars must be long enough to reach the old bolt holes and bond holes, in some cases requiring bars as long as 48in.

Another advantage claimed for the electrically-welded joint is the high conductivity obtained by the use of this process. The electric welding bars are made of low carbon steel, and are, therefore, of low resistance, and the cross-section being large, the conductivity of the joints averages over 50 per cent. higher than the rail itself.

The results obtained experimentally by the Lorain Steel Co. have been amply borne out by practice. Even with a strain of 350,000lb. we have never succeeded in shearing off a weld made in this way. On making a joint we use a bar 1in. by 3in. having three bosses, as shown in the accompanying diagrams, and weld one bar to each side of the rail web.

The trouble with regard to the breaking of the rails through the old fish bolts was largely reduced by reaming out the bolts, and it is interesting to notice that much more trouble was experienced in rails in which the holes had been punched than in those in which the holes had been drilled.

(To be concluded.)

BRUSH-GUTMANN INTEGRATING WATTMETERS FOR ALTERNATING CURRENTS.

The Brush-Gutmann integrating wattmeter is of the induction motor type. The standard single-phase two-wire meters are for 45 to 60, 100 to 115 and 200 to 220 volts. Meters above 100 amperes capacity are furnished with series transformers, reducing the maximum current in the series coils to 5 amperes; those for use on circuits of over 250 volts have also a potential transformer. For three-wire circuits the standard two-wire meter is used. For meters below 50 amperes the connecting box is made so that the series coils of the meter are connected to each of the outers. To meters above 50 amperes a series transformer is attached, with two primary coils and one secondary. For balanced two and three-phase circuits the same type of meter as the single-phase two-wire standard is employed.

Meters for primary circuits are similar in general design to the secondary meters, but the series coils and main terminals have extra high insulation and a potential transformer is provided, which may be placed in any convenient position. Meters above 50 amperes also have a series transformer. The standard pressures are 1,000, 2,000, 5,000 and 10,000 volts. The capacities range from 2½ to 1,000 amperes. The standard frequency is 50 to 75 ~ per second for the 60-cycle meter, 80 to 100 ~ per second for the 90-cycle meter, 115 to 140 for the 133-cycle meter. We are informed that variation of frequency and difference in wave form have no bad effect. Permanent overloads of 50 per cent. or temporary overloads of 100 per cent. are said to be permissible, and loads of the lowest power-factors are recorded as correctly as non-inductive loads.

The loss in the shunt coil varies from ½ to 3 watts, depending upon the voltage and frequency, and the drop in pressure through the series coils is about 0·25 volt in small meters and less in those of greater capacity. The readings, which are direct in watt-hours, are true within 2 per cent. from starting load to 50 per cent. overload for meters up to 50 amperes, and in larger sizes within 3 per cent. from starting to 25 per cent. overload. Temperature changes have no effect from 40°F. to 120°F.

Standard meters do not exceed 10½lb. net weight, and the overall dimensions are 8⅞in. long by 6⅝in. wide by 6½in. deep for all capacities.

The back of the meter is cast iron, while the front or case, and the cover for the small connecting box immediately below, are aluminium; all interior brackets and clamps are of bright lacquered aluminium. The aluminium case fits against the base ledge of the cast-iron back with a deep groove, and a cementing material put into this groove makes an absolutely water tight joint. The holes where the connections go through from the connecting box at the bottom into the meter proper are filled with rubber gaskets, and the wood block holding the connections presses a thick layer of felt tightly against the wall between it and the interior of the meter. The dial window and the small window for observing the disc are also sealed, and all holes drilled through the back of the meter to receive screws, &c, are likewise sealed with plaster of paris to prevent tampering.

A thin aluminium disc shown in Fig. 1, slotted in peculiar spiral lines, to obtain the highest possible torque acts as an armature, and is carried on a slender steel spindle. This spindle is turned and polished at the lower end to a fine ball-shaped pivot, and at its upper extremity carries a worm of special alloy which does not rust; motion is transmitted through the worm to the recording train. Owing to the weight of the disc and spindle being only ¾oz., the fine sapphire in the lower bearing is subjected to no appreciable pressure. The upper bearing for the spindle is simply a brass terminal. Its function is more that of a guide than a bearing, and it is practically free from friction. In case of accident to the disc, jewel or spindle, the armature can be removed without altering the calibration of the meter.

Fig. 2 shows the permanent magnet which is built of laminated steel in two parts, the main magnet, body and the bridge. The former comprises the larger part of the entire magnet mass, and stands vertically above the disc. The bridge is located beneath the disc and completes the magnetic circuit of the main magnet, except at the gap in which the disc rotates, and at a narrow gap towards the back, designed to make the bridge free from actual magnetic contact with the main magnet. The two gaps add slightly to the reluctance of the entire laminated magnet, but it is still so low that the magnetic flux is large, and hence the self-induction of the shunt coil is as high as possible. On the bridge below the disc is a heavy copper band with a small gap on the lower side. On each side of this gap is a brass connecting block with a small set-screw; each block is drilled so that a loop of wire may be moved to any desired position, and clamped by the set-screws, thus bridging the gap. When the gap is closed in this way by the loop of iron or copper wire the secondary current induced in the closed circuit formed by the band and loop—when of the correct dimensions—reacts upon the shunt field just enough to cause it to be in apparent quadrature with the impressed E.M.F. —that is, the secondary current induced in the disc by the modified field are of the phase necessary to measure the true energy in the circuit when these currents are acted upon by the field of the series coils. The loop of wire used to bridge the gap is long enough to give a

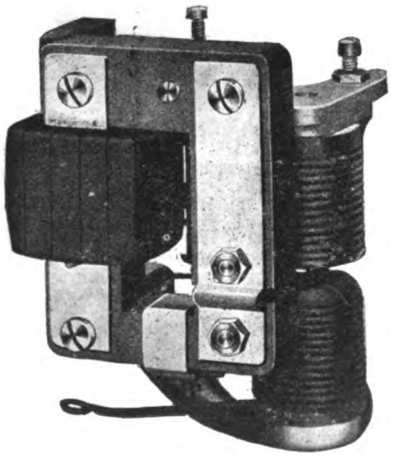

Fig. 2.—Magnet showing Shunt and Series Coils.

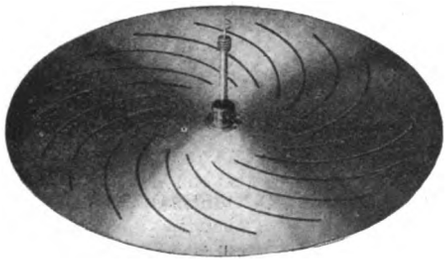

Fig. 1.—Armature Disc.

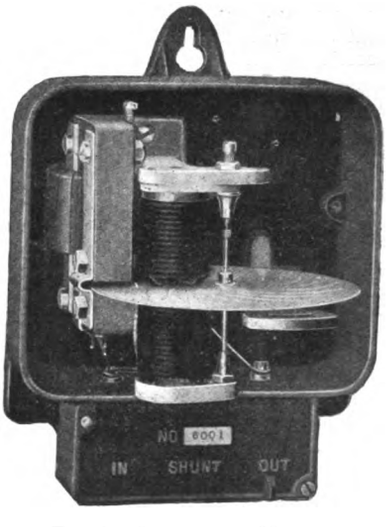

Fig. 3.—Interior of Meter.

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wide range of adjustment, and the necessary alteration of the loop from the 60 to the 133-cycle position, or vice versa, is quickly and easily effected. On the inner side of the main magnet, and held on the part connecting the back and front legs, is the friction-compensating piece or light-load adjustment, which is moved in a vertical direction by means of a screw working against a small lug on the side of the large bracket carrying the laminated magnet and series coils.

The back leg of the laminated steel magnet carries the shunt-energising coil, held in place by projections on the aluminium side-straps of the magnet. The shunt coil is wound according to the voltage with proportionately less or more turns, to get as much self-induction as possible in the small space. There are two series coils in the meter, carried on the main bracket at such a point that they have a maximum effect in producing rotation of the disc. The coils are held by small aluminium clamps, screwed firmly to the bracket, and are as small and light as the required field strength permits. Few turns are used, so that no inductive drop in the circuit at heavy load is caused; the field strength at any load is exactly proportional to the current flowing, and a straight-line characteristic is obtained for the meter.

The train is very carefully constructed. The plates are of sheet brass, and the recording mechanism produces the least amount of friction possible, owing to the accurate method of cutting the teeth in the wheels and pinions. The lettering upon the white enamel dial is heavy, plain and easily read at a distance. The connecting box is below the meter proper, and cast in one piece with the main back, so that the lid covering it comes just at the back of the ledge on the aluminium case. The lid is sealed effectively by means of the small lug on its lower edge and the screw which holds the lid when closed. The lid is swung from the upper left-hand corner, and when dropped down gives ready access to the terminals.

The Brush Company, who are manufacturing the above meter, are also making a portable apparatus for testing alternating-current wattmeters, either in the station or on the consumer's premises. It is designed for use with a standard indicating or integrating wattmeter with, when convenient, a standard voltmeter. The apparatus includes two non-inductive resistances and a water rheostat for light loads, together with a transformer for heavy loads, the whole being complete with switches and terminals. The resistances absorb 100 and 30 (or 50) watts respectively, and the range of the water rheostat is 5 to 40 watts. The various terminals are plainly marked with small plates, making it very simple to connect the set for use. The standard set is of a convenient size and shape, being 10½in. long, 7½in. broad and 9in. deep. The box is of polished wood with a strong leather handle and self-closing lock, weighing complete 15lb.

ROYAL COMMISSION ON LONDON TRAFFIC.

Thursday, April 28.

Mr. G. C. CUNNINGHAM, general manager of the Central London Railway, said that cheap and rapid transit was the great want of the day in London. There were three possible modes of obtaining this. First, there was the elevated system, but although a very complete means of communication could be carried out at a comparatively low cost of construction by this means, the appearance of the structures was so much against its adoption that serious attention could hardly be given to it. Secondly, there was the surface system, which, although convenient for outlying and suburban districts, could not be carried to the centre of London or through the narrow streets of the City, where rapid communication was necessary. Surface tramways also lacked speed owing to the delay by interruptions of cross traffic. The carrying capacity of a tram system was also much below that of a tube railway. There remained the underground system, to which all the objections stated to the other two systems did not apply. The two methods of underground construction were by shallow subways and deep tube. The advocates of the shallow subway claimed that the trains could be more quickly and easily reached by passengers, and that it could be more easily ventilated. While prepared to grant the first claim, he regarded the second as more doubtful. His objections to this system were its great cost and the long and extremely harassing disturbance to the streets during construction. With a deep tube railway all this disturbance during construction was absolutely avoided. Another valuable fact in tube construction was that the lines could cross above or below each other without the least difficulty, and in a manner which no other system could do. Looking at the matter from various points of view, therefore, he was of the opinion that the deep-tube system was the one best suited to carry out a comprehensive and complete scheme for London. One of the chief difficulties to be guarded against in tube railways was fire, but in his opinion this was more surely obtained by constant vigilance, and the maintenance of perfect fire appliances, than by any initial difference in construction, except, of course, that the use of combustible matter should be reduced to a minimum. A shallow subway, however, could have just as disastrous a fire on it as a deep tube. After dealing with the precautions taken on the Central London Railway, witness continued that as a further precautionary measure he had designed, and the company had constructed, six steel cars. The frames, outside paneling, and the roofs were all of steel, the latter being lined on the inside with asbestos millboard. The floor also was of steel framing, with boards, and the inside paneling of the cars was all of "Uralite." The consequence was that in these cars there was scarcely anything that could burn, and certainly nothing to start a conflagration. Another advantage of these cars was that owing to the thinness of the walls, from 4in. to 5in. additional internal width was obtained. The lifts on the Central London Railway worked well, the cost of operation amounting to about $\frac{1}{10}$d. per passenger. Doubtless, if this could be eliminated there would be a valuable addition to the net revenue, but it was one of the necessary expenses of the deep tube system. He did not desire to lay out a complete system of tube railways for London, but certain principles seemed to him to be of weight in the consideration of any complete system. In the first place, the traffic to be provided for was mainly a traffic coming into the heart of London in the morning and out again in the evening, and not one passing throug from one side of the City to the other. To meet this condition of affairs it appeared to him that elongated double track loops, about 6 or 7 miles in length, taking in a breadth of half a mile, round which trains could run all day in both directions, and extending from the outskirts to the centre of the City, would be the fundamental idea for the construction of the system. Such a loop as was proposed by the extension of the Central London to Liverpool-street and then back by the Strand, Piccadilly, Knightsbridge-road to Hammersmith, and thence to Shepherd's Bush, gave a fair notion of what was indicated. Various loops might come in from various quarters—north, south, east and west—and they would be crossed by subsidiary lines, to and from which communication would be made from interchange stations. But each loop would be complete in itself, and there would be no physical junction with other tube lines, nor should any attempt be made to bring in the trains of other railway companies, as this would only cause disturbance without affording accommodation of practical value. In some instances, instead of a loop, double lines running in and reversing—as on the system at present used—would be sufficient, but the amount of service that could be given on this compared with a loop was definitely less, and the possibility of transforming this into a loop in future to meet increased traffic should be kept in mind. The distance to which any loop or line should go out to the suburbs was a question that would have to be decided for each particular case. In this way means would be afforded for getting from any one to any other part of London rapidly and at a moderate price. In a lengthy discussion on the public usefulness and financial success of any tube system, witness gave it as his opinion that this would depend upon the rate of fare charged, and looking at the matter from the point of view of the working community, he was of the opinion that low fares for long distances, and not low fares for short distances was the policy to adopt. In support of this he described the policy of the Central London Railway, and pointed out that the average receipt per passenger was more than upon any other of the London urban railway companies, being 1·86d. as against 1·78d. on the City and South London Railway, 1·50d. on the District Railway, 1·64d. on the Metropolitan Railway and 1·55d. on the North London.

Mr. JAMES DEVONSHIRE, managing director of the Metropolitan Electric Tramways (Ltd.), and director of the North Metropolitan and Harrow Road and Paddington Tramways Companies, spoke first with regard to the question of running powers into London, in which was involved the system of traction to be adopted. The chief case which he instanced was that of West Ham, where at the present time there exists a through running of cars over lines owned by the West Ham Corporation and the London County Council, the cars being at present worked by horse traction and operated by the North Metropolitan Tramways Company. When, however, the West Ham Corporation carried out the electrification of their portion of these tramways, considerable trouble would ensue at the boundary between the counties of London and Essex. He considered that upon these through lines from Stratford to Aldgate it was desirable that a uniform system of electric traction should be adopted. The West Ham Corporation had, he thought, very wisely decided upon the overhead trolley system, as this was the only system that had proved a commercial success so far. The attitude of the London County Council, as far as their portion of the line was concerned, was very uncertain. Considerable negotiations had been going on between the North Metropolitan Tramways Co. and the Council with regard to this matter, and conferences had taken place. After first practically deciding upon the overhead trolley system for both the Aldgate and Poplar routes, the latest communication to the company by the Council made no mention whatever of the electrification of the Aldgate and Bow route, and stated that the Poplar route would be reconstructed upon the conduit system. It had been stated that the reason for this *volte face* on the part of the County Council was that they had been unable to obtain the consent of the Borough Council of Poplar to the overhead system on the tramways passing through their district. On the other hand, he surmised that, with regard to the Aldgate route, the Council, being aware that the existence of the shallow railway from Aldgate to Bow station did not admit of the adoption of an underground conduit system, had come to the conclusion to drop the matter altogether. He considered that this was one of those matters which should be properly referred to any new tribunal which might be formed as the outcome of the report of the Royal Commission on London Traffic, and the tribunal, he thought, should have plenary powers to override the veto vested in local authorities when that veto was properly exercised in the interests of the public. He believed that the failure of the County Council to obtain the consent of the road authorities to the use of the overhead system could be very largely attributed to the fact that the Council, notwithstanding the protests of the technical Press, had wilfully disregarded the advice that had been given against the adoption of the conduit system for a great majority of the streets over which their tramways were laid. The result had been to educate

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the local authorities into the belief that the conduit system was the only system for London. The same question of through communication would also arise at Finsbury Park, Highgate Archway, Edgware-road and Harrow-road. He believed that upon the publication of the official figures of the results of the first section of the London County Council's conduit tramways it would be shown that they were a financial failure. It was a remarkable fact that the North Metropolitan Tramways Co., under its various Acts of Parliament, and under sec. 26 of the London County Tramways (Electrical Power) Act, 1900, itself had power to equip electrically the whole of the leased tramways in London with the consent of the County Council on the overhead system, none of the road authorities having any veto at all in the matter; and inasmuch as the Metropolitan Electric Tramways (Ltd.) was constructing a system of trolley tramcars running up to the boundaries of the County of London, he contended that the wisest course for the County Council to adopt was to allow the North Metropolitan Tramways Co. to reconstruct the line within the county upon the same system. Witness next went on to deal with some of the disadvantages which might arise from the operation of sec. 43 of the Tramways Act, 1870, which concerns the purchase by local authorities. There were two instances in London, he said, in which one pair of a double set of tramlines was in one county and the other portion in another county—namely, at Finsbury Park and Harrow-road. The dates of purchase by the local authorities did not coincide, and the difficulties that might arise could very well be imagined. With regard to the abolition of the veto, he confirmed the previous evidence of Mr. Sellon and other witnesses upon this point, mentioning, however, that inasmuch as the Metropolitan Electric Tramways (Ltd.) and the North Metropolitan Tramways Co. would probably not have much occasion in the future to promote tramways, the disadvantages of Standing Order 22 of the House of Commons might not materially affect them, but his objection to the retention of the veto by local authorities was on account of his experience of the unfair use which had been made of this against the North Metropolitan Tramways Co. in the past.

Friday, April 29.

Mr. H. M. BATE, principal clerk in the Public Health Department of the Corporation of London, gave similar evidence to that already given by Mr. A. C. Morton and others, as to the impossibility of admitting tramcars into the City streets. If further facilities were required for bringing the public into the City, the remedy was by means of tube railways. The question of the breaking up of the streets by statutory companies was also gone into, but no new opinions were expressed.

Mr. J. DOUGLAS MATHEWS, a member of the City Corporation, spoke first of all as to street widenings. He stated that the street traffic would be lightened if there were better communication between the railways north and south of the river, and a railway running from Dalston and making a connection with the Thames Tunnel Railway at Bishopsgate would do much to afford relief in this matter. Such a line would enable passengers from the North and Midlands to travel direct through to the south of England or vice versa, without entailing any of the driving across London through the streets.

The Commission adjourned.

PHYSICAL SOCIETY.

At a meeting of the Physical Society held on April 22nd, Dr. R. T. Glazebrook, F.R.S., president, in the chair, a Paper on

"Normal Piling as connected with Osborne Reynolds' Theory of the Universe,"

was read by Prof. J. D. EVERETT. The closest arrangement of equal spheres *in plano* is the triangular one in which each is touched by 6. To obtain the closest packing in space, the pile of spheres must consist of a succession of these tiers. In building such a pile, the laying of each successive tier gives a choice between two different positions of this tier relative to its predecessor. Suppose two regular tetrahedrons to be placed base to base, so that one is the reflection of the other relative to the base; and let the edges of one of these tetrahedrons be parallel to the six lines which join the centres of four spheres in mutual contact (say in the first and second tiers). The peculiarity of "normal piling" is that this rule holds in passing from each tier to the next, through the whole pile. The other alternative is represented by the edges of the second tetrahedron, and gives equally close packing. If we use the two tetrahedrons alternately as our guides in laying successive tiers, we obtain the system of closest piling which comes next in simplicity to normal piling. It may be called "antinormal piling." In normal piling every sphere belongs to six lines of spheres which are continued through the whole pile. They are parallel to the six edges of the standard tetrahedron. In antinormal piling there are only three such lines of instead of six. In normal piling every sphere belongs to four sets of triangularly arranged tiers, which are parallel to the four faces of the tetrahedron. In antinormal piling there is only one set instead of four. Again, in normal piling, there are three sets of squarely arranged tiers, their planes being at right angles. In antinormal piling there are only fragmentary traces of square arrangement. Prof. O. Reynolds' theory asserts that the universe is composed of infinitely hard equal spherical grains in approximately normal piling, which, on striking, rebound without loss of relative velocity, their free paths being infinitesimal compared with their diameters, except in places where the grains are out of gear (called surfaces of misfit). A spherical surface of misfit is the simplest kind of atom of ordinary matter, and is propagated as a solitary wave through the surrounding grains by the transfer of grains across it in the reverse direction. The excitation of electricity by friction is explained as the tearing away of a cluster of grains from one part of a normal pile and thrusting it into another part. Disarrangements of opposite kinds are produced at the two places, each involving diminished closeness of packing. Magnetism is explained as a rotational displacement of a spherical cluster of grains, sufficient to cause grains near the equator of the sphere to slip a tooth (as it were) in their gearing with the grains outside, while grains nearer the poles have not moved far enough to slip a tooth. The spherical cluster is thus subjected to rotational strain and stress. Attractions and repulsions are manifestations of a tendency of disarranged grains towards closer packing, a tendency due to the continual impacts from without, which (as in the kinetic theory of gases) are equivalent to external hydrostatic pressure. The Paper maintains that, in a struggle for existence between different kinds of closest piling, represented by separate clusters with room to change their arrangements, normal piling possesses great advantages, first, in its six sets of lines of spheres, which serve as battering rams, and secondly, in its four sets of tiers in closest array, which facilitate the coalescence of adjacent clusters.

An Automatic Gas Pump

was exhibited by Mr. C. E. S. PHILLIPS. The apparatus is constructed upon a plan which enables the pump, when once set in operation, to continue automatically and to produce as perfect a Torricellian vacuum as possible. It has been devised with a view to providing a comparatively portable machine suitable for special laboratory work or for researches requiring prolonged pumping, and consists of three distinct parts—viz., a small motor-driven mechanical pump, a four-way control valve and a modified Toepler apparatus, by which the final vacuum is obtained. Experiment has shown that the apparatus is fairly rapid in its action. In a preliminary trial, a Röntgen-ray bulb of 200 ccs. capacity was exhausted in half an hour. The glass work is easily removed for cleaning or repairs, and the wood supports are fitted with adjustable brackets. The height of the complete apparatus is 18in.

There was also an exhibition of spectroscopic and other scientific apparatus by Mr. PETER HEELE.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E FOURNIER D'ALBE.]

Hertzian Waves and Phosphorescence.—C. Gutton has found that not only does the induced E.M.F. due to the variation of a magnetic field brighten a calcium sulphide screen, but Hertzian oscillations, producing, as they do, very intense E.M.F.'s, do the same. He produced the electric oscillations by means of a small Blondlot oscillator 2cm. in diameter, placed in vaseline oil, and transmitted the oscillations from the generator to the sulphide screen by means of parabolic mirrors. As soon as the waves impinge upon the sulphide screen, the latter becomes more clearly visible, and the author says that this effect is more striking than that obtained with a magnetic field only. Hertz's experiment on the polarisation of electric waves is particularly suitable for showing that it is they which brighten the phosphorescence. The author placed a set of parallel copper wires 1cm. apart between the mirrors. On making it turn in its own plane, the author found that the phosphorescence became a minimum when the wires were parallel to the direction of the electric force, and a maximum when they were perpendicular. The position for maximum could be fixed to within a few degrees. The reflection of electric waves by a plane mirror is more easily observed by means of phosphorescence than with the aid of a resonator. The maximum position corresponds to an equality in the angles of incidence and reflection. The Hertzian waves appear to act in the same manner as the N-rays, since they increase the luminosity in a vertical direction, and diminish it in a tangential direction. Instead of a phosphorescent body, a feebly luminous body may be employed, as in the case of N-rays. The Hertzian resonator may be improved and simplified by substituting a phosphorescent screen for the spark.

[C. GUTTON, *Comptes Rendus*, April 18, 1904.]

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Radium Rays for the Blind.—E. S. London gives an account of some remarkable attempts to utilise the rays of radium for the instruction of the blind. He found that the rays, though they probably exert some feeble effect upon the optic nerve itself, act in a much more pronounced manner upon the retina, and that whatever effect can at present be produced is conditional upon the retina, or some small portion of it, having retained its susceptibility for light. If a box containing a radium preparation is approached towards the head of a person whose eyes are bandaged, he perceives a general diffused luminosity, which is centred to some extent towards the direction of the box. With some practice, the subject can indicate the direction in which the box is situated, and if the operator traces lines and curves in front of his eyes with the box, he can trace them out after him with a fair amount of accuracy. But the practical value of these observations is annulled by the fact that the rays are very dangerous to the eyes, leading easily to retinitis and blindness. On the other hand, the rays may be usefully employed in conjunction with a platinocyanide screen. The author encloses such a screen in an opaque frame which is held in front of the eye in a dark room. Objects are shown as silhouettes on the screen, and the blind subjects are told their shapes as first, with the aid of the sense of touch, and when they acquire some practice they are able to trace them out themselves. In this way the reading of raised letters is greatly facilitated, the vague visual impression strengthening the tactual perception. Ordinary screens illuminated with electric light were also tried, but were found to irritate the eye by the heat rays.

[E. S. London, *Archives d'Électricité Médicale*, April 25, 1904.]

Radio-therapeutics.—J. Bergonié records an interesting case of the cure of a cancroid of the eyelid by Röntgen rays. The patient was a woman of 63, suffering from cancer of the eyelid and the orbit of 20 years' standing, but recently accelerated. Röntgen rays of sufficient intensity to penetrate a thorax were applied to the eye through an aperture in a lead screen during 11 sittings of five minutes each extending over a month. Six weeks after the treatment the cancer had completely disappeared, leaving the eye closed, indeed, but covered with a normal skin, through which the eyeball could be felt to be in a normal condition.

[J. Bergonié, *Archives d'Electricité Médicale*, April 25, 1904.]

Barbed Damping Device.—MM. Favé and Carpentier describe a new device for damping oscillations which combines a very small moment of inertia with a high damping coefficient. It consists of a stellar arrangement of very thin glass fibres or natural hairs, fastened to the oscillating needle with its plane horizontal and its centre in the axis of oscillation. The fibres used have a diameter of about $\frac{1}{10}$mm. The nature of the surface appears to be without influence. Although a multiplicity of fibres is essential to the efficiency of the damping device, a limit is set to their number by the necessity of keeping them a certain distance apart. Otherwise, the air is carried along by one fibre and the next is shielded from its influence. This drag is perceptible even when the distance between two successive fibres is 100 times as great as the diameter of the fibre. The authors give the following formula governing the relation between the diameter D of the fibres and the coefficient ρ (in dynes) of the resistance per square centimetre of the transverse section for a velocity of 1cm. per second:—

$$(\rho - 0{\cdot}00135)\,(D + 0{\cdot}00283) = 0{\cdot}0007765.$$

The authors remark that the theoretical formulæ given by Stokes and later by Tomlinson do not apply to these very small diameters.

[Favé and Carpentier, *Comptes Rendus*, April 18, 1904.]

Conductivity of Sodium.—A. Bernini has endeavoured to dispel the uncertainty hitherto attached to the conductivity of the alkali metals, even after Matthiessen's work, by an accurate determination of the conductivity of sodium at various temperatures. He overcame the difficulties inherent in the rapid oxidation of the metal by passing it through hydrogen into a capillary tube, into which it was poured by melting, the oxide being, by a suitable arrangement of the tube, left behind. The resistivities obtained ranged from 0·05 at 0deg. to 0·095 at 125deg., with a sudden upward jump from 0·065 to 0·09 at the melting point. Sodium is, therefore, one of the best conductors of electricity. Its resistance, as in the case of the other metals, increases with the temperature, and to an extent nearly proportional to it. The temperature coefficient is greater for the liquid than for the solid state. At the melting point, 97deg., the resistance suddenly changes in the proportion of 1 to 1·337. The author took care that the solid sodium was free from discontinuities, and eliminated errors in the estimation of diameters by repeating all the measurements with pure mercury.

[A. Bernini, *Physikalische Zeitschrift*, May 1, 1904.]

Internal Field of Insulators.—W. von Nikolajew describes some experiments which clearly demonstrate the existence of an electric field in the interior of an insulator immersed in an electrolyte traversed by a current. He fills a cylindrical vessel terminating below in a long vertical tube with nitrobenzol, and floats in the latter another cylindrical vessel, held down by a thread attached to the bottom of the tube. The second vessel is thus free to rotate. A metallic rod is suspended freely in the interior vessel by another thread, and a current from a transformer giving 15,000 volts is taken through the nitrobenzol by means of two electrodes dipping into it. When the current is made, the rod sets itself in the line joining the two electrodes, though it does not do so when the electrodes are outside the vessel, so that the movement is not due to the direct influence of the electrodes. When the rod is placed in a slanting position the interior vessel begins to rotate, and continues to do so until the torsion of the thread stops it. The rotation is fast when the dimensions of the apparatus are small. If the rod is fixed in the smaller vessel in an eccentric position, the vessel is urged in the same direction as soon as the current is established.

[W. von Nikolajew, *Physikalische Zeitschrift*, April 15, 1904.]

The Experimental Determination of the Form-factor of Alternating Currents.—Messrs. P. Rose and A. Kühns, in a communication from the Physikalisch-Technische Reichsanstalt, describe the following method for determining experimentally the form-factor of alternating-current waves. The form-factor f is defined as the ratio of effective volts to mean volts—*i.e.*, $f = \frac{1}{\tau/2}\sqrt{\int_0^{\tau/2} e^2 dt} \div \frac{1}{\tau/2}\cdot\int_0^{\tau/2} e\,dt$. The dividend coincides with the reading of an alternating-current voltmeter, and the divisor may be obtained in the following manner. A disc of insulating material, half of whose periphery is covered by a metal segment, is rotated by the alternating-current machine, the form-factor of which is to be found. Two brushes, placed side by side, rub on the periphery of the disc. The whole arrangement acts like a switch, which makes contact during one-half of the alternating-current wave and breaks contact during the other half. In this way a pulsating continuous current is obtained, and, if this pulsating current is sent through a continuous-current voltmeter of the D'Arsonval type (having small self-induction) or through a wattmeter in the manner described below, then the reading will represent half the mean voltage of the alternating current. The form-factor, therefore, is obtained by dividing the effective volts, as read off the alternating-current voltmeter, by double the reading of the continuous-current instrument. If a wattmeter is used for this purpose, a constant continuous current is sent through the main coil, while the voltage coil is fed by the pulsating continuous current. Thus the wattmeter is converted to a voltmeter, suitable for indicating the mean of the pulsating wave sent through it. In this manner the authors determined the form-factors of various waves and found that they agreed very closely with the form-factors obtained by the aid of a planimeter.

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POWER STATION DESIGN.

The large attendance at the meeting of the Institution of Electrical Engineers last week showed that one of the chief subjects of interest at the present time is the design of large power houses, a Paper upon which was presented by Mr. C. H. MERZ and Mr. W. MCLELLAN. Through the entire Paper there is one dominant theme: economy in capital expenditure is as important as economy in works costs. We are glad to see this point well emphasised in a Paper before the Institution. Many years ago, when we initiated the practice of publishing analyses of accounts of electricity undertakings, we attached considerable importance not only to the total capital expenditure, but also to the various items which contributed to the whole. The tables which we then published periodically enabled a comparison to be made of the expenditure on the larger electricity undertakings under the headings Land and Buildings, Plant, and Mains, and the percentages of the total capital expenditure which these items represented. This analysis, taken in conjunction with the analysis of the works costs on the same sheet, led, we believe, to a far better appreciation of the business aspect of electricity supply, and, as the industry—and more particularly the municipal branch of it—grew, we continued the same policy with our more detailed weekly analyses of the accounts. It is only recently that we discontinued these, in the conviction that the lesson had been properly taught, and that engineers no longer confined their attention to endeavours to approach as nearly as possible to lowering the record in works costs, irrespective of the increased capital charges which might be incurred in doing so. The Paper by Mr. MERZ and Mr. MCLELLAN proves that we were not wrong, and we trust that the authors will be successful in driving the lesson well home by means of their detailed review of the elements of power station design.

At the very commencement, the Paper shows that the consulting engineer has large scope for putting to the test his talents in the direction of economical design. "When we consider that a boiler only costs £2 or £3 a kilowatt, and a turbine or high-speed reciprocating set £10 at the outside, it is surprising to find power stations running out (as they still do in many cases) to a total cost of £40, or even more, per kilowatt. In other words, the mere collecting and joining together of the principal apparatus may cost three or four times as much as the apparatus itself." Curves are then given

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which demonstate that a reduction of capital outlay by £1 per kilowatt represents, in the particular case chosen for the example, a greater reduction of the total costs than a saving of 6 per cent. in the coal bill. This is with a load-factor as high as 30 per cent.; with lower load-factors the effect is far greater. Although, as we have said, economy in capital expenditure may be considered the principal theme running through the Paper, there are others as well, and the all-important principle that absolute reliability of supply must stand before everything is not forgotten, nor, of course, the necessity of keeping down works costs as far as is possible without too extravagant capital expenditure. It should always be borne in mind that simplicity of design in an electricity works does not only conduce to economies in the capital expenditure, but it also, as a rule, tends to increase the reliability of the plant as a whole. To increase this factor of reliability also, Messrs. MERZ and MCLELLAN recommend that the sub-division of the plant into "units" should be carried to its ultimate logical conclusion by the formation of absolutely independent unit sets, including boilers, engines, dynamo and all auxiliaries, the only points of contact being at the sources of water and coal supply and the 'bus bars. Before applying this generalisation to the actual general arrangement of the works, the authors of the Paper consider the relative merits of the several types of engine, giving the palm to steam turbines for use in large units such as are required in a power-house. The gas engine is passed over with a few words, the authors apparently thinking that, if it is the engine of the future, at any rate it is not the engine of the present. The best disposition of boiler plant in view of the small space taken by the steam turbine units, the best position for the auxiliaries, and whether these should be electrically driven or steam driven, and the problem as to the extent to which advantage may accrue from labour-saving devices, are all clearly discussed, and certainly promise that the debate at the Institution (not yet terminated at the time of writing) will be a good one. The method in which the question of spare plant and rating is dealt with, especially as regards the relation between overload capacity and spare units, is also excellent, and little fault can be found with the authors' views under this heading. The last part of the Paper, dealing with switchboards and switch gear will be published in our next issue. On the whole, the Paper is one of the best that has been contributed to the Institution in recent years, both as regards its intrinsic merits and its value in starting a discussion—commenced at the Institution, but likely to continue for weeks in the form of interesting informal debates in engineers' offices and works.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

The Grant and Validity of British Patents for Inventions. By JAMES ROBERTS, M.A., LL.B., A.I.E.E. (London: John Murray.) 25s. net.

Owing to the highly complicated character of many modern inventions, to the various pitfalls which patent procedure have placed in the way of the unwary but ever-hopeful inventor, and to the fact that the grant of letters patent by no means implies validity, a work on patent law and procedure, which professes to deal with this highly important but somewhat difficult subject from the standpoint of the inventor, must possess considerable interest, not only for inventors, but also for manufacturers and all persons interested in the exploitation and development of patents. The aim of Mr. Roberts, who is an acknowledged authority on patent law, has been to give a clear and simple exposition, with as few legal technicalities as possible, of patent law and procedure so as to enable inventors to obtain a valid grant of letters patent for their inventions, and it must be acknowledged that a large measure of success has been achieved by the learned author. It is by no means easy to grasp the rules relating to the grant and validity of patents, which are to be gathered mainly from the reports of actions for infringement and petitions for revocation of patents; yet a knowledge of them is essential to the patentee who wishes to secure a patent which is not afterwards open to attack, and this knowledge can undoubtedly be gained from the present volume.

Of the three parts into which the book is divided, the first is devoted to a statement of the general principles of patent law. After a short introductory chapter, the author deals, in Chapter II., with the limits of "manufacture," the distinction between principles and inventions and between inventions and their objects, patents for improvements and master and combination patents. Inventions in relation to the history and development of the arts form the subject matter of the third chapter, and prior user and publication, the minimum of public knowledge necessary for a patent invention, and proof of ingenuity all receive adequate treatment. Chapter IV., which treats of the persons to whom patents may be granted, is, however, hardly full enough. The conditions upon which patents are granted are clearly set out in Chapter V., while the important subject of the construction of specifications is dealt with in Chapter VI. The remaining chapters are devoted to the procedure to obtain a patent, opposition to grants of letters patent and appeals, and amendments of specifications.

The second section is composed of abstracts of a number of leading patent cases, with interesting notes by the author appended to each case. These cases, which have been carefully chosen, give the subject matter of the patent, the point or points in issue and the decision. In addition, the drawings which accompanied the original specifications are in several instances reproduced, thus enabling readers to grasp more readily the principle of patent law involved in each case. Many of the cases given are "electrical," and were reported in the columns of *The Electrician* when they were before the Courts, so that the lessons they are intended to bring home will be the better appreciated by our readers.

The third part is composed of the text of the Patent, Designs and Trade Marks Act of 1883, the Amendment Act of 1885, the Patents Act of 1886, the Patents, Designs and Trade Marks Act of 1888, the Patents Acts of 1901 and 1902, the International Convention for Protection of Industrial Property, with instructions to applicants for patents, &c. A very full index, with tables of cases cited, &c., add to the utility of the work.

Though the learned author only professes to deal with the subject up to the point of obtaining a valid grant of letters patent, there are, however, one or two matters which we should like to see included in future editions—*e.g.*, the action for infringement, the grant of compulsory licences and the procedure for obtaining an extension of the grant of letters patent. However, the volume, taken as a whole, is an excellent one, and cannot fail to be of considerable assistance, not only to inventors and manufacturers, but to lawyers and others who wish to get a good up-to-date treatise on patent law.

It is a striking fact that nearly 50 per cent. of the patents granted in this country each year are invalid, and though we are on the eve of a departure in British patent practice, it is doubtful how far this will assist inventors or manufacturers. As our readers know, the Patent Act of 1902 provides for a 50 years' search in prior British patents by the Comptroller of Patents as to the novelty of the invention sought to be protected. The necessary arrangements have not yet been completed for putting this provision into force, but, in any event, it will only affect one cause of invalidity, and it is doubtful whether the act will simplify patent procedure.

Die Elektrometallurgie der Alkalimetalle. By H. BECKER (Halle-a-S.: Wilhelm Knapp.) 6m.

Our diligent cousins are preparing monographs on the latest phase of chemical industry—that which depends on the use of electrical methods. A considerable area of work has been covered by previous monographs of this kind, section after section of manufacturing electrochemistry having been handled, some of

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them with conspicuous success. It may be assumed that a monograph must include everything proper to the subject of which it treats, and, if this be admitted, the substance of the present effort is justified; it includes not merely those early and semi-abortive efforts to prepare sodium chemically which were generated by the desire to manufacture aluminium in like manner, but also refers with becoming brevity to the researches of Wöhler, who proposed in 1827 to utilise potassium for the same end. With corresponding completeness it describes the very latest methods patented and published on the eve of the issue of this book.

As would be expected, the largest section of the work is occupied by descriptions of electrolytic processes as distinct from chemical and electro-thermic methods; it is divided according to the raw material used. Thus, processes using sodium chloride are grouped together; processes starting with caustic soda form another division, sodium carbonate and sodium nitrate a third and fourth. All processes in which sodium alloys are obtained in place of the pure metal are handled collectively. The chief of them are known to our readers, but one or two may be spoken of now. The author's own process consists in electrolysing sodium carbonate or a mixture of sodium carbonate and caustic soda. The apparatus generally resembles the Castner, but heating is to be internal by means of the current, and is adjusted so that the centre only of the mass of electrolyte is fluid, and the walls of the apparatus are actually composed of congealed electrolyte. The advantages of using sodium carbonate are its cheapness and the fact that by its electrolysis no hydrogen can be generated, and no explosion can occur. The method has been put to work in France. The Darling process uses sodium nitrate in the anode compartment and caustic soda in the cathode compartment, the function of the latter being to convey sodium to the cathode out of reach of the anode and its oxidising surroundings. A diaphragm of magnesia and Portland cement held in an iron cage separates the two electrolytes. The heating is internal; NO_2 and O are collected at the anode and converted into nitric acid. The advantages claimed are the comparative cheapness of sodium nitrate and the recovery of a valuable product—nitric acid. The process has been worked at Philadelphia within the last year or two, but not much has been heard of it lately.

Electro-thermic processes are represented by a method devised by the author, in which he heats in a furnace of the Willson type a mixture of carbon and a sodium salt. In principle the method is equivalent to the old chemical processes in which sodium carbonate or caustic soda were heated with carbon in retorts fired externally, but the idea has been extended thus: For sodium alone, modern electrolytic processes are fairly economical, and there is no great prospect of ousting them by a furnace process, but sodium salts containing another metal, such as the chromate or aluminate may be reduced by carbon in an electric furnace, the sodium distilled off, and the heavier metal or its carbide run down and tapped in the usual way. The idea is ingenious, and though there are difficulties in its realisation, it is worthy of attention. The book is full and fair and useful.

Specification. No. 7. (London: "Builders' Journal and Architectural Record.") 1904. 2s. 6d.

Although intended chiefly for architects and builders, this annual contains also a considerable amount of matter of direct or indirect interest to electrical engineers. In the chapter devoted to the planning of machine shops and the general arrangement of works, the pros and cons of electrical driving have been ably discussed. Useful information of a general nature with regard to lighting schemes, power transmissions, lifts, telephones, &c., will be found in the book, and a number of specifications applying to these branches of the electrical industry is appended.

Simple Experiments in Static Electricity. By PERCIVAL G. BULL (London: Percival Marshall & Co.) 6d.

The author has described in popular language some of the many interesting experiments which may be performed with static electricity. No very elaborate apparatus are required, and the work is of such a nature as may readily be carried out by the average schoolboy.

SUPPLY OF ELECTRICITY BILL.

The following bill, intituled "An Act to Amend the Acts Relating to Electric Lighting," passed its first reading in the House of Lords on Thursday last:

Be it enacted by the King's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:—

Compulsory Acquisition of Land for Generating Stations.

1. (1) The Board of Trade may by provisional order authorise any local authority, company or person, who are authorised by the same or any previous provisional order or by Act of Parliament to supply electricity in any area, to acquire compulsorily for the purpose of a generating station any land specified in the order, whether situated within or without the area of supply, and in the case of a local authority, whether situated within or without their district.

(2) For the purpose of the acquisition of land authorised to be taken compulsorily under any such provisional order, the provisions of the Lands Clauses Act which relate to the purchase and taking of lands otherwise than by agreement, and to the entry upon lands by the promoters of the undertaking, are, subject to the modifications set out in the schedule to this act, incorporated with the Electric Lighting Acts, as well as the provisions of those acts already so incorporated by the Electric Lighting Act, 1882.

(3) Rules made by the Board of Trade under sec. 5 of the Electric Lighting Act, 1882, shall provide for proper notice being given of an application for a provisional order by which it is proposed to take land compulsorily, to owners, lessees, and occupiers of land, and also for public notice being given of the proposal by advertisement.

Breaking up Streets, &c., outside Area of Supply.

2. For the purpose of enabling electricity to be brought into an area of supply from a generating station situated outside that area, the Board of Trade may by provisional order apply to any roads, railways or tramways situated outside that area, the provisions of the Electric Lighting Acts which authorise, or enable the Board of Trade to authorise, the breaking up of any road, railway or tramway, so far as those provisions do not already so apply.

Supply in Bulk.

3. The Board of Trade may, by provisional order—

(*a*) Authorise any company or person to supply electricity in bulk to any local authority, company or person authorised to supply electricity in any area for the purpose of distribution by that local authority, company or person within that area; and

(*b*) Provide for any supply so authorised being compulsory; and

(*c*) Define what are to be the limits of supply for the purpose of the provisions of the Gasworks Clauses Act, 1847, incorporated in the Electric Lighting Act, 1882, in the case of a company or person so supplying electricity in bulk; and

(*d*) Make such other provisions as appear to them necessary for adapting the Electric Lighting Acts to any case where a company or person are authorised to supply electricity in bulk in any area.

Provisions as to Right of Local Authority to Purchase.

4. (1) The Board of Trade may by provisional order exclude the application of the power of purchase given by sec. 2 of the Electric Lighting Act, 1888, as respects the whole or any part of any undertaking authorised after the passing of this act to which they consider it is inapplicable, either by reason of the undertaking being situate in a number of districts, or by reason of the objects of the undertaking not being such as can be properly carried out by local authorities, or by reason of any other special circumstances affecting the undertaking, but before doing so shall cause notice to be given to any local authorities who would have the right to purchase under the said section, and shall consider any objection made by any of those authorities.

(2) Where any generating station, mains, or other works of a company used solely for supplying electricity within the district of a local authority are situated outside the district of that local authority, the generating station, mains, and other works so used shall for the purposes of the provisions of the Electric Lighting Acts, and any provisional order conferring on local authorities power to purchase undertakings, be deemed to be situated within the district of that local authority:

Provided that this provision shall not apply in a case where the generating station, mains, or other works belong to a company authorised to supply electricity in bulk only.

(3) Any local authority having power under the Electric Lighting Acts or any provisional order to purchase so much of the undertaking of a company as is within the district of that local authority may, with the consent of and upon such terms and conditions as may be approved by the Board of Trade, and with the consent of the company, transfer their rights of purchase to any other local authority having power to purchase so much of the same undertaking as is within the district of that last-mentioned local authority, and the deed of transfer may contain such consequential provisions as may be necessary for giving effect to the transfer.

Exercise of Electric Lighting Powers by Authorities Jointly.

5. The Board of Trade may, with the concurrence of the Local Government Board, by provisional order make such provisions as appear to them necessary or expedient, by the constitution of a joint committee or joint board or otherwise, for the joint exercise of the powers under the Electric Lighting Acts, or this act, or any provisional order, by two or more local authorities as respects any area of supply consisting of the whole or parts

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of the districts of those authorities, in any case where it appears to them that the joint exercise of those powers would be expedient, and any such provisional order may contain such provisions as may appear necessary or proper for adapting any of the provisions of the Electric Lighting Acts, or this act, or any such provisional order, to the case of any committee or board so constituted.

Provision as to Consents of Local Authorities to Grant of Provisional Order.

6. (1) The Board of Trade shall, on considering whether any provisional order should or should not be granted, take into consideration the views of the local authorities affected on the subject, but whether the consent of any local authority is or is not given, may grant the order or not at their discretion.

(2) Sec. 1 of the Electric Lighting Act, 1888, is repealed from the beginning of the section down to "with such consent."

(3) The notice required by sec. 4 of the Electric Lighting Act, 1882, to be given to a local authority on or before July 1, need not be given to the local authority of a district in which it is not intended to take power to distribute electricity.

Revision of Maximum Price.

7. (1) With a view to making five years the ordinary period of revision of maximum price and allowing representations as to revision to be made by consumers, sub-sec. 2 of sec. 32 of the schedule to the Electric Lighting (Clauses) Act, 1899, shall for the purpose of incorporation with any act or order passed or confirmed after the passing of this act, be read as if the words "five years" were substituted for the words "seven years," and the words "or such number of consumers not less than 20, as the Board of Trade consider sufficient, having regard to the population of the area of supply" were inserted after the words "either the local authority or the undertakers."

(2) Where any act or provisional order passed or confirmed before the commencement of this act enables the Board of Trade to revise or vary any maximum prices to be charged for electricity, that act or order shall be construed—

(*a*) So as to enable the revision or variation to take place at an interval of five years after the commencement of the act or order, or the last revision, in cases where a longer interval is fixed by the act or order; and

(*b*) So as to enable the power of revision or variation to be exercised on the representation of such number of consumers, not less than 20, as the Board of Trade consider sufficient, having regard to the population of the area of supply, in cases where the power cannot under the act or order be exercised on such a representation or the representation of a less number of consumers.

Certification of Meters.

8. (1) For the purpose of incorporation with any act or order passed or confirmed after the commencement of this act—

(*a*) Sec. 49 of the schedule to the Electric Lighting (Clauses) Act, 1899 (which relates to meters), shall be read as if the words "and fixed and connected with the service lines in some manner approved by the Board of Trade" were added at the end of the section;

(*b*) Sec. 50 of the same schedule (which relates to the certification of meters) shall be read as if the words "and to have been fixed and to have been connected with the service lines," and the words "or where any such meter is unfixed or disconnected from the service lines," were omitted therefrom; and

(*c*) The same section shall be read as if for the words "to be a correct meter" there were substituted the words "to be a meter capable of ascertaining the value of the supply within such limits of error as may, as respects meters of the class to which the meter belongs, be allowed by the Board of Trade."

(2) So much of any act or provisional order relating to the supply of electricity passed or confirmed before the commencement of this act as requires that in order that a meter may be considered to be duly certified, it must be certified to have been fixed and to have been connected with the service lines in some manner approved by the Board of Trade, shall cease to have effect, but every duly certified meter must be fixed and connected with the service lines in some manner approved by the Board of Trade.

(3) A meter shall be certified to be a correct meter within the meaning of any act or provisional order relating to the supply of electricity passed or confirmed before the commencement of this act if it is capable of ascertaining the value of the supply within such limits of error as may, as respects meters of the class to which the meter belongs, be allowed by the Board of Trade.

Accounts of Local Authorities.

9. For the purposes of sec. 9 of the Electric Lighting Act, 1882, the accounts of any undertakers being a local authority shall be made up to March 31 in each year, and accordingly as respects those accounts June 30 shall be substituted in that section for March 25, and March 31 for December 31: Provided that if any such undertakers show to the Board of Trade that some other dates are, owing to special circumstances, more convenient in their case than March 31 and June 30, the Board of Trade may substitute such other dates for the said March 31 and June 30, and this section shall as respects those undertakers be construed with the substituted dates.

Supply of Electricity to Premises having Separate Supply.

10. Notwithstanding anything in the Electric Lighting Acts or in any Act of Parliament or provisional order authorising an undertaking, a person shall not be entitled to demand from undertakers authorised to supply electricity in any area a supply of electricity for any premises having a separate supply, unless he has agreed with the undertakers to pay to them such minimum annual sum as will give them a reasonable return on the capital expenditure, and will cover other standing charges, incurred by them, in order to meet the possible maximum demand for those premises; the sum to be so paid shall be determined in default of agreement by arbitration under the Electric Lighting Act, 1882.

Provisions as to Contracts under 45 and 46 Vic. c. 56, s. 11.

11. Where any local authority authorised to supply electricity have entered into a contract under sec. 11 of the Electric Lighting Act, 1882, with any company or person authorised by any provisional order to supply electricity, the Board of Trade may upon such terms and conditions as they think fit, exempt that company or person from any provisions contained in the provisional order which appear to the Board of Trade such as to prevent the company or person carrying the contract into effect.

Definitions.

12. In this act, unless the context otherwise requires—

The expression "provisional order" means a provisional order under the Electric Lighting Acts.

The expression "Electric Lighting Acts" means—

(*a*) As respects England and Ireland, the Electric Lighting Acts, 1882 and 1888; and

(*b*) As respects Scotland, the Electric Lighting Acts, 1882 and 1888, the Electric Lighting (Scotland) Act, 1890, and the Electric Lighting (Scotland) Act, 1902.

The expression "authorised" means authorised by Act of Parliament or provisional order.

The expression "area of supply" means any area within which any local authority, company or person are authorised to supply electricity under the Electric Lighting Acts.

The expression "road" includes any street as defined by the Electric Lighting Act, 1882.

The expression "generating station" includes all machinery and appliances ordinarily used in connection therewith.

Application of Act to Scotland and Ireland.

13. (1) In the application of this act to Scotland the Secretary for Scotland shall be substituted for the Local Government Board as respects provisional orders relating to Scottish local authorities, and May 15 shall be substituted for March 31, and August 1 shall be substituted for June 30.

(2) In the application of this act to Ireland the Local Government Board for Ireland shall be substituted for the Local Government Board as respects provisional orders relating to Irish local authorities.

Short Title and Construction.

14. (1) This act may be cited as the Electric Lighting Act, 1904.

(2) This act and the Electric Lighting Acts shall be construed together as one act and may be cited as the Electric Lighting Acts, 1882 to 1904.

SCHEDULE.

Modifications of the Lands Clauses Acts.

The following modifications shall have effect in the construction of the provisions of the Lands Clauses Acts incorporated by this act for the purposes of the Electric Lighting Acts:

(*a*) The expression "special act" means the Electric Lighting Acts, inclusive of any provisional order authorising the compulsory acquisition of land, except that the period of three years mentioned in sec. 123 of the Lands Clauses Consolidation Act, 1845, shall be calculated from the passing of the act confirming the provisional order; and

(*b*) The expressions "the promoters" and "the undertaking" mean respectively the undertakers and the undertaking under the Electric Lighting Acts; and

(*c*) The expression "land" includes easements in or relating to land.

SOME PROPERTIES OF ALTERNATORS UNDER VARIOUS CONDITIONS OF LOAD.*

BY A. F. T. ATCHISON.

In the following Paper an endeavour has been made to point out some of the chief factors which govern the behaviour of alternators under different conditions which occur in engineering practice.

E.M.F. on Open Circuit.—When no current is being taken from the machine, the E.M.F. induced in the armature conductors is

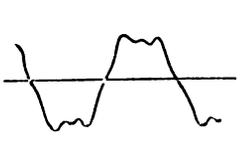

FIG. 1.

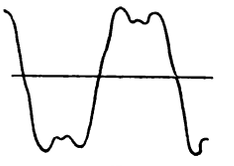

FIG. 2.

simply that due to their rotation through the magnetic field produced by the field magnets themselves, and under no other circumstances can this identical condition exist. This E.M.F. will hereafter be referred to as the *nominal* induced E.M.F. The E.M.F. wave-form of the complete armature on open circuit will clearly be affected by any alteration in the flux distribution, and as an interesting example of this are shown two oscillograms of the open circuit E.M.F. wave-forms of the same alternator; Fig. 1 being that corresponding to a moderate excitation, and Fig. 2 corresponding to

* Abstract of a Paper read before the Birmingham Local Section of the Institution of Electrical Engineers on April 20th.

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a powerful excitation, the difference in form being due to the change in permeability in different regions of the flux, owing to the difference in degree of saturation.

E.M.F. Induced with Machine Loaded.—The flux which exists at any instant will be the resultant of those produced by all the magneto-motive forces which may be acting. Now the magneto-motive force due to the armature current will give rise to a flux of which the greater part (if the reluctance of the leakage path be high) will traverse the same magnetic path as the flux produced by the magneto-motive force of the field current, and may be considered to combine with this flux to form a resultant flux. This part of the effect of the armature current represents "true armature reaction." There is also a portion of the flux produced by the armature current which will leak along the air-gap and link with the armature conductors without traversing the path of the field magnet flux. This flux gives rise to what may be called the "leakage self-induction" of the armature, and should be carefully distinguished from the flux "linked with the armature when carrying unit current," since, as just considered, the greater part of the flux contained in this definition is already taken into account by the consideration of armature reaction. Since in practice the armature resistance is always kept so low that the drop of pressure due to this is very small, it is clear that the effects of armature reaction and leakage self-induction will be the controlling factors in the regulation of an alternator.

Considering first the case when the armature current is in phase with the nominal induced E.M.F., it is clear that in this case the current reaches its maximum when the armature coil is in a position midway between two field poles, as shown in Fig. 3, since the rate of change of the flux through the coil is then a maximum, and passes through its zero value when the amature coil is immediately facing a pole; further, it will be seen that the effect of the armature current in this case is merely to increase the flux in the edge of the pole from which the coil is receding and to decrease it in the side of the pole which it is approaching. (In the case of a synchronous motor clearly the reverse will take place since the current flows

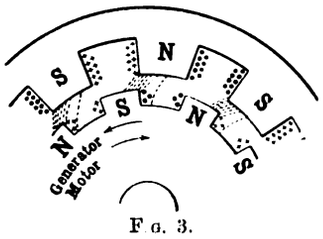

Fig. 3.

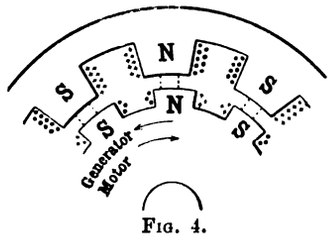

Fig. 4.

Demagneti-ing { Lagging Current in Generator
Effect { Leading Current in Motor.

against the induced E.M.F.) Hence, with the current in phase with the induced E.M.F. there is no weakening or strengthening of the field as a whole, but merely distortion—if we neglect the increase of reluctance due to the greater saturation of the one side of the pole piece, which effect might be slightly in excess of the corresponding decrease of reluctance in the other side. Similarly, if we consider a current lagging behind the nominal E.M.F., then, since the current will not have reached its maximum value until the armature coil is partly facing the next pole, it will readily be seen from Fig. 4 that a "demagnetising" effect is produced (and a magnetising effect in the case of the synchronous motor), and the field as a whole is weakened. Similarly with the current in advance of the E.M.F. the generator field will be strengthened and the synchronous motor field weakened.

The armature leakage reactance is of the nature of a true self-induction, and the E.M.F. induced thereby will be in quadrature with the current, and hence with a lagging current will have a component in opposition to the nominal induced E.M.F., and in the case of a leading current, a component in conjunction with it. Thus armature reaction and leakage reactance have a similar effect, and since they always exist conjointly it becomes convenient to consider them together and represent the combined effect by the term "synchronous reactance" of the armature. In general, this is different numerically from the value which is obtained by passing an alternating current of known frequency through the armature when at rest.

If we denote the synchronous reactance by pL and combine with it the resistance R of the armature, we obtain $\sqrt{R^2+p^2L^2}$, which may be termed the "synchronous impedance" of the armature. To obtain the value of this experimentally the simplest method is to make use of the open-circuit characteristic curve and the short-circuit characteristic curve, in the manner originally suggested by Dr. Behn-Eschenburg (*The Electrician*, Vol. XXXV., p. 424).*

* See also the articles by Behrend and others on this subject in *The Electrician*, Vol. LII., p. 410, and in the issue of April 22nd, p. 5.—Ed. *E.*

The first of these curves will be of the form of a magnetisation curve, but with the "knee" more rounded off—since, in general, the various portions of the magnetic circuit will become saturated in succession. The second curve will be usually a straight line for the greater part of its length. Then if at any excitation the value of the nominal induced E.M.F. be divided by the corresponding short-circuit current, the quotient is the value of the synchronous impedance of the armature at that excitation. The synchronous reactance may then be calculated when the resistance is known, thus $p^2L^2=Z^2-R^2$, $pL=\sqrt{Z^2-R^2}$, where Z = synchronous impedance found as above. On the basis, therefore, of a definite armature impedance, it is possible to predict the regulation of the machine on loads of different power-factor.

(A) *Non-Inductive Load* (Fig. 5).—Draw from O, OR and OL at right angles, representing in magnitude the quantities RI and pLI respectively, their vector sum OZ then represents the E.M.F. consumed by the impedance of the armature. Since the load is non-inductive the P.D. will be in phase with the current, and hence the P.D. vector will be in the same direction as OR, and since it is the vector difference of the E.M.F. (OE) (whose length is known from

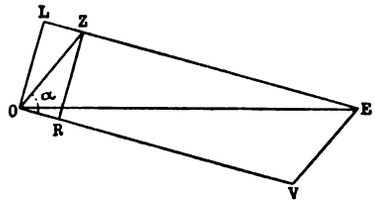

Fig. 5.

the open-circuit characteristic) and the E.M.F. consumed by the impedance, the triangle OZE may be constructed, ZE being parallel to OR. From the figure $(OE)^2=(OV)^2+(VE)^2-2OV.VE\cos O\hat{V}E$ or $E^2=V^2+I^2Z^2+2V.I.Z.\cos\alpha=V^2+I^2Z^2+2V.I.R$, since $\cos\alpha=R/Z$

Hence $$V=\sqrt{E^2-p^2L^2I^2}-RI \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

(B) *General Case, Power-factor = cos θ, where θ = Phase Difference between Current and P.D.*—The vector diagram in this case is shown in Fig. 6, and is constructed as follows:—OR and OL are drawn at right angles as before, representing the quantities RI and pLI, the E.M.F.s consumed by the resistance and synchronous reactance respectively, giving the resultant OZ, the synchronous impedance E.M.F. The vector OV is drawn differing in phase from RI by the angle θ, $\cos\theta$ being the given power-factor of the load. The length of OE, the open-circuit E.M.F., is known, and hence the point V is determined by constructing the triangle OVE, in which VE is equal

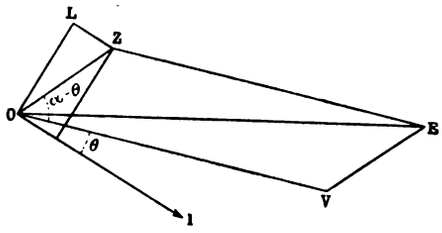

Fig. 6.

and parallel to OZ. From the figure $V^2=E^2-I^2Z^2-2V.I.Z.\cos(\alpha-\theta)$; and therefore

$$V=\sqrt{E^2-I^2Z^2+I^2Z^2\cos^2(\alpha-\theta)}-IZ\cos(\alpha-\theta),$$
$$=\sqrt{E^2+I^2Z^2\{\cos^2(\alpha-\theta)-1\}}-IZ\cos(\alpha-\theta),$$
$$=\sqrt{E^2-I^2Z^2\sin^2(\alpha-\theta)}-IZ\cos(\alpha-\theta),$$
$$=\sqrt{E^2-I^2Z^2(\sin\alpha.\cos\theta-\cos\alpha.\sin\theta)^2}-IZ(\cos\alpha.\cos\theta+\sin\alpha.\sin\theta).$$

Now, $\sin\alpha=pL/Z$, and $\cos\alpha=R/Z$;

$$\therefore \quad V=\sqrt{E^2-I^2(pL\cos\theta-R\sin\theta)^2}-I(R\cos\theta+pL\sin\theta) \quad . \quad . \quad (2)$$

which is the general equation for the regulation curve. On the basis of the quantity "synchronous reactance" found from the open and short-circuit characteristics the regulation of the machine may be predicted from the equation just given. The question whether or no the results thus obtained, using the value of synchronous impedance given by the short-circuit curve, are to be relied upon as agreeing with those actually obtained by experiment has been investigated in the experiments described below.

Before giving the results of some experiments on the subject, it is proposed to examine some important properties of alternators which may be deduced from the above considerations. The general equation implies that the P.D. V falls off much more rapidly on inductive loads than on non-inductive ones and may *increase* at first on a capacity load or one taking a leading current—*e.g.*, in the case of

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over-excited synchronous motors and converters. Before discussing other methods of calculating regulation and armature reaction, the results are given of some experiments carried out by the writer to investigate the value of the quantity synchronous impedance as obtained from the open and short-circuit characteristics. The full-load current was obtained on short-circuiting the armature with the field only excited to a small fraction of the normal amount. Four machines of different types were experimented on—viz.: Machine A.—"Fynn" type of inductor alternator (two-phase), by Johnson and Phillips. Machine B.—An old single-phase inductor alternator, by

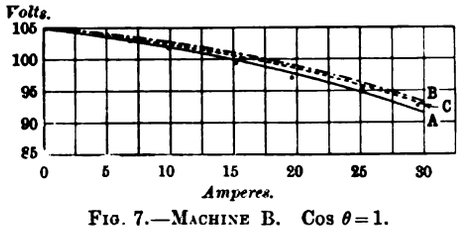

FIG. 7.—MACHINE B. Cos $\theta = 1$.

Pike, Harris & Co. Machine C.—E.C.C., three-phase, of the "fly-wheel" type, with revolving fields. Machine D.—Fuller-Wenström, with revolving armature (single phase). In the following tests machines A and C were run as single-phase machines, only one phase being loaded.

It may be noted that, as a matter of fact, in the determination of the open and short-circuit characteristics, exact constancy of speed is not essential, since on open circuit the E.M.F. is strictly proportional to the speed, for a given excitation, and the readings for the open circuit can, therefore, be accurately corrected in proportion

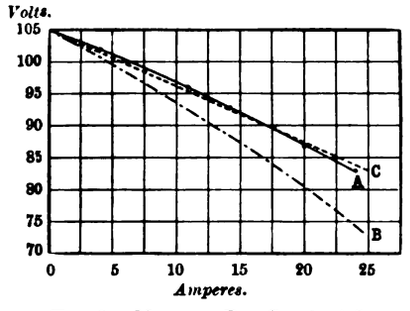

FIG. 8.—MACHINE B. Cos $\theta = 0{\cdot}5$.

and reduced to the normal speed should it for any reason be impossible to maintain this perfectly constant throughout; and, secondly, the short-circuit current is practically independent of the speed through a very wide range of the latter for the following reason:—Since the armature resistance is always small in comparison with the reactance term, the short-circuit current $I = E/\sqrt{R^2 + p^2L^2}$ may be written $I = E/(pL)$, of which both numerator and denominator are proportional to the speed.

Experiments with machine A showed that for this alternator the curve calculated from the synchronous impedance lay in each case

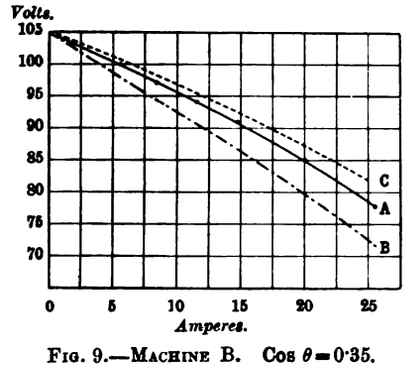

FIG. 9.—MACHINE B. Cos $\theta = 0{\cdot}35$.

below the curve obtained experimentally, showing that the open and short-circuit characteristics give too high a value for the synchronous impedance—*i.e.*, the machine is found to regulate considerably better than would be predicted by this theoretical method.

Machine B.—Curve A in Fig. 7 is the actual regulation curve of the machine on a load of unity power-factor, and curve B that calculated from the synchronous impedance. In Fig. 8 curves A and B are the same with the machine working on an inductive load of power-factor 50 per cent., and the corresponding curves A and B (Fig. 9) are the experimental and calculated curves on a load of 35 per cent. power-factor. In this machine the agreement between the theoretical and actual curves is remarkably close in the case of the non-inductive load, but on the loads of low power-factor the regulation is again considerably better than that predicted by the theoretical curves.

Machine C.—The agreement was very close.

Machine D.—This machine (considerably the largest of those tested) shows excellent regulation, having a drop of terminal voltage of only 4 per cent. from no load to full non-inductive load. In this case, too, the actual curve (A, Fig. 10) agrees closely with the theoretical curve (curve B).

From these tests it appears that the tendency is for the value of synchronous impedance, as calculated from the open and short-circuit characteristics, to come out too large. This is due to the fact that, in so determining the value, the machine is working with a very much under-excited field or with a very excessive armature current, both of which circumstances would give rise to a larger amount of armature reaction than would occur under normal working conditions. Further, since the short-circuit current is practically

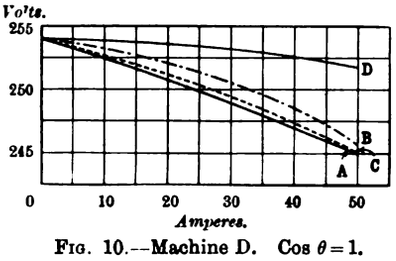

FIG. 10.—Machine D. Cos $\theta = 1$.

a wattless lagging current, its maximum value will occur when the armature coils are approximately under the pole-pieces, and hence, as previously shown, the armature reaction will be still further exaggerated.

An ingenious suggestion for estimating the effective impedance of the armature under more normal conditions is the following, due to Prof. Baum:—The machine whose impedance is to be measured is run as an unloaded synchronous motor, and its field excitation is increased until about the full-load armature current is flowing (according to the well-know "V curves" of the synchronous motor); and then the algebraic difference between its "nominal" counter E.M.F. (obtained from the open-circuit characteristic) and the P.D. across the armature terminals will be almost exactly the E.M.F. consumed by the impedance. If, then, this difference be divided by the armature current, the quotient may be taken as the effective armature impedance. The reason is clear from the simple vector diagram of the E.M.F.s (Fig. 11). The vector OR represents the ohmic drop in phase with the current, and therefore, since the motor is over-excited, nearly 90deg. ahead of the impressed P.D. vector OV. OL is the effective inductance E.M.F. in quadrature with OR, and combines with it to give OZ the

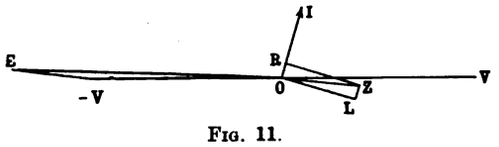

FIG. 11.

vector of impedance E.M.F. Hence the vector of counter E.M.F. OE is determined, and since the armature drop will always be small compared with OE or OV, it is clear that the counter E.M.F. OE will be very nearly in opposition to the impressed P.D. OV, and hence the algebraical difference may be taken with sufficient accuracy as representing the vector difference. This method, again, is open to the objection that the machine is working with an *over*-excited field, and with a current about 90deg. behind its (counter) E.M.F.; and, further, it may not be always possible or convenient to run the machine as a synchronous motor. Testing machines A and D in this way, the values of the impedance work out to 4·6 and 2·7 ohms respectively (as compared with 3·9 and 1·1 found from the short-circuit method), which are excessive. The explanation of this is probably that the simple vector diagram of E.M.F.s is not sufficiently near the true conditions to justify its use in this way when the two machines have widely different wave-forms.*

(To be continued.)

* Unless the wave-form of the motor is approximately of the same form as that of the generator, it is probable that the additional accuracy might be lost, owing to the extra cross-currents between the machines.

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CORRESPONDENCE.

AUTOMATIC REGENERATIVE CONTROL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is particularly refreshing to read such a lucid exposition of the principles of regenerative motors as that which appears in your current issue. Most people find difficulty in understanding the system, because it is so simple—they can scarcely believe that so much can come out of so little.

Your remarks on the braking effect are very much to the point; the moment the car passes over the brow of a hill, acceleration is automatically checked, there is no loss of time, therefore 30 amperes of regeneration are quite as effective as 60 amperes of rheostatic brake, and with very much less heating. In driving the car the same effects are observed. With series parallel control the driver must repeatedly cut off the current to check the speed, whereas, with the regenerative control the right amount of current is kept on all the time. Now 30 amperes for two minutes has only half the heating effect of 60 amperes for one minute—this, I think, is the reason why the motors do not get hot. At Devonport the maximum current when the motors are put in parallel is 140 amperes, but with the regenerative motors the maximum current is only 80 amperes, both cars running to the same time-table.

There can be no doubt at all that greater perfection will be attained with motors specially built to suit the conditions, but in the meantime, the results are very good with converted motors. In the course of four or five weeks, further experience will be gained on the lines of the Gravesend Tramways Co. and of the Halifax and Bournemouth Corporations with five regenerative cars. All these lines have very severe gradients.

—Yours, &c., JOHN RAWORTH.

London, May 3.

THE DESIGN OF ELECTRICAL MACHINERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the abstract of the above Paper, published in *The Electrician* of April 29th, I find that through an oversight a factor has been omitted from the commutation formula. This should read—

$$\delta = AT_p.T.L.R\,\frac{P}{4}.K,$$

where P equals the number of poles of the machine. The sparking voltage is, of course, proportional to the periodicity, and, consequently, to the number of poles.

The following corrections should be made.

$$\text{Max } Ec = F.\delta/75 \times 10^7 AT_p.L.$$

$$\text{Max } AT_p = \frac{2}{P}\sqrt{\frac{\delta.W_\tau}{Ec.L}}.$$

I regret having to trouble you in this matter, but should be very much obliged to you, if you would kindly print the above corrections.—Yours, &c.,

Rhyl, May 2. L. J. HUNT.

COMPLETION OF THE PRACTICAL SYSTEM OF UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The matter brought before your readers by Prof. David Robertson in your issue of April 22nd owes its urgency to the fact that some further tinkering with the established nomenclature is threatened from St. Louis. There is a good deal to be said in favour of Prof. Robertson's proposals if a unification of the electrical system of units is now to be carried out. But he probably underrates the inertia to be overcome before the C.G.S. system can be made to give way before his "M.K.S.O." system, and everybody persuaded to measure pressure in newtons per square metre instead of dynes per square centimetre. The radical changes proposed by him could only be justified on the ground of finality, and I doubt if he himself would make such a claim for them.

The duality in the system of electric units is a relic of the time when electricity and magnetism were two distinct sciences, with nothing but a rough analogy of the phenomena of attraction and repulsion to connect them. The advance of the electron theory is gradually reducing the whole of electromagnetic theory to a theory of the electron at rest and in motion. Such a sweeping generalisation cannot be carried through without profoundly affecting our conceptions of electric quantities. Now the ohm, though it can be easily stored and handled, is peculiarly unfortunate from the theoretical point of view. The theoretical structure of resistance is as complicated as the physical structure which gives rise to it. Its adoption as the fourth fundamental unit would therefore compare unfavourably with the quantities of length, mass, and time, which are really fundamental.

I do not maintain that the time is quite ripe yet for the complete rationalisation of our units in the light of the electron theory, but the advantage of bearing the ultimate goal in mind is obvious. The natural unit of electricity is the electron itself, or, since it is inconveniently small, some multiple of it, preferably a trillion electrons, which (to take a leaf out of Prof. Robertson's book) might be called the "trelectron." A coulomb would be about five trelectrons. A current of one ampere would be generated by the passage of five trelectrons per second through any cross-section of the conductor. One trelectron would repel another at a distance of one metre in air with a force of 40 million kilogrammes.

Electric quantity being simply the number of electrons, electric current is the number of electrons per unit time, and the difference of potential between two points is the work spent on the unit quantity, say ergs per electron, in bringing it from one point to the other. Putting ϵ for the new fundamental unit of electric quantity, we get the following dimensions:—

$$\text{Electric quantity} : \epsilon.$$

$$\text{Current} : \epsilon T^{-1}. \quad \text{Difference of potential} : ML^2T^{-2} \times \epsilon^{-1}.$$

From these we may obtain the dimensions of resistance by applying Ohm's law:—

$$\text{Resistance} = \text{E.M.F./current} = ML^2T^{-2}/\epsilon \times T/\epsilon = ML^2T^{-1}/\epsilon^2 = R.$$

$$\text{Resistivity} = LR = ML^3T^{-1}/\epsilon^2.$$

$$\text{Conductivity} = 1/LR = \epsilon^2/ML^3T^{-1} = \epsilon/L^3 \times \epsilon/MLT^{-2} \times L/T = \text{density of electrons} \times \text{mobility, the mobility being the steady velocity acquired by an electron under unit force acting upon it within the conductor.}$$

It will be seen that although the conductivity comes out as a perfectly clear conception, though not a fundamental one, the resistance does not. This circumstances does not materially affect its value as a practical working unit, but it does, I think, militate against its adoption as a fundamental unit in a system aiming at finality.—Yours, &c.,

Dalkey, May 1. E. E. FOURNIER D'ALBE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: While cordially approving of the suggestions put forward by Prof. Robertson in your issue of the 22nd inst., I can foresee formidable difficulties in the way of their practical adoption. These difficulties are due entirely to the innate conservatism of human nature. Had electrical engineering made less progress within the last two decades, there might have been some hope of the adoption by all members of the profession of a strictly logical system of electromagnetic units. As matters stand at present, however, I can see very little hope of success for a proposal which involves radical changes in some of the generally accepted units. Will any number of resolutions or recommendations passed at International Electrical Congresses induce the host of designers to abandon their present methods, merely in order to satisfy the fastidious taste of their scientific confrères? And if not, what advantage is there in tampering with the existing system, beyond the somewhat imaginary one of eliminating the innocent yet much abused 4π from certain equations, merely in order to have it reappear in others?

I cannot but regard the gay and irresponsible sort of way in which some writers proceed to establish new units of their own and coin names for them as a most reprehensible practice, entirely opposed to the true interests of science. By way of illustration, I may refer to a Paper by Dr. Kennelly (referred to in *The Electrician*, Vol. LII., pp. 275 and 526) which bristles with such unfamiliar terms as "abfarads," "abcoulombs," "gausses," "gilberts," "abstatvolts," certainly more remarkable on the score of originality than on that of euphony.

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The danger connected with any attempt to alter the existing system appears to me to lie in the creation of two distinct systems, one used by theorists and the more enlightened and advanced members of the electrical engineering profession, the other by those who are merely concerned with the more or less mechanical application of general principles to practical problems. Since the design of electrical machinery and apparatus has now to a large extent become standardised, it would appear an extremely difficult matter to uproot existing practice in this matter. The only result, therefore, would be to make the language of the scientific investigator much less intelligible to the practical man than it is at the present time.

That the danger of such duality in units, and the consequent setting up of barriers between departments of science which should form an organic whole, is by no means imaginary, is only too clearly evidenced by the nomenclature of the physiologist, whose electrical vocabulary is an unintelligible jargon to the practical electrician.

For this reason, and this only, do I consider that Prof Robertson's pr oposals are not likely to be of real service. The matter would, of course, be completely altered were we in a position to start with a *tabula rasa*.

As to his proposal to substitute "kram" for "kilogramme," I cannot but regard this as a touch of humour.—Yours, &c.,

London, N.W., April 29. ALFRED HAY.

WIRELESS TELEGRAPHY.

[Translation.]

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In an article which appeared in the *Pall Mall Gazette* of April 27th, entitled "Wireless Telegraphy at Work. The Story of the Hertzian Waves," describing the De Forest system installed on the ship "Haimun" for the purpose of reporting incidents in connection with the Russian-Japanese war, there is a statement to the effect that the De Forest apparatus is immune from interference, and that no one is able to intercept signals sent by this system. In this connection we should like to mention the following facts:—

1. In spite of this alleged superiority of the De Forest system, the number of apparatus of the Marconi and of our system is immensely greater. The number of apparatus worked by the Marconi or by our system is as large, or even larger, than the number of installations of all the other systems combined. If, therefore, the assertion were true that the De Forest system does something which the other two systems mentioned are absolutely unable to do, then it would follow that most of the purchasers of wireless telegraph installations have bought and are still buying under a misconception.

2. It is alleged that this immense superiority of the De Forest system is due to a receiver which works without a tapper. Any person who understands anything of wireless telegraphy will recognise at once that this property of the receiver does not in any way prevent a third party from intercepting the telegrams.

3. That such a receiver, without the tapping devices, is not really new is evidenced by the fact that the Marconi Company, Fessenden and our own company have possessed for many years receiving apparatus which may be worked without a tapper.

4. This new receiver, used by the De Forest system, is covered in America by the patent of Fessenden, and in the other countries by a patent belonging to us, which protects the same arrangement. If, therefore, the De Forest system gives extraordinary results, the credit ought to belong to Prof. Fessenden or to ourselves.—Yours, &c.,

For the Gesellschaft für Drahtlose Telegraphie,

Berlin, May 2. COUNT ARCO.

DANGER OF ELECTROSTATIC SHOCKS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondents seem to have overlooked one important point in connection with the lamentable accident at Bow—viz., that a though the voltmeter might be standing at zero, as stated in the evidence, yet this would only go to show that there was zero P.D. between the 'bus bars and not that the whole system was at the earth's potential; unless, of course, some point in it had been properly earthed. I should say it was not impossible to charge up the cables, &c., to a potential considerably above that of the earth. In fact, if the time interval required for a soaking-in charge is not equal to that of a soaking out, the system must become charged. Another thing has not been taken into account apparently, and that is that there was the capacity of *three* long cables, not only *one*.—Yours, &c., ANON.

London, May 2.

ERRATUM.—In Mr. G. H. Nisbett's letter on the danger of electrostatic shocks, which appeared in our Correspondence columns last week, the voltage of the high-tension cable after short-circuiting for two minutes should have been 0·08 volt, and not 0·8.

PARLIAMENTARY INTELLIGENCE.

ILFORD URBAN DISTRICT COUNCIL BILL.

THE "BERMONDSEY" CLAUSE GRANTED.

When this bill came before the House of Lords Committee of which Lord Clifford of Chudleigh is chairman on Friday,

Mr. BAGGALLAY, K.C., spoke on behalf of the gas company. He said that a double-barrelled principle was involved: First, how far unrestricted municipal trading ought to be allowed, and, secondly, how far it should be allowed when that municipal trading was to a certain extent carried on with money contributed to the funds of the district through the rates, by a body with whom the local authority was to compete. He would not discuss the questions as to whether electric lighting should be carried on by municipalities or as to whether the form of accounts prescribed by the Board of Trade was the best. But the question of the insertion of the "Bermondsey" clause had arisen many times and Paliament had given decisions in both ways. The earliest cases in which the clause had been inserted were the Aberdeen and Dundee tramways at the instance of railway companies. Only on the previous day a similar clause had been placed upon the Belfast Corporation in respect of its tramway undertaking. The principle in this particular case was merely to make the Ilford electricity undertaking self-supporting, which was a very fair thing to do. In the course of a lengthy criticism of the Ilford accounts, he maintained that merely writing off the capital instalments was not equivalent to setting aside a sum for depreciation. Not even 1 per cent. had been set aside at Ilford, and if the accounts had been kept in the proper manner, the undertaking would have shown a loss instead of the small profit which it did.

The CHAIRMAN, at the close of Mr. Baggallay's speech, said he hardly thought the comparison an analogous one, as the railway company did not have to make yearly payments in order to exhaust its capital loans.

Mr. WEDDERBURN, K.C., replying for the promoters, produced precedents on the opposite side, and said that, as far as electric lighting undertakings were concerned, the clause now asked for had only been inserted in three instances. In all the cases on which it had been refused it had been admitted to be unsound commercially.

After deliberation,

The CHAIRMAN said that the Committee had decided to insert a clause upon the lines of that in the Willesden Act (see *The Electrician*, Vol. LI., page 255), but the terms of it would not be decided until after discussion.

Mr. WEDDERBURN, after consultation with his clients, declined to discuss the clause at this stage, reserving the right to endeavour to have it struck out at a later stage.

The bill, with the clause inserted, was accordingly reported for third reading.

LONDON UNITED TRAMWAYS BILL.

A Committee of the House of Commons, presided over by Mr. Henry Hobhouse, considered this bill on Tuesday.

Mr. BALFOUR BROWNE, K.C., who with Mr. Lewis Coward, K.C., the Hon. J. D. Fitzgerald and the Hon. Evan Charteris, said that the bill was for the conferring of further powers upon the London United Electric Tramway (1901), Ltd., for constructing additional tramways, widening and altering roads, acquiring lands, &c. The only new line for which powers were being sought was one between Baber Bridge and Staines. An extension of two years was being sought for a line authorised in 1901 from Hanwell to Brentford and the Surrey system which started at Molesey and ran to Thames Ditton, Surbiton, and then north to Kingston and then south to Hook and New Maldon. With regard to the opposition to the new line, the promoters were in a difficult position as between the Middlesex County Council and the Bedfort Parish Council. The invariable rule of the former was that when a tramway was laid upon a main road, the road should be widened to 50ft. at the expense of the promoters, and to this the company agreed. But the Parish Council in question asked that none of their land might be taken in order that the widening should take place; they preferred a single line. The company was prepared to do either, and he would leave it to the two authorities to settle the matter between them. The Middlesex County Council, however, was petitioning on a large number of other details chiefly with regard to the construction of the track, lighting, &c. The following is a summary of the requests of the County Council and the extra cost which they would incur to the company if carried out: Wood paving of track and to 2ft. on either side of the rails, extra cost £9,805; 12in. or 18in. granite kerbs, £6,965; drainage for track, £500; wood paving from kerb to kerb at one particular spot, £415; new surface-water drain, gulleys and manhole, £1,245; lighting of track, £2,100. With regard to the latter point, the request was that the company should provide electric lighting upon the trolley standards at cross roads. But he maintained that this was the duty of the local authority.

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Mr. J. CLIFTON ROBINSON, engineer and managing director to the London United Tramways Co., described the system of the company already in existence. With regard to the 5 miles of line proposed to Staines, the cost of construction only would be £62,497, widening to 50ft. would cost £13,197, widening the three bridges £870 and land £25,209. The total cost would be £109,605, or £21,143 per mile. With regard to lighting the road, this was creating a precedent. He doubted whether the company had the statutory power to do this. The bill asked for 30 years, at the end of which the lines could be purchased by the County Council, the purchase to be as a going concern. These terms were precisely the same as those inserted in almost every tramway bill or light railway order which the tramway company had ever been granted. It was the invariable policy of the company to allow their overhead wire standards free for lighting purposes at the hands of the lighting authority.

Cross-examined by Mr. HARPER for the Middlesex County Council, Witness refused to discuss the question of the width of High-street, Brentford, as the trams were laid there, and had been sanctioned by the Board of Trade. He would undertake to pave the track with wood paving when the County Council paved the remainder of the roadway in the same way. The County Council was only the purchasing authority in Middlesex by reason of agreements with the local authorities, and could only purchase with the consent of the local authority. He complained of the attitude which the Middlesex County Council took up with regard to the London United Tramways Co., as there was a tacit understanding that no preamble opposition should be made to any of the company's proposals; this present opposition was distinctly a preamble opposition.

Local evidence was then gone into. On Wednesday the case for the Middlesex County Council was opened, the Hon. Scott Montague and the chairman of the Middlesex County Council both testifying as to the narrowness of Brentford High-street and the danger of increasing the traffic through it which would result if the Staines extension were sanctioned.

After speeches by counsel, the committee deliberated in private, and

The CHAIRMAN said that the committee found the preamble of the bill proved, subject to the following conditions:—The requirements of the Middlesex County Council were granted in the following respects: Width of road, water surface drainage, kerbing, wood paving as offered by Mr. Robinson, lighting at cross roads and lateral roads when required by the Council (all such works to be carried out to the satisfaction of the county surveyor), clause 20 to be amended so that no new obligations should be put upon the County Council by reason of any agreements with the local authorities, the agreement with the Staines Rural District Council to be scheduled to the bill or incorporated in a clause in the bill; term of purchase 25 years under a similar clause to that in sec. 3 of the Middlesex Act of 1902 as to exercise of the option of the Council to purchase. With regard to Bedfort, wood paving would have to be put in so far as the houses were concerned, but the portion of the green required should be granted.

The opposition to the extension of the time for the authorised lines having been settled, this part of the preamble was also found proved.

NORTH WALES ELECTRIC POWER BILL.

A Committee of the House of Lords, of which Lord Clifford of Chudleigh is chairman, considered this bill on Tuesday.

Mr. BAGGALLAY, K.C., who appeared for the promoters, with Mr. Vesey Knox and Mr. Gully, said that the bill was promoted by the North Wales Electric Power and Traction Co., and proposed to authorise them to utilise the waters of Llyn Llydaw, on the eastern slopes of Snowdon, for generating electrical energy, and also to use that energy for power purposes over a large area which included the whole of the counties of Carnarvonshire, Merionethshire and Anglesey, a small portion of the county of Flint and a considerable portion of the county of Denbigh. The small portion of Flint included the towns of Rhyl and St. Asaph. The primary object of the bill was for supplying electrical energy for the purpose of some narrow gauge railways and light railways which were authorised in 1901, to the Beddgelert and Creosor Railway Co., and also to authorised electrical undertakings throughout the scheduled area. The only specific works which it was proposed by the bill to construct was a dam which was necessary to raise the waters of Llyn Llydaw to a sufficient height to get a good fall down to the power house, so that the water level would be about 20ft. higher than it was at the present moment. By that means it was possible to get a fall of about 1,150ft. within a very short distance of the power house. Most of the power schemes which had hitherto been proposed had utilised fuel where it could be cheaply obtained for the purpose of generating electricity, and very few cases had been put forward on the lines of this one. There was one or two, however, such as the Shannon scheme in Ireland, and the scheme which intended to utilise the waters on the West Coast of Scotland, at Loch Leven, but this was the first case of the sort which had been proposed where the water was in the immediate neighbourhood of the power house. There existed already in the neighbourhood or would exist a large number of persons and undertakings capable of using the power. With regard to the light railways already mentioned, the bill of the South Snowdon, Portmadoc and Beddgelert Railway Co. authorised the transfer of that undertaking, which owned the railways, to the North Wales Electric Traction and Power Co., which company was already incorporated under the Companies Acts. The history of the negotiations was as follows:—The Portmadoc and Creosor Railway Co., already referred to, which was authorised in 1901, also had power to supply a very small area in that district with electrical power "in bulk." The company was, however, in financial difficulties and negotiations were entered into with the Northern Counties Traction Co. This company, after carefully considering the project, came to the conclusion that the water power available was exceedingly good and could be relied upon, but that a bigger scheme should be carried out. The result was the North Wales Electric Power and Traction Co. was formed and a prospectus was issued in 1903, and £170,000 was at once subscribed by some 50 shareholders, who took 34,000 shares. In order to carry on the negotiations with the original company successfully, and to take in the large area scheduled, it was necessary to make arrangements with certain gentlemen who had rights as to the waters of Llyn Eigiau, and these gentlemen had now come into the company and were acting as promoters of the present undertaking. The consideration to these gentlemen was £40,000, of which, however, only £3,000 would be paid in cash, the remaining £37,000 being given in fully paid-up shares. The capital of the North Wales Electric Power and Traction Co. was fixed under its Articles of Association at £270,000 in shares, with power to issue £135,000 debentures. Under all these negotiations, therefore, it was proposed that the promoting company should carry out the scheme of the South Snowdon, Portmadoc and Beddgelert Company, and, as a matter of fact, a large part of the work was under construction. The power which it was estimated would be obtained from the waters available would be 12,000 H.P. The railways would utilise about 1,000 H.P., and there would therefore be, at any rate at the commencement, 11,000 H.P. available for other purposes. The price of electricity to the consumer was estimated to be 1½d. per unit to start with. He was quite aware that this figure had been beaten by other power companies, notably by the Newcastle Company, but there was a difference in the circumstances of the two undertakings. The Newcastle Company had a much more compact area, and therefore the cost of laying mains, &c., was not nearly so great. Roughly speaking, the estimates for the hydraulic work amounted to £4,500, the pipe line to the power station would cost £16,000, the power station itself £36,000, transmission lines £21,000, land £8,750, making in all something over £86,500. Adding to this the £40,000 for the acquisition of the private undertaking in the north of the district already referred to, a total of £126,500 was arrived at, and this was the amount which would be the first expenditure. The £86,500 for the new work would be provided out of £170,000 already subscribed, and this would leave something like £80,000 available for the construction of the railways, so that persons dealing with the promoters would find their financial position was £170,000 subscribed, plus the property represented by the £40,000 for the private undertaking, making a total of £210,000.

On Wednesday, Mr. Baggallay continuing his opening statement said there were three classes of opposition. The first was with regard to the transmission of power by means of overhead wires, which it was proposed to do under the bill, subject to the provision that any local authority being an urban district council, borough council or rural district council might appeal to the Board of Trade against the proposition of the company in respect of that particular locality. The Board of Trade would have the power to modify the proposals if it thought fit. Similar powers to erect overhead lines had been given in other bills although they had not been put into effect. The promoters objected, however, to the county councils having a veto in this matter. Another point being raised by the petitioners was as to the desirability of granting these powers to a limited liability company such as this, but he thought there was little in this, as, curiously enough, the only really successful power undertaking was that of the Newcastle-upon-Tyne Electric Supply Co., which was a limited company. Then there was the question as to the supply of energy for power and lighting. The bill included the usual clauses as to supply to authorised undertakers and for power purposes, and the current was only to be used for lighting upon the premises in which a power supply was taken. Many petitioners required an absolute veto as regards their districts, but he desired to have the usual clause giving the appeal to the Board of Trade, such as was in the Somerset and Cleveland Bills. With regard to the opposition of the Carnarvon Corporation, he was afraid they were in a peculiar position. The Carnarvon Corporation entered into an agreement with the National Electric Construction Co., but when the Local Government Board inquiry was held, the inspector refused to grant the loan because he considered that the Corporation would do better to take energy from the promoters of this bill. Counsel for the Carnarvon Corporation said that this was not so. Now, although the Corporation was willing to take a supply from the promoters, the National Electric Construction Co. was taking action against the Corporation for breach of contract. [Counsel for the Carnarvon Corporation again dissented.] Another point in the opposition of the petitioners was the financial position of the promoters, but he would be able to show that he came before the Committee with a much stronger case in this respect than most power bills.

Mr. RAWLINGS, the chairman of the North Wales Electric Power and Traction Co., detailed the purchase of the private undertaking mentioned in the opening speech. With regard to undertaking generally a contract had been entered into with Messrs. Bruce Peebles & Co. to erect certain works, including the first power station, for £145,000. The work was actually under construction. As to the practicability of transmitting electrical energy by means of overhead wires, he instanced a scheme in the Sierra Nevada mountains in California, where the power was transmitted in this manner for a distance of 35 miles, and although the wires ran along the public road for the whole way, no accident had ever happened. The restrictions upon the use of overhead wires in England had had a very prejudicial effect upon the electrical industry in Great Britain. The comparison of generation of electrical power by water and by steam was £4 or £5 per horse-power as against £15.

Cross-examined by Mr. LLOYD, K.C., for the Colwyn Bay Urban District Council, Witness said he had had 25 years' experience in California, and had been in England for three years. When he was first consulted with regard to this scheme he could not believe that such an amount of water power was available in England, but since he had visited the spot he was quite convinced on the matter. He admitted that before

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the prospectus of the company had been issued £170,000 had been underwritten, and that in response to the issue of the prospectus no further capital was subscribed. The bill gave a clause to Lord Penrhyn providing that he should have a veto in respect of touching any of his property. The standard dividend was fixed at 10 per cent., although it was a fact that the usual standard dividend was 8 per cent. The standard price per unit was 2½d., but it did not follow that this would be the price charged. Messrs. Bruce Peebles & Co. held one-third of the shares of the company and several of the directors were interested in the St. Helens Cable Co. He agreed that at present a large majority of the shareholders were either interested in manufacturing plant for the works, or else had underwritten the capital.

In answer to several questions as to omitting Llandudno, Rhyl, St. Asaph and other towns from the area covered by the bill, witness refused to agree to do this, on the ground that the larger the area the better the chance of the success of the company.

Further cross-examination: He was aware of the history of electric supply in Carnarvon, and he knew that the Corporation was waiting the decision of the Local Government Board as to the loan. The inquiry was postponed, but had since been held, and no decision had yet been given. In the estimates given by Mr. Baggallay, he did not include anything for mains, and a sum of £10,000 for working capital should be added.

Capt. OSMAN, member of the firm of stockbrokers who have underwritten some of the capital, gave evidence in favour of the bill, and said he had trusted to the advice of Sir Douglas Fox and the other engineers in taking an interest in the scheme. He was quite certain that, acting on this advice, he could secure further sums of money for the undertakings. The difficulty with regard to these schemes was obtaining the first capital, and this had been overcome in this instance.

Mr. S. Z. DE FERRANTI said the promoters had consulted him as an electrical engineer, and he had gone very carefully into the whole of the details of the scheme. The conditions were very favourable, because, unlike many water power schemes, the capital cost of utilising the water was very low. He was quite satisfied that more than 12,000 H.P. would be available, and going upon the assumption that there would be a 25 per cent. load-factor, which was the basis upon which the figures for revenue and profits were calculated, the net sale of electricity would be more than 12,000 H.P. The use of overhead wires was the only method which would give a proper financial result for a scheme of this kind. We must learn by experience, and therefore we must look to the Continent and America. It was a curious thing that in Germany and Switzerland, which were the most protected countries in the world so far as the safety of the public was concerned, rules had been evolved which gave every protection against any possible injury from overhead wires. If any explanation were needed as to the little use of overhead wires in connection with power schemes in this country, it was on account of the fact that the cable manufacturing companies had in the past been largely concerned with the promotions, and it was to their interest to use underground cables. He himself was a director of the British Insulated and Helsby Cables (Ltd.) and this company had been largely interested in the Midland power scheme, and he was quite sure that they would not have put in so much underground cable in that scheme if they had not been cable manufacturers. There was no scheme such as this in Great Britain, but a considerable quantity of water was being used at Foyers in Scotland for electrolytic purposes. In the Black Forest a large system of generation and distribution was being developed so as to supply the small cottage manufacturers, so to speak—*i.e.*, to give a cheap supply to persons who did their work in their own homes.

Cross-examined: With regard to the danger of overhead wires due to storms, &c., many years ago a large portion of the City of London was lighted by means of overhead wires, but although during a heavy snowstorm practically all the telephone and telegraph wires were blown down, the electric light mains withstood the storm. The reason was that the extra heat of the electric light wires, due to the heavy currents, prevented the snow and sleet freezing upon them. With regard to wind pressure, the reason why accidents to telegraph poles were so often heard of was because wires were continually being added without any corresponding strengthening of the pole. Upon their proposed poles only three cables would be carried, and they would have to be worked under the rules of the Board of Trade. If everything in which there was an element of risk was to be shunned, we should soon cease to exist altogether. The area covered by the bill was 2,100 sq. miles. The cost of overhead wires would be, roughly, £600 per mile, whilst underground cables of the same thickness would cost £1,800 per mile.

Yesterday Mr. MENZIES, manager of a number of quarries in the Nantlle district, near Carnarvon, gave evidence as to the need for cheap power.

A large amount of similar local evidence was also given, the chief point of it being that a supply of cheap power was needed. If any other body could supply it cheaper than the promoters, it would be taken from them in preference to the promoters. The Yale Electric Power Co., which was supplying around Festiniog, was not sufficiently large to take in all the orders for current which were available.

Mr. TOMKINSON, one of the owners of the waters of Llyn Eigiau, detailed the powers he possessed in this district. These were of the most complete character, and nothing more was necessary in order to carry out the scheme in that district,

Mr. A. A. C. SWINTON said the promoters had submitted the whole of the scheme to him, and he considered the district a very valuable one for such a proposal. Taken all round, the price at which electrical energy could be supplied was 1½d. per unit. If it were not for the expenses of distribution, of course, the selling price could be much less. An area of this character gave the two essentials for a successful power scheme—viz., a good diversity factor and a good load-factor. On the question of overhead transmission, he was fully convinced that over a large part of the area this was quite feasible. He was concerned with a power scheme which would utilise the waters of Loch Lomond, and transmission would be made over a distance of 25 miles by means of overhead wires. Again, the Board of Trade had recently sanctioned the use of such transmission in the Stroud Valley, and the wires would pass through an urban district. But it was not proposed to carry the overhead wires through the thickly-populated parts of towns, and the Board of Trade would, of course, fix the routes. He saw no danger of using such a means of transmission. The use of overhead wires permitted higher pressures than upon underground cables because the loss increased only as the square of the pressure. There were also means of affording protection in populated districts by netting as was done on the Continent. With regard to estimates, he had allowed for an initial instalment of 8,000 H.P. of plant in order to have 6,000 H.P. fully available, and this would cost £53,946. For the pipe line and dam must be added £25,000, and for distribution he added £140,000, based upon what he had done in the Loch Lomond scheme. Allowing 10 per cent. for contingences, this brought the total up to £242,000. The purchase of Llyn Eigian, £20,000, for legal and general expenses and £28,000 for working capital made the total £330,000. Estimates of revenue had been arrived at as follows:—Assuming the sale of 6,000 E.H.P. with a 25 per cent. load-factor, this amounted to 9,803,440 units per annum. Deducting 15 per cent. for loss in transmission, left a total of 8,322,000 units per annum. The working expenses, including depreciation, oil, stores, waste, office expenses, rates, taxes, &c., amounted to £21,000. The revenue from the sale of current at 1½d. per unit on the average would amount to £52,075, and deducting £21,000 for working expenses, this left a total of £31,075, which would be sufficient to pay a dividend of 8 per cent. on the capital of £330,000, and still leave a margin for contingencies and reserve of £4,675 per annum.

Cross-examined: For lighting purposes in a small town to individual consumers, he should say that 7d. per unit would be a good price and 5d. a cheap one. Supplied in bulk, 3d. and 3½d. per unit would be good prices. For power, 1½d. and 2d. per unit would be a good price. Of course, these prices would not apply in the case of a big demand, say, to quarries, nor was this figure the one at which the company would necessarily supply. They were only good prices for electric supply. So far as the character of the area was concerned, it could not be compared with Lancashire and other areas, but it was exactly similar to what was being done in Switzerland and North Italy.

By the Earl of LAUDERDALE: The actual loss in transmission upon the Loch Lomond scheme which he had mentioned was 3½ per cent. over 25 miles. The cost of the transmission line, which was on private property, was £22,000.

Mr. HARPER, of the firm of Messrs. Harper Bros. & Co., engineers to the scheme with Sir Douglas Fox and Partners, said a feature of the scheme was the great fall, the head of water being 1,150ft. Llyn Llydaw was 1¼ miles in length and ½ mile in width, and the area was 5½ million sq. ft. The watershed from which the water was drained was 1¾ sq. miles, including the summit of Snowdon. By means of two dams of 100ft. each in length it would be possible to raise the water level by 30ft, the pipe line entering the lake 30ft. below the normal water level. It was estimated that there was a three months' supply in the lake without any rain. The pipe line would run through a tunnel 600ft. long, and duplicate pipes would be laid. Pelton water-wheels and three-phase generators would be employed in the power house. A supply of electrical power in these districts would greatly facilitate the construction of tramways and light railways. According to another engineer Llyn Eigiau would give twice as much power as Llyn Llydaw. A contract for the electrical equipment of the Llyn Llydaw power house had been let for £36,159.

Under cross-examination, witness said it was not the intention of the promoters to undertake a supply for lighting as a limited company, and to make use of the undertaking of the statutory concern to accomplish this. The cost of the construction of the light railways and tramways which were authorised would be £50,000.

TOTTENHAM COURT ROAD TRAMWAY.

LONDON COUNTY COUNCIL TRAMWAYS AND IMPROVEMENTS BILL.

When Mr. Compton Ricketts' Committee of the House of Commons resumed consideration of this bill on Monday,

Mr. POLLOCK, K.C., said that the Highways committee of the County Council, after consideration of the decision given on the previous Thursday, had decided to select Percy-street as the terminus for the tramway. One alternative was, however, to continue the line for the 600ft. beyond Percy-street where the statutory width could not be obtained, as a single line, and thus make connection with Oxford-street.

The CHAIRMAN said that this was in the minds of the Committee when the decision was given on Thursday.

Mr. POLLOCK said there was another proposal which he had to make which he considered a more important one—viz., that the tramway should be allowed to continue, as proposed, by a double line all the way to Oxford-street, only on the condition that at some future date powers should be acquired for widening the narrow portion of Tottenham Court-road sufficiently to secure the maximum width. A precedent for this he could quote in connection with a line which the County Council promoted in 1902 down Hammersmith Broadway. There the Hammersmith Borough Council refused to sanction the tramway unless the Broadway was widened, and they offered to bear one-third of the cost of this if the County Council would bear the remaining two-thirds. This was eventually agreed to, and the line was sanctioned under the condition that it could not be opened until the widening had been made. In this case, however, he had received no offer from either the Holborn or St. Pancras Borough Councils to contribute to the widenings.

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The CHAIRMAN said that if the promoters could give him within a reasonable time a definite offer from the borough councils interested to contribute to the cost of the widenings the Committee might feel inclined to look at the matter again. But the Committee had an idea that the Council had a wider scheme later on giving some connection between the north and south of the river, and, this being so, it was thought that the Council might feel inclined to consider the whole thing then rather than to have it in drips, so to speak. It was this feeling on the part of the Committee which partly influenced the decision already given.

Counsel for all the petitioners against the bill opposed any of the alternatives of the County Council being adopted, and urged the Committee to adhere to their decision not to consider a tramway under any conditions beyond Percy-street.

The CHAIRMAN, in face of this opposition, consulted the Committee, and announced that, in the interests of all parties, the decision given on Thursday would be adhered to. The consideration of the scheme from Hampstead-road to Percy-street would be proceeded with.

Mr. M. FITZMAURICE, the Council's chief engineer, gave evidence as to the widths under the new conditions, and stated that there would be a single line for the "dead" end and a cross-over at Percy-street.

Mr. Ald. PURCHASE of the St. Pancras Borough Council, stated that the position of his Council would not be altered by the change of terminus.

Mr. A. BAKER, chairman of the Highways committee, spoke as to the London County Council's views upon a tramway down Tottenham Court-road. Although the decision of the Committee on Thursday had shorn the scheme of some of its utility, there would still be a great public advantage in constructing the line as far as Percy-street.

Mr. A. L. C. FELL, the general manager to the Council tramways described the terminus at Percy-street. The double lines there would converge into a single line 60ft. long for the purpose of changing the direction of the cars. There would be a clear width of 12ft. 10in. on either side of the single line. The time which he estimated that it would take a car to get in and out of the terminating section would be 1½ minutes. The average speed on the line would be 6 miles an hour. It was his opinion that the construction of the tramway would result in the omnibuses being superseded.

On Tuesday Mr. Fell was cross-examined by Mr. COURTHOPE MUNRO on behalf of the Holborn Borough Council. Witness said the line would terminate on the south side of Percy-street, and although he admitted that it might be better, from the point of the cross traffic from Bailey-street to Percy-street, that the line should stop on the north side, he thought it was a question of the degree of the cross traffic. For 10 minutes that morning he had watched that spot and had only seen one vehicle cross Tottenham Court-road between these points.

Re-examined: Ten tramcars would carry the same number of passengers as 25 omnibuses, and, by reason of the greater speed, less congestion would be caused quite apart from the fewer number of cars.

Mr. E. HARPER, statistical officer to the London County Council, handed in tables of the traffic in Tottenham Court-road.

Mr. A. YOUNG, chief valuer to the Council, gave evidence to the effect that the construction of tramways invariably enhanced the value of property in the neighbourhood.

Mr. G. A. SUTTLE, an alderman of the St. Pancras Borough Council, spoke in favour of the line on the ground of public convenience.

The case for the Holborn Borough Council was then taken.

Mr. BAGGALLAY, E.C., said that in the eyes of the Holborn Borough Council the terminus at Percy-street was even more objectionable than the one originally proposed. He advocated that a scheme of widening was necessary before the tramway was constructed, and in as much as 5½ years must elapse before the existing northern lines could be reconstructed for electric traction, he failed to see the need of any immediate hurry in sanctioning a line down Tottenham Court-road.

Evidence, including that of the Police, was then heard against the proposal.

On Wednesday further evidence was given on behalf of the police, the Borough of Holborn and omnibus proprietors against the tramways.

Lord ROBERT CECIL, K.C., then proceeded with his case for the frontagers along the line of tramways. In addressing the Committee, he said no public case had been made out to justify Parliament in inflicting injury on private individuals, and that the main object of the St. Pancras Council in assenting to the proposal was the widening of Hampstead-road. Further, apart from any other consideration, it was not wise to grant the tramways, as such a decision might possibly prejudge a recommendation in the report of the Royal Commission on London Traffic.

Sir RALPH LITTLER, K.C., on behalf of the Charing Cross, Euston and Hampstead Railway Co., addressed the Committee from the point of view of the competition with his line which would be set up.

Mr. ERSKINE POLLOCK, K.C., having spoken on behalf of the London County Council, the Committee deliberated in private. After a short interval,

The CHAIRMAN announced that the Committee had decided to sanction a double line as far as Francis-street, and to allow a single line to project beyond that point for the purpose of changing the cars, so long as it did not block the entrance to any street. A further condition would be that horse cars should not be run on the line. He also mentioned that the Committee were not unanimous in their decision.

Yesterday the consideration of another portion of the bill was commenced

Mr. POLLOCK said that tramway No. 3 was a double line, 1 furlong 7·3 chains in length, commencing near the junction of Waterloo-road and York-road and terminating by a junction with the existing tramway in the Waterloo-road at a point 2½ chains or thereabouts southward of the existing tramway. An agreement had been come to with the Lambeth Borough Council as to the construction of a refuge in the centre of the road upon part of the line, and the tramway, so far as this was concerned, would not be constructed without the consent of the Borough Council. The total cost of the line was estimated at £8,500. The width of the road at the spot where the termination would take place was 48ft. The chief opposition to the route was by the London and South-Western Railway Co. by reason of the great congestion which it was alleged would be caused near to the Waterloo Station, owing to the steep slopes leading from the station. There were also petitions by frontagers.

Mr. MAURICE FITZMAURICE, engineer to the County Council, gave particulars of the widths of the roadway along the route.

Mr. ALLAN BAKER, chairman of the Highways committee gave evidence as to the greater desirability of the new terminus, as it would take the passengers nearer to Waterloo Bridge.

Mr. A. L. C. FELL, the Council's tramways manager, said the line was being promoted purely in the public interest and not for the purpose of making an increased remuneration, as it was not proposed to increase the number of cars.

After hearing the case for the London and South-Western Railway Co., the Committee found that the preamble of the bill was not proved.

The Committee adjourned.

OTHER ELECTRICAL BILLS.

The *Holywood Tramways Bill* came before a House of Lords Committee last week presided over by Lord Camperdown. The proposal was to construct an electric tramway between Holywood and Belfast, a distance of just under 5 miles. A small portion of the line which was inside the borough of Belfast would be constructed by the Belfast Corporation, and the company which the bill sought to incorporate would have running powers over it. The promotion was entirely at the hands of local persons. The capital asked for was £54,000, and no difficulty was anticipated in raising this sum. The opposition to the scheme was by the Down County Council and the Belfast and County Down Railway Co., the former in respect of width of roads and the latter with regard to competition. The bill took powers to enable the proposed company to erect its own generating station or to purchase its current from the Belfast Corporation or anyone else it thought fit. Mr. T. H. Minshall, the electrical engineer to the scheme, gave an undertaking to the Down County Council that the statutory width of 9ft. 6in. from the outside rail to the kerb would be maintained throughout the route. Evidence was then called on behalf of the Belfast and County Down Railway Co., during which it was stated that an endeavour was being made to equip electrically the line between Belfast and Holywood, but that an estimate received from the Westinghouse Electric Co. showed that it would cost the company nearly as much as the line itself had originally cost. As soon as an electrical company could show them that a cheaper and better service could be maintained by electricity than that at present working it would be adopted. On Monday the case for the Belfast and County Down Railway Co. was gone into. This was, of course, on the point of competition, and after the evidence of the chairman of the company, Mr. Roman, K.C., addressed the Committee. In the end the Committee found that the preamble of the bill was proved, some unimportant amendments being made when clauses were considered.

The *Kettering Improvement Bill* was before the unopposed Committee of the House of Lords on Monday. The objects of the bill, which has already been passed by the House of Commons, were fully set out in *The Electrician*, Vol. LII., p. 831. The bill was ordered for third reading.

A Committee of the House of Lords, of which Lord Clifford of Chudleigh was chairman, had before it the *West Riding Tramways Bill* on Friday last week. Under previous acts granted to the West Riding Tramways Co. certain lines were authorised, the majority of which were under construction. Some of the lines, however, were allowed to lapse owing to a pure oversight, as an extension of time could have been obtained upon application to the Board of Trade. The application to the Board of Trade, however, had not been made until it was too late, and consequently this bill was rendered necessary. A few new lines were also sought in the bill. The only opposition was by the Yorkshire Electric Power Co., which objected to a clause which gave the tramways company the right to enter into working agreements with other tramway undertakings and to supply electricity to any tramway undertaking. They argued that an unfair competition would be set up with the Yorkshire Power Co. if the clause were inserted, as it would enable the promoters to supply electrical energy to any tramway over which they did not have running powers. The Committee decided to pass the preamble of the bill with the clause as originally drafted.

The *Crystal Palace Gas Bill* came before the unopposed Committee of the House of Commons on Friday last week. As originally deposited, the bill contained a clause giving the company the right to claim compensation in respect of damage to its mains through electrolysis, and also the "Bermondsey" clause, which it was proposed to apply to the Beckenham Urban District Council. Both, however, have now been withdrawn.

The *Baker Street and Waterloo Railway Bill* came up for third reading in the House of Commons on Thursday last week. Mr. Causton had a motion down for the rejection of the bill, but it was announced that Mr. Yerkes had come to an agreement with the Southwark Borough Council to pay £6,000 towards the expense of providing subways at the Elephant and Castle. The bill was accordingly read a third time.

In the House of Lords on Thursday last week, the *Charing Cross, Euston and Hampstead Railway, Acton Improvement, Southill Nether Tramways* and *St. Marylebone Electric Lighting Bills* were read a second time. On Friday the *Great Northern and City Railway*, the *Corbridge Gas* and the *Hampden-in-Arden Gas Bills* were read a third time.

In the House of Commons on Friday last week the *Harrow Road and Paddington Tramways Bill* was read a third time. On Monday the *Southport and Lytham Tramroad Bill* was read a second time. On Wednesday the *Chesterfield Corporation (Tramways and Improvements)* and the *Preston and Blackburn Tramways Bills* were read a second time.

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DUBLIN SCIENCE SCHOOL.

In the House of Commons on Wednesday, Mr. MOONEY asked the Chief Secretary to the Lord Lieutenant of Ireland whether he was aware that dissatisfaction existed respecting the appointment of an English architect to act jointly with an Irish architect in the erection of the College of Science and Art in Dublin; and whether he could explain why it was necessary to import an architect, in view of the fact that competent professional men were available for the work in Ireland.

Mr. V. CAVENDISH, replying for Chief Secretary, said he was not aware of any dissatisfaction. There was no Irish architect experienced enough to design such a building according to modern requirements.

LEGAL INTELLIGENCE.

Siemens Brothers & Co. (Ltd.) v. Patent Exploitation (Ltd.)

In the House of Lords on Friday (before Lord Macnaghten, presiding, and Lords Davey, James of Hereford and Robertson), arguments were begun in this appeal (by Siemens Brothers & Co., Ltd.), from an order of the Court of Appeal (see *The Electrician* Dec. 5, 12 and 26, 1902) reversing a judgment of Mr. Justice Buckley. Respondents who were the registered legal owners of certain letters patent (as assignees of Charles Addison Hitchcock) numbered 1,110 of 1890, for "An Improvement in Galvanic Batteries" commenced (in November, 1900), an action to restrain an alleged infringement of their patent by appellants, and for damages or an account of profits and costs. (Similar proceedings commenced against others are in abeyance pending decision in the present appeal). Mr. Justice Buckley held that the letters patent were invalid upon the grounds of want of novelty, and that the claim was too wide (see *The Electrician*, Vol. XLVIII., pp. 547, 585 and 626). Defendants appealed, and the judgment of Mr. Justice Buckley was reversed, an injunction was granted, and an inquiry directed as to damages, respondents getting the costs of the action and appeal.

Mr. Fletcher Moulton, K.C., and Mr. A. J. Walter were for the appellants, and Mr. Astbury, K.C., and Mr. A. B. Shaw for respondents.

Mr. MOULTON said the letters patent of Hitchcock related to the manufacture of what was known as a dry galvanic cell, or more commonly known as a galvanic battery. He went on to explain the construction and action of galvanic cells, the various devices adopted to obviate polarisation, to render their contents unspillable, &c. All that, he said, was common knowledge at the date of the patent, and Hitchcock, in the specification, commenced by giving one example of a dry cell constructed in accordance with the alleged invention. Such example consisted of a Leclanché cell rendered dry in the following manner:—The zinc anode was of the ordinary cylindrical shape, and formed the outside walls of the cell. It was lined with a layer of plaster of Paris mixed with salammoniac, flour and zinc chloride. The mixture was run into the pot in a liquid condition and set into the condition of a semi-solid around a former placed inside the zinc pot, thus constituting a kind of porous pot saturated with the exciting liquid. The carbon rod forming the cathode was then placed inside this plaster porous pot or layer. The carbon was surrounded with pulverised carbon and manganese dioxide, mixed with water, salammoniac and zinc chloride, and packed in a semi-solid condition around the carbon. The whole battery was then covered over with a solid layer of pitch to seal the battery hermetically.

Lord MACNAGHTEN: I see in the appellants' case it is stated that the use of the zinc pot as an anode, of a carbon rod as a cathode, of plaster-of-Paris as an absorbent, of flour as a substance to prevent the plaster-of-Paris setting hard, of zinc chloride as a hygroscopic, of salammoniac as an excitant, and of a mixture of carbon and manganese as a depolariser, were all old and common knowledge when Hitchcock's letters patent were granted.

Mr. MOULTON: Yes. That is why we say that, upon the true construction of the specification, the alleged invention was not novel.

Lord DAVEY: You also say that it was not subject matter for valid letters patent, and that you did not infringe.

Mr. MOULTON: Yes, those shortly are the grounds of appeal. Continuing, counsel said the patentee did not limit his invention to a battery constructed according to the prescription given in his specification, but stated in terms in his specification that the electrodes, the excitant and the depolarising agents could all be changed; and further stated, in terms, that the important feature of the invention was the interposition between the electrodes of two layers of exciting composition in a semi-solid or plastic state, the one in contact with the cathode having depolarising agents mixed with it, and the one in contact with the anode having no such depolarising agents in its composition. The exact words of the specification were "the materials mentioned as electrodes and as exciting and depolarising agents, and their proportions, may be varied, as the important feature of the invention is the interposition between the positive and negative electrodes of two layers of exciting composition in a semi-solid or plastic state. . . ." The invention claimed was "a galvanic battery having the space between its positive and negative electrodes filled with a semi-solid or plastic exciting agent in two layers, the one layer in contact with the negative electrode having depolarising agents intermixed therewith, and the other layer in contact with the positive electrode having no such depolarising agents, substantially as set forth." Appellants' case was that the patentee had deliberately elected to claim all batteries consisting of layers such as described whatever were the substances used in constructing them, and that by reason of prior common knowledge and prior specifications, the invention so far as its alleged important feature and so far as it was claimed was not novel and not subject matter for valid letters patent.

Lord DAVEY: How was that met by the respondents?

Mr. MOULTON: They said that the general words of the specification and claim must be cut down and interpreted by certain particular features to be found in the special prescription given as an example. But they never pointed out anything in the specification which indicated how or to what extent the express language of the specification was to be cut down.

Lord DAVEY: I see in the respondents' case a statement that at the date of the letters patent dry batteries were unsatisfactory and little used, and that their specification consisted in the construction and arrangement of a dry battery, "having a combination of parts and ingredients all or most of which were old, but which had never previously been so combined and arranged and were not all previously thought to be desirable, whereby a dry battery was produced for the first time of great efficiency and utility and which speedily obtained a large and continuous sale."

Mr. MOULTON: Yes. Continuing, learned counsel said respondents called evidence at the trial to show that at the date of their patent it was novel in dry galvanic batteries to have the space between the two poles filled with two different semi-solid or plastic layers, built up as described in their specification, needing no diaphragm between them, each containing an excitant and one only—namely, that next the carbon and cathode pole having depolarising material mixed with it, but a careful consideration of previous inventions showed that, in fact, this combination had been anticipated. In conclusion, he submitted that the decision of Mr. Justice Buckley was right; that the Court of Appeal went wrong by adopting the argument of respondents that, notwithstanding the general words used in the specification, those words must be cut down by special characteristics to be found in the materials included in the special prescription. The Court, by a majority of two, decided that pulverisation was of the essence of the invention, and that plastic or semi-solid as applied to layers must be limited to plasticity or semi-solidity arising from the mixture of finely pulverised insoluble depolarisers with liquid so as to form a pasty mass. He submitted that the general words of the claim could not be cut down by conditions and left out of the particular prescription, nor, when properly construed, could respondents claim by their specification an invention which, in view of the state of common knowledge, and in view of earlier specifications disclosed in the particulars of objections, was not novel and was not the subject matter of valid letters patent.

Mr. A. J. WALTER, who followed for appellants, submitted that a patentee might make a claim either for a class or for an individual thing. He referred to Bender's battery and to Thiébaut's, as showing that a want of novelty existed in respondents' patent. He submitted also that the limitation contended for in the claim could not be justified.

Mr. ASTBURY, K.C., for respondents, reminded their lordships (on Tuesday) that infringement was not seriously denied, and that there was no question of utility to be decided whether there was an invention or not. He went on to explain the many attempts made to produce a really efficient and cheap dry cell, and respondents claimed that their battery was the best that had been produced so far, because, while it was reasonable in price, it was clean to use, effective and reliable. To that must be attributed the position it soon attained in the market. He submitted that appellants had made out no case and that the decision of the Court of Appeal was right and should be affirmed.

Mr. ASTBURY, K.C., continued his argument yesterday (Thursday). The evidence given by respondents' witnesses (he said) proved that at the date of their patent it was a novelty in dry batteries to have a space between the two poles filled with two separate semi-solid or plastic layers, built up as described in respondents' specification, needing no diaphragm between them, which contained an excitant and only one—namely, that next the cathode having depolarising material mixed with it. None of the documents cited by appellants were any anticipation of that combination. Counsel then dealt at length with the evidence, explaining how the respondents' letters patent differed *inter alia* from Newton (4,739 of 1880), Webb and Jensen (1,998, of 1883), Thiébaut (142,524 of 1881) and the additions thereto of Aug. 16, 1881, and April 3, 1882, and that of Bender (48,695 of 1888). Respondents' battery owed its superiority largely to pulverisation, but pulverisation was but one feature of the patent. The semi-solid or plastic state of the filling was the essence of the invention. A two-paste Lechanché battery was not known before the date of the patent. The patentee worked out the problem of getting the advantages of the different features of then existing inventions without their disadvantages. The onus was on the appellants to show that the alleged anticipations would do what respondents' patent would, and there was no suggestion of that in the evidence.

Mr. MOULTON, K.C., replied on the whole case, and submitted that the evidence of respondents' witnesses at the trial, on which they so greatly relied, in no way decided the question at issue. He pressed their lordships to allow the appeal.

Lord MACNAGHTEN said they would deliver judgment on a future day.

Macartney, McElroy & Co. (Ltd.) v. Brighton Corporation.

In our last issue we briefly referred to Thursday's proceedings in this action, in which plaintiffs seek to recover from defendant Corporation about £16,000 for work done in connection with the laying of the first lines of electric tramways in Brighton. In the course of his re-examination by Mr. Fletcher Moulton on behalf of the Corporation,

Mr. MAY said it was true that he paid plaintiffs at the rate of 7s. 1½d. per cubic yard for excavation on (B) on the invoices of June, July and August, 1901. He referred the invoices to his assistant, Mr. Smith, for examination, after which witness drew his certificate. The September invoices were also charged at the same rate, and paid. The amount of

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7s. 1½d. per yard for excavating, &c., was wrong also on (A). The excavation work under (B) was similar to that under (A), only it was over a very much wider area and very much greater depth, (A) being for 4in. from the existing surface of the road and (B) 19in. And still he considered the tendered sum included the whole of the work specified in both (A) and (B).

Ald. J. C. BUCKWELL, J.P., said he quite understood that the tender price was inclusive for the whole of the work under (B). Nothing passed at the committee meeting when the tenders were considered to make him think otherwise, or to show that any member or official regarded it as anything but an inclusive price. The tender was accepted on the understanding that it was an inclusive one, and no authority was given to anybody to vary the terms. It was necessary to have excavating, concreting and floating work done in order to construct the wood pavements, and therefore he considered the price included such work.

The FOREMAN OF THE JURY at this stage said the jury thought the calling of the town councillors was a waste of time.

It was therefore agreed that no further evidence should be submitted, and Mr. LUSH, K.C., on behalf of plaintiffs, then asked that the following list of questions should be submitted to the jury:—

1. Did plaintiffs and defendants both believe when the contract was executed that 12s. 7d. per yard super. was the sum to be paid for supplying and laying wood blocks only, and that excavating, concreting and floating was to be paid for in addition, and was the contract executed by both parties in that belief and on that basis?
2. Did both parties to the contract act throughout on the above basis?
3. Have the Corporation paid the plaintiffs for excavating, concreting and floating under (B), and, if so, what sum has been paid?
4. Was it practicable from the materials given in the form of order and the specification to estimate the amount of excavation necessary for (B)?
5. Did defendants leave to the borough surveyor, Mr. May, the negotiations and carrying out of the contract, and did he so act with authority of defendants?
6. If the jury find for plaintiffs on (B), then for what amount?

Mr. FLETCHER MOULTON, K.C., for the Corporation, submitted that none of these questions should be submitted to the jury, that the construction of the contract was a question for the judge, that Mr. May neither had nor could have any authority to contract; and that the Public Health Act, 1874, required that this contract should be under seal. Mr. Moulton proceeded to address the jury. Contracts by corporations, he said, were required by law to be executed under seal, and the question as to what the intention of the parties was must be, in almost every case, shown by the contract itself. He urged that, as business men, they must decide that, if a person received a tender for £23,000 for "the construction of wood-paved carriage-ways and crossings on each side of the tramway tracks," he must have assumed it included the whole of the cost unless otherwise clearly stated. If not, how could he decide what tender to accept? It was not denied by plaintiffs that 10 out of 12 tenderers for this particular work understood that they were tendering for the whole of the work. If the plaintiffs thought they were only tendering for a portion they should have taken every care that the Corporation knew they thought so. The Corporation thought it was an inclusive price.

Mr. LUSH followed for plaintiffs, and agreed that there was a question as to the construction of the very difficult set of documents which formed the contract, but that was not a question of law and was for the judge to advise the jury upon. The question whether the document was to be reformed on the ground that it did not express the meaning of the contracting parties would be discussed thereafter. His point, so far as it affected the jury, was that if that contract did not mean what he contended it did, it did not carry out the intentions of the parties. The real intention was that plaintiffs should be paid 12s. 7d. per yard for laying the wood, and that their right to be paid for the other work depended on the price to be found in the bill of quantities and schedule of prices. He urged that the Works committee knew that 12s. 7d. only included the wood. He protested against the Works committee affixing the Corporation seal to the contract, and so relying solely upon the word of their surveyor that it was an inclusive price, without themselves taking the trouble to look into the documents and seeing what the tender covered.

Mr. Justice GRANTHAM having put Mr. Lush's questions to the jury, briefly summed up. He agreed with Mr. Moulton as to the legal aspect of the matter. It seemed to him that the plaintiffs' was the only view he could take of the transaction. The whole of this trouble might have been avoided if Mr. May had acted as any ordinary person would have acted, and he considered that, if the Corporation had been in the habit of employing a solicitor, and the question had gone to the solicitor when it first arose, no difficulty would have occurred at all.

As briefly recorded in our last issue, the jury answered the six questions submitted, as under:—

No. 1, Yes; No. 2, Yes; No. 3, Yes; No. 4, No; No. 5, Yes; No. 6, For the plaintiffs at 7s. 1½d. per cubic yard. The total amount due to plaintiffs under this figure was £14,621. 7s. 2d.

On Friday the matter was mentioned to Mr. Justice Grantham, who was asked to hear the arguments of counsel on Wednesday. His lordship assented to this proposal. But later his lordship said that, in consequence of the present position of the cases to come before him, he would be unable to take the hearing of the legal arguments in the action that day. The case would, therefore, be adjourned to a future date.

Smith v. Charing Cross, Euston and Hampstead Railway Co.

Last week, in the Court of Appeal (the Master of the Rolls, Lords Justices Romer and Mathew), plaintiff appealed from a judgment of Mr. Justice Kekewich. The original action was brought to recover arrears of salary and damages for wrongful dismissal under an agreement whereby plaintiff was appointed general manager and secretary of defendant company. Plaintiff was to receive no payment by way of salary until after the first public allotment of shares. Defendants, with a denial of liability, paid £1,050 into court as sufficient to satisfy plaintiff's claim. Mr. Justice Kekewich held that plaintiff had no claim to any salary, on the ground that there had been no "public allotment of shares." With regard to the claim for wrongful dismissal he held that, though plaintiff had been wrongfully dismissed, he had suffered no damage, as there was only a faint possibility of there being thereafter a public allotment. He accordingly gave judgment for plaintiff for 40s. without costs.

After the arguments had continued for some time, the case was settled on the terms that defendants should pay plaintiff £2,500.

Kershaw v. Lawson.

On Saturday Mr. Justice Kennedy heard an action brought by plaintiff to recover from Mr. H. J. Lawson £200 on a bill accepted by defendant and dishonoured on presentation.

Mr. NORMAN CRAIG, for plaintiff, said that in 1901 plaintiff and two others obtained a provisional order to construct a light railway in Warwick and Worcester, and formed a limited company. In 1902 the promoters agreed to sell their interest in the order (for £4,125, payable by instalments) to the Electric Tramways and Maintenance Co. (Ltd.), a company controlled by defendant. In the event of the failure of the assignees to perform their obligations all money paid was to be forfeited, so that the assignment was conditional. £350 and £550 was paid and then default was made. In 1903 judgment was obtained for £2,249, notice of forfeiture of money paid was given and a petition to wind up the construction company was filed. This was adjourned from time to time to allow a scheme for the re-sale of the provisional order by defendant's company. The negotiations failed and it was arranged that the promoters should abandon the winding-up petition, that they should retain the order, and that Mr. Lawson should pay them £50 cash and give them two bills for £200 each at three and six months.

For the defence it was denied that defendant agreed that the promoters should retain the order and the question was whether the property in the order was in Mr. Lawson or in the promoters. Mr. Lawson said he was prepared to pay £400 the moment the order was handed to him.

His LORDSHIP gave judgment for plaintiff for the amount claimed, with interest and costs.

County of London and Brush Provincial Electric Lighting Co. (Ltd) v. Scottish House-to-House Electricity Co. (Ltd.)

On Friday, in the Chancery Division, before Mr. Justice Farwell, Mr. Rolt moved his case for the appointment of a receiver of the defendant company. Plaintiffs were mortgagees for £75,000, and they had practically financed the defendant company. They held certain stock and other securities, and at the end of March, being dissatisfied, they took a further mortgage in the form of a charge on the undertaking, and an assignment of the book debts. The security became enforceable on demand, which had been made, and the company were unable to pay.

Defendant company offered no opposition.

His LORDSHIP made the order asked for, directed an account to be taken of and what was due, the receiver to receive the profits of the undertaking if and when it was sold.

Knight v. Isle of Wight Electric Light and Power Co. (Ltd.)

This case was to have come before Mr. Justice Joyce on Friday on a motion to sequestrate the company for committing a breach of an injunction restraining them from committing a nuisance, but it was not mentioned by counsel.

We are informed a settlement has been arrived at by the parties by the defendant company acquiring plaintiff's lease.

National Telephone Co. v. Flook.

In the City of London Court last week, the National Telephone Co. sued defendant for £6. 10s. for a year's telephone service. Defendant, after using the telephone for 12 months, gave notice to discontinue, and it was disconnected. The company now sued for a second year's service.

Mr. GAINE, for plaintiffs, said defendant gave notice on the day that the 12 months' service expired. Telephone contracts could only be put an end to on giving six months' notice, expiring at the end of any one year.

Judge RENTOUL, K.C., said the company were entitled to the full year's charges. Defendant had broken his contract, and must pay £3 damages and costs.

Mr. GAINE asked on what grounds was the sum of £6. 10s. to which the company was entitled to be arbitrarily reduced?

Judge RENTOUL said on the ground that equity must govern the law. £3 was heavy enough punishment for defendant to pay for breaking his contract.

Synchronising City Clocks.—At the last meeting of the Court of Common Council (City of London) Mr. Wilkinson moved that the Streets committee should consider the desirability of applying the regulations as to synchronising with Greenwich time to existing as well as to future clocks erected in the City over the public ways. A great deal of public inconvenience was, he declared, caused by the erratic conduct of the "public" clocks in the City district. Mr. Barber reminded the Court that in all great cities on the Continent the public clocks were synchronised. Mr. White considered such expenditure quite unnecessary. There was a church clock in Cannon-street which had been keeping correct time since 1691. The resolution was carried.

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MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Middlesex Education committee require an electrician to be responsible for the gas engines and dynamos at polytechnics in the county and for the care of electrical plant, also to assist in taking some of the electric light wiring classes. Salary £150 per annum. Applications to Mr. B. S. Gott, Guildhall, Westminster, by June 1. See advertisement.

A young electrician is required to assist with office work in dynamo department of Messrs. W. H. Allen, Son & Co., Bedford. See advertisement.

An improver is wanted to act as switchboard attendant in small station, also lamp trimmer to attend to Brockie-Pell and Nernst street lamps in small town. Applications to Messrs. Talbot and Stevenson, 26, Victoria-street, London, S.W. See advertisements.

An assistant electrician is wanted for the instrument department of Crompton & Co., Arc Works, Chelmsford. Applications to the works manager. See advertisement.

Derby Corporation Tramways committee require a chief motor instructor and car shed superintendent. Applications to the town clerk (Mr. G. Trevelyan Lee), Tennant-street, Derby, by 17th inst.

Hornsey Town Council require a junior electrician-in-charge. Salary 30s. Applications to borough electrical engineer by to-morrow (Saturday).

A principal is required for Blackburn Municipal Technical School. Salary £500. Applications by noon 16th inst.

Mr. C. U. Cooke of the Crewe electricity works has been appointed engineering clerk of works at Middlesex County Asylum, Napsbury.

EDUCATIONAL NOTICE.

Institute of Chemistry.—In the final examination for the Associateship (A.I.C.) of the Institute of Chemistry, recently concluded, the list of successful candidates is just issued. Examinations were made in mineral, metallurgical and organic chemistry, and other subjects, including therapeutics, pharmacology and microscopy.

Accident.—In the railway accident which occurred at Waterloo Station, London, yesterday afternoon, we regret to find that among the injured was Mr. W. H. M. Wilson, electrical engineer, of Galesbury-road, St Ann's Hill, London, S.W.

Ancient Lights.—An important decision relating to ancient lights was given in the House of Lords on Monday in the action "Colls *v.* Home and Colonial Stores (Ltd.)." The question of ancient lights has been a fruitful source of trouble to electricity supply undertakers, and the judgment of the Law Lords will have a far-reaching effect.

Aston.—The Council have abolished the scheme of wiring premises and supplying fittings on the "free" wiring system.

Asuncion (Paraguay).—An electricity supply station has been established in this town, and, if successful, is to be extended. There is some demand for electric lamps, fittings, motors and accessories. Catalogues, &c, as far as possible, should be in Spanish.

Barnstaple.— The Corporation have borrowed £5,400 from Huddersfield Corporation at 3¾ per cent. for electric lighting extensions.

Birkenhead.—During the year ended March 31 the units of electricity generated were 661,171, the number of consumers 606, an increase over the previous year of 113,533 units and 124 customers.

The Electricity committee propose to invite tenders for laying additional mains in Grange-road and Conway-street, and for feeder and distributor mains to supply the suburbs of Upton and Prenton. The committee further recommend the borrowing of £20,000 for feeders, distributing mains, meters, service cables, &c., estimated to be required during the ensuing three years.

Birmingham.—A special meeting of the Tramways committee was held yesterday, when the terms of the agreement entered into with the City of Birmingham Tramways Co. for the electrification of the tramways from the centre of the city to Hay Mills were discussed.

Bolton.—For the position of assistant electrical engineer the Tramways committee received over 200 applications.

The capital expenditure upon the municipal electric tramways for the year to March 31 was £92,835, compared with £80,737 in the preceding year, and the income £95,095, against £85,703. The profit was £2,260, against £4,966.

Bootle.—On Wednesday the Council resolved to adhere to their decision not to grant Liverpool Corporation the privilege of running electric tramways along Balliol-road.

Bray.—The Electric Lighting committee have selected the following six candidates (out of 68 applicants) from whom the appointment of a resident electrical engineer will be made:—A. T. Bartlett (Siemens Brothers & Co.), C. B. Clancy (assistant engineer at Dublin), A. T. Evans (assistant engineer at Bray), G. M. Harriss (Carlow, candidature withdrawn), W. H. Miller (Belfast) and W. J. U. Sowter (Dorchester).

Burnley.—The Electricity committee recommend an increase in the salary of the borough electrical engineer (Mr. R. Birkett) to £450 per annum.

Bury (Lancs.)—An inquiry was held here last week into the application of the Corporation for power to borrow £45,000 for electric lighting extensions.

The town clerk said that, under the Tramway Act, 1870, they had borrowed money for 30 years, but under the powers now being sought it was desired to repay it in 25 years. They had powers to borrow money for that purpose under that act, but the Council now desired those powers under the Electric Lighting Acts. As to existing loans, the town clerk said that in 1895 powers were obtained to borrow £30,000, and that was increased four years later to £50,000. The output had been increasing month by month, and last year they sold 424,993 units. After allowing for interest and sinking fund, &c., there was a profit of £21 last year, and this year there would be a substantial profit.

Technical evidence was supplied by the engineer and manager, Mr. S. J. Watson.

Canary Islands.—A concession has been granted to the Société Anonyme des Tramways Electriques de Teneriffe for constructing and working an electric tramway from San Cristobal de la Laguna to Tacoronte.

Electricity supply works are projected for Las Palmas.

Cannock.—The District Council have decided to borrow £8,000 for electricity supply.

Cheltenham.—In submitting to the Council on Monday the estimates for the ensuing year, Ald. Waghorne, chairman of the Finance committee, said £2,500 had to be provided to meet the estimated deficiency on the past year's working of the electricity undertaking. Ald. Waghorne suggested that the president of the Institution of Civil Engineers should be asked to nominate an expert to consider the best means of dealing with the accumulated deficiency on the undertaking from previous years.'

Church Lighting.—St. Mary's, Islington (London), the parish church, which was opened last week after complete renovation, is lighted electrically by current taken from the municipal mains.

Conway.—The Town Council have decided to apply for a provisional electric lighting order.

Darlington.—The Council have decided to abandon for the present the proposal to adopt a "free" wiring scheme.

Devonport.—The new electric tramway route between Camel's Head and St. Budeaux is now in operation.

Dock Lighting.—Coal porters at the Victoria and Albert Docks, and at Tilbury, have struck, owing to the danger of unloading coal at night, while at Poplar and other places on the lower Thames, where electric lighting has been adopted, no friction has arisen between employers and their workmen.

Dover.—On Tuesday a special meeting of the Council was held to seal a mortgage for £150,000 for the purchase of the electricity undertaking of the Dover Electricity Supply Co., and to authorise payment of the purchase-money and expenses of acquiring the undertaking. The resolution was carried.

Dudley.—For the year ended March the receipts of the electricity undertaking amounted to £10,600. Working expenses were £5,608, leaving a gross profit of £4,924. The number of units generated was 470,000.

Eastbourne.—In presenting the accounts of the electricity department on Monday,

Councillor Simmons explained that that was the first year the interest on the whole capital expenditure (£150,000) had been paid in full. In addition, they had lowered the price of current by 1d. per unit, and yet were able to show a net profit of £3,867. It was proposed that £1,000 should be carried to depreciation, that £750 should be allocated to relief of rates, and that the balance be carried forward. The Electric Light committee also proposed that the charge for public arc lamps be reduced from £25 to £22 per annum, and private supply by ½d. per unit. It was estimated that those reductions would absorb about £2,000.

Exhibition —Bradford exhibition was formally opened by the Prince of Wales on Wednesday. The electrical and general engineering sections include exhibits by the Corporation electricity department, the British Westinghouse Co., Matthews and Yates, Campbell and Isherwood, &c.

Folkestone.—Folkestone Electricity Supply Co. offer to light all public lamps now in use in the town, including supply of current, maintenance of lamps, &c., at £4,796 per annum, or £1,000 less than the estimate of the Lighting committee, on a 14 years' contract, or, as an alternative, to light existing arc lamps only at £20 each per annum instead of the present charge of £24. The Council offer £15 per lamp per annum for the existing arcs under a yearly contract.

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The Corporation had before them on Wednesday Mr. C. H. Merz's report on electric traction, and has decided to ask Lord Radnor to acquiesce in the adoption of the overhead system.

Gateshead.—A deputation of tradesmen and manufacturers waited upon the Council on Wednesday to protest against the Corporation's refusal of an offer by the County of Durham Electrical Power Distribution Co. to reduce the price of electricity 25 per cent. on condition that the period of the company's lease was extended.

The Mayor said the offer had been refused in the interests of posterity, so as to bring the date of the company's arrangement to a close at the same time as the tramway company's.

Gloucester.—The past (third) year's working of the electricity department has resulted in increases of £1,300 (28 per cent.) in receipts and £370 (15 per cent.) in expenditure over the previous year.

Gosport.—Application has been made by the Council to the Board of Trade for an extension of their Electric Lighting Order, 1900, stating that active steps are being taken to carry out its provisions. The Provincial Tramways Co. will probably lease the order.

Halifax.—The Tramways committee have appointed a sub-committee to consider an offer by a London syndicate to take over the Corporation's powers to construct tramways from the borough boundary to West Vale, Brighouse, via Elland and Bailiff Bridge.

Hammersmith (London).—On Wednesday the Council adopted the estimate submitted by the Finance committee for electric lighting extensions amounting to £40,000.

Holyhead.—Mr. Price White, borough electrical engineer of Bangor, has been instructed by the District Council to prepare plans and specifications for an electric lighting scheme at a fee of 35 guineas.

Ilford.—Sanction to a loan of £20,500 for electric tramway extensions has been obtained. The Local Government Board have refused to authorise borrowing for the purchase of electric motors and fittings to be let out on hire, on the ground that the Council have no authority to engage in such work.

Islington (London).—The Lighting committee have reported against the continuance of certain incandescent electric lighting and have made experiments with a "flame" electric lamp, claimed by the makers to consume less current and give more light. The manufacturers offer, under a substantial guarantee, to erect, on columns to be provided by the Council, any number up to 12 flame lamps complete at £13. 10s. per lamp, the carbons and parts of lamps required to be obtained from the manufacturers during the currency of the guarantee. The committee recommend that the work be carried out.

The committee also report that, having regard to the fact that in the past unexpected increases in the price of coal have been detrimental to the economical running of the electricity station, they recommend a contract be entered into for the supply of 10,000 tons, with the option of taking up to 50,000 tons (four years' supply), of Welsh steam coal, to be delivered as required, at 7s. 3d. per ton at pit's mouth, or 16s. 3d. delivered at Eden Grove siding.

Keighley.—Ald. Paget announced at a recent Council meeting that the amount of assistance required by the electricity department from the rates this year was £1,608, compared with £3,200 last year.

The work of converting the tramways to electric traction has been commenced.

King's Norton.—The Council on Wednesday referred to the Tramway committee a proposal to extend the tramway system from Selly Oak to Northfield.

Light Railway.—The Board of Trade have, after modification, confirmed the Aldershot and Farnborough Light Railway (Amendment) Order, 1904, amending the Aldershot and Farnborough Light Railway Order, 1902.

Lincoln.—At the meeting of the City Council on Tuesday, Ald. Wallis said the Electricity committee recommended the adoption of the G.-B. surface contact system of traction on the local tramways. The plans had been prepared for submission to the Board of Trade for its approval of the system. Messrs. W. Griffiths & Co. had shown that they were prepared to indemnify the Council for any loss it might sustain from the adoption of the system. The terms of the guarantee provided that the Council should withhold all payments for the electrical equipment until 15 months after running the system and a three months' probationary period. The minutes were confirmed.

Liverpool.—At the Corporation meeting on Wednesday Mr. Armour criticised the report of the consulting electrical engineer (Mr. A. Bromley Holmes) on the charges to be made for electrical energy:—

He moved an amendment that the report, with the exception of the recommendation that the price of electric energy supplied to the Tramways committee be increased from the present rate of 1·05d. to 1·12d. per unit, be approved, and that, with the view of strengthening the position of the committee, the price charged to the Tramways committee be increased from 1·12d. to 1·25d. per unit. This, said Mr. Armour, would put their accounts in a safer condition financially, and they would be able to act fairly to the general consumers. In reply, Sir Charles Petrie said originally it was proposed that the Tramways committee should have a separate generating station, but the Council decided that the station should be a joint one. The Tramways committee paid its proportion of interest and sinking fund and other charges. The charges made to the Tramways committee were equitable as between the Lighting and Tramways departments. The charges made to private consumers compared favourably with those paid by consumers in other parts of the kingdom.

The amendment was lost.

London County Council.—At Tuesday's meeting the estimates of expenditure for 1904-5 were considered. The estimate of receipts and expenditure for the tramways included :—

Income.—Balance at beginning of year, £10,462. *Southern System:* From horse traction, £119,885; from electric traction, £484,325. *Northern System:* Rent (less income tax), £62,190. *General:* Interest, £1,400. Total, £678,262, compared with £610,159 for 1903-4, an increase of £68,103.

Expenditure.—*Southern System:* Working expenses, &c.—Horse traction, £135,110; electric traction, £317,320; provision for renewals, £18,258; debt charges, £133,522. *Northern System:* Rent, repairs, insurance, inspection, &c., £675; debt charges, £36,756. *General:* Drawbacks on rent of surplus property, &c., £600; debt charges, £16,126; promotion of tramway bills, £3,000. Estimated balance at end of year, £16,895. Total, £678,262, compared with £610,159 in 1903-4, an increase of £68,103.

Lord Welby, in submitting the whole of the estimates, said that one of the greatest of the works which the Council had in hand is the electrification of the tramways. The best financial result earned by the tramways was in the year 1899-1900, when they gave £71,000 in relief of rates after making full provision for interest and sinking fund on the tramway debt. Of this sum about £40,000 was derived from the northern system and the remainder from the southern. From that time, however, the surplus remaining after payment of principal and interest of debt had declined. On the northern lines it had fallen from £40,000 to £25,000 in consequence of the sale by the North Metropolitan Company of lines outside the county, while the general dislocation of traffic caused by the work of electrification, added to improvements of the service, only left the southern system in equilibrium after payment of principal and interest. This result appeared disappointing, and he thought it must be conceded that, in framing the estimates of last year, the effect of electrification in dislocating traffic was not sufficiently foreseen; but let them summarise the result of working the tramways as a whole. The loss on the northern tramways was disappointing, and the possibility of their sale was not, apparently, anticipated. Nevertheless, the northern tramways paid interest and sinking fund on their debt, and still provided a good surplus. The Council, in working the southern system, had applied a considerable part of the original surplus in improving the service—in improving locomotion in the southern district. The Council had maintained a night service in the interest of the public, and had devoted a part of its profits to this service, which was not remunerative. It had further devoted a very large sum, part of its profits, to improving the wages and reducing the hours of its employés. The work of electrification had proved more expensive than was anticipated, owing largely to the temporary arrangements for the supply of power. Taking the result of the tramway undertaking as a whole, even under the severe strain to which it was now subjected, equilibrium would, according to the estimate, be maintained after paying the full charge of interest and sinking fund. During the current year the electrification of the greater part of the southern system would be completed, and it might be hoped that in 1905-6 traffic dislocation on this part would be at an end. Up to March 31, 1904, debt to the amount of £246,591 had been paid out of profits, and £294,592 had been carried to the relief of rates. They had found that the process of electrification was expensive, and that it imposed a heavy strain on tramway finance. The Finance committee could but hope that this experience would induce the Council to complete the southern system before it entered into fresh heavy expenditure in the north, bearing in mind especially the very high price at which it was raising money for capital expenditure.

Mr. Allan Baker claimed that on the whole the tramway policy of the Council was a success financially. He pointed out that with all the difficulties they had had to contend with on the southern lines, they had still been enabled to pay the interest and debt charges.

The estimates were agreed to.

Fares.—It was agreed, on the recommendation of the Highways committee, (*a*) That on and after Monday, May 9, 1904, the fares charged on the workmen's cars on the London County Council tramways, for any distance beyond those covered by the present ½d. fares, be 1d. for a single journey, and 2d., to be paid in advance, for a return or double journey, the 2d. ticket being available on the day of issue only, for the return journey or for a single journey, by any car on any route and at any time; and that the issue of 2d. return tickets be not commenced on the all-night service cars until after 2 o'clock a.m. each day. (*b*) That on and after Monday, May 9, 1904, ordinary fares be charged up to 2 o'clock a.m. each day on all the all-night service cars on the London County Council tramways.

London County Council Tramways.—On Saturday last electric cars started running through St. George's-road, which extends from Westminster Bridge-road to Newington Butts. This new route is used by cars from Westminster Bridge to New Cross-gate, which will, on Monday next, extend their journey southward to New Cross.

Long Eaton.—It was reported to the Council on Monday that the profit on the electric lighting undertaking for the 15 months

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ended March was £884. 10s. 10d. For houses, shops, chapels and manufactories, a flat price of 4d. per unit will in future be charged; and for power and heating the present rate is to be continued.

Loughborough.—An inquiry was held here last week into the application of the Council for permission to borrow £5,000 for electric lighting.

Manchester.—By arrangement between the Electricity and Gas departments a part of Piccadilly is to be lighted electrically.

Marylebone (London).—At last Friday's meeting of the Borough Council it was agreed to appoint representatives to attend a conference proposed by the St. Pancras Borough Council with the view to petitioning the Board of Trade to promote legislation on behalf of electricity supply undertakers to enable them to obtain compulsory powers of purchase of land and for the repeal or modification of the law relating to actions against such undertakers for nuisance and damage. It was further agreed to appoint three delegates to attend a conference of representatives of London local authorities which is to be held at the Guildhall, E.C., on May 18, with reference to the proposed purchase by the Government of the National Telephone Co.'s undertakings.

Metropolitan Asylums Board.—The Board has decided to re-model the fire alarm and telephone system at Darenth Asylum at an estimated cost of £375.

Middlesbrough.—The income of the electricity department for the year ended March was £9,037. 10s. 6d., and the total expenditure £3,993. 1s. 5d., giving a gross profit of £5,044. 9s. 1d., compared with £3,260. 17s. 9d. in 1903. Interest and sinking fund amounted to £4,509. 16s. 4d., leaving £534. 12s. 9d. profit (against a loss of £485), which is to be placed to reserve. The revenue showed an increase of £2,213, or 34 per cent.; the expenses an increase of £529, or about 15 per cent. Units sold were 630,407, against 446,343, an increase of 41 per cent. The works cost per unit has been reduced from 1·86d. to 1·52d., or by 0·34d. per unit.

Morley.—The Corporation on Monday discussed a proposal to increase the salary of the borough electrical engineer (Mr. John Ellis) by £50 per annum. The voting was equal, and as the mayor declined to give his casting vote the proposal was not adopted.

Morpeth.—A special meeting of the Council was held last week to consider tenders for public lighting. A motion to accept the tender of the Gas Company was lost. Tenders were also submitted by the Northern Counties Electricity Supply Co, and the Gas Company has now submitted an amended offer, necessitating another meeting.

Musselburgh-Portobello Tramway.—Edinburgh Corporation have now sanctioned the construction of this line by the National Electric Construction Co. (Ltd.) and work was commenced on Wednesday.

Nelson.—The annual report and accounts of the electricity and tramway and light railway department for year ended March 31 have been issued. The borough electrical engineer and tramways manager (Mr. W. Alan Fraser) states that the figures for the latter department were affected by unfavourable weather.

The total income was £4,675, expenditure £3,583. Interest absorbed £781, and sinking fund instalment £232, leaving £79 profit.

On the electricity supply department there was a small profit, although Mr. Fraser states that the department is handicapped by having a capital of £8,000 due to old plant upon which no return is obtained, although interest and sinking fund are still being paid. The output of the department is making steady progress, the increase during the year being 18 per cent. for lighting, 240 per cent for motive power, and 115 per cent. for tramways and light railways. The least satisfactory item in the accounts (Mr. Fraser states) is the high expenditure for fuel, caused, no doubt, by running non-condensing all day, thus taking more steam than the refuse destructor can generate and necessitating keeping a boiler under steam. The total receipts amounted to £6,627 and expenditure (including £1,857 interest on loans and £1,577 for sinking fund) £6,226. The total units of electric current sold amounted to 555,876, including 141,002 for lighting, 21,669 for motive power, 209,200 for tramways, 170,611 for light railways and 13,394 by contract. The equivalent of 17,556 8 c.p. lamps is connected for private lighting in addition to 168 H.P. in motors. The maximum demand was 593·6kw.

Newcastle-on-Tyne.—On Wednesday Sir Charles F. Hamond submitted a report from the Parliamentary, Bye-Laws and Tramways committees asking the Council to give the committees power to negotiate with the Tramways Company for an amicable settlement of the running powers dispute. He asked that the Council should authorise the committees to ascertain from the company on what terms they would be prepared to sell their entire tramway undertaking, and if not, whether they would be prepared to lease the same, the Corporation to have entire control of the working of the lines, and keeping them and their equipment in repair. Sir Charles F. Hamond, on being appealed to, agreed that his motion with regard to purchase should stand over, and the other recommendations were agreed to.

Northampton.—The Council, who have obtained a report from Mr. C. H. Gadsby upon the undertaking of the Northampton Electric Light and Power Co. putting the value at £120,000, including £30,000 for goodwill, have provisionally offered £100,000 for the undertaking. Some time ago the Council offered £70,000, but this was declined.

Nottingham.—An inquiry was held here last week into the application of the Corporation for power to borrow £100,000 for electric lighting extensions.

The Town Clerk (Sir SAMUEL JOHNSON) said that was the seventh application made by the Council for borrowing powers for their electric lighting undertaking. The present application was made to meet the demands upon the electricity undertaking, of the progress of which Sir Samuel gave an interesting sketch.

The Borough Electrical Engineer (Mr. H. TALBOT) also gave evidence and said there had been a steadily increasing demand for electricity, which they had been able to supply at a profit.

Oulton.—The Council are asked to authorise an application for a provisional electric lighting order.

Poplar (London).—The Finance committee reported on Wednesday, agreeing to the proposals of the Lighting committee that consumers' accounts should in future be collected by the electricity department, thus enabling the latter to keep in touch with consumers, so that bad debts might be avoided, &c.; that a separate banking account be kept for the electricity department, and that the wages of the electricity department be paid by that department's own officials, the electricity department taking full responsibility.

Post Office Telegraphs.—The Postmaster-General announces that the line of underground telegraph cable now runs continuously from London to Carlisle, and from Manchester to Leeds will soon be completed. The permanent line will soon be available as far as Warrington, and provision has been made in the present financial year's estimates for a further very considerable extension of the underground line.

Potchefstroom (South Africa).—The local electricity supply company, who are supplying current in the business portion of the town, have been asked by the Town Council to submit a scheme for street lighting.

Presentation.—A silver tea and coffee service was presented by the Nelson electrical and tramways staff to Mr. M. B. Henry, assistant electrical engineer, on his departure to take up the position of resident electrical engineer at Radcliffe.

Preston.—The Council have been guaranteed 3½ per cent. interest on £6,000 for five years to make good any loss which may result from a proposed extension of the electric tramways, and this extension will therefore be carried through.

Printers' Exhibition, London—Outside an exhibition devoted exclusively to electrical exhibits we doubt if any of the numerous displays of trade specialities have a greater general interest than those associated with the printing and allied trades. There is certainly no branch of industry in which electricity plays a larger part in industrial operations than the printing trade, which is, at the present time, employing the electric motor largely in driving the very varied kinds of machines used in the making of books, newspapers, catalogues, &c., and in printing operations generally, including letterpress, lithographic, stereotyping, machine composition, type founding, hot and cold rolling, binding, &c. At the Royal Agricultural Hall, London, there was opened on Saturday last a most instructive exhibition of printing trade requirements and at many of the stands the driving of machinery is done by electric motors, amongst the firms supplying these machines being the Union Electric Co., who at stand 148 have a large display of dynamos and motors, arc lamps, measuring instruments, resistance apparatus, &c., and, in addition, are driving by their electric motors the machinery at the exhibits of Messrs. John Esson & Son (stands 15 and 16), Diamond Tag Co. (stand 72), Messrs A. E. Dent & Co. (stand No. 4), and also the conspicuous stand of John Haddon & Son, where a dynamo of the Union Co.'s make is driven by means of special speed variation gear so as to obtain direct coupling to the gas engine. "Inverted" and "indirect" arc lamps, specially designed for use in the printing trades, are also shown by this company, several of the stands at the exhibition being rendered conspicuous by the use of their "Miniature" arcs. At stand 172 Electromotors Limited, have on show a number of machines of standard size from ½ B.H.P. to 15 B.H.P. At stand 137 the Electromotor and Dynamo Co. display electric motors, speed reducing gear, electric pulley blocks, goods' hoists, &c. At stands 187 and 188 Messrs. A. Elder & Co. show dynamos and motors and a new type of complete gas generating plant. At stand 185 Messrs. F. A. Glover & Co. show a number of electric motors, a special Linotype motor for driving type setting machines of this class, electric fans, ventilators, &c. At stand 98 Messrs. F. W. Potter & Co. show "Wing" electric motors from ⅛ H.P. to 6 H.P., "Wing" electric fans, &c. Gas engines are a prominent feature at a number of the stalls, conspicuous amongst these being Messrs. Crossley Bros. & Co., who show numerous examples of their latest designs of these well known engines, one of the P.E. type, with dynamo, giving 18 B.H.P. as a regular load. At this stand there is also a LL type oil engine, with dynamo combined, capable of developing 3¼ B.H.P. at a regular working load. A suction gas plant, driving one of these engines, is also shown. Some electrical and portable tell-tales, "Simplex" automatic switches, time re-

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corders, &c., are shown at stand 153 by Messrs. J. J. Stockall & Sons. This interesting exhibition remains open until May 14, and well merits a visit from all who take an interest in the "art preservative."

Queenborough.—The new pier, which is 600ft. in length, and has cost £100,000 to build, has been provided with four electric travelling cranes in place of the former steam cranes.

Rangoon.—The Municipality do not appear to make much progress with their electric lighting and tramway scheme. As there have been various statements published concerning the tenders for these works, we give the following information:—

As far back as Dec., 1902, offers were invited for a concession for the construction of electric tramways and the erection of electricity works. Tenders were to be in by June 30, 1903. The successful tenderer was not required to contribute towards the purchase of the existing horse tramways, and the concession was for a period of 42 years. The licence would, however, be granted subject to the Indian Electricity Act then about to come into force. Five tenders were sent in, including a joint tender from the Brush Electrical Engineering and the British Electric Traction Companies. After prolonged discussion, all the tenders were rejected owing to alleged misunderstanding on the part of some of the tenderers as to the scope of the tramway extensions required, and four of the tenderers were requested to send in further offers by Nov. 30, 1903, under somewhat closer conditions. The amended joint tender of the Brush and British Electric Traction Companies was, we understand, then accepted by the Municipality for recommendation to the Government of India, the sanction of the latter being necessary before a licence under the Indian Electricity Act could be granted. It was publicly known that one of the tenderers was the practical owner of the horse tramways, and had offered to hand over those tramways to the Municipality free of charge on condition of his tender being accepted. In view of this, the Brush Co. and the British Electric Traction Co. then submitted an alternative tender by which they offered to find the purchase money required for the existing tramways, not to exceed 4 lakhs of rupees, subject to the term of the concession being increased to 49 years, basing the latter condition on the powers apparently reserved to the Indian Government under clause 10 of the Indian Electricity Act. After some correspondence with Rangoon Municipality the Government advocate decided that this reading of the clause was inadmissible, and that the alternative tender in question could not go through. Notwithstanding this, the Lieutenant-Governor offered to accept the joint tender of the Brush and British Electric Traction Companies on the basis of the 42 years allowed by the act, but subject to payment of 4 lakhs of rupees for the existing tramways and subject also to the deposit required being increased from 20,000 rupees, as specified in the original conditions, to 1 lakh of rupees. The tenderers pointed out that their offer to pay 4 lakhs of rupees for the tramways was conditional upon the extension of the term of the concession by seven years, and that if only 42 years could be granted the alternative tender would not hold. The other tender was, however, rejected, and negotiations came to an end with a letter written by Mr. A. B. Cook, the representative of the companies, to the secretary of the Municipality in which it was stated the second tender was made in strict accordance with the published conditions of the Municipality. The company were willing to accept a 42 year franchise subject to the original conditions, but they were not willing to pay 4 lakhs of rupees and were not willing to make a deposit of 1 lakh of rupees, this being in excess of the amount stipulated in the conditions.

Redditch.—The accounts of the Electricity department were presented on Tuesday, and showed a profit of £460 for the past year.

Reichenberg (Austria).—The project for the establishment of an electricity supply undertaking in this city has now taken definite form. The territory which the undertaking is to supply is about 10 miles square, and already 24 towns and villages are subscribing towards the capital stock. Some 10 more are expected to join later. The population is about 60,000, and the estimated ultimate cost of the scheme £80,000. At first energy for light and power only will be supplied, but ultimately a system of electric tramways will be constructed and equipped. It is likely that a number of small electric tramway and lighting concessions now owned by companies in this district will be taken over by the local authorities at the expiration of the concessions. Communications concerning the supply of plant, &c., may be addressed to M. Alfred Ginskey, Mafferdorf, and Dr. Richard Parkl, Reichenberg, Austria.

Rotherham.—The gross profit on the electricity department for the past year was £6,067. 19s. 2d., and after deducting all charges, including sinking fund and interest, there was a net profit of £1,278. 8s. 11d., compared with a deficit of £733. 14s. 7d. in the previous year. The average price per unit, including lighting, power and tramways, came out at 2·085d.

The chairman of the Electricity committee (Ald. Winter) stated on Wednesday that the working costs and management expenses were a credit to the management and staff of the department, because from the published lists of all public electricity undertakings in the United Kingdom Rotherham took first place with regard to low cost per unit sold. On the question of depreciation Ald. Winter said they were apparently making more ample provision than most towns. Out of 22 towns, all of which had been working, with one exception, for more than seven years, there were only one or two instances where any depreciation was allowed.

The total tramway traffic receipts amounted to £20,968. The net result was a slight deficit (£21. 16s. 5d.) but that was after allowing £2,693. 6s. 6d. for renewals. If they had acted on the principle suggested to them of ¾d. per car-mile for depreciation, instead of showing a deficit they would have had a surplus of £1,050. Also, if the whole of the lines had been running from the commencement of the financial year they would have had an addition to the receipts of something like £4.200, and that would have given them a substantial profit, even after setting aside a sum equivalent to 1½d. per car-mile for renewals and depreciation. The receipts per car-mile averaged 9½d.; operating charges, 5·67d. The cost per unit per car-mile was 1·50d.

St. Louis Exhibition, 1904.—As announced elsewhere, this exhibition was opened on Saturday last, and the official catalogues of the British exhibits are ready. The following firms are exhibitors in the machinery and electricity group:—John Fowler & Co. (Leeds), Greenwood & Batley (Leeds), Davidson & Co. (Belfast), F. B. Behr (working model of mono railway and car), London, Consolidated Electrical Co. (London), Sherard Cowper-Coles & Co. (London), A. C. Cossor (London), India-Rubber, Gutta Percha & Telegraph Works Co. (London), Muirhead & Co. (London), Cambridge Scientific Instrument Co. (Cambridge), Crompton & Co. (London and Chelmsford), F. Darton & Co. (London), Elliott Bros. (London), Everett, Edgcumbe & Co. (London), Kelvin and James White (Glasgow), Nalder Bros. & Co. (London), Nalder Bros. and Thompson (London), R. W. Paul (London), Synchronome Company (London), Industrial Engineering Co. (Hyde) and the General Post Office (London). In the Mines and Metallurgy section, Messrs. John Davis & Son (Derby), Mr. James Fairley (Chester-le-Street), Edgar Allen & Co. (Sheffield) and the Blast Furnace Power Syndicate (London) have exhibits of an electrical character, the last-named firm showing diagrams and apparatus to demonstrate the Thwaite electrostatic system of depositing dust from blast-furnace gases, and photographs and plans showing the application of the Thwaite-Gardner blast furnace power system for generating energy for electric light and power.

St. Pancras (London).—On Wednesday the special committee appointed to consider the recent action of "Colwell and others *v.* St. Pancras Borough Council" for damages for vibration, &c., reported that the plaintiffs required £8,906. 12s. 9d., which included the properties and the whole of the trade interests to settle their claims. It was decided to pay this sum and to charge same against the electricity reserve fund.

A motion was passed to put penny-in-the-slot electricity meters in the new municipal workmen's dwellings, charging at the rate of 4d. per unit.

St. Petersburg.—With reference to a proposal to convert the horse tramways in this city to electric traction, the City Council have appointed a commission to inquire and report as to the power available from the waters of the river Wuoksa.

Spain.—A concession has been granted to the Seville Tramways Co. (Ltd.) for the construction and working of an electric tramway from Arscife de Capuchinos to San Fernando, Seville.

The public works department of the Spanish Government have authorised the conversion to electric traction of certain horse tramways in Madrid owned by the Sociedad Concesionaire del Tranvia de Estaciones y Mercados de Madrid.

A concession has been granted to a Spanish concessionaire for the construction and working of an electric tramway from Mondariz to Porrino (Pontevedra).

Stafford.—The Council have approved the substitution of eight additional arc lamps for gas lights for public lighting.

Stirling.—The equivalent of 14,1108 c.p. lamps are connected to the mains, compared with 10,414 at the corresponding period last year.

Southport.—Traffic receipts on the Corporation tramways during the past year were £17,646, an increase of £1,259 over the previous year. Working expenses were £10,986, a decrease of £225. After payment of sinking fund charges and interest there is a deficit of £341. 0s. 2d., against £1,182. 12s. 10d. last year.

The net profit on the past year's working of the electricity department is £3,316, of which £2,250 has been applied to relief of rates.

South Shields.—A report on the tenders recently received for the leasing of the Corporation's tramway powers and the construction of electric tramways will shortly be considered by the Council. The tenderers, it will be remembered, are the South Shields Tramway and Carriage Co. and Messrs. Rowcliffe & Co., who are acting for a Manchester syndicate.

Stockton-on-Tees.—A profit of £2,320 has been made on the past year's working of the electricity department.

Sunderland.—River Wear Commission have sanctioned the laying of mains from the North-Eastern Marine Engineering Works to the Sunderland Shipbuilding Yard. A new road at Pallion is to be lighted by Nernst lamps.

Swansea.—For the year ended March 31 the profit of the electricity department was nearly £1,000, against about £400 last year.

Tariff Reform.—A meeting was held last week of the Engineering and Machinery committee of the Tariff Commission, at which arrangements were completed preparatory to the taking of evidence.

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The members of this committee are as follows :—Dr. F. Elgar, F.R.S., managing director and naval architect of the Fairfield Shipbuilding and Engineering Co.; Mr. G. Flett, managing director of Dick, Kerr & Co.; Mr. W. Harrison, chairman of Harrison, Macgregor & Co.; Mr. H. D. Marshall, managing director of Marshall, Sons & Co.; Sir A. Noble, Bart., K.C.B., F.R.S., chairman of Sir W. G. Armstrong, Whitworth & Co.; the Hon. C. Parsons, F.R.S., of C. A. Parsons & Co., Parsons' Marine Steam Turbine Co., Newcastle and District Electric Lighting Co., and Scarborough Electric Supply Co.; and Mr. A. W. Maconochie, M.P., of Maconochie Bros. A form of inquiry, framed with the view of obtaining information of the engineering and machinery trades, has been sent to manufacturers in these branches of industry throughout the country.

Tunbridge Wells.—The Council are recommended by the Lighting committee to refuse the offer recently made by Mr. Tylor, on behalf of a London syndicate, to purchase the municipal electricity works for an amount equivalent to the capital expenditure to date (about £80,000), plus a bonus of £10,000.

Urgency Repairs.—A somewhat novel case was heard at Bristol Police Court recently. An employé of the Bristol Tramway Co. was charged with furiously driving an electric trolley repairing waggon. It was admitted that defendant was travelling at a speed exceeding what might be considered reasonable under normal conditions, but it was urged that it was reasonable for him to proceed in haste to a spot where danger to the public existed from a broken guard wire which had fallen upon the trolley line. The bench dismissed the case on payment of costs.

Wakefield to Leeds by Tramway.—The Wakefield and District Light Railways Co. have asked Leeds Corporation to grant running powers over the municipal tramways into the city.

Warrington.—For the year ended March there was a deficieney of £640 (after taking into account interest and sinking fund) on the municipal electric tramways.

Warsaw.—In an interesting report on the trade of Poland and Lithuania for 1903, Mr. Consul J. Murray states that electric motors are being gradually introduced into a large number of factories in Warsaw, and that some firms are considering the question of putting down steam turbine plant. There is a considerable extension of electric installations proceeding in the principal Russian towns. These works include the introduction of electric light and tramway electric traction in Warsaw. The completion of this extensive undertaking is to be made by the end of May, 1905.

West Bromwich.—The borough electrical engineer (Mr. J. H. Wray) has issued his annual report to March 31.

The total number of units sold was 1,105,006, an increase of 319,158 units over the previous year. The plant capacity of the works was 1,150kw. The maximum load occurred on Dec. 19, and amounted to 788kw. The number of consumers wired during the year was 23, representing 1,146 8 c.p. lamps. The total works cost per unit sold was 1d., and the revenue from the lighting supply was small considering the number of units sold. The average price obtained was only 2·81d. per unit. The total amount received from the sale of electricity was £9,315, including £6,502 from the tramway company. There was a profit of £1,545, compared with a deficit of £435 last year. The total capital expenditure stands at £56,506.

Westminster (London).—The Works committee are obtaining counsel's opinion as to whether it is possible, should any statutory company having the use of the streets and the subsoil of the streets without payment promote a bill for further powers, to obtain the insertion of a clause to the effect that, should any alteration of the company's pipes, mains or boxes be at any time necessary in consequence of any works required to be executed by the Council, the cost of such alteration shall be borne by the company.

West Ham.—The Board of Trade recently issued the draft provisional order authorising the Corporation to construct a short length of tramway to effect a junction between certain existing lines. As the order contained clauses limiting the time for constructing the line to two years, and making it compulsory to run workmen's cars over the whole of the tramway sytem at fares not exceeding ½d. per mile, the Tramways committee objected, and the clause as to workmen's cars has now been excised.

Weymouth —The Corporation have decided to seek powers to construct electric tramways within and beyond the borough. Local feeling is much divided on the tramway question

Whitchurch.—The Parish Council have granted the South Wales Electrical Power Distribution Co. permission to lay mains in the district in order to supply current to certain business premises, and the Council have also asked the District Council to undertake the electric lighting or to assist the Parish Council by acting as their intermediary in obtaining electric lighting powers.

Whitstable.—A committee has been appointed to report as to the desirability of establishing electricity supply.

Worksop.—For the past year the income of the Electric Lighting committee was £2,171, compared with £840 in 1903. Total expenses were £1,428. After providing for interest and sinking fund, there was a deficit of £685, compared with £1,050. 8s. 9d. last year.

Worthing.—The Council resolved on Tuesday to supply electric current for public lighting at actual cost (including capital charges), and for the present half-year the charge is to be 4½d. per unit. The charge hitherto has been £16 per lamp per annum, which the mayor (Ald. E. T. Cooksey) states has worked out 1½d. per unit less than cost price.

York.—The gross revenue of the electricity department for the year ended March 31 was £9,114. 1s. 2d., expenditure £4,964. 5s. 4d., net revenue £4,149. 15s. 10d. Interest and sinking fund absorbed £3,799. 4s. 8d., leaving a net surplus of £350. 11s. 7d. to carry to reserve.

Zanzibar.—It is announced that a proposal is under consideration to extend the electric lighting system, which is at present confined to the Sultan's palace, to the whole city, both for public and private supply. There is also under consideration the construction and working of an overhead electric tramway through the city and into the suburbs. Mr. A. S. Rogers, Regent and Prime Minister to the Sultan, Zanzibar, East Africa, is the person to be communicated with regarding the supply of plant, &c.

Ibero-American Benevolent Society.—A charity which has for many years received assistance from the submarine telegraph section of the electrical industry is that of the Ibero-American Benevolent Society, whose 14th anniversary dinner is announced to take place at De Keyser's Royal Hotel, Victoria Embankment, London, on Saturday, May 14, when Sir Ernest Flower, M.P., will be in the chair.

Football.—The Arc Works Club (Crompton's) have this year been in good form, winning the Essex Junior Cup. The re-played match between the Arc Works and Tilbury teams took place on 30th ult., when the Works won a well-contested game by one goal to nil. Sir Carne Rasch, M.P., president of the Essex Football Association, presented the cup and medals.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Canterbury Lighting committee invite tenders for one Lancashire or dry-back marine boiler, superheater and steam pipes, one 300kw. steam dynamo, switchboard and connections, and extensions to economiser. Specifications, &c., may be inspected at the offices of the consulting electrical engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, London, S.W., and can be obtained there after May 4. Tenders to the town clerk (Mr. Henry Fielding) by 10:30 June 1. An advertisement contains further particulars.

Glasgow Corporation invite tenders for main cables, electricity meters and carbons for 12 months from May 31. Specifications, &c., from the chief engineer (Mr. W. A. Chamen), 75, Waterloo-street. Tenders to the town clerk (Mr. James G. Munro), City-chambers, Glasgow, by 23rd inst. See also advertisement.

Glasgow Corporation also invite tenders for supply and erection of four sets of 800kw. dynamo panels and for cast-iron joint-boxes. Tenders to the town clerk by May 9.

Hornsey Town Council invite tenders for condensing plant, water cooling apparatus, pipe work and valves, water softener and purifier, switchboard and connections. Specifications, &c., may be inspected at the office of the consulting engineer (Mr. Robert Hammond, M.Inst.C.E.), 64, Victoria-street, Westminster, S.W. Tenders to the town clerk (Mr. F. D. Askey), 99, Southwood-lane, Highgate, London, N., by 10:30 a.m., May 30. See also advertisement.

Stretford Electricity committee invite tenders for supply and erection of a 400kw. steam-driven generator. Forms of tender and specifications from Mr. T. L. Miller (Messrs. T. L. Miller and Wilson), 19, Brazennose-street, Manchester. Tenders to chairman of committee, Council offices, Old Trafford, Manchester, by the morning of May 18. See also advertisement.

Kilmarnock Corporation invite tenders for overhead equipment, trolley wires, poles and brackets, &c., rolling stock, wiring of generating station and car shed. Specifications, &c., after May 10 from the town clerk, Mr. W. Middlemas. Specifications and drawings can be seen at, but not obtained from, the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, London, S.W. Tenders to the town clerk before noon May 28. Further particulars are given in an advertisement.

Kilmarnock Corporation also invite tenders for tramway permanent way construction, excavations, concrete foundations, steel rails, fish-plates, and special work, &c. Tenders to the town clerk (Mr. W. Middlemas) before noon May 17.

Mexborough District Council invite tenders for two 100kw. steam dynamos. Specifications, &c., may be inspected at the office of the Council's consulting and resident engineer, electricity works, Mexborough. Tenders to the clerk (Mr. J. W. Hattersley), Hope-street, Mexborough, by May 21. See also advertisement.

Brighouse Corporation invite tenders for laying cables (including supply, delivery and erection of all materials and accessories

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therefor). Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Sillar and Leigh), 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster, London, S.W., and can be obtained from the latter office after May 7. Tenders to the town clerk (Mr. James Parkinson), Town Hall, Brighouse, by May 19. See advertisement.

Handsworth District Council invite tenders for supply and delivery of lighting feeders, mains and road work. Specifications, &c. (after 9th inst.), from the clerk (Mr. H. Ward), Council House, Handsworth. Specifications and drawings may be seen at, but not obtained from, the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, London, S.W. Tenders to Mr. Ward before noon May 25. See also advertisement.

Partick Town Council invite tenders for a water-tube boiler, economiser, feed pump, hot-well tank and pipe work, condensing plant, oil separator, cooling tower and C.I. pipe and tank work. Specifications and forms of tender from the town clerk (Mr. James Donaldson), Burgh-chambers, Partick. Copies of specification may also be inspected (but not obtained) at the office of the consulting engineers (Messrs. Kincaid, Waller, Manville and Dawson), 29, Great George-street, Westminster, S.W. Further particulars are given in an advertisement. Tenders to Mr. Donaldson before noon May 24.

Pietermaritzburg Corporation invite tenders for the supply of six completely-equipped electric tramcars (double-deck single-truck type), to be delivered within three months, and one completely-equipped water sprinkler, to be delivered within one month of date. Specifications, &c., from the offices of the Corporation's electrical and tramway consulting engineers (Messrs. Mordey and Dawbarn), 82, Victoria-street, London, S.W. Tenders, addressed to the London agents of the Corporation (Messrs. Ford Bros), 12, Southampton-street, Fitzroy-square, London, W., by noon, May 16. See also an advertisement.

Royton and *Crompton* District Councils invite tenders for overhead equipment and cables. Specifications, &c., from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, S.W. Tenders to chairman of the Tramways committee, Town Hall, Royton, by noon May 28. See also advertisement.

The Lords Commissioners of the *Admiralty* are prepared to receive proposals from persons willing to submit for competitive trial range-finders, both large and small, for naval use. Conditions, &c., will be furnished to bona fide inventors or manufacturers of such instruments on application to the Director of Navy Contracts, Admiralty, London, S.W. Full descriptions of the range-finders proposed must be sent in by June 30. See also an advertisement in our last issue.

Bermondsey (London) Borough Council invite tenders for plant and connections required in the utilisation of exhaust steam for heating purposes and water connection between the artesian well pump and overhead tank. Tenders to the town clerk (Mr. Fredk. Ryall) by noon May 9.

Aberdeen Electric Light committee invite tenders for supply and erection of mild-steel coal bunkers, together with coal and ash conveyor of endless-chain bucket type, and accessories. Tenders to city electrical engineer (Mr. J. Alex. Bell), Milburn-street, Aberdeen, by noon May 14.

Stoke-upon-Trent Corporation invite tenders for electricity meters, demand indicators and house services and cutouts. Tenders to the town clerk (Mr. John B. Ashwell), Town Hall, by 5 p.m. May 13.

Whitby Corporation invite tenders by 12th inst. for a surface condenser with air pump and piping.

Rugby District Council invite tenders by May 20 for service cable.

The *May-Oatway Fire Appliances* (*Ltd.*), 92 and 94, Paul-street, London, E.C., invite tenders for wiring the various installations set out in an advertisement in another column. Tenders close May 11.

Walthamstow District Council require tenders for supply of tramcars. Tenders to Mr. C. Sydney Watson, clerk and solicitor, Town Hall, Walthamstow, by 5 p.m. May 20.

The Electrical committee of *Bristol* Corporation invite tenders for one 750kw. to 1,000kw. single-phase turbo-alternator. Tenders to Mr. H. Faraday Proctor, Temple Back, Bristol, by noon May 16.

Neath Corporation invite tenders for electric light mains, feed pillars and switchboards. Tenders to the town clerk (Mr. Edwin C. Curtis) by May 16.

The Metropolitan Borough of *Hackney* invite tenders for electricity supply mains (feeders and distributors). Tenders to deputy town clerk (Mr. W. A. Williams) before 4 p.m. May 26.

London County Council require tenders for switch-gear as set out in our last issue (p. 34). Tenders to Mr. G. L. Gomme, County Hall, Spring-gardens, S.W., by May 17.

London County Council also invite tenders by 17th inst. for 10 water-tube boilers with superheaters for Greenwich tramway power station.

Southampton Corporation require tenders by 11th inst. for arc lamps, motors and service cables.

Tenders are invited until 11th inst. by the *French* Post and Telegraph Authorities for two large telephone switchboards. Tenders to 103, Rue de Grenelle, Paris.

The Municipal Authorities of *Kaiserlautern* (Germany) invite tenders until June 1 for the concession for constructing and working electric tramways.

Tenders are invited by the Director-General of Public Works, Madrid, for the construction and working of an electric tramway in *Bilbao*. An application for a concession has already been made by a local company, who will enjoy certain preferential rights over other tenderers. Tenders will be adjudicated on July 6. The "Madrid Gazette" of April 30 contains additional particulars.

The Director-General of Posts and Telegraphs, *Madrid*, will receive tenders up to May 31 for the establishment and working of a telephone system between Elche, Novelda, Asbra, Monova, Elda, Pinoso and Crevillente. A plan has been submitted to the Director-General which will have preference under equal conditions, the competition turning on the number of years before the installation becomes the property of the Government, the maximum having been fixed at 20. The "Madrid Gazette" of May 1 contains further details.

The "Madrid Gazette" of May 1 contains a notice calling for tenders for the supply of 11,000 metres of telegraph cable and 11,000 metres of wire rope. Tenders have to be in by May 29 and will be adjudicated on 31st by the Director of Posts and Telegraphs, 10, Calle de Carretas, *Madrid*.

It is announced that the Commercial Intelligence Department of the Board of Trade, 73, Basinghall-street, London, E.C., have received a complete translation of the notice issued respecting the tenders invited by the municipality of San Luis, Potosi, *Mexico*, for the electric lighting of that city. Tenders will be received up to May 15. (See also *The Electrician*, April 22, p. 35.)

TENDERS RECEIVED AND ACCEPTED.

Lancaster Town Council have received the undermentioned tenders for the construction of permanent way of tramway extension, cable conduit and drain boxes and overhead trolley wire construction. The work is to be carried out under the supervision of the electrical tramways engineer (Mr. W. A. Tester):—

R. W. Blackwell & Co. (*accepted*)	£13,389 13 5	Brit. Elec. Equipt. Co.	£13,194 5 4
Macartney, McElroy & Co.	13,444 5 5	Bailey, Pegg & Co	12,055 10 2
		G. Freeman & Sons	11,505 15 9
		G. Hill & Co.	11,481 5 9

Manchester Electricity committee have accepted the tender of the General Electric Co. for seven motor generators for Oldham-road and Stuart-street sub-stations; that of C. A. Parsons & Co. for two 750kw. generating sets for Bloom-street works; and that of John Spencer & Co. for steam piping. The total amount of the tenders is about £20,000.

Middlesex County Council have accepted the tender of J. G. White & Co. for constructing a light railway from Manor House, Green Lanes, London, N., to the Alexandra Palace gates at £39,245, and that of Mr. Clift Ford for the lines from the gates at Wood Green to the Palace and from the gates at Muswell-hill to the doors of the Palace.

The Metropolitan Asylums Board have accepted the tender of Bergtheil and Young for wiring the Eastern Hospital and Ambulance station at £3,378. 15s. 6d. There were six tenders (varying from that of the accepted to £5,273); the covering estimate of the engineer was £3,500.

Shoreditch (London) Borough Council have accepted the following tenders:—

Johnson and Phillips, house service cables (vulcanised rubber and lead-covered single cables); Dewhurst's Engineering Co. and Richard Wood & Co., electrical sundries; Sloan Electrical Co., arc lamp globes; Middleton Bros. and James Gibb & Co, engineers' stores.

Hanley Corporation have accepted the tender of the British Westinghouse Co. for a steam alternator at £3,162. There were 18 tenders, varying from £2,799 to £3,773. Four firms tendered for a turbo-alternator, the figures varying from £2,840 to £3,650.

Hanley Corporation have also accepted the tender of Bertrams Limited (out of 30 tenders received) for a jet condenser at £495, and that of A. Bolton & Co. for three down-take superheaters at £388. Sixteen tenders were received for the latter portion of the work.

Launceston (Tasmania) City Council have placed orders with Ferranti Limited for 500 electricity meters at £1,218 and with the British Insulated and Helsby Cables Limited for 50 prepayment meters.

Coventry City Council have accepted the tender of Siemens Brothers & Co. for a 600kw. alternator, and that of J. and H. McLaren for a triple expansion steam engine.

Partick Electrical committee have accepted the tender of Bruce Peebles & Co. for a 500kw. traction generating steam set and for extension of the main switchboard.

Gloucester Town Council have accepted the tender of S. Rawlinson & Sons for tramway tower wagon at £65. 6s. 6d., and that of Holloway, Son & Co. for 36 pairs of rubber gloves at 4s. 9d. per pair.

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Gloucester Corporation have also accepted the offer of A. Pole & Son for advertising on the light railway cars at £20 per running car per annum for seven years.

Kingston-on-Thames Council have accepted the tender of W. T. Glover & Co. for 1 mile of low-tension concentric armoured cable at £291.

Poplar Borough Council have accepted the tender of Williams & Co. at £509 for a 25 B.H.P. electric motor, complete with rheostat, switch and fuses, together with well engine and pump.

Bolton Electricity committee have accepted the tender of the British Insulated and Helsby Cables (Ltd.) for cables and that of Mr. R. W. Kenyon for casings, &c.

The Admiralty have placed an order with Dick, Kerr & Co. for five 600kw. and one 300kw. steam generator sets, six motor generator sets, and two balancer sets, main switchboard, switch gear and auxiliary plant for Portsmouth Dockyard.

London County Council have accepted the tender of H. Lovett (Ltd) for the erection of the superstructure of Greenwich electricity station at £52,970.

Ipswich Council have accepted the tender of Johnson and Phillips for 5,000yds. of lighting main and 200yds. of cable for services at £896. 5s. This was the lowest of eight tenders submitted.

Hammersmith Borough Council have accepted the tender of James Bartle & Co. for extensions of feed-water reserve tank at £125. 16s.

Stoke-on-Trent Council have accepted the offer of the General Electric Co. for the supply of motors on the deferred payment system.

Keighley Council have accepted the tender of Mr. J. W. Laycock for tie bars, bolts, nuts and washers for the tramways at £648. 18s. 6d.

Reading Corporation have placed a further order with Dick, Kerr & Co. for five double-deck bogie cars and one watering cart.

Lincoln City Council have accepted the tender of Bruce Peebles & Co. for a steam dynamo.

Llandudno District Council have accepted the tender of W. T. Glover & Co. for cable at £218. 8s. 2d.

BUSINESS NOTICES.

Henley's (South African) Telegraph Works Co. (Ltd.) have opened an office at 3, Chorlton-chambers, Harrison-street, Johannesburg, for the sale of wires and cables for electric lighting, telephones and telegraphs. The parent company are sending a large stock to their store in that city immediately from the coast, when they will be in a position to give prompt delivery to users in the Rand district. Their Johannesburg house will henceforward be the head office in South Africa.

Mr. J. A. Smeeton has resigned his position with Mr. Arthur Koppel, and has joined the staff of Richardsons, Westgarth & Co. (Ltd.) as manager of their London office at 9, Gracechurch-street, E.C.

Mr. Ernest Syer, electrical accessories dealer, removes to 45, Hatton-garden, London, E.C., on 11th instant.

The Underfeed Stoker Co. (Ltd.) will remove on 12th inst. to Coventry House, South-place, London, E.C.

LIQUIDATIONS, BANKRUPTCIES, &c.

Statutory meetings of the creditors and shareholders of the Electric Timber Seasoning and Preservation Co. (Ltd.) were held in London on Friday.

The company was promoted by the Founders' Synd. (Ltd.) in April, 1899, with a nominal capital of £150,000 in 60,000 6 per cent. cumulative preference and 90,000 ordinary shares to acquire the British patent rights in the Nodon-Bretonneau electrical process of seasoning and preserving timber, and to commercially introduce the process into this country. The purchase price was £100,000 (£10,000 in cash and £90,000 in shares). The promoting syndicate acquired the English rights from a French company for £6,500 cash and £43,500 in shares of a company to be formed. The prospectus issued brought in applications for about 28,000 shares, but 8,000 had been forfeited for non-payment of calls. The capital at the disposal of the company on commencing business was about £3,500 after payment of the part purchase price. The directors and their friends subsequently provided £4,950 for current expenses on the security of debentures. Land was taken at Charlton, but very little trading had been done, the capital having been expended in experimental work. Failure was attributed to want of working capital. Unsecured debts were about £2,670, and assets (charged under the debentures) comprised Charlton lease, plant, machinery and patents, the value of which had to be ascertained, book debts £200 and unpaid calls £3,000. The Official Receiver and a committee of inspection have the liquidation in hand.

A summary of the statement of affairs of the McGuire Mfg. Co. (Ltd.) gives the total deficiency at £25,267. 3s., £11,000 being in respect to shares issued by the company as fully paid in connection with the purchase of certain patent rights and other property, £12,859. 10s. in respect to shares issued for cash, and the balance (£1,407. 13s.) in respect to deficiency of assets to meet liabilities to unsecured creditors. The company was formed in Feb., 1901, to work patents for electric motor trucks, for which orders were obtained from the British Westinghouse and the British Thomson-Houston Companies. A special manager, acting under the directions of the official receiver, has been carrying on the business with a view to the completion of contracts and the sale of the assets as a going concern. Mr. F. W. Pixley, C.A., has been appointed liquidator, with a committee of inspection.

The first meetings of creditors and contributories of the Automatic Telephone Co. (1903) (Ltd.) will be held at Bankruptcy-buildings, London, W.C., on 17th inst.

Claims against the British Fuel Economiser and Smoke Preventer (Ltd.) must be sent by June 18 to the liquidator (Mr. R. Gray Orr), 12, Great Dover-street, London, S.E.

C. A. Smith (trading as C. J. Smith), electrician, 23, King-street, Regent-street, W., and 6, Granard-road, Wandsworth, S.W., London, has been adjudicated bankrupt. Mr. R. J. Ward, 2, Clement's Inn, W.C., has been appointed trustee in this failure.

Sales by Auction.—Mr. Henry Sherley-Price (of Wheatley Kirk, Price & Co.) has been appointed by the Court to sell by public auction in one lot as a going concern, at the Mart, Tokenhouse-yard, London, E.C., on Tuesday, May 31, the extensive freehold and well-equipped car-building works known as the Castle Car Works, Hadley, near Wellington, Salop, together with the whole of the fixed plant and machinery and trade connection. Particulars and further information from the receiver and liquidator (Mr. H. D. Eshelby, F.C.A., of Messrs Harmood Banner & Son), 24, North John-street, Liverpool; of Messrs. Gribble, Oddie, Sinclair and Johnson, solicitors, 38, Bedford-row, London, W.C., or of the auctioneers, 46, Watling-street, London, E.C., and Albert-chambers, Albert-square, Manchester. See also advertisement.

Messrs. Wheatley Kirk, Price & Co. have also received instructions to sell by public auction piecemeal at an early date (owing to the taking over of the premises by the County of London Electric Supply Co.) the entire contents of the premises situated at 14, Graham-street, City-road, London, including a 12 N.H.P. Crossley gas engine, Dowson gas plant, 20-ton and 7-ton rope travellers and gantries, electric lighting machinery, &c. Further particulars are given in an advertisement. Catalogues shortly from the auctioneers, 46, Watling-street, London, E.C., and Albert-chambers, Albert-square, Manchester.

Plant, &c, for Sale.—A 12in. spark-induction coil, with Nodon valve and transformer, are for sale by Mr. T. Scott Anderson, Royal Exchange-buildings, Sheffield. See also advertisement.

Mexborough Urban District Council invite offers for two 50kw. steam dynamos (Alley and MacLellan-Mavor and Coulson sets), with spare armatures. The sets can be seen working at any time, or information will be supplied by the Council's electrical engineer, Mr. J. Senior. See also advertisement.

About 300yds. of 19/16 cable, a new earth indicator, field rheostat, &c., are advertised for sale by Messrs. T. E. Evans & Co., 126, Bute Docks, Cardiff.

Messrs. Hooker and Harris, Retreat-place, Hackney, London, have for sale some electric lighting plant. See advertisement.

Mr. J. Light, Wolverhampton, has for disposal a Robey steam engine, suitable for driving a dynamo. See advertisement.

A large quantity of second-hand Simplex conduit and fittings in good condition is advertised for sale by the Western Electric Co., North Woolwich.

Fireproof Cables.—St. Helens Cable Co. announce they are now able to supply the trade with a practically fireproof cable. The following (among other) properties are claimed for these cables:—(1) A flame, or even an arc, playing on a piece of the cable cannot set fire to it; (2) on withdrawing the flame, the cable is not only not alight, but not even glowing; (3) the fireproof properties are not affected by immersion in water, as the fireproofing materials are insoluble. Vulcanised rubber and Dialite insulated are, it is stated, made up in this manner at a moderate increase in price.

"Brush Bulletins."—The Brush Company have issued a binding case for holding copies of the "Brush Bulletins" issued from time to time by the company.

Electric Welding.—The Electric Welding Co., 28, Basinghall-street, London, E.C., are issuing card particulars of electric welders, together with a photograph of a sample board, showing a number of articles electrically-welded.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from April 27 to May 3, with the ports of destination:—

Aden, £46. *Africa*—Alexandria, £549; Beira, £35; Cape Colony, £335 (including £204 telegraph material); Delagoa Bay, £413; Durban, £258; East London, £37. *Argentina*—Buenos Ayres, £77; Rosario, £22 (telegraph material). *Australasia*—Adelaide, £142; Brisbane, £258; Fremantle, £191; Hobart, £16; Lyttelton, £113; Melbourne, £1,401; Perth, £130; Sydney, £2,096 (including £239 telegraph material); Wel-

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lington, £800. *Belgium*—Antwerp, £30. *Brazil*—Rio Janeiro, £161 (including £149 telegraph material). *Canada*—Halifax, £2,620 (telegraph cable). *Ceylon*—Colombo, £474. *Channel Islands*, £71. *China*—Shanghai, £78. *Denmark*—Copenhagen, £34. *France*—Paris, £95. *Germany*—Hamburg, £430. (telegraph material). *Gibraltar*, £77. *Holland*—Amsterdam, £55; Rotterdam, £15. *Hong Kong*, £340. *India*—Bombay, £142; Calcutta, £1,660 (including £81 telegraph material); Madras, £304. *Japan*—Yokohama, £135. *Mexico*—Vera Cruz, £444. *Portugal*—Lisbon, £187; Oporto, £30. *Russia*—Reval, £123. *Straits Settlements*—Penang, £73; Singapore, £84 (including £43 telegraph material). *Surinam*, £35. *Sweden*—Gothenburg, £80; Stockholm, £101 (including £85 telegraph wire). *Zanzibar*, £80 (including £28 telegraph material). Total £14,877, against £23,430 in the corresponding week last year (April 29 to May 5).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

January 29, 1904.

2,202 J. WILKINSON and S. W. MITCHELL. Electric tramways.
2,230 A. ECKSTEIN and A. E. ANGOLD. Salford. Arc lamps.
2,243 A. THOMSON. Trolleys for collecting electricity.
2,249 H. SIMMINS. Electric fire alarm.
2,269 T. W. BARBER. Sparking plugs.
2,273 R. A. HADFIELD. Magnetic material. (Date applied for, June 12, 1903, date of application in U.S.)*
2,274 W. L. WISE. Telegraphic transmitters. (James Harvey Pierce, U.S.)*
2,277 J. H. SUGRUE. Electric low-water alarm for boilers.
2,279 F. H. HADFIELD. Trolley-heads.
2,282 E. ROBERTS and R. MITCHELL. Electric light fittings.
2,285 F. J. GREEN. Polarisation of Hertzian waves. (Date applied for, Jan. 29, 1903, date of application in U.S.)*
2,288 R. P. WILSON and A. G. MARSHALL. Electric signalling apparatus for tramways and railways.

January 30, 1904.

2,307 VERITYS LIMITED and J. W. EWART. Birmingham. Arc lamps.
2,315 J. C. MCIVER and A. F. GUY. Liverpool. Terminal attachment device.
2,344 E. C. HOEGERSTAEDT and R. G. FOTHERGILL. Old Charlton, Kent. Electro-mechanical regulators.
2,347 R. STARKE. Composition for electrical conduits.
2,358 R. PETERS. Process for utilising the waste ends of carbons from arc lamps.*
2,361 B.T.-H. Co. and F. SAMUELSON. Emergency governing devices.
2,362 B.T.-H. Co. and A. S. CUBITT. Coil windings for electrical apparatus.
2,363 B.T.-H. Co. (G.E. Co., U.S.). Automatic switches.
2,373 E. WAKLEY and W. HARRIS. Safety apparatus in connection with overhead wires.
2,380 O. A. ROSEN. Device for protecting a wire branch which depends from an overhead electric wire.*

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1903.

6,249 SPERRYN and WOOD. Tumbler switches.
6,337 VON KRAMER. Electric controllers.
6,490 CAROLAN (G.E. Co., U.S.) Switches.
6,502 CAROLAN (G.E. Co., U.S.) Electric coil-forming apparatus.
6,510 BASTIAN. Electrolytic electricity meters.
6,635 B.T.-H. Co. and WEDMORE. Switches.
6,660 BRANDER. Support for hand set of combined table and wall telephones.
6,671 HIGGISBOTTOM. Telephonic or electric signalling apparatus.
6,718 VON ZWEIGBERGK. Controllers for electric circuits.
6,719 VON ZWEIGBERGK. Automatic controllers for electric circuits.
6,853 DRAULETTE. Electric road vehicles.
7,241 WHIPP. Loose handle and quick break combined switch and fuse.
8,831 HEYLAND. Compounding of synchronous alternators for single and polyphase currents.
9,088 MARSH. Contact-makers for electrical recording turnstiles.
9,805 and 9,806 CAROLAN (G.E. Co., U.S.) Emergency brakes for vehicles or trains.
9,811 CAROLAN (G.E. Co., U.S.) Method of winding dynamo-electric machines.

1904.

113 FÜRST and KRAGL. Telephones and time recorders therefor.
193 SIEMENS BROS. & Co. (Siemens and Halske A.-G.) Equipment of electrically propelled railway cars.
711 E.A.G. vorm. W. LAHMEYER & Co. Controlling devices for electric vehicles. (Date applied for, June 22, 1903.)
1,878 LE CARBONE. Arc lamp. (Date applied for, Aug. 22, 1903.)
2,358 PETERS. Utilising waste ends of carbons from arc lamps.
2,438 ADLER. Automatic switches.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension Australasia and China Telegraph Co. (Ltd.)

The sixty-first half-yearly general meeting was held on Wednesday, under the presidency of Sir JOHN WOLFE BARRY, K.C.B.

The ASSISTANT-SECRETARY (Mr. W. R. Lyne) read the notice calling the meeting and the certificate of the auditors.

The CHAIRMAN then said: Gentlemen, the report and accounts which I have had to lay before you are not altogether of a pleasant nature, though I think that they might have been worse—when we consider the circumstances under which we have had to conduct our business during the period under review. The gross revenue for the half-year amounted to £265,000, against £267,000 for the corresponding period of 1902, a decrease of £2,294. The gross revenue includes £13,008 for interest on reserve fund investments, which it was agreed should be treated as revenue, and £9,460, the unappropriated balance of reserve fund for removal of head offices. If these two items had not been brought into revenue the decrease would have appeared as about £25,000. In crediting the revenue account with the interest on investments, we have followed the principle adopted by the Eastern and other telegraph companies, and in the case of the unappropriated balance, the shareholders will no doubt remember that in 1899 and 1900 the Directors set aside a sum of £15,000 out of revenue for the expense of removal from Winchester House to Electra House, and the £9,460 therefore credited in the present half-year's account is the balance of this amount, the removal being now complete. The receipts for messages, however, show a net decrease of £20,850, which is a lower figure of diminution than was estimated by the Company, and may, under all the circumstances, be considered as a not unsatisfactory result of our working under all the conditions now existent. This decrease is spread over a large number of different traffics. Practically all the American traffic exchanged with Australasia, China, Japan and the Philippines has been diverted to the new Pacific cables, as was only natural considering the geographical position of these countries. A proportion of the traffic between Australasia and Great Britain has also been diverted to the Government Pacific competing line, but I am glad to say that the actual loss of revenue from the competition of both the British Government and the Commercial Pacific cables has been less than we anticipated. The reduction in tariffs with China, Japan and the Philippines, which was the necessary outcome of the Commercial Pacific cable, to which reference was made at our last meeting, came into operation on July 15, 1903; but an increase of traffic has taken place which has considerably lessened our estimated loss from this cause. Considerable increases have taken place in our through traffic with the Straits Settlements and the Dutch Indies, and in the number of messages exchanged between India and China, Japan and the Straits Settlements. The Company have also benefited by the satisfactory rise in the value of silver and the introduction of the new system of quarterly revision of the rate of collection in countries using the silver currency.

Turning to the expenditure, we find that the working and other expenses amounted in round figures to £142,000, against £121,000 for the corresponding period of 1902, showing an increase of from £20,000 to £21,000. As an explanation of this somewhat large increase in our working expenses, I should mention that about £11,000 of it is due to increased station expenses, principally in Australia and China—in the former case, owing to the larger staff required at all the stations in the colonies in connection with the competition which has been actively carried on by the bounty-fed British Pacific cable. In addition to this, we have had to face a heavy expenditure in connection with our two new repairing vessels, one of which we have had stationed for the past seven months at Adelaide in order to be available for repair of the cables landing in Australia. In consequence of the Commonwealth edict prohibiting coloured labour, we have been compelled to keep a white crew on board, involving us in considerable expense. Circumstances have arisen, however, which have compelled us to temporarily transfer the cable ship "Restorer" to Singapore, and it is possible that she will not again take up her station at Adelaide. If this can be arranged, we confidently hope to effect a considerable saving in this item in the future. The additional expenses attending the maintenance of cables and depreciation of the ships during the half-year after crediting the accounts with the amounts received for charter of the Company's vessels, &c., represents roundly £10,000.

The net profit for the half-year amounted to £105,854 to which is added £71,036 brought forward from the previous account, leaving an available balance of £176,890. The usual quarterly interim dividends of 2s. 6d. per share were paid during the past year and your Directors now propose to distribute another of like amount to-morrow, making a total of 5 per cent. In addition to this it is proposed to pay a bonus of 4s. per share, making a total distribution to the shareholders of 7 per cent. for 1903, and to carry forward £41,890, as against £71,036 brought forward from last half-year. You will observe that the capital account has been increased during the half-year under review by a further issue of £13,462 of the 4 per cent. mortgage debenture stock, making a total issue up to Dec. 31, 1903, of £602,400. As you will see in the accounts, the reserve fund has been debited with £10,854, the cost of further partial renewals to the Hong Kong–Foochow and Penang–Malacca sections. The necessary cable, about 153 miles in length, was taken from the Company's stock at Singapore.

The Company's maintenance ships have been fully employed during

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the half-year under review on renewals and removing faults from the various sections of your cables. The Company have laid some additional short lengths of cable for the Dutch Government to connect their possessions in the Java Seas, and the profit on this work will be credited in the next half-year's accounts. The work was prolonged and difficult owing to the inclement weather experienced, strong currents and the difficult nature of the cable ground, but it was completed to the satisfaction of the Netherlands Government, and the cables will act as additional feeders to the Company's system.

As mentioned in the report, the Directors have considered it advisable in the interests of the Company for one of their number and the General Manager to visit the Company's stations, and accordingly Mr. Peel, accompanied by Mr. Hesse left London in November last for that purpose. These gentlemen have made a lengthened stay in the colonies, where, besides interviewing our local representatives and obtaining a close insight into the working of the stations, they have had an opportunity of meeting the principal statesmen, officials and members of the mercantile community, with whom they have fully discussed cable matters and removed many erroneous impressions regarding the Company's position *vis-à-vis* the Pacific Cable.

Since the close of the half-year hostilities between Russia and Japan have broken out resulting in a large increase not only to the Government and Press but also to the ordinary traffic with China and Japan. In consequence of the sealing by the Russian authorities of the Vladivostock ends of the cables connecting Japan with the Russian landline system, the bulk of the Japanese traffic was for a time forwarded by the southern route. This extra war traffic threw a considerable amount of additional work on the Company's staff, but we are pleased to state that the Company's manager in China reports that the heavy traffic has been expeditiously transmitted, the staff working cheerfully and well for long hours at high pressure (applause). The Great Northern Telegraph Co. have, however, since obtained a connection with the Russian landline system at Kiachta, through which a considerable amount of traffic is now passing, so relieving the strain upon our staff. Since the last time I had the pleasure of addressing the shareholders no further action has been taken by the Federal Government of Australia respecting the agreement entered into with the Company for extending to Melbourne and Brisbane the privileges enjoyed by the Company in the other State capitals in Australia of dealing direct with the telegraphing public, and the projected conference to be held between the Governments interested in the British Pacific cable to consider what effect the agreement might have upon the Pacific cable, and other questions, has not yet been held. Pending a decision being come to, the tentative arrangement, by which the Company is permitted to have its own offices and deal direct with the public in Melbourne, remains undisturbed. In the meantime, active competition has been carried on between the Pacific Cable Board and the Company for the Australasian traffic, but notwithstanding all the efforts of the former and the unfair treatment to which we have, in so many ways, been subjected, and to which I have alluded on previous occasions, the Pacific Cable has not been able to secure a materially larger proportion of the traffic than they have hitherto carried. This severe competition, however, has, as before mentioned, entailed a considerably increased expenditure at all our Australasian stations. The result of the competition is that the Company's cable system in Australia is scarcely remunerative, the receipts at the present time barely covering the working expenses. Moreover, as in the opinion of competent judges it will take some years for Australia to recover from the recurrent droughts and financial depression from which she has so greatly suffered, we do not anticipate much increase in the volume of traffic in the near future. I may here remind you that in the year 1899, when we protested to Her Majesty's Government against the injury that would be caused to private enterprise if the Pacific cable were laid, we were told by the Colonial Office that the primary object of the Government was not competition but the establishment of a new service required in the public interest, and that it would be the duty of Her Majesty's Government in so far as they might be responsible for the Pacific Cable to avoid unnecessary injury to the interests of the shareholders of the Eastern Companies. The Colonial Secretary also stated that the reduced rates would certainly lead to an increased volume of business, and that there would be ample and remunerative work for both routes. What has happened? The Governments interested in the Pacific cable have employed energetic canvassers in the principal capitals of Australia; they have made arrangements for all undirected telegrams, both in Australasia and Great Britain, handed in at their offices to be transmitted by the Pacific route only, which, I venture to think, is an abuse of the monopoly granted to the various Post Offices for quite other purposes, and have in other ways entered into the keenest competition with the Company. The result has been, not only that the interests of the shareholders of the Eastern Companies have materially suffered, but the Canadian and Australian Governments are becoming alarmed at the large sums periodically required to make up the heavy deficit on the interest of the cost of the Pacific cable and its working. The traffic also has not responded to the low tariff as predicted by the Colonial Office, with the exception of that between America and Australia, which has somewhat increased, but this is chiefly to the benefit of the commercial community in the United States, who obtain a considerable reduction of tariff in their trade competition with Great Britain for the trade of our colonies. Finally, to sum up my remarks on this question, the Pacific cable was not really required, either in the interests of Great Britain, Canada or Australia, while the interests of the shareholders in this Company have been unnecessarily injured, and heavy burdens have been laid on the taxpayers of the Mother Country and of the colonies who are partners in the enterprise. I now move the adoption of the report and accounts and the payment of the dividend of 2s. 6d. per share, together with a bonus of 4s. per share, both tax free, making a total of 7 per cent for 1903.

The Marquess of TWEEDDALE, K.T., seconded.

Mr. WALTER S. SETON-KARR asked for information as to the probability of the Marconi system competing with the submarine system.

The CHAIRMAN: Upon the subject of wireless telegraphy I have on several occasions explained my views to the shareholders. I have nothing to add to the opinion I have previously expressed. The more experience we have of wireless telegraphy, whether conducted by Marconi or by De Forest—as is now carried out by *The Times* newspaper, as many people have seen during the war in the Far East—or by other inventors, they all come to the same thing. That is to say, it is a system which is extremely ingenious and extremely valuable within moderate limits, and where speed and secrecy are not essential. All these points, I think, have been proved by the experience of past years, which we can now look back upon; and I am happy to say that, although, perhaps, it was rash of one to prophesy two years ago, yet all I said on those occasions seems to have been justified by our later experience. I venture to think that we need not look upon wireless telegraphy as a serious competitor to cable enterprise.

Mr. JOHN NEWTON: You referred to the wireless message in *The Times*, but I should like to ask whether that message did not come over the cables of this Company after it had been forwarded from the centre of the ocean to the sea coast. If that is so, it proves that your prophesy was correct—that the further development of wireless telegraphy will be an advantage to submarine telegraph enterprise.

The CHAIRMAN: Mr. Newton's remarks are absolutely to the point. The messages that were sent by *The Times* wireless installation must have reached Europe through our system. They only travelled a very moderate distance to where the cable is in existence, and they were then transmitted through it.

Mr. NEWTON: Will you permit me further to state that your speech was rather a gloomy one, and that I do not think the shareholders need consider it so in effect for this reason—that what you have just said brings wireless telegraphy up to date. There is another feature also for us to bear in mind—namely, that a new people have sprung into existence and have entered into the comity of nations. This is a fact which will develop commerce and other things, and the Company should derive great advantage from the position which Japan has now taken up, and only quite recently taken up.

The CHAIRMAN: I should be very sorry for the shareholders to think that the remarks I made took a very gloomy view of the situation, but I always like—and I shall always do so as long as I am Chairman—to take the shareholders into my complete confidence, and to bring before them the conditions of our working, which at one time are very satisfactory and at other times are not to be regarded as so satisfactory (hear, hear). The report before you is, by comparison, one of the unsatisfactory kind, but I do not myself look forward to anything but a continuance of the prosperity of this Company, although under different circumstances. We are now working under severe competition, which naturally adds to our expenses and takes away a portion of our traffic. These circumstances are new, and they have produced considerable results on the past year's accounts. I think that we shall have this to contend with in the future, but I think I am justified in saying that the heavy burden of working expenses has nearly, if not quite, reached its maximum in respect of the particular things we have had to deal with. I do not look to a further increase in our expenses as being necessary for dealing with the competition of the Government or for the abstraction of traffic, and therefore I hope that our next report will show some alleviation in this respect which we have not been able to bring before you on this occasion. But I am anxious not to hide anything from the shareholders, for I think it is desirable that they should know what we know on this side of the table, and that they should be informed where the pressure is on the Company.

The motion was then carried unanimously. Mr. F. A. Bevan and the Hon. A. G. Brodrick were then re-elected as Directors, and Messrs. Deloitte, Dever, Griffiths & Co. and Welton, Jones & Co. were re-appointed auditors. A vote of thanks to the Chairman and Directors terminated the proceedings.

Cuba Submarine Telegraph Co. (Ltd.)

The sixty-fifth ordinary general meeting was held on Wednesday, Mr. CHARLES W. PARISH presiding.

The SECRETARY (Mr. James Scott) read the notice calling the meeting and also the report of the auditors.

The CHAIRMAN said: The accounts deal with the latter half of last year, when the traffic receipts amounted to £16,205, which is £2,508 more than we earned during the similar months of 1902. The greater part of this increase is due to our having had the temporary advantage of some of the French Company's traffic owing to their New York-Hayti cable being broken. Besides our traffic receipts of £16,205, we have interest on investments and deposits of £2,430 for the half-year, &c., giving a gross income of £18,643. Expenses amount to £5,810, and after placing £5,000 to reserve, and providing for the dividend on the preference shares, we are able to propose a dividend at the rate of 5 per cent. per annum on our ordinary capital. During the latter half of 1902 the working expenses amounted to £6,100, or £290 more than we spent last half year. Our 1875 cable between Cienfuegos and Santiago became interrupted last December, and the repairing steamer which the Mexican Telegraph Co. were good enough to hire to us failed to restore communication. This has made it necessary to contract for a new cable to be laid this autumn. The expenses of the repairing ship and of the new cable will amount to some £60,000, and I must congratulate our shareholders that we have built up such a large reserve fund as will enable us to meet this outlay and still leave our company in a very strong and satisfactory financial position. The life of cables is always an un-

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certain item, but I do not think we have any cause to grumble over the loss of this cable, which, after all, has done us good service for nearly 30 years. The report contains two disappointing references—firstly, to our unsettled claim against the United States Government for the damage done to our cables during the Spanish-American War, and, secondly, to the yearly subsidy still unpaid by the Republic of Cuba for the coast cables. As regards the first claim, our Foreign Office write us that His Majesty's Ambassador is continually pressing the matter upon the authorities at Washington, and we still look forward to a satisfactory settlement before long; and as regards the subsidy for the coast cables, our agent at Havana is following up our claim, and I have every hope that President Palma will soon decide in our favour, and see that our company receives the settlement which is due to us. I now move the adoption of the report and accounts.

Mr. GEORGE KEITH seconded, and the resolution was carried.

Resolutions approving the dividends, and thanking the chairman and directors for their services brought the meeting to a close.

Submarine Cables Trust.

The thirty-third ordinary annual meeting was held on Tuesday, the Most Hon. the Marquess of TWEEDDALE, K.T., presiding.

The SECRETARY (Mr. Sidney Collett) having read the notice calling the meeting,

The CHAIRMAN said: The condition of the trust is in every respect satisfactory, and we have had a very favourable year. The revenue, which comprises dividends on our various investments and interest on deposits, for the year ended April 15 last, amounted to £24,583, against £24,591 in the previous year, showing on the face of it a decrease of £8. This decrease, however, is more apparent than real, and is due to the fact that we received from the Commercial Cable Co., dividends for only three quarters, instead of dividends for four quarters, the fourth dividend, amounting to about £116, having come in just after the close of the financial year. Our receipts, therefore, were in fact rather larger than those of the previous year. After paying the usual half-yearly coupons on Oct. 15, 1903, and April 15, 1904, there was a surplus sufficient to enable us to redeem 36 certificates, exclusive of the coupons of reversion, which we did, leaving a balance to be carried forward to the next account of £61. This is the largest number of certificates redeemed out of surplus revenue for many years, and makes the total number of certificates redeemed and cancelled to date 999, leaving 3,201 certificates outstanding out of the original 4,200. I now move the adoption of the report and accounts.

Sir JOHN DENISON-PENDER, K.C.M.G., seconded the resolution, which was carried unanimously.

The retiring auditors were re-appointed, and the meeting closed with a vote of thanks to the chairman and Trustees.

West Coast of America Telegraph Co. (Ltd.)

The seventh ordinary general meeting was held on Tuesday, Sir JOHN DENISON-PENDER, K.C.M.G., presiding.

The SECRETARY (Mr. Fred. L. Robinson) read the notice calling the meeting and the report of the Company's auditors.

The CHAIRMAN said: Gentlemen, I will make a few observations with regard to the chief points in the directors' report. The receipts for 1903 came out at £35,707, compared with £34,294 in 1902, an increase of £1,413. On the other hand, the expenses, which, in 1902, were £24,295, are this year £28,381, or an increase of £4,086. It is on that, naturally, that you will ask certain questions, and I, therefore, now propose to deal with this increase. To begin with, it ought to be put under two heads—the increase in the cost of working the stations and the general business of the Company and the increase in the cost of the repairs to cables. Although you can keep some control over the expenses of the stations, you cannot keep any control over the expenses of the repairs, for the cables are at the bottom of the sea, and you have to repair them when they require it or the revenue from them disappears entirely. Taking the first head, of the increase in the stations' expenses of £1,246, out of that amount £729 is due to increased salaries and wages. We have had to put more men on to the service, and that, of course, raises the salaries account; and there is an increase also of £237 in rent and taxes. Of course, having had more men, we have to get more quarters for them; and, besides that, rents as a rule, have gone up. Then, £110 is for renewals of furniture and keeping the furniture and the requisites of the stations in a proper condition. The increase of £136 in miscellaneous expenses is chiefly for telephones at the stations. We have had to put the stations at the different places on the telephone system, for in many places merchants require that boys may be sent round to them for their messages. We have to meet strong competition, and we must do this. With respect to the £2,812 which makes up the total increase of £4,086, this amount simply represents the cost of the maintenance of the cables. We had this year five repairs instead of four last year. The carrying out of these repairs was also considerably delayed by bad weather, which means that the ship was out for a longer time, and there was more expense as regards the cost of fuel. We may, however, I hope, get some return for that in the present year, because we have replaced bad pieces of the cable by new. I was in hopes to-day that I should be able to say that this year we have had no repair to make, but this morning we have received news that one of our cables is down. The ship will have to go 700 miles to get to the spot, but I am glad to say that it is not a cable that will materially affect our revenue. With respect to the cable steamer, which is one of the most important points of a telegraph cable company, although our boat is old, she has just gone through her sixth survey with very little expense, and, as far as we are concerned, she is as good as ever for our work. In a couple of years, however, I think we shall have to put new decks into her, as Lloyd's may insist on that. That will cost us a certain amount, but we have a fund which will easily meet any outlay which we are called upon to incur on the ship. After paying interest on debentures, amounting to £6,000, and the dividend on the income bonds, which comes to £800, there is a balance to credit of revenue of £526. 8s. 2d. on the year's working, and adding the amount brought forward from last year of £571. 3s. 1d., there remains a balance of £1,097. 11s. 3d., which it is proposed to carry forward. I now move the adoption of the report and accounts.

Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E., seconded the motion, which, after a brief discussion, was carried unanimously.

The re-election of the retiring director, Mr. Frederick Walters, was then approved. The retiring auditors were re-appointed, and a vote of thanks to the chairman and directors terminated the proceedings.

ELECTRICITY SUPPLY CO. FOR SPAIN (LTD).—The directors' report for 1903 states that revenue (with interest on deposits and transfer fees) produced £32,617. 13s. 6d. Deducting interest, &c., and providing £1,942 for redemption of debentures, there remains (with amount from last year) £14,411. 19s. 4d. It is proposed to write off the whole of debenture expenses account (£9,369) and to carry forward £5,043. The directors do not recommend any dividend on the share capital although the full dividend on the preference shares might have been declared.

MORRIS AIMING TUBE AND AMMUNITION CO. (LTD.)—The chairman stated on Tuesday that the company possessed in its factory at Dagenham very complete and up-to-date shops and appliances. The board considered that the time had come when they could profitably and advantageously extend the scope of their business. Their power plant at Dagenham ran most economically when at full pressure, and, having some power to spare, they had decided to use it in developing a branch of business with which they had always had to do, and with which they were fully competent, both in knowledge and connection, to deal. They were erecting another shop and the necessary plant and machinery for the manufacture of dynamos and electric motors, for which there was a large and ever-increasing demand, and they had secured the services of Mr. T. Hawkins, well known in electrical circles, as the manager of their new department. They had every confidence in the success of the new branch, and could interweave it most satisfactorily with their present business. It would require no great capital outlay, and they should be saved the burden of the usual heavy dead charges, as they had the site, power, plant and administration service already at hand.

WESTON-SUPER-MARE AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The directors' report to be presented at the meeting to-day states that total capital expenditure to Dec. 31 last was £107,803. 9s. 3d. Gross revenue from electricity supply was £3,708. 7s. 11d., and from tramways £5,849. 12s. 7d. Deducting expenses (£7,884. 16s. 10d.) and adding £2,960. 12s. 11d. from last account, £4,683. 10s. 1d. was available. Providing for preference dividends, a division at the rate of 4 per cent. per annum on the ordinary shares is recommended, leaving £3,204. 2s. 2d. to be carried forward. The equivalent of 12,528 8 c.p. lamps is connected to the mains, an increase of 42 per cent. for the year.

WORCESTER ELECTRIC TRACTION CO. (LTD.)—The directors' report for the 14 months ended Dec. 31, 1903, states that a contract has been entered into with the British Electric Traction Co. to provide funds for the construction and electrical equipment of nearly 5 miles of tramways and light railways within the city of Worcester. Of these, 3¾ miles were passed by the Board of Trade for public traffic on Feb. 6. The total capital expenditure to Dec. 31 amounted to £76,650. 18s. 9d., revenue amounted to £9,627. 2s. 7d., and expenditure to £9,103. 14s. 11d., leaving a profit of £523. 7s. 8d. to be carried forward.

NEW COMPANIES.

CHARLTON SYND. (LTD.) (80,819)—Reg. April 30, capital £5,000 in 4,990 A shares of £1 each and 10 B and 190 C shares of 1s. each, to adopt certain agreements for the acquisition of the business of electrical engineers now carried on as Johnson and Phillips at Victoria-road, Charlton, Kent, and to carry on the business of electrical, telegraph, telephone and general engineers and merchants, cable makers and contractors, company promoters, financiers, &c. The subscribers are A. Govey, H. R. Ireland, J. G. Brotheridge, H. A. Nutland, A. Dudley, J. M. Young and J. S. Dare.

ELECTRIC CIRCUIT-BREAKER (LTD.) (80,821)—Reg. April 30, capital £12,000 in £1 shares, to adopt an agreement between A. Parsons and G. Hall, and to carry on the business of founders, manufacturers of machinery and tools, metal workers, &c. First directors are A. Parsons, G. Hall, J. Carter and T. Taylor.

ELECTRIC LIGHT INSURANCE AND MAINTENANCE CO. (1904), LTD. (80,801)—Reg. April 28, capital £5,000 in £1 shares, to acquire business carried on by the Electric Light Insurance and Maintenance Co. (Ltd.), to adopt an agreement with the Sir Hiram Maxim Electrical and Engineering Co. (Ltd.), to carry on the business of electricians, mechanical engineers, suppliers of electricity, to construct, fix and insure the maintenance of cables, wires, lines, accumulators, lamps and works, &c.

HOPE-SMITH ELECTRICAL CO. (LTD.) (5,595)—Reg. in Edinburgh April 27, capital £3,000 in £1 shares, to take over the business of E. P. Smith, engineer, and to carry on the business of electrical, mechanical and general engineers, &c. The subscribers are E. P. Smith, electrical engineer, W. Spence, W. Massey, electrician, T. Yeates, W. Donaldson,

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D. Hope, engineer, and J. Hope, jun., brassfounder. First directors, J. Hope, jun., and E. P. Smith.

J. C. LYELL & CO. (LTD.) (80,797)—Reg. April 28, capital £2,000 in £1 shares (1,500 preference), to acquire the business carried on by J. C. Lyell & Co. and to carry on the business of electricians, mechanical engineers, manufacturers of and dealers in all apparatus used in the generation, accumulation, distribution and employment of electricity, &c. Reg. office, 55, Victoria-street, London, S.W.

TOPSHAM ELECTRICITY SUPPLY CO. (LTD.) (80,826)—Reg. April 30, capital £3,000 in £1 shares, to carry on in Devonshire or elsewhere in the United Kingdom the business of electricians and suppliers of electricity. First directors are T. J. Holman, A. A. Amos and C. J. Gale.

WALLACE LAMP SYND. (LTD.) (80,790)—Reg. April 27, capital £35,000 in £1 shares, to acquire certain patents for manufacture of electric lamps or parts thereof, to adopt an agreement with G. Wallace, and to carry on the business of electric lamp manufacturers, electrical and mechanical engineers, electricians, manufacturers and makers of dynamos, motors, apparatus and fittings, suppliers of electricity, &c.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (April 21, 1904). Price of silver 25 1/16d. per oz. (May 5). Consols 89½—89⅝ for money, 89⅝—89¾ for account; 2½ per cent. annuities 89¼—89¾ (May 5). Consols Pay Day, June 1; Stocks and Shares Continuation Days, May 10 and 25; Ticket Days, May 11 and 26; Pay Days, May 12 and 27; Mining Share Carry-over Days, May 9 and 24.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—Particulars will be found on another page of the drawing of 1644 per cent. mortgage debenture bonds of £100 each in this company, which will be paid off at par on July 1 at Parr's Bank, Bartholomew-lane, London, E.C.

AUCKLAND ELECTRIC TRAMWAYS CO. (LTD.)—During 1903 the capital expenditure was £82,663. 17s. 3d., making the total expenditure on electrical construction £506,835. 3s. 5d. Revenue amounted to £82,929. 13s., and working expenses to £62,106. 14s. (including interest, rental and percentage of profits payable to Auckland City Council, cost of repairs and maintenance, &c.), £4,000 is placed to contingency provision account, leaving a profit of £20,822. 19s. The directors recommend £5,000 being placed to depreciation, payment of dividend at rate of 4½ per cent. (£13,500), leaving £2,322. 19s. to be carried forward. There is now in operation 17·2 miles of tramways, and a further 1·4 miles are in course of construction and will be opened before the summer season.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—The directors' report for year to Dec. 31 last, just issued, states that there was a net profit of £28,057. 11s. 5d. Preference dividend absorbs £18,000 and £7,000 is put to general reserve, leaving £3,057. 11s. 5d. to be carried forward.

CHANGE OF NAME.—The title of the County of London and Brush Provincial Electric Lighting Co. (Ltd.) has been changed to "The County of London Electric Supply Co. (Ltd.)"

CRAIGPARK ELECTRIC CABLE CO. (LTD.)—For the year to March 31 the net profit was £4,433. 9s. 5d. Preference and ordinary shareholders of the old company have received dividends at the rate of 6 per cent. per annum for the period from Jan. 1 to May 31, 1903, and the preference shareholders have been paid their dividends to Sept. 30 last. The directors now recommend the payment of the balance preference dividends and a dividend at the rate of 5 per cent. per annum on the ordinary shares for the 10 months since the formation of the present company. The business of the company has been satisfactory, and the new works are now in complete operation, with excellent prospects for the current year.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—An extraordinary meeting will be held on 12th inst. to discuss and approve a resolution "that the capital of the company be reduced from £1,000,000 to £941,090, in 150,000 A and 26,564 B shares of £5 each and 23,564 B shares of £2. 10s. each, by cancelling paid-up capital which has been lost or is unrepresented by available assets to the extent of £2. 10s. per share on each of the 23,564 B shares which have been issued and are now outstanding, and by reducing the nominal amount of such B shares to £2. 10s. each."

FIFE ELECTRIC POWER CO.—At the first annual meeting, on Tuesday, it was decided to proceed with the building of the company's first power station at Dunfermline.

GLOBE TELEGRAPH AND TRUST CO. (LTD.)—A dividend is announced of 5s. per share on the ordinary shares making 5½ per cent. for the year.

NEW GENERAL TRACTION CO. (LTD.)—At an extraordinary meeting the issue of £80,000 prior lien bonds was authorised, and the seal of the company was ordered to be affixed to a contract with the Coventry Electric Tramways Co. for the construction of new tramways and the reconstruction of part of the existing tramways to electric traction.

RAND CENTRAL ELECTRIC WORKS (LTD.)—The result of the working for April was 882,915 units of electric current generated, yielding a gross revenue of £7,800, compared with 630,205 units and £5,444 in the corresponding month of last year.

ROTHESAY TRAMWAYS CO. (LTD.)—The capital outlay to Dec. 31, 1903, including cost of reconstruction, amounts to £112,622. 13s. 5d. £44,337.12s. 6d. is due to the British Electric Traction Co. for advances, &c. The year's revenue was £8,653. 17s. 1d. and expenditure on revenue account was £8,894. 14s. 1d., leaving a debit balance of £150. 17s. The loss is attributed to the exceptionally bad weather and depressed state of trade in the district.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have ordered a further issue of 5,015 4½ per cent. £5 fully-paid cumulative preference shares of the *Metropolitan Electric Supply Co. (Ltd.)* to be quoted.

WEST INDIA AND PANAMA TELEGRAPH CO. (LTD.)—The directors recommend a dividend of 6s. per share on account of arrears of dividend on the first preference shares.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 30	1,188	+ 280	48	57,704	+ 11,825
Airdrie	,, 22	207	...	11	2,046	...
Ayr Corporation	,, 23	162	+ 2	49	13,258	+ 120
Barnsley	,, 22	163	+ 12	16	2,525	- 163
Barrow	,, 22	157	+ 106	11	1,671	+ 1,018
Bexley District Council	,, 28	180	...	29	4,741	...
Birkenhead	May 1	1,010	+ 10	...	...	...
Birmingham Corporation	April 30	263	...	17	4,888	...
*Birmingham Tramways Co.	,, 30	5,237	+ 102	17	88,082	+ 4,732
*Blackburn Corporation	,, 29	869	+ 84	5	4,664	+ 201
Blackpool Corporation	,, 28	507	+ 101	4	3,042	+ 173
Blackpool and Fleetwood	,, 30	320	+ 14	18	4,805	- 312
Blackp'l, St. Anne's & Lytham	,, 28	248	+ 248	26	4,672	+ 4,098
Bolton Corporation	May 1	1,757	+ 174	5	8,878	- 127
Bournemouth Corporation	April 27	1,018	+ 43	4	4,714	+ 321
*Bradford Corporation	...	...	...	...	...	...
Brighton Corporation	May 1	814	+ 26	4	4,008	+ 32
Brisbane Tramways	Mar. 16	2,256	- 282	11	25,028	- 679
*Bristol Trams & Carriage	April 29	4,797	+ 253	28	106,565	+ 8,997
*Buenos Ayres & Belgrano	Mar. 27	3,899	+ 756	‡24	76,033	+ 3,808
	April 3	3,252	- 141			
Burnley Corporation	,, 30	997	+ 276	5	5, 81	+ 1,171
Burton Corporation	May 1	312	..	39	12,951	...
Calcutta Tramways Co.	April 30	R34,038	+ R4,068	18	R620,576	+ R85,723
Camborne-Redruth	May 2	95	...	26	2,802	...
Cardiff Corporation	April 30	1,879	+ 160	4	8,548	+ 240
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 30	6,850	+ 44	18	124,780	- 1,028
Chatham & Dist. Lt. Rys.	,, 28	558	+ 115	17	8,912	+ 1,565
City & South London Rly.	May 1	2,681	- 320	18	55,108	- 1,684
Cork Electric Trams Co.	April 28	434	- 33	17	6,781	- 218
Darwen Corporation	,, 29	222	- 6	4	958	- 112
Devonport & Dist. Trams	,, 22	518	+ 99	16	7,502	+ 1,054
Dover Corporation	,, 30	182	- 29	5	928	- 76
Dublin & Lucan Railway	May 1	165	+ 8	18	1,737	+ 84
Dublin Southern District	April 29	1,029	+ 181	¶18	75,891	+ 1,462
Dublin United	,, 29	4,177	+ 415			
Dudley—Stourbridge	,, 22	800	- 96	16	12,246	+ 480
Dundee Corporation	,, 27	794	+ 11	...	...	...
East Ham Council	,, 30	728	+ 150	4	3,294	+ 870
Gateshead & Dist. Trams	,, 22	865	+ 111	16	13,900	+ 725
Glasgow Corporation	,, 30	13,916	+ 735	48	658,512	+ 59,975
Glossop	,, 30	100	...	17	1,682	...
Gravesend—Northfleet	,, 22	244	+ 65	16	3,562	+ 552
Gt. Northern & City Rly.	,, 30	917	+ 2	11	10,295	...
Greenock & Port Glasgow	,, 22	539	+ 13	16	7,614	+ 638
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 29	258	+ 45	16	4,021	+ 320
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 30	2,088	+ 235	4	9,061	+ 732
Ilford District Council	,, 30	446	+ 129	4	2,072	+ 229
Ilkeston Corporation	...	...	...	...	...	...
Ipswich Corporation	,, 30	397	...	4	1,937	...
Isle of Thanet Co.	,, 30	429	+ 36	...	...	...
Kidderminster & District	,, 22	113	+ 7	16	1,621	- 56
Kirkcaldy Corporation	,, 27	208	...	9	1,877	...
Lanarkshire Trams Co.	,, 28	623	...	27	9,981	...
Leeds Corporation	,, 30	5,392	+ 181	5	28,660	+ 2,067
Liverpool Corporation	,, 23	10,191	+ 685	17	163,739	+ 8,752
*Liverpool Overhead Rly.	May 1	1,555	- 70	18	27,913	+ 72
*London County Council	April 23	10,922	+ 2,483	§3	86,751	+ 7,560
Lowestoft	...	...	...	...	...	...
Manchester Corporation	,, 30	11,918	+ 281	4	47,112	+ 12
Mersey Railway	,, 30	1,521	+ 428	17	24,846	+ 6,162
Merthyr	,, 22	192	+ 19	16	3,147	+ 192
Middleton	,, 22	325	+ 40	16	4,206	+ 78
Nelson Corporation	,, 30	114	+ 57	5	576	+ 272
Newcastle-on-Tyne Corp.	,, 30	3,519	+ 440	17	59,293	+ 7,665
Newport (Mon.)	,, 30	453	+ 153	4	2,130	+ 506
Oldham, Ashton & Hyde	,, 22	551	+ 23	16	8,120	- 503
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams.	,, 29	1,324	+ 182	17	23,380	+ 3,099
Peterborough	,, 22	144	+ 20	16	1,919	- 239
Poole and District	,, 22	323	+ 45	16	4,033	- 10
Portsmouth Corporation	,, 30	1,656	+ 250	15	8,277	+ 814
*Potteries	,, 22	1,701	+ 225	16	26,461	+ 2,066
Reading Corporation	,, 28	588	...	...	...	...
Rochdale Corporation	May 2	116	+ 1	...	...	...
Rothesay	April 22	117	- 1	16	937	+ 37
Salford Corporation	May 2	3,967	+ 851	5	18,330	+ 2,029
Sheerness	April 20	52	- 25	16	757	- 202
Sheffield Corporation	May 1	4,451	+ 286	§5	21,091	+ 181
*Southampton Corporat'n	April 23	900	+ 8	...	...	...
Southend Corporation	,, 27	264	+ 41	4	1,142	+ 111
Southport Tramways	,, 22	300	+ 48	16	4,147	+ 279
S. Staffordshire Trams.	,, 22	793	+ 20	16	12,134	+ 197
Stockport Corporation	,, 29	505	+ 210	4	2,023	+ 693
Sunderland Corporation	May 1	1,135	+ 130	4	5,194	+ 14
*Swansea Trams	April 22	500	+ 60	16	7,576	+ 261
Taunton Trams	,, 22	51	+ 5	16	788	- 56
Tynemouth and District	,, 22	249	+ 16	16	3,495	- 123
Tyneside Trams Co.	,, 27	337	+ 72	17	4,980	+ 705
Wallasey District Council	,, 30	565	+ 21	§4	2,995	+ 34
Warrington Corporation	,, 23	302	+ 8	4	1,244	+ 29
West Ham Corporation	,, 26	716	...	9	4,276	...
Weston-super-Mare	,, 20	75	+ 1	16	654	- 88
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 22	387	+ 21	16	5,541	- 267
Worcester	,, 22	269	+ 121	11	2,849	+ 1,162
Wrexham	,, 22	135	+ 24	16	1,704	- 60
Yorkshire Woollen District	,, 22	651	+ 400	16	8,590	+ 3,780

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., May 4.	Rate per Cent. Yielded.	Dividend Due.	Business Week to May 4 Highest.	Business Week to May 4 Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	2/6	Anglo-Arg'tine Sh(1to880,007)5%Cm.Pf.	4⅞—5¼	4 17 7	April, Oct	5 1/16	4 15/16
St.	6%	Do. Permanent 6% Deb. Stock	127 —132	4 11 11	..	..	..
t.	34/2	Auckland Elec. Trams 5% Deb. (red.)	98 —100	..	..	99½	..
10	10/0	Barcelona Tramways Ord.	6 —8	6 5 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 6	..	..	..
100	5%	Do. 5 per Cent. Debs.	96 —99	5 1 9	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	3/4—7/8	..	..	..	..
1	..	Do. 5% Cum. Pref.	3/4—7/8	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	99½	..
10	8%	Bristol Tramways and Carriage Ord.	18 —19	4 4 2	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 18 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	99 —102	5 17 8	..	..	..
St.	5%	Do. Pref. Ord. Stock	99 —102	5 0 0	..	101	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10¾	5 11 7	..	10 3/32	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102¾—104¾	4 6 7	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	8¼—9	8 17 9	..	8 3/8	8 1/32
10	6/0	Do. 6 per Cent. Cum. Pref.	9¾—10½	5 17 0	Feb, Aug	10¼	9 15/16
St.	5/0	Do. 5 per Cent. Perpetual Debs	114 —117	4 6 0	..	115½	115
5	3/0	Buenos Ayres and Belgrano Ord.	2⅝—2¾	5 3 9	..	2 31/32	2 29/32
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼—5⅝	5 4 4	..	..	..
5	3/0	Do. "B"	4¼—5¼	5 14 4	..	..	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	4 19 6	..	..	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	96 —101	5 0 0	..	..	..
5	3/6	Calcutta Tramways	7 —7½	4 0 0	..	7 3/32	7 1/32
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —109	4 3 7	..	..	..
1	1/0	Cape Electric Tramways Shares	2 —2⅛	7 11 1	..	2⅛	..
St.	4%	Central London Ordinary Stock	92 —95	4 4 2	June, Dec	94⅜	93⅛
St.	4%	Do. 4 per Cent. Pref. Stock	98 —101	3 19 9	..	100	..
St.	4%	Do. Deferred Stock	85 —88	4 11 3	..	86¼	..
100	4%	Do. 4 per Cent. Debs.	110 —113	3 10 9	..	112½	111½
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	99	..
St.	2%	City and South London Rly. Con. Ord.	49 —52	4 11 4	Feb, Aug	51½	50½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 8	Feb, Aug	..	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 —109	3 13 5	May, Nov	106½	..
St.	5%	†Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	99 —102	4 18 3	..	..	..
10	6 0	Dublin United Trams. (1896) Ltd., Ord.	12½—13¾	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8¾	†Gt. Northern & City Rly. Prf. Ord. (4%)	5½—6½	4 12 2	..	..	..
10	8/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	9½	..
10	10%	‡ Imperial Tramways Ord	18 —19	5 5 3	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	103 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	1½%	Liverpool Overhead Railway Ord.	4¼—4½	3 1 1	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	4 0 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11½—11¾	4 5 2	..	..	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	101 —103	3 18 5	..	101¼	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	1/4—1/2	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	1/4—1/2	5 0 0	..	..	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 5 0	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 —2	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 —102	4 18 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 —106	4 5 11	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	90 —93	3 7 7	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	12/6	Anglo-American	49 —52	5 12 4	F,My,Ag,N	50	..
St.	25/0	Do. Preferred	93 —95	6 1 0	F,My,Ag,N	94½	93½
St.	2/0	Do. Deferred	7¼—7¾	1 5 10	F,My Ag,N	7½	..
100	£2	Commercial Cable Capital Stock	180 —190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93 —95	4 4 6	Jn Ap,Jy,O	95½	02½
10	7/0	Cuba Submarine Ord.	7½—8½	3 8 5	Feb, Aug	7¾	..
10	10/0	Do. Preference 10 per Cent.	15½—16½	6 1 3	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	7⅞	..
50	4½%	Do. 4½ per Cent. Deb.	99¾—102⅞	4 9 3	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10½	6 3 10	Ja,Ap,Jy,O	10 1/16	10¼
100	4½%	Direct West India Cable 4½% Rg.Db.(rd.)	98 —101	4 9 1	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	123 —128	5 9 5	Ja,Ap,Jy,O	128	124½
St.	17/6	Do. 8½ per Cent. Pref. Stock	85 —88	3 19 6	Ja Ap,Jy,O	87½	..
St.	4%	† Do. 4 per Cent. Mort. Deb. Stk. (rd.)	103 —106	3 15 6	May, Nov	105½	104
10	2/6	Eastern Extension	12 —12½	5 12 0	Ja,Ap,Jy,O	12⅝	12 3/16
St.	4%	Do. 4 per Cent. Deb. Stock	103 —106	3 16 0	Feb, Aug	106	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	99 —102	3 19 0	Feb, Aug	..	..
25	4%	† Do. 4% Mauritius Sub. Debs. (red.)	99¾—101⅞	3 19 8	May, Nov	..	..
10	20 0	Great Northern of Copenhagen xd & bonus (Coupon No. 60)	26 —27	5 11 1	Jan, July	26⅝	26½
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —101	4 9 6	June, Dec	..	..
25	37/6	Indo-European xd & bonus	40 —43	5 16 3	May, Nov	..	..
100	4%	Pacific&Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..
10	2/0	West African Telegraph Shares	5 —6	1 13 4	..	..	..
2½	..	West Coast of America	1/32—3/32	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 10	Jan, July	..	..
10	..	West India and Panama	1/4—1/2	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	5½—6½	9 12 0	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 18 4	Jan, July	..	..
10	3/0	Western Telegraph	12½—13¾	5 9 10	Mr,Jn,O,D	12⅝	12½
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 17 9	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99 —102	3 19 5	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	9¼—9¾	5 12 10	Ja Ap Jy O	9⅝	9
10	3/0	Do. 6 per Cent. Pref.	12¼—13	4 12 4	Ja Ap,Jy,O	12⅝	12⅜
8	4/0	Reuter's	6¼—7¼	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	117 —122	4 18 4	April, Oct	..	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	4¾—5¼	5 14 8	August	..	..
St.	6%	National Co. Pref. Stock	103 —105	5 14 10	..	103¾	103
St.	5%	Do. Def. Stock	88 —91	5 10 10	..	89½	88
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 —12	5 0 0	Feb, Aug	11½	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5¼	4 15 8	Feb, Aug	5 3/16	5 3/32
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 —99	3 11 5	June, Dec	97¾	97¼
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 —104	3 17 10	..	103¾	102¼
1	0/8	†Oriental	1/8—1 1/16	6 6 8	April, Oct	1	..
1	0/7	† Do. 6 per Cent. Cum. Pref.	1/8—1 1/16	5 12 11	..	..	..
5	3/0	United River Plate	5¼—6	5 16 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¼—5¼	4 15 8	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 —106	4 15 10	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	1/8—1/4	..	..	..	..
1	0/8½	Do. 7% Cum. Pref.	1 —1½	5 12 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd.&con.)	115 —120	3 15 6	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9¾—10¼	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
St.	4½%	†Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord	10¾—11½	4 5 1	..	10¾	..
5	3/6	Do. 7 per Cent. Pref.	10¼—10⅝	3 5 1	Mar, Sept	10⅝	..
5	3/0	Calcutta Electric Supply Ord.	6⅞—7¼	4 9 8	..	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 —109	3 13 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7¼—7¾	5 3 3	Feb, Aug	7⅞	7⅝
5	2/3	Do. 4½ per Cent. Pref.	5 —5⅛	4 5 9	Feb, Aug	5⅛	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	..	..	..
5	1/7	Do. Do. (1903)	4¾—5	..	..	4¾	..
St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 10	..	103¼	..
5	3/6	Chelsea Electric Supply Ord.	6⅛—6¾	4 1 5	March	6½	6⅜
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 3 1	Jn, Dec	109	..
10	5/0	City of London Electric Lighting Ord.	10½—10¾	4 13 0	Feb, Aug	10⅝	10 7/16
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅝	13 5/16
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec	124½	124
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	..	..
10	4/0	County of London & Brush Prov. Ord.	7 —8	5 0 0	..	7⅜	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106 —109	4 2 11	..	106	..
St.	4½%	† Do. Second Deb. Stock Prov. Certs.	99 —102	4 8 3	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 8	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 8 0	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
5	5/0	Hove Electric Lighting Ord.	7⅜—8¼	5 0 0	..	..	..
St.	..	I of W. Elec Lt. & Power 4½% Db. St. (red.)	102 —104	..	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	1/32—1/16	..	..	..	..
5	7/0	Kensingtn & Knghtsbdge Ord.	11½—12½	4 16 0	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6¾—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Knghtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	103½	..
3	..	London Electric Supply Ord.	1¼—1⅜	..	..	1⅜	1 31/32
5	3/0	Do. 6 per Cent Pref.	4½—5	6 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 —98	4 2 11	Mr,Jn,S,D	96½	..
10	9 6	Metropolitan Electric Sup. Ord.	19 —20	4 7 6	April, Oct	19⅞	..
5	1/4½	Do. 4½ per Cent. Cum. Pref.	5¼—5⅝	4 3 9	..	5 5/16	5 3/16
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —98	3 11 9	..	..	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	96 —98	4 11 9	..	..	..
10	6,0	Notting Hill Electric Ord.	12½—13¼	4 8 11	March	12½	..
5	4 0	Oxford Electric Ord.	5¾—6	5 8 4	March	..	..
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 3	..	..	..
1	..	Rand Electric	7/8—1	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	98 —101	4 9 1	April, Oct	..	..
5	9 6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	14¾	..
5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	8 1/16	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3 —3½	5 14 3	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	3/0	South London Electric Supply Ord.	3½—4	3 15 0	..	3 15/16	3⅞
5	2/6	Urban Electric Supply Ord.	4⅜—4½	5 2 6	..	..	..
5	2,6	Do. 5% Cum. Pref.	4¾—5	5 0 0	..	4 13/16	4¾
5	7/0	Westminster Electric Supply Ord.	12½—13½	5 0 0	Mar, Sept	13	12 15/16
5	2/6	Do. 5 per Cent. Cum. Pref.	6½—6¾	3 14 0	..	..	..
		ELECTRIC MANUFACTURING &c.					
5	4/0	British Insulated & Helsby Cables Ord.	5½—5¾	6 19 2	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	5 5/16	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —106	4 5 9	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	3¾—4¼	7 1 2	..	4	3 15/16
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	90 —93	4 7 0	..	..	..
½	..	Brush Electrical Engineering	½—1	..	March	⅞	¾
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1—1½	..	Mar, Sept	1⅛	1⅛
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	73 —78	5 17 8	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	10¼—11½	6 10 5	Jan, July	11	10½
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5⅜	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 8	Nov, May	105½	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	3/4—7/8	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¾—2¼	6 13 4	Jan, July	1⅞	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96 —99	5 2 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7¾—8¼	..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5 —5¼	5 9 1	..	..	..
St.	4½%	Do. 4½% Deb. Stock	102 —104	4 7 2	..	..	..
5	..	Edison & Swan United("A"Sh.) (£3 pd.)	3/4	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1/2—1¼	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	74 —79	6 6 7	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5⅜—6¼	5 12 0	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅜—5¾	5 2 2	..	5 5/16	5¼
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	101 —107	4 5 2	..	..	..
2	1/2½	Electric Construction Co.	1¾—1¾	6 7 1	Jan, July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2½—3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9¼—9⅞	5 2 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5¼	4 1 10	Feb, Aug	5¼	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..	..
10	16/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 7	Feb, Aug	19½	19
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 —102	3 18 5	Mar, Sept	100	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	36/0	Telegraph Construction & Mainten'ce.	34 —37	6 9 10	Mar, July	36⅛	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
5	..	Willans and Robinson Ord.	2 —3	..	Apr, Oct	2 1/16	2⅛
5	..	Do. 6 per Cent. Cum. Pref.	3 —4	..	Apr, Oct	3⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	90 —95	4 5 9	May Nov	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

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NOTES.

WE publish in this issue a useful set of recommendations which have been issued by the Home Office with regard to the construction of underground sub-stations. It is announced that a regular code of regulations will be drawn up shortly, the present memorandum being issued in the meantime in order that the errors in design and the dangerous features of some of the existing sub-stations may not be repeated in new ones about to be constructed. The most important feature in these recommendations is the clear distinction drawn between sub-stations and transformer pits or boxes, and in this direction Mr. G. S. RAM, His Majesty's Electrical Inspector of Factories, who is of course responsible for the regulations, might have gone even further. The use of transformer pits should be avoided as much as possible, and, fortunately, this is the present tendency of modern practice. For the benefit of those towns where the distribution of the load is so thin as to warrant the employment of single transformers in pits, stringent regulations should be enforced ensuring that the pits should be so designed that it is physically impossible for a person to enter them. All manipulation of the switches and fuses would then have to be done from above, and the arrangements should be such that the live parts of these are not easily accessible.

Mr. RAM'S minimum size of 2ft. square for a transformer chamber into which a man may enter is, we think, too small, although we are aware that many of the existing "sub-stations" have smaller dimensions than this. As a separate shaft for descent is specified, only three walls 2ft. broad are left against which to place the 30kw. transformer and the high and low-tension switchboards. We think, therefore, that engineers would do well to work to Mr. RAM'S second dimension—50 sq. ft.—as a minimum, and assume that even their smallest sub-stations will soon have to supply 75kw. Taken generally, we cordially endorse the recommendations in the circular, and welcome this sign that the placing of electrical sub-stations under the Factory Acts will tend rather to improve practice in this branch of electricity supply than to impose onerous regulations.

WITH the extension of large power stations and the extended adoption of high pressures, it is being realised that an alteration must be made in our standard practice for high-tension switch gear. The Ferranti type of switchboard, notwithstanding its high cost, has long been the most popular for high-tension work, but that high-pressure circuits often carry much larger currents than formerly, it is realised that it is not always expedient to break them at the switchboard itself. The Continental practice of placing the contacts and moving parts of the switches immediately behind the board, the levers only being in front, did not place the switches further apart from one another, and was, therefore, more dangerous instead of less dangerous than the "backless" board, but the adoption of the completely enclosed oil-break switches as also the overhead arrangement designed by Mr. PARTRIDGE for the Willesden station of the Metropolitan Electric Supply Co. were both steps in the right direction.

THE present tendency is to go still further in adopting means to prevent a fire or short-circuit from spreading from one large power-circuit to another. The switches themselves—and also the 'bus bars and disconnecting plugs—are placed in separate fire-proof chambers, far away from the "operating" board, and worked either mechanically, pneumatically, or by means of an auxiliary circuit. The only objections that can be raised to this method are the initial expense, and, in the case of electric or pneumatic "remote control," a possible failure of the driving devices, while if a system of levers and brickwork is employed, this is often heavy and cumbersome. On the other hand, switchboards in which this system has been adopted partially or in its entirety

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have been found to work satisfactorily, and it is now generally considered that their advantages outweigh their disadvantages. We may, therefore, look forward to the success of both the switch-gears described in this issue—that at Carville power house, illustrated in Messrs. McLellan and Merz's Paper, and the one which is to be erected in the new generating station being built for the London County Council tramways.

Mr. Sheardown's Paper on tramrails and rail bonding, the conclusion of which will be found in this issue of *The Electrician*, deals almost entirely with continuous rail joints, describing the three methods which are in practical use, and contrasting their strong and weak points from the users' point of view. It is probably the most complete study of the subject which has been published, and should be read by all tramway engineers who have not had personal experience of welded joints. A continuous tramway rail offers very great advantages compared with any form of mechanical joint. It is safe to say that no form of fish-plate or sole-plate joint will last nearly as long as the body of the rail; generally a year's wear at most loosens the bolts, the rail-ends rise and fall under the wheels, the hammering so caused rapidly aggravates the trouble, and in the end the rails have to be renewed because they are worn out at the joints. To be free of this is evidently worth some addition to the first cost of constructing a tramway, and, of course, the rolling stock will also benefit by the provision of permanently perfect joints, or, rather, the elimination of joints.

The "Falk" cast welded and the "Lorain" electrically-welded joints, both require a rather extensive provision of apparatus, and must be used on a large scale to bring the cost down to a reasonable figure. This is especially the case with electric welding, which calls for 125kw. of electrical energy at the point of application. This fact will put it out of court in a great many cases, and the alternative use of a portable cupola for the "Falk" process has obvious objections. The Tramway Act provision that only 100yds. of street may be opened up in a continuous length for laying a tramway is seriously against the use of either method in this country. The Lorain process seems to have been worked out in a very thorough way, and should give excellent results if carefully applied. It appears to be superior to either the "Falk" or the "Thermit" processes, partly because the work is much more under control, and therefore likely to be more uniform in quality, and for other reasons.

The "Thermit" process enjoys an enormous advantage over either of the others in that it requires but a small and relatively inexpensive outfit, and can be used for discontinuous w rk without much disadvantage. Whilst the joint may be fairly described as "cast-welded" it should be more secure than that made by the "Falk" method, because a smaller quantity of much hotter metal is employed, thereby ensuring a weld between the rail ends and less softening of the rail head —just as a hot well-tinned bit will sweat a joint in a gutta-percha covered wire with less melting of the G. P. than is produced by a too cool or dirty bit. The control of the metal's composition is also a point in favour of "Thermit." On the whole it seems probable that the electric weld in its modern form will make the best job, but that the convenience and small cost of the "Thermit" apparatus will give it the advantage for small systems and repair jobs.

The superior permanence of rail conductivity over any ordinary bonding system due to either method needs no emphasis, but it is hardly of secondary importance to the mechanical advantages which may be anticipated.

On another page of this issue will be found a description of some automatic devices for the protection of electrical mains and generators in the event of breakdown. The two devices which will probably appeal most strongly to electrical engineers—although all are exceedingly ingenious—are the Manchester dynamo type of reverse current cut-out and the time-limit relay. The former is an adaptation of an old principle, and, like all other inventions possessed of merit, appears so exceedingly simple that it is surprising nobody ever thought of doing the same thing before. The time-limit relay, on the other hand, although simple enough, must have required a considerable expenditure of time and thought. At first sight the necessity for the employment of two compartments in the diving-bell and two liquids is not apparent. But on consideration, it will be seen that if only mercury were used the relatively small viscosity of atmospheric air would necessitate the hole in the cover of the diving bell being of such small dimensions that an infinitesimal portion of solid matter would close it and render the apparatus useless.

A debatable point is raised by a letter which appears under the title of "Municipal Appointments" in our Correspondence columns this week. The writer protests against the publication of candidates' names in the "short lists" of applicants chosen to appear before municipal committees. He asks us to consider the question of refusing to publish these "short lists" in our columns, but so far from this desire being universal, it happens occasionally that correspondents ask us particularly to publish the fact that they were among the selected few. On the other hand, if a candidate particularly desires that his name should not be published, and expresses this desire in sending in his application for the appointment, there are very few Electricity Committees who would not respect his wishes. Moreover, as a rule, Electricity Committees and employers are sufficiently broad-minded not to resent an ambition on the part of their staff to fill better appointments or to let the appreciation of their officials' abilities by outside bodies stand in the way of advancement.

Analyses of Capital Expenditure in Electricity Works.—In reply to inquiries, the detailed analyses in tabular form of the capital expenditure on electricity works, referred to in our leading article last week, were commenced, together with analyses of the works and total costs, in 1892. They were first published annually, and subsequently at more frequent intervals. We were the first journal to publish comparative analyses of the capital expenditures of the various electricity works.

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The Boyle Lecture.—Prof. J. J. Thomson will deliver the Robert Boyle lecture in the hall of Balliol Coll ege, Oxford, on Friday, June 3rd.

Electrical Engineer (R.E.) Volunteers.—The Army Council has approved the establishment of a drill station at Winchester by the Electrical Engineer Volunteers.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 18, 1902
Beissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904

Royal Society.—The Royal Society candidates mentioned in a note in *The Electrician*, Vol. LII., p, 765, were duly elected as Fellows at the meeting of the Society held last week, May 5th. They include, Dr. A. C. Dixon, Prof. C. J. Joly, Dr. A. Muirhead, Dr. M. W. Travers and Mr. G. T. Walker.

North-East Coast Institution of Engineers and Shipbuilders.—At a meeting of this Institution, to be held next Wednesday, the president will move an alteration in the bye-laws. This will provide for new officers entering upon their duties on August 1st instead of at the closing meeting of the session, and also for the installation of the new president at the October meeting instead of at the last meeting of the old session.

The late Mr. McMillan.—At the meeting of the Institution of Electrical Engineers on Thursday last week it was announced that the president (Mr. R. Kaye Gray) had purchased the collection of books belonging to the late Mr. W. G. McMillan, and presented it to the Institution library. The president afterwards stated that it was hoped that a Paper by Mr. Alex. Siemens upon the Berlin–Zossen high-speed railway experiments would be read this session.

Personal.—The President of the Board of Education has appointed Mr. Sydney Wells, Principal of the Battersea Polytechnic, to be a member of the Teachers' Registration Council.

Mr. Gordon W. Miller, C.B., Director of Navy Contracts, has been appointed Accountant-General of the Navy in succession to Sir Richard D. Awdry, K.C.B., who retires on the 31st inst. Mr. W. C. B. Hall, I.S.O., Assistant Director of Navy Contracts, has been promoted to be Director in place of Mr. Gordon Miller.

Single-phase Motor Patent.—In the English patent No. 23,037 of 1903, Mr. B. G. Lamme describes means for reducing the current in the armature-turns of single-phase motors short-circuited by the brushes, and thereby bettering the commutation properties of the machine. He accomplishes this by connecting the junction points of the armature coils through resistance leads with the commutator segments. These resistances he proposes to place in the armature slots along with the armature coils.

Wireless Telegraphy in France.—The Paris correspondent of the *Standard* on Saturday reported that the Minister of Posts and Telegraphs was providing a series of wireless telegraph receiving stations round the coast for use by private as well as Government vessels. The stations already existing at Ushant and Poqueroles are to be improved, and additional stations will be erected at Cap de la Hague, the Pointe de la Courbe and Ajaccio. A development of Prof. Branly's system is to be employed, with which it is claimed all records have been beaten. The warship "St. Louis" is stated to have received messages from the Port Vendres station whilst in the Straits of Bonifacio, a distance of 450km.

"Electrification" of the London and North-Western Railway.—In order to ascertain the relative advantages of electric and steam traction, the London and North-Western Railway Co. are completing preliminary arrangements for the electrification of their Newport Pagnell branch line in Buckinghamshire, which leaves the main route to the north at Wolverton. This distance of 4 miles, with stoppages at the two intermediate stations of Bradwell and Great Lingford, is now accomplished by steam locomotion in 12 minutes. The conductor system will be the same as that used by the Lancashire and Yorkshire Railway between Liverpool and Southport.

Royal Institution.—At a general monthly meeting of the members of the Royal Institution on Monday, the Duke of Northumberland, K.G., president, in the chair, the nomination of the following vice-presidents for the ensuing year was announced:—Sir William Abney, K.C.B., Mr. Shelford Bidwell, Right Hon. Lord Kelvin, Dr. Ludwig Mond, Sir Thomas H. Sanderson, G.C.B., Sir Felix Semon, Sir James Crichton-Browne (treasurer) and Sir William Crookes (honorary secretary). The election of other officers was announced in our last issue. Several honorary members were elected, including Prof. J. N. Craft, Prof. L. P. Cailletet, Prof. and Mme. Curie, Prof. G. Lippmann, Prof. F. W. G. Kohlrausch, Prof. L. Boltzmann, and Prof. P. Zeeman.

Birmingham Local Section of the Institution of Electrical Engineers.—In accordance with the rules of the Institution relating to local sections, the Committee of the Birmingham Local Section have prepared the following list of officers to act during the session 1904-5:—

Past Chairmen: Sir Oliver Lodge, F.R.S., Henry Lea, J. C. Vaudrey. *Chairman:* Dr. W. E. Sumpner. *Vice-Chairman:* R. Threlfall, F.R.S. *Present Ordinary Members of Committee (remaining in office):* T. Hawkins, R. H. Housman, J. H. McLean, W. O. Rooper, C. E. C. Shawfield, A. M. Taylor, R. A. Chattock,* S. H. Holden,* R. C. Jackson,* R. K. Morcom,* P. Orsettich. *Hon. Secretary:* D. K. Morris. *Assistant Hon. Sec.:* J. K. Catterson-Smith.

New members are denoted by an asterisk. Other nominations are invited, but in the event of no such further nominations being received no ballot will require to be circulated.

Royal College of Science.—The President of the Board of Education has appointed a Departmental committee to inquire into the present working of the Royal College of Science, including the School of Mines; as to what manner the staff, together with the buildings and appliances now in occupation or in course of construction, may be utilised to the fullest extent for the promotion of higher scientific studies in connection with the work of exisiting or projected institutions for instruction of the same character in the metropolis or elsewhere; and to report on any changes which may be desirable, in order to carry out such recommendations as they may make. Sir Francis Mowatt, G.C.B., is chairman of the committee, and Mr. J. C. G. Sykes, assistant-secretary in the branch of the Board which deals with evening schools, technology and higher education in science and art, has been appointed secretary. The London County Council is represented on the committee.

Obituary.—We regret to announce the death of Mr. Ernest Talbot, of the firm of Messrs. Stevenson and Talbot, which took place on Thursday, May 5th, after a long illness. Mr. Talbot was the fourth son of the late Mr. Frederick Talbot, of Smethwick, and was educated at King Edward VI. Grammar School, Birmingham. About 1872-3 he entered the office of the late Dr. John Hopkinson at the works of Messrs. Chance, Bros. & Co., and when Dr. Hopkinson removed to London to commence consulting work he took Mr. Talbot with him. During the whole of Dr. John Hopkinson's professional career Mr. Talbot was his chief assistant. At the death of Dr. Hopkinson, Mr. Talbot was taken into partnership by Mr. Charles Hopkinson and Mr. Bertram Hopkinson, the partnership being mutually dissolved at the end of last year, and in January he took into partnership Mr. David Stevenson. Mr. Talbot was a member of the Institution of Civil Engineers, and also a member of the Institution of Electrical Engineers. He leaves a widow and four children.

Opening of Kettering Electricity Works.—The new electricity works of the Kettering Urban District Council were opened on Saturday by Mr. Andrew Carnegie, who, on the same day, also opened a public library which he had presented to the town. In 1896 the Kettering Council obtained a provisional order, and Messrs. Kennedy and Jenkin were subsequently retained as consulting engineers. The system adopted is a three-wire continuous one with 460 volts between the outers. For steam-raising purposes there are four Lancashire boilers, having an aggregate evaporative capacity of 26,000lb. per hour. One of these boilers is worked in conjunction with a dust destructor. The engine room houses four Willans high-speed compound two-crank engines, coupled directly to a

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similar number of Parker dynamos, which have a total capacity of 350kw. The boilers are hand-fired, natural draught is employed, and the engines run non-condensing. For balancing, a combined balancer booster has been installed, together with a 240-cell E.P.S. battery, having a capacity of 360 ampere-hours and a maximum discharge rate of 280 amperes. Distribution is effected by means of Glover's lead-covered cables laid solid in wood troughs.

Association of Municipal Corporations.—The annual meeting of this Association was held at the Guildhall, London, on Saturday, and was attended by about 250 representatives of English, Welsh and Irish municipalities. After the association had been welcomed by the Lord Mayor, Sir Albert Rollitt, M.P. took the chair, and, in moving the adoption of the council's report, referred to the Borough Funds Act. The need of such an act, he said, had been shown in the case of Marylebone, which had, in his opinion, come out of the electric lighting muddle with clean hands. The circumstances had been very difficult, but had been met with courage and energy. The following proposition was subsequently put by the town clerk of Wisbech :—"That it is expedient that statutory powers be given to municipalities generally to sell or hire electric wires, motors, lamps, and fittings, and to fix the same on consumers' premises, and that it be referred to the council to consider the best method of giving effect to the resolution." The town clerk of Crewe seconded the resolution, but the chairman observed that wide considerations were raised by the proposition, and suggested that these should be included among the matters to be referred to the council. This suggestion having been agreed to, the resolution was carried.

Cheap Supply "In Bulk."—It is possible that the North-Eastern Railway will light their entire premises at Hull electrically, and will also drive all cranes, hoists, &c., by electricity; this will necessitate the consumption of about 1,225,000 Board of Trade units per annum. The company have not yet decided whether to build their own power station or to purchase energy from the Hull Corporation. The borough electrical engineer has submitted a report to his committee, and the latter have recommended the Council to offer 1,000,000 units a year at 1¼d. per unit on a basis of a 27 per cent. load-factor. This figure of 1¼d. per unit will be liable to an increment or decrement of $\frac{1}{16}$d. for each 3 per cent. increase or decrease in load-factor, and the offer is also subject to a three years' agreement. At a meeting of the Hull Corporation last week, the matter came up for consideration.

Ald. Dr. HOLDER thought the Council should have fuller information. There was a limit to reduction, and the step contemplated might result in disaster.

Mr. HANGER thought that rather than pay the price quoted the company would put down independent plant.

Ald. GILLETT protested against being compelled to pay 4½d. per unit for his electric light, while the North-Eastern Company were to have it at 1¼d.

After discussion, the CHAIRMAN (Mr. Millington) agreed to take the minutes back, but stated that it would be difficult to bring forward any figures. The railway company required electricity for the whole of their system, and the committee could give particulars as to extensions of plant that would be required.

The Institution of Electrical Engineers.—At the conclusion of the ordinary general meeting at the Society of Arts on May 19, a special general meeting of members and associate members will be held for considering and, if thought fit, passing a resolution having for its object the alteration of certain of the Articles of Association. A new office will be created, and the holder will bear the title of "President Elect," these latter words being inserted after the word "President" in the first line of Article 39. By a similar insertion in the first line of Article 41, the new officer will become a member of Council. An addition to Article 42 stipulates that the "President Elect" shall not assume office as President until the first ordinary general meeting of the session ensuing next after his election. The President in office at the time of election of a President Elect will continue in office until the President Elect assumes office, but the other elected members of Council will assume office immediately upon election. From Article 45, which commences, "The Council shall, previous to the annual general meeting in each year, prepare a list of members whom they propose as suitable for the offices of President, Vice-Presidents and Treasurer for the ensuing year," it is proposed to delete the last four words. By inserting the words "President Elect" after the word "President" in the 7th line of Article 49, the former will take the chair at council meetings in the absence of the President, and, failing the presence of either, the chair will be taken, as at present, by the senior Vice-President or the senior member of Council present.

The London Telephone System.—The following are the notices of motion in connection with the conference which will be held at the Guildhall on Wednesday next on the question of the purchase of the National Telephone Co.'s system in London :—

1. That this conference is of opinion that it would be inexpedient for the Government to acquire the undertaking of the National Telephone Co. on any other terms than those set out in the agreement between the Postmaster-General and the company, dated November 18, 1901, and strongly deprecates the increased cost that would be entailed by the proposed acquisition of the undertaking before the expiration of the existing licence in 1911.
2. That this conference is of opinion that before any agreement is entered into with the National Telephone Co. for the purchase of their system, the terms of the proposed arrangement should be submitted for the consideration of the local authorities within the London telephone area.
3. That this conference again protests against the Post Office telephone tariff, being of opinion that the charge for the use of a telephone in the London area should not exceed the sum of £10 per annum for an "unlimited service," and that the other charges for the use of telephones should be proportionately reduced.
4. That in the opinion of this conference the trunk-line service is inadequate and unsatisfactory, and requires considerable improvement.

The clause referred to in (1) has reference to the purchase of the National Telephone Co.'s systems in the London area upon the determination of the company's licence. Sec. 3 of the clause in question provides that the company's plant shall be purchased at its fair market value without any addition for compulsory purchase or any compensation in respect of goodwill. The agreement referred to between the Postmaster-General and the National Company was published in *The Electrician*, Vol. XLVIII., p. 313.

Breakdown on the "Tube."—Traffic was suspended from about 10:30 to 11 a.m. on the Central London Railway on Saturday. It appears that extensive alterations to the system are being carried out, including the erection of a new sub-station at Bond-street and the installation of a motor-generator for exciting purposes at the Shepherd's Bush generating station, and this work was the indirect cause of the cessation of traffic. Two new panels are being added to the power-station switchboard, one to control the new sub-station, the other to control the motor-generator. The latter consists of a 5,000 volt-induction motor connected directly to a 125kw. continuous-current generator, and this machine was supplying exciting current for the alternators running at the time. In order to carry out some work on one of the new panels, a contractor's workman went below the switchboard gallery and proceeded to open what he thought to be a dead oil-break switch. He counted the panels on the board and counted the switches underneath so as to ensure opening the proper switch. However, it seems that he miscalculated, and opened what proved to be the high-tension switch controlling the generator of the motor-generator exciter. The loaded machines lost their excitation immediately, the emergency stops on the engines came into action and an entire shut-down resulted. Steps were taken at once to get under way again, and the steam exciters were started up. Less than half an hour elapsed between stopping and re-starting of the traffic, and, everything considered, this was a creditable performance. On the night before the occurrence took place the officials were considering the advisability of installing a battery to work in parallel with the motor-generator, which would, of course, render a recurrence of the breakdown impossible.

The National Electrical Manufacturers' Association.—The first annual dinner of this Association was held at the Hotel Cecil on Wednesday, Mr. Walter Davenport, the secretary, occupying the chair. About 100 covers were laid, and the function being more of a social than a formal nature, a most

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enjoyable evening resulted. The usual loyal toast was proposed by the chairman, and afterwards that of the "Imperial Forces" was proposed by Mr. F. H. Nalder, and responded to by Lieut. E. J. Hogan. In giving "Success to the Association," the chairman congratulated the Association on the flourishing condition which it held for so young a society. He said that the membership roll showed a total of 64, and that the committee had invested £100 in Consols since January 1st, and it would take something very serious to make them break into this investment. The progress of the Association was so rapid that he foresaw the formation of local sections at no distant date. Mr. C. S. Northcote replied, and hoped they would continue to be prosperous. "The Electrical Profession and Industry" was proposed by Mr. H. Hirst and responded to by Mr. W. M. Madden. Owing to the absence of Mr. S. Patersen, the toast of "Guests and Visitors" was proposed by Mr. George Verity, who referred to the good work of the Contractors' Association. This toast was responded to by the National Electrical Contractors' president, Mr. W. R. Rawlings, who pointed out that the Manufacturers' Association was practically the offspring of that over which he presided. Very good feeling existed between the two societies, and he felt sure that between them they could do a large amount of good work. At the conclusion of the proceedings, which were interspersed with music and singing, a handsome service of plate was presented to the chairman, who returned thanks and responded to the toast of "The Chairman," proposed by Mr. David Smith.

Engineering Standards Committee.—We are informed that a conference of tramway pole manufacturers will take place at the Institution of Civil Engineers on Thursday, June 2nd, at 2:30 p.m. The recent electrical conference convened by the sub-committee on Generators, Motors and Transformers to discuss certain points which have arisen with reference to the proposed standards for motor speeds and frequencies, and to which reference was made in *The Electrician*, Vol. LII., pp. 514 and 594, led to such satisfactory results and proved of such great assistance to the work of that sub-committee, that the Electrical Tramway sub-committee propose to adopt the same course. The sub-committee on Electric Tramways, which is presided over by Mr. A. P. Trotter, was formed at a meeting of the Electrical Plant committee in May last year, and consists of the following gentlemen :—

Messrs. A. P. Trotter (*Chairman*), Philip Dawson, F. Forbes Higginson, E. R. Hill, J. H. Rider, W. Rutherford, H. M. Sayers, R. H. Scotter, A. M. Sillar, J. J. Steinitz, A. H. Walton, Leslie S. Robertson (*Secretary*), C. le Maistre (*Electrical Assistant Secretary*).

Several sittings have been held and a large amount of information, relating to both sectional and taper poles, has been gathered through the medium of circular letters addressed to users and manufacturers. The replies which were received to these circulars were very carefully considered by the sub-committee, after which they proceeded to draft a proposed standard specification for three-section tramway poles. This conference has been convened to discuss some of the more important questions which have arisen as the result of the committee's enquiries. We are requested to state that the committee will welcome any gentlemen desirous of attending to give evidence on the subject of tramway poles. Particulars of the conference may be obtained on application to the secretary, Mr. Leslie S. Robertson, 28, Victoria-street, Westminster.

The Scarborough Tramways.—Some information regarding the opening of the electric tramway system of Scarborough, as well as a few technical particulars of the undertaking, were published in *The Electrician* of April 29th, p. 44. Messrs. Edmundsons send us the following additional details of the system :—The rails are of the girder type, 6in. deep, the 1⅛in. groove rails weighing 90lb. to the yard and the 1¼in. groove rails weighing 91lb. to the yard. The fish-plates weigh 38lb. per pair, and they are bolted to the rails by six 1in. bolts. Points, crossings and special work were supplied by Messrs. Hadfield's Steel Foundry. There are 21 passing places in the town, so situated that each one of them is visible from the adjacent passing places. Wherever necessary, the rails are drained with Hadfield's drain boxes, and on the steepest portions of the track with Crosta's drain boxes and sump. Every joint is double bonded with Blackwell's Neptune bonds. An unusually large number of sharp curves occur, having radii from 32ft. 6in. upwards. No less than 37 curves have radii under 50ft. The concrete is composed of one part of Portland cement, one part of sharp sand and five parts of clean broken stone or shingle. Four different kinds of paving are used—viz., tar macadam between rails, with a granite margin to the rails; basalt lava between rails, with an 8in. basalt margin and tar macadam outside this; wood paving between rails, with 15in. wood outside and a 3in. granite border; and wood paving right across the street. Special construction was necessary where the tram rails go over the Aquarium top, and in this instance the tramway company put in transverse steel girders, so that they rested over the main piers of the Aquarium, and longitudinal creosoted pitch-pine sleepers resting on these, to which the rails were fixed by coach screws. The Aquarium Company also, under a mutual arrangement, considerably strengthened their underworks, which was done by pulling down the original brick piers and rebuilding them with cast-iron columns in the centre. The poles of the overhead construction are 31ft. long, let 6ft. into the ground, and are made up of three parallel sections of solid-drawn steel tube. Guard and span wires are of bi metallic bronze. The feeder pillars are of Callender's design. They contain the main feeder switches, switch fuses, pilot connections and lightning arresters. At half-mile sections and at the end of special overhead work there are section boxes on the poles, containing two main switches for separating any portion of the overhead line. The cars are driven by two 35 H.P. motors (G.E. 58 type) and they are equipped with a track brake, wheel brake, B.T.-H. electric brake and Tidwell's patent life-guards. One of the special features of the car is the folding step, which folds on closing the gate and opens when the gate is opened. The Scarborough Electric Supply Co., which hitherto has supplied single-phase current only, has put down two Parsons 300kw. continuous-current turbo-generators, a Tudor battery and a 200-ampere Highfield booster for supplying the traction load. Edmundson's Electricity Corp. were the contractors for the permanent way and overhead work, and they also supplied and connected up the new switchboard for the continuous-current plant of the supply company.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, May 13th.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.

8 p.m. Meeting at the Royal College of Science. Messrs. Merz and McLellan's Paper on "Power Station Design," read in London, will be discussed, following which M. J. H. Dowling will describe a small magnetic separator for iron filings.

ROYAL SOCIETY.

9 p.m. Conversazione at Burlington House, Piccadilly.

WEDNESDAY, May 18th.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

8 p.m. Visit to the electrical power plant at the Birmingham Small Arms Works.

7:30 p.m. Annual General Meeting at the University, when the list of officers for the ensuing session will be announced. Paper to be read: "Motor Starting Switches and Resistances," by F. O. Hunt.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Annual General Meeting at 92, Victoria-street, Westminster. Paper to be read: "Some Notes on Steam Turbine Testing," by C. F. Seeley.

THURSDAY, May 19th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Extra Meeting at the Society of Arts, when the discussion upon Messrs. Parsons, Stoney and Martin's Paper, entitled "The Steam Turbine as Applied to Electrical Engineering," will be taken.

FRIDAY, May 20th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Radiation and Emanation of Radium," by Prof. E. Rutherford.

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UNDERGROUND ELECTRICAL SUB-STATIONS.

The following "Memorandum of Recommendations" with regard to underground sub-stations has been issued by the Home Office. The memorandum only applies to sub-stations which a man can enter, and not to mere boxes :—

Apart from the conditions prescribed by the Board of Trade, these premises are subject to the general provisions of the Factory Act, 1901, and to the regulations which the Home Secretary has power to make under sec. 79 of that act for the safety of persons employed. They are now inspected by the Factory Department of the Home Office, and it is found that many have been constructed and fitted up in a manner dangerous to persons having to enter them, the danger being often due to the insufficient size or faulty design of the chambers themselves, and hence not admitting of satisfactory remedy without practically reconstructing the chambers. The necessary safeguards required by the Factory Act can be introduced more effectively and economically at the time of construction than later, and hence, pending the issue of regulations as above, the following general recommendations have been drawn up for the information of persons who may be about to construct such chambers. They are based upon recent practice observed in the stations of this class belonging to electrical undertakings in different towns.

1. *Dimensions.*—Ample space should be allowed for persons to enter and freely move about and carry on all necessary operations of switching, &c., within the chamber without danger of accidental contact with live conductors. There should be sufficient head room for a tall man to stand upright on the floor or insulating platform, if any, without touching the roof or any cables, lamps, battens or apparatus fixed thereto. A height of not less than 7ft. from floor to ceiling would in general suffice, and this is frequently adopted in modern stations. If the roof is arched the height of 7ft. should be measured to the spring of the arch. The area will in general be roughly proportional to the output for which the chamber is designed, but the shape of the chamber has frequently to be adapted to local circumstances. Thus the plan of the chamber may be square or it may have to be long and narrow. There should be ample space to walk past the transformers and to work the switches, &c., so that if the chamber has to be narrow it should be long enough to allow of the low-pressure switchboard on one wall not being immediately opposite to the high-pressure switchboard on the other wall. The switchboard should not be fixed on the wall over the transformers, so that the switches cannot be worked without the operator being in contact with the cases of the transformers, or even standing upon them. In residential areas where the houses are scattered, it frequently happens that single transformers only are required at the same spot. Up to the size of 30kw. these are often put into brick pits or iron boxes which are so small that a workman cannot enter them. Where, however, the pits or boxes are large enough for a person to enter at all, they should be of such dimensions that a man can *safely* enter and do what work may be necessary. Transformers made by different firms vary considerably in dimensions, but in general a minimum area of 4ft. square would be sufficient for single-transformer chambers, and would allow of a satisfactory arrangement of switchboards. When outputs larger than 30kw. are required from one station it is suggested that the chambers shall be large enough to accommodate all apparatus necessary for dealing with an output of 75kw., and for such stations it is proposed that there shall be a minimum width of 5ft. and a minimum area of 50 sq. ft., the actual shape of the station depending on local circumstances within these limits. If the plan of the chamber is a square, the minimum inside dimensions for 75kw. will therefore be practically 7ft. cube, which, again, is in accordance with recent practice. No part of the above area should be utilised as an entrance to the chamber. An additional space in the case of the single-transformer (30kw.) chamber not less than 2ft. by 2ft., and in the case of a 75kw. (or more) chamber not less than 3ft. by 3ft. should be provided for the purpose of entry. Entrance through the roof of the chamber proper is objectionable, because (*a*) if any water enters it falls on that part of the floor which it is important to keep dry, (*b*) the necessary ladder obstructs working space and (*c*) a person going down the ladder frequently has to descend very close to live conductors. Entrance should, therefore, always be at the end or side of the chamber proper.

Stations above 75kw. capacity.—It is recommended that for every 10kw. additional, not less than 5 sq. ft. should be added to the floor area, the minimum height remaining 7ft. as before.

Double floor stations (*i.e.*, where the transformers are on the floor of the chamber with a working platform above, all the switch gear, &c., being above the platform).—Chambers of this description may be used for double the output of single-floor chambers of the same area, provided that the height from the working platform to the roof is not less than 7ft. and the height below the working platform and the floor not less than 6ft.

Construction.—It is obviously essential for safety that the chambers should be watertight. The walls, floor, &c., should be impervious, having regard to the maximum pressure of water in the surrounding soil. Glass pavement lights are not recommended as they are generally found to give trouble, not only by leakage of rain water through the joints, but also, and more frequently, on account of condensation of water on the under-side at night or during cold weather.

In case water should, through any cause, find its way into the station, it is desirable that the floor be laid on an incline of not less than 1 in 100 towards a sump situate in the entrance annexe, immediately below the manhole. It is recommended that the sump be not connected with the town drainage system, as there have been many instances of flooding of chambers by water "backing up" the drain during thunderstorms or heavy rains. There is also a risk of the trap being allowed to become dry and the chamber becoming filled with sewer gas. No chamber should be put to work if water is found to enter from outside; and in the event of its becoming wet subsequently, no person should be allowed to handle the apparatus until the electrical pressure is cut off, unless special precautions are taken.

Ventilation.—Good ventilation is required, first, on account of persons having to work in the chambers; secondly, in order to keep the temperature moderately low; thirdly, in order that any moisture condensing on the walls or apparatus may be readily carried off; and fourthly, in the case of a newly constructed chamber, in order that the moisture coming from the masonry may be gradually carried away. For this purpose it is necessary to provide ventilating ducts, an inlet duct at one end, and an outlet duct at the other. It is preferable that the inlet be near the floor of the chamber, and the outlet near the roof. If the ducts are sufficiently large, the warmth of the chamber due to the transformers will in general suffice to maintain a sufficient current of air. Should this be insufficient, an electric fan at the mouth of the outlet duct is recommended. It is frequently found that the ventilating ducts provided are not large enough to serve the purpose, and it is therefore recommended that the sectional area of each duct should be not less than 1 sq. in. for every 10 cubic ft. capacity of the chamber. This rule, which is in accordance with modern practice, will give for a 30kw. chamber an area about equal to that of a pipe of 4in. diameter and for a 75kw. chamber 7in. diameter. Where possible the ducts should be led above the ground level into special ventilating posts or up the wall of adjacent houses. Ventilating gratings in the pavement frequently give trouble by allowing rain water to pass into the chamber. In any case it is advisable that the mouth of the outlet duct be not immediately over the switchboards or transformers.

Manhole Covers.—Various kinds of manhole covers are in use. The essential point in the design of a cover is that, while capable of being quickly and readily opened when necessary, it should keep rain water from entering the chamber. Except in very large chambers, the one entrance serves for the access of workmen and also for the introduction of transformers and apparatus. For the latter purpose the opening must in general be not less than 2ft. square, but is often considerably larger. Some covers are arranged to be bolted down with a red-lead joint to be opened only for the removal of transformers, &c., a small opening similar to a manhole in a boiler being provided in the cover for ingress of persons. This arrangement, although satisfactory for keeping out water, is for several reasons not very desirable. It becomes difficult for a man to pass through such an opening and get to, or from, the ladder in safety. In the case of deep stations the result of a fall might be serious, while in the event of accident in the chamber such a small opening might be very embarrassing For these reasons a cover opening to the full size of the manhole is to be preferred. A cover, which is often used and appears to meet the requirements, is provided with a trough round the inside of the frame to catch any water which may find its way in round the edge of the lid, the trough being drained by a pipe leading to the street gutter. The level of the manhole in relation to the surrounding paving or ground should also be such that rain water will readily flow away from the manhole. A good type of cover frequently used provides for the lid being locked back when open; a grating, which can be readily opened from the inside, covers the opening when the lid is open. An iron ladder at an angle to the wall, with flat treads, is preferable to a vertical ladder or iron bars built into the brickwork. The ladder should be securely attached at the top, but may be arranged to be readily moved when transformers, &c., have to be lowered.

Door and Stairway from Street.—Sub-stations are sometimes constructed with a permanent stairway in place of a ladder, and others have, in addition, a vertical doorway above ground leading on to the street in place of the more usual trapdoor in the pavement. This practice has great advantages in the case of a station which has to be frequently visited, as is often the case when, in addition to being a transforming station, it contains arc lighting or other switchboards and instruments requiring attention or observation during certain hours daily. It is recommended, therefore, that a door and a stairway should be provided for sub-stations which have to be frequently visited, and for all sub-stations of over 300kw. capacity.

Arrangement and Protection of Apparatus.—A clear passage not less than 3ft. wide should be provided in front of the switchboards or other apparatus which have to be handled. All high-pressure apparatus or cables should be distinguished by means of red paint or otherwise, and should be kept, as far as possible, in a distinct portion of the station. High-pressure and low-pressure switchboards should be kept apart. All high-pressure apparatus and cables should be protected so that accidental contact with the same is impossible.

The metallic portion, other than the conductors of every transformer, must be efficiently connected with earth, in accordance with the Board of Trade regulations, and other metal work not in connection with the circuits should, where practicable, be connected to earth. Wherever nuts are used on electrical apparatus, it is recommended that they be secured by lock-nuts.

Where switchboards are provided with cable or other connections at the back, which may have to be examined and adjusted from time to time, there should be a clear space at the back of the boards not less than 3ft. wide. The chamber will, therefore, have to be larger accordingly for this class of switchboard, unless it is arranged that all pressure can be entirely cut off from the sub-station when examination or work at the back of the boards is undertaken. It is recommended that a telephone communicating with the generating station be provided in every sub-station. No conductors or live metal should be within reach

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of a person on the entrance ladder. The handling of conductors carrying alternating currents, even at low pressures, being dangerous, it is recommended that any fuses used in the low pressure, as well as the high pressure, circuits be of the switch fuse or other type, in which the fuse can be replaced when necessary without the handling of live metal. The passage way or working space in the chambers should not be obstructed by cables, transformers or other apparatus or lumber.

Where extra high pressures, or motor generators, or rotary transformers are used, additional space is needed.

In many chambers the floor is covered to the thickness of an inch or more with an insulating asphalte, but in any case it is recommended that insulating platforms or indiarubber mats be provided, since dangerous shocks "to earth" may be obtained by persons standing on brick or cement floors even when dry. Platforms or mats are, however, of little use unless kept in a dry state.

When any cleaning or work on apparatus or conductors, necessitating the shutting off of the supply, has to be undertaken, precautions should be taken to ascertain definitely that the supply has been cut off, not only from the high-pressure feeding main generally in use, but also from any duplicate or inter-connecting feeder. Serious accidents have occurred at incoming cable terminals from neglect of such precautions. Care should also be taken that there is no feeding and consequent transforming backwards from the low-pressure distributing network. In order that mistakes may be the more readily avoided, it is important that the arrangement of switch gear, cables, &c., be carried out on a systematic and orderly plan.

ELECTRICITY SUPPLY UNDERTAKINGS IN THE COUNTY OF LONDON IN 1902.

A return prepared by the Statistical Department of the London County Council gives an analysis of the accounts and other statistics for the year 1902 or 1902-3 of electricity supply undertakings within the county of London. The following is an abstract :—

At present there are 15 local authorities and 14 companies which possess statutory powers for supplying electricity within various districts in London. The 15 local authorities possessing statutory powers are the borough councils of Battersea, Bermondsey, Bethnal Green, Fulham, Hackney, Hammersmith, Hampstead, Islington, Poplar, St. Pancras, Shoreditch, Southwark, Stepney, Stoke Newington, Woolwich. With the exception of Bethnal Green all are now supplying current. In this case a site for a generating station has only recently been obtained. In the case of Stoke Newington, the Borough Council does not generate its own current, but takes a supply in bulk from the neigbouring boroughs of Hackney and Islington.

Eight of the 14 companies supply areas which are not limited to one metropolitan borough ; it is, therefore, of great importance, in view of the possibility of the purchase of the undertakings by the local authorities in 1931, that the accounts should, as far as possible, be separately stated for each borough. This, however, is not done. The County of London and Brush Provincial and the Metropolitan Companies keep separate accounts for each order, and the Charing Cross and Strand Company keep their City accounts separate. None of these, however, provide for the separation of accounts for each borough area. The only parts of the county for which no statutory powers are at present possessed, either by the local authority or by a company for supplying electricity therein, are the following :—St. Peter, Westminster, in the City of Westminster ; the portion of Chelsea detached in the Borough of Paddington ; the portion of Chelsea detached in the Borough of Kensington ; Lincoln's Inn and Staple Inn in the Borough of Holborn ; part of Woolwich parish north of Thames.

From the following will be seen the extent to which competition has been authorised by Parliament in the various areas constituting the county of London :—One company and the local authority compete in Bermondsey, Rotherhithe and Newington ; two companies compete in the whole City, Horselydown and St. Olave and St. Thomas, the northern part of Camberwell, Chelsea, Finsbury (except Charterhouse and St. Luke), Greenwich parish, Saffron-hill, St. Andrew and St. George, and St. Giles and St. George, small part of South Lambeth, all Southwark except Newington and small part in south-east of St. Saviour, all Westminster except St. Peter, detached part of St. Margaret and St. John and small part in east of St. Martin-in-the-Fields ; three companies compete in St. Saviour, Southwark (small part in south-east), and St. Martin-in-the-Fields (small part in east).

In the following table the various undertakings have been set out in the order of lowest price obtained for private supply, only such undertakings being taken as had completed one full year's working.

The column headed "Surplus available, &c.," does not in all cases represent the difference between the two preceding columns ; this is accounted for by the fact that interest on deposits and investments and exceptional receipts have been included. With regard to the prices obtained for public lighting, it will be noticed that in some cases capital charges in respect of lamp standards are included, whereas in the other cases the price is for the supply of current only. The County Council has now decided that public lamps do not appertain to electricity supply undertakings, but that loans for that purpose ought to be borrowed under the Metropolis Management Acts. A condition which must affect the working of an undertaking arises when it is worked in conjunction with a refuse destructor. This is the case with the undertakings of six local authorities—viz., Bermondsey, Fulham, Hackney, Shoreditch, Stepney

Local authority or company.	Full year of working.	Average price obtained for current per unit.		Proportion of public lighting to total supply.	Amount per unit sold.			Load-factor.
		Private supply.	Public lighting.		Excess of revenue over expenditure.	Interest or interest and dividends paid.	Surplus available for repayment of capital or depreciation.	
		d	d.	Per cent.	d.	d.	d.	
Stepney Borough Council	3rd	2·7	1·60	25	1·27	0·52	0·78	21·1
Poplar Borough Council	2nd	2·81	2·86 (a)	26	1·39	0·73	0·66	22·37
Bermondsey Borough Council	1st	3·13	3·06	35	−0·02	0·97	−0·99	13 8
Shoreditch Borough Council	5th	3·15	2·61	23	0·96	0·69	0·27	18·52
Hackney Borough Council	1st	3·3	2·30 (b)	33	2 01	1·35	0·72	15·88
Charing Cross and Strand Supply Corporation—City undertaking	1st	3·48	..	..	0·59	1·86	−0·57	6·55
Battersea Borough Council	1st	3·57	1·79	41	1·00	1·60	−0·60	13·26
Hammersmith Borough Council	5th	3·67	2·12 (b)	19	1·41	0·74	0·77	15·02
Blackheath and Greenwich Company	2nd	3·72	..	..	1·98	1·39	0·59	10·97
Charing Cross and Strand Supply Corporation—West End undertaking	11th	3·89	2·27	4	1·83	1·90	0 69	19·36
Southwark Borough Council	3rd	4·01	2·87	31	1·22	0·91	0·31	14·73
City of London Company	11th	4·02	1·99 (b)	8	2·28	1·59	0·71	12·09
St. James' and Pall Mall Company	13th	4·03	2·67	2	2·31	1·46	0·91	17·69
St. Pancras Borough Council	11th	4 04	2·43 (a)	21	1·83	0·56	1·27	17·51
Woolwich District Company	9th	4·14	..	..	2·17	1·93	0·24	7·52
Hampstead Borough Council	8th	4·26	2·62 (b)	8	2·04	0·89	1·15	13·83
South London Supply Corporation	3rd	4·31	..	..	1·62	1·33	0·29	12·98
London Supply Corporation	17th	4·42	..	..	2·10	1·74	0·36	17·86
Kensington and Knightsbridge Company	16th	4·49	2·50	1	2·47	1·50	0·98	12·92
Westminster Supply Corporation	12th	4·53	2·14 (b)	13	2·47	1·66	0·84	17·73
County of London & Brush Provincial Co.	6th	4·58	..	..	2·28	2·81	0·14	12·5
Crystal Palace District Company	10th	4·62	..	..	0·91	1·83	−0·92	9·07
Metropolitan Company	13th	4·87	2·10	(c)	2·12	1·96	0·20	11·92
Fulham Borough Council	1st	4·89	1·01	55	0·88	1·30	−0·42	14·67
Islington Borough Council	7th	5·04	2·93	40	1·58	1·18	0·40	12·85
Chelsea Company	13th	5·05	..	..	2·98	1·97	1·03	11·97
Brompton and Kensington Company	14th	5·36	..	..	3·27	1·84	1·47	13·82
Notting Hill Company	11th	5·72	2·50	4	3·05	2·62	0·45	13·12
Averages for local authorities	..	3·74	2·40 (a)	26	1·49	0·87	0·63	16·05
Averages for companies	..	4·40	2·11 (a)	4	2·24	1·83	0·56	13·75

(a) Including part capital charges in respect of public lamps. (b) Including capital charges in respect of public lamps. (c) Information not available.

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Local authority or company.	Accumulated capital exp.			Deduct.			Total deductions.		Net capital expenditure.		
	Amount.	Per unit sold.	Per kw. of plant install'd.	Repaid off loans or paid into sinking funds.	Amount standing at credit of depreciation fund.	Written off from time to time out of rev. or other sources.	Amount.	Proportion to accumulated capital expenditure.	Amount.	Per unit sold.	Per kw. of plant install'd.
Borough Councils.	£	£	£	£	£	£	£	per cent.	£	£	£
Battersea	176,219	0·23	198	3,812	..	..	3,812	2·16	172,407	0·22	193
Bermondsey	44,235	0·16	118	68	..	..	68	0·15	44,167	0·16	118
Fulham (*a*)	191,130	0·25	212	4,776	..	..	4,776	2·50	186,354	0·23	207
Hackney	227,066	0·14	126	2,617	..	..	2,617	1·19	224,449	0·14	125
Hammersmith	190,329	0·11	76	14,540	..	..	14,540	7·64	175,789	0·10	70
Hampstead	321,794	0·12	67	22,281	970	4,279	27,530	8·55	294,264	0·11	62
Islington	388,670	0·16	107	20,646	..	..	20,646	5·31	368,024	0·16	101
Poplar	187,539	0·10	117	1,030	..	..	1,030	0·55	186,509	0·10	117
St. Pancras	429,659	0·10	85	33,244	..	7,622	40,866	9·51	388,793	0·09	77
Shoreditch	288,397	0·09	94	10,610	..	..	10,610	3·68	277,787	0·09	91
Southwark	79,571	0·12	66	1,599	..	..	1,599	2·01	77,972	0·12	64
Stepney	150,458	0·09	123	407	603	..	1,010	0·67	149,448	0·08	112
Woolwich	74,435*b*	0·43	115	210	..	..	210	0·28	74,225*b*	0·43	114
Total for local authorities	2,749,502	0·13	99	115,840	1,573	11,901	129,314	4·71	2,620,188	0·12	95
Companies.											
Blackheath and Greenwich	221,217	0·25	126	..	1,000	..	1,000	0·45	220,217	0·25	126
Brompton and Kensington	259,924	0·13	104	..	37,199	36,317	73,516	28·30	186,408	0·10	74
Central	337,111	..	..	..	..	..	..	..	337,111	..	..
Charing Cross and Strand—											
West End undertaking	764,804	0·11	174	..	75,000	..	75,000	9·81	689,804	0·10	157
City undertaking	591,101	0·31	123	..	..	..	..	..	591,101	0·31	123
Chelsea	476,488	0·21	154	..	27,336	56,496	83,832	17·16	392,656	0·17	127
City of London	1,956,208	0·14	109	..	182,235	..	182,235	9·33	1,773,973	0·13	99
County of London	1,166,317	0·24	175	..	28,451	..	28,451	2·44	1,137,866	0·23	171
Crystal Palace	129,731	0·32	151	..	..	10,314	10,314	7·95	119,417	0·29	140
Kensington & Knightsbridge (*c*)	428,483	0·12	95	3,736	44,741	24,534	73,011	17·02	355,472	0·10	79
London	1,164,819	0·29	166	..	..	227,566	227,566	19·53	937,253	0·23	134
Metropolitan	1,846,448	0·15	98	..	98,447	..	98,447	5·34	1,748,001	0·14	93
Notting Hill (*d*)	274,040	0·24	114	2,615	16,500	..	19,115	6·98	254,925	0·22	106
St. James' and Pall Mall	526,629	0·08	98	..	..	97,250	97,250	18·47	429,379	0·06	80
South London	301,629	0·28	100	..	2,533	..	2,533	0·84	299,096	0·27	100
Westminster	902,523	0·08	92	..	114,466	717	115,183	12·77	787,340	0·07	80
Woolwich District	62,730	0·11	67	..	700	..	700	1·12	62,030	0·11	67
Total for companies	11,410,202	0·15	121	6,351	628,608	453,194	1,088,153	9·54	10,322,049	0·14	110
Total	14,159,704	0·15	116	122,191	630,181	465,095	1,217,467	8·60	12,942,237	0·13	106

(*a*) Fulham—The destructor and electricity works accounts are inseparable.
(*b*) Woolwich—Excluding £95,158, the capital expenditure in respect of the undertaking taken over from the Woolwich District Company.
(*c*) Kensington and Knightsbridge—The figures given for this company include £73,045, the proportion attributable to the company of the total capital expenditure in respect of the joint generating station, and £3,736 the proportion of the sinking fund.
(*d*) Notting Hill—The figures given for this company include £63,782, the proportion attributable to the company of the total capital expenditure in respect of the joint generating station, and £2,615 the proportion of the sinking fund.

and Woolwich. Different systems seem to be followed by these authorities in adjusting their accounts, as will be seen from the following table, which shows the various methods adopted, together with a few other particulars bearing on the subject.

Refuse destructor undertaking.	Total capital expenditure at end of 1902-3.	Gross cost during 1902-3, including debt charge.				
		Met by sundry receipts.	Charged to rate account.		Charged to electricity account.	
			Amount.	Equiv. per ton of refuse destroyed.	Amount.	Equiv. charge per unit generated.
Bermondsey.	£30,061	£46	£4,077	6s. 11·4d.	£300	0·20d.*
Fulham	21,837	332	3,304	2s. 3d.	..	..†
Hackney	39,224	8	5,020	2s. 11·4d.	2,272	..‡
Shoreditch	23,942	403	3,942	3s. 2·4d.	3,756	1·13d.§
Stepney	18,000	..	..	..	2,034	0·43d.‖
Woolwich	24,656	..	..	..	..	..¶

* The estimated saving in coal is charged to electricity account.
† The cost of destructor is inseparable from expenditure of electricity undertaking. The charge made by combined undertakings to cartage department for destroying refuse is 2s. 3d. per ton, and to public for trade refuse 1s. 6d.
‡ The value of 5lb. of coal is charged to electricity account for each unit generated by steam.
§ The net cost of maintenance of destructor is debited to electricity account after charging scavenging department 2s. per ton of refuse destroyed. The debt charge is paid out of the general rate.
‖ During the early part of 1902-3 the charge made to electricity account per unit was 0·3d., it is now 0·5d.
¶ The method of adjustment has not been decided on as yet, the destructor only having commenced work on April 2, 1903.

Only two of the companies have now any founders' shares—viz., the Chelsea and Nottingham Companies—these shares in each case being entitled to half the profits after 6 per cent. dividend has been paid on the ordinary shares. No dividend has yet been paid on the Chelsea founders' shares, but 3 per cent. was paid on the Notting Hill shares in respect of 1902. As much as 18 per cent. was paid on these shares for 1899 and 16 per cent for 1900, but nil for all the other years. Four of the other companies also possessed founders' shares originally, but these were cancelled by the allotment to the holders of such shares of a certain amount of ordinary and preference stock at par by way of exchange. This method, of course, meant losses to the companies concerned in the shape of premiums, an estimate of the losses, based on the respective values of the shares at the particular dates, being as follows:—Brompton and Kensington £46,500, Metropolitan £112,500, St. James' and Pall Mall £168,000, Westminster £120,000.

In connection with the matter of premiums, it should be remembered that premiums are not always realised by a company when issuing new capital, even though that capital may stand above par value, but are sometimes allowed to the shareholders as a bonus, the capital being issued at par to them pro rata. Quite £30,000 was foregone by the Westminster Company in this way over the new £140,755 preference capital issued during 1902-3, and similarly during the previous year the amount of bonus allowed to the shareholders over the issue of new ordinary shares must have been close on £200,000.

The above table relating to capital expenditure at end of year is interesting.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"A First Book on Electricity and Magnetism." By W. P. Maycock. (London: Whittaker & Co.) 2s. 6d.

"Leçons sur L'Electricité." By Eric Gerard. Vol. I., 7th edition. (Paris: Gauthier-Villars.) 12fr.

"Dynamo Attendants and their Dynamos." By Frank Broadbent. 4th edition. (London: S. Rentell & Co.) 1s. 6d.

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A "REMOTE CONTROL" SWITCHBOARD FOR THE LONDON COUNTY COUNCIL TRAMWAY POWER HOUSE.

One of the most interesting parts of the equipment of the power house for the London County Council tramways which is under construction at Greenwich will be the switch gear. This is to be on the "remote control" system which has been employed at some works in the United States, and is now beginning to find favour with engineers designing large power houses in this country. The principle is also being

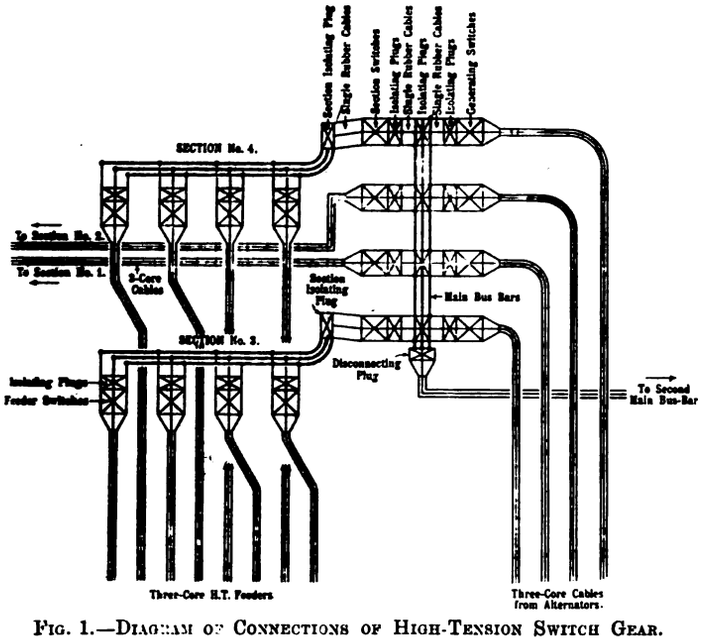

FIG. 1.—DIAGRAM OF CONNECTIONS OF HIGH-TENSION SWITCH GEAR.

employed, for instance, at the Carville station of the Newcastle-upon-Tyne Electric Supply Co. (see Messrs. Merz and McLellan's Paper in this issue) and at the Lots-road generating station of the Underground Electric Railways Co. of London. The specification for the Greenwich switchboard, which has been drawn up by Mr. Rider, the electrical engineer to the London County Council tramways, contains many points of novelty. One of these in particular is that the whole arrangement of the switch gear (with the exception of the details of the switches and measuring instruments themselves, which are, of course, to be of the contractors' standard patterns) has been drawn out in detail by Mr. Rider. Not only has the exact size and position of the board as well as the position of the cables and their chases been absolutely fixed, but the design of the whole of the switch gear, 'bus bars, and even such matters as the details of the isolating plugs have all been worked out beforehand.

By the term "remote control" switchboard is implied an arrangement of switch gear in which the switches themselves and the 'bus bars are placed at convenient places in fire-proof compartments at a considerable distance from the actual operating board itself. This latter resembles, as it were, a toy switchboard in which all the connections are made by small switches on a low-pressure circuit, these closing or opening the circuits of the motors or electromagnetic devices which operate the switches themselves.

The extra high-tension switch gear will be the most important part of the plant. This is, of course, for the purpose of connecting the main generators to the feeders and also to supply means for paralleling the generators and regulating their pressure and output. Provision has also to be made for isolating speedily from the 'bus bars any feeder circuit that has become defective or short-circuited. There will, in all, be eight generators supplying three-phase current of 350 amperes at 6,600 volts between phases. These machines are star-connected, the centre point of the star being permanently connected to earth. There will be 32 feeders, divided into eight sets of four each. Each of these sets of four feeders will correspond to one of the generators, and a 'bus bar will be provided for this group and the generator. Provision is also made, however, for all these eight 'bus bar sections to be connected together on one of two sets of main 'bus bars, and this, in fact, will be the normal method of working the station, all the generators running in parallel according to usual practice. If, however, it should be found advisable to isolate any dynamo or any set of four feeders and run them independently of the rest, this can be done by switching off the 'bus bar section in question from the main 'bus bars. It may be mentioned here, however, that the first equipment will only include four generators and four groups of four feeders each. These will occupy exactly half the station, and the remaining half of the equipment will be precisely similar and capable of being connected up to the first half. Both sides of the switchboard are, however, to be erected now, and provision is made for the two sets of main 'bus bars to be connected together through an interconnecting switch and disconnecting plug.

The cables from the generators to the switchboard are three-core, and are first connected through trifurcating boxes and isolating plugs to the instrument transformers. On the other side of these transformers is again a trifurcating box, and the cables run three-core to one of the two sets of main 'bus bars, being connected to them through oil switches and isolating plugs. The feeders are led through their instrument transformers in the same way before reaching the switchboard, the only difference being that connections are taken from the first trifurcating box to spark-gaps, which are for the purpose of discharging any excess pressure which may occur in the cable on switching on or off.

Connection between each feeder and its 'bus bar section is made through an oil switch and isolating plug, in the same way as in the case of the generator cables. There is, however, one point of difference—the main feeder switch is fitted with an excess current release with a time limit arrangement, while the corresponding release coil for the generators is only actuated by a reverse current. These arrangements are made clear on Fig. 1, in which, however, only two of the section 'bus bars

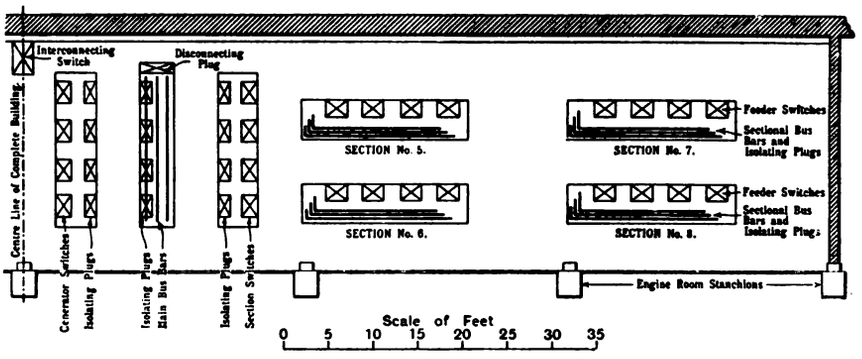

FIG. 2.—PLAN OF RIGHT-HAND HALF OF SECOND GALLERY.

and one of the main 'bus bars are shown. The instrument transformers have also been omitted so as not to crowd the drawing. All the main switches and isolating plugs are placed in brick chambers on a gallery which runs on the side of the engine room farthest from the boilers, but in which there is no actual switchboard. Fig. 2 is a key plan showing the disposition of the switchboards on one half of this gallery. The switches of the four feeders forming each section, together with their 'bus bars, are contained in four chambers of this character, the four switches in each section being separated from one another by brick partitions. Similar independent chambers contain the section switches and isolating plugs connecting the sections to the main 'bus bars, the main 'bus bars with their isolating plugs, and the four generator switches with their plugs. The cables leading to these are run in special vertical chases in the walls of the building. These are open,

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and at about 4ft. intervals an iron brick is placed to which a cleat is clamped to secure the cable. Lead-covered cables are used to connect the machines and feeders to their switches. These cables are laid symmetrically and are always visible. The operating board will be placed on a gallery overlooking the engine room (Figs. 3 and 5) below the gallery on which the main switches themselves are. Although this board, as we have already stated, resembles an ordinary switchboard on a controlling switch is sufficient to cause the main switches to open or close, and a red or blue indicating lamp, F and G or P and Q (Fig. 3) glows, the "red" indicating that the switch is closed and the "blue" that it is open.

On the generator panels, in addition to the main switch, there are two other switches, A and C. A is an emergency switch, by means of which the engine may be stopped through an electromagnetic controlling device, which shuts off steam at

A Engine Stop Governor Switch.
B Main Generator Controlling Switch.
C Engine Governor Regulating Switch.
D Regulating Resistance Indicator Scale.
E Regulating Resistance Operating Wheel.
F Red Indicating Lamp.
G Blue Indicating Lamp.
H Synchronising and Voltmeter Plugs.
I Reverse Current Time Limit Relay.
J Integrating Wattmeter.
K Alternating-current Wattmeter.
L Power-factor Indicator.
M Indicating Wattmeter.
N Direct-current Ammeter.
O Feeder Controlling Switch.
P Red Indicating Lamp.
Q Blue Indicating Lamp.
R Integrating Wattmeter.
S Overload Time-limit Relay.
T Alternating-current Ammeter.
U Power-factor Indicator.
V Indicating Wattmeter.

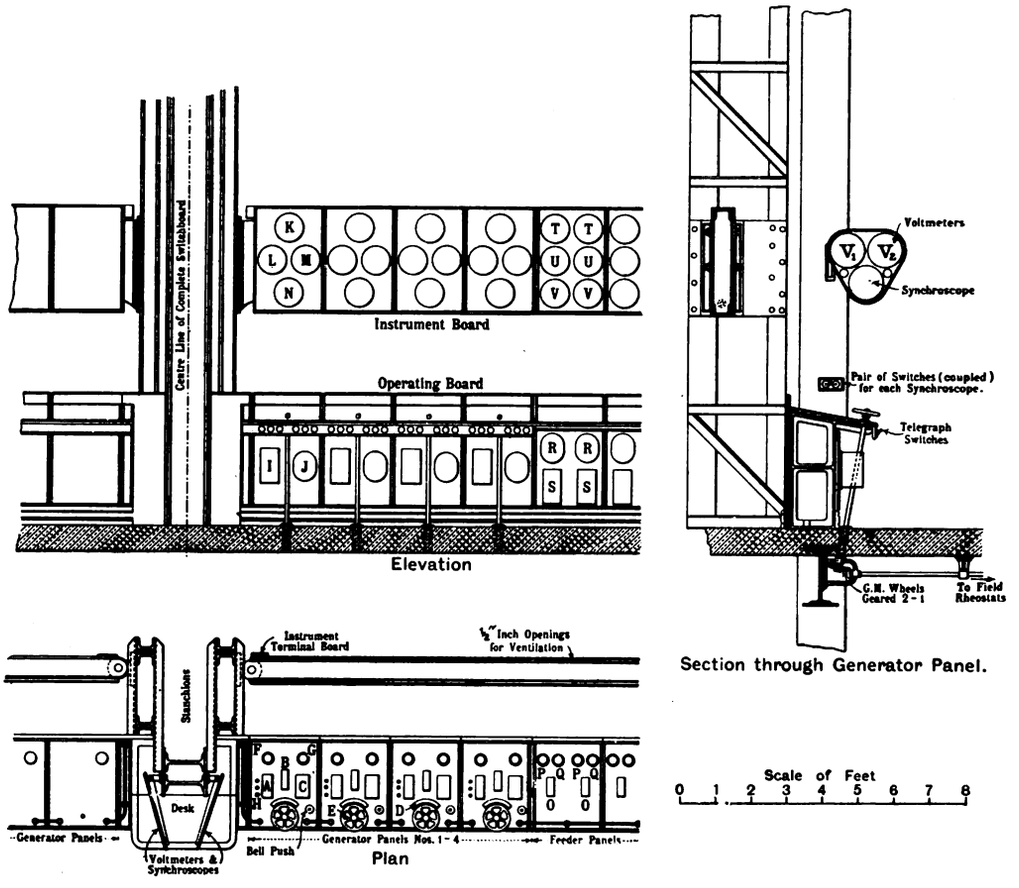

FIG. 3.—PORTION OF INSTRUMENT BOARD AND OPERATING BOARD.

reduced scale, there is one important point of difference—viz., that the switchboard attendant, instead of having his back to the engine room, faces it. The switches will be placed on a sloping desk, and on the part of this corresponding to the generator panels will be four hand wheels for working the field rheostats. The rheostats themselves will be placed below the gallery, and will be actuated by mechanical gearing. Above this desk is a the throttle valve. C is connected to a small motor which acts as a controlling weight on the governor arm. On sending a current in either direction through the circuit which C controls, the motor is made to rotate and wind itself either backwards or forwards upon a screwed spindle, thus speeding the engine up or down. By means of the lettering on the other parts of the board the position and use of the various other

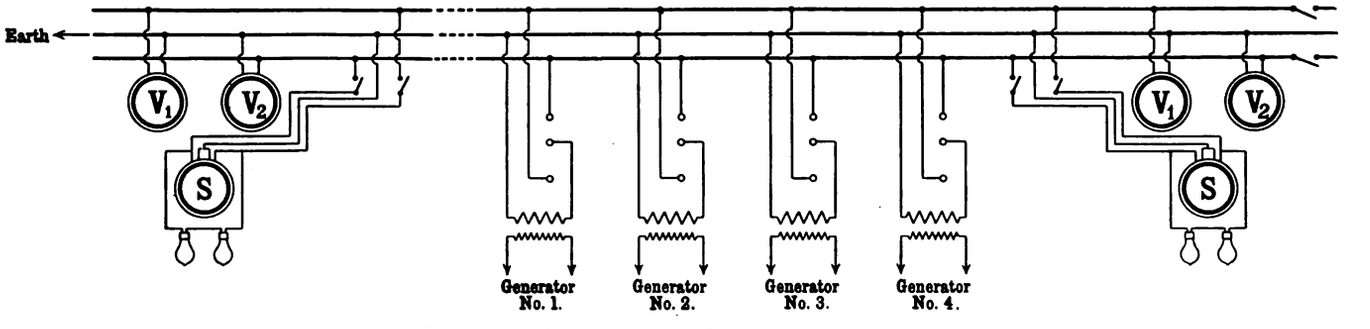

FIG. 4.—DIAGRAM OF CONNECTIONS FOR SYNCHROSCOPES AND VOLTMETERS.

sort of canopy, upon which the measuring instruments are placed, and the space between these and the desk allows the attendant to have a full view of the engine room. As we have already stated, all the switches are worked by low-pressure continuous current from the operating board, switches on the latter board closing the circuits of the tripping coils of the main switches in the brick chambers. The construction of these switches will be such that one brief contact of the apparatus may be seen. A swing bracket containing two voltmeters and a synchroscope is placed at each end of both of the two halves of the switchboard. To describe the synchronising arrangements, reference must be made to Fig 4. In addition to the instrument transformers already mentioned, a voltmeter transformer is connected to one phase of each of the generator cables. One terminal of the secondary of this transformer is connected to the middle of three 'bus bars and

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the other terminal to the centre point of a two-way plug switch. This switch is arranged with a short and a long plug, so that the transformer may be connected to one of the voltmeters V_1 or V_2; and as only one short and one long plug is provided, it is impossible for two machines to be put on to the same voltmeter. We will assume that generator 1 is running and that generator 2 has to be run up and connected in parallel to it. By means of the long plug, generator No. 1 is connected to the voltmeter V_1 and generator No. 2 is connected to the voltmeter V_2 by the short plug. The voltmeter readings show when the two machines are running at the same voltage. The synchroscope switches are then closed, and when the needle of this latter instrument comes to rest, the attendant sees that the machines are in synchronism,

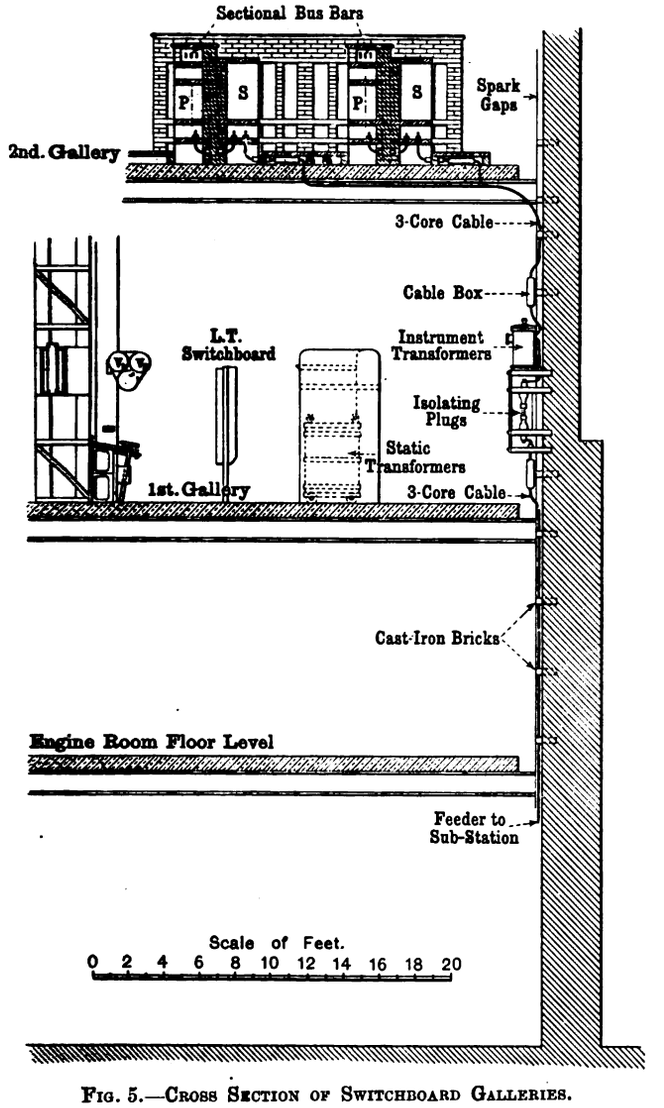

FIG. 5.—CROSS SECTION OF SWITCHBOARD GALLERIES.

P=Chamber for Isolating Plugs.
S=Chamber for Oil switches.

and switches in. The reason that there are four voltmeter and synchroscope brackets is simply for convenience in operating, so that one of them is near each generator panel.

When synchronising, it may be mentioned, no signals will be transmitted from the switchboard attendant to the engine driver, but by each engine there will be a synchroscope, and the driver will regulate the admission of steam in accordance with its indications. These instruments are so dead beat in comparison with synchronising lamps that no difficulty is anticipated with this arrangement. The switchboard attendant, however, will be able to signal to the driver when he desires an engine to be started or stopped. Two large illuminated dials 7ft. high, with letters 10in. high, will be fixed on the wall of the engine room facing the switch gallery and in view of the driver of the four machines placed in each half of the engine room. These boards will bear the signals "Slow," "Run up," "On load," "Reduce," "Stop," "No. 1," "No. 2," "No. 3," "No. 4," "A," "B." If the engineer at the switchboard wished to tell the driver to start No. 1 engine he switches on the left-hand tumbler switch A on the generator panel (Fig. 3). This lights up the signal "No. 1" on the board and is a direction to the driver to stand by at No. 1 engine. The second switch lights up the word "Slow" and indicates that the engine is to be started at a slow speed. "Run up" implies that the machine is to be run up in order to be paralleled to the 'bus bars, and, when the switchboard attendant has switched this machine, in he presses the fourth switch which lights up the words "On load," when the driver knows that the machine is switched on. If the machine is to be stopped the signal "Reduce" is given. While the driver reduces the speed, the switchboard attendant reduces the field and finally the signal "Stop" is given. The numbers 1, 2, 3 and 4 on one board and 5, 6, 7 and 8 on the other refer to the number of the generator, and A and B on one board and C and D on the other refer to the exciting sets.

There will be three low-pressure switchboards, more or less of the standard pattern, and direct-operated. The chief one of these is placed on the first gallery parallel to the operating board, in the position shown in Fig. 5. Fifteen of its 45 panels are connected to a set of 220 volt three-phase 'bus bars for supplying the induction motors which drive the auxiliaries in the station. These 'bus bars are supplied by a smaller switchboard placed in a line with the static transformers seen in Fig. 5 on the same gallery. Next to these 15 panels come seven, which are supplied from a battery of accumulators at a voltage of 125. It is from these panels that current is taken for the operating mechanism of the high-tension switches, and they also supply the incandescent lamps for lighting the station. In this manner both the lights in the station and the switch gear are unaffected by any breakdown of the generating plant. The remaining panels of this board are for the most part ordinary tramway feeder panels, for the parts of the tramway line near the power house. They will be supplied from the third low-tension switchboard on the floor of the engine room near the motor generators forming the local sub-station. The 550-volt direct-current section part of the switchboard on the gallery also supplies the motors of some of the auxiliaries in station, and also the arc light circuits.

The whole specification has been prepared in great detail, and reflects considerable credit upon Mr. J. Shepherd, Mr. Rider's chief assistant, to whom the work of designing the board was entrusted.

POWER STATION DESIGN.*

BY C. H. MERZ AND WM. McLELLAN.

(Concluded from page 91.)

5. SWITCH GEAR.

Switch gear suitable for large power stations has only been recently developed, and on this account reliability of operation must be secured by a relatively heavy capital outlay. As the manufacture of high-tension switches and automatic protective devices becomes standardised and better understood we may look for a reduction in first cost. On account of the absolute crippling of the power station which takes place if there be any serious failure of the switch gear, it is certainly justifiable to take every precaution to secure reliability, even at the expense of capital expenditure.

The simplicity of the Ferranti single-phase board probably first directed the attention of engineers to the necessity of sub-dividing high-tension switch gear from the machine to the 'bus bars, at the 'bus bars themselves, and from the 'bus bars to the outgoing feeder. Recent tendency in switchboard design† seems at first sight a retrograde step in the way of complication. The extra complication, however, is due rather to the fact that the system is a three-phase one‡ than that complication has been introduced. In fact,

* Abstract of a Paper read before the Institution of Electrical Engineers on April 28th.

† See *Transactions* American Institute of Electrical Engineers, Vol. XVIII., "The Control of High Potential Systems of Large Power," by E. W. Rice, jun. See also "Three-phase Switch Gear," by A. C. Eborall, *Engineering*, September 25, 1903, *et seq.*

‡ Even if single-phase motors are largely introduced for traction or other purposes, it seems probable that three-phase generation and distribution will still be resorted to on account of (*a*) cheaper machines, (*b*) cheaper and more easily insulated cables.

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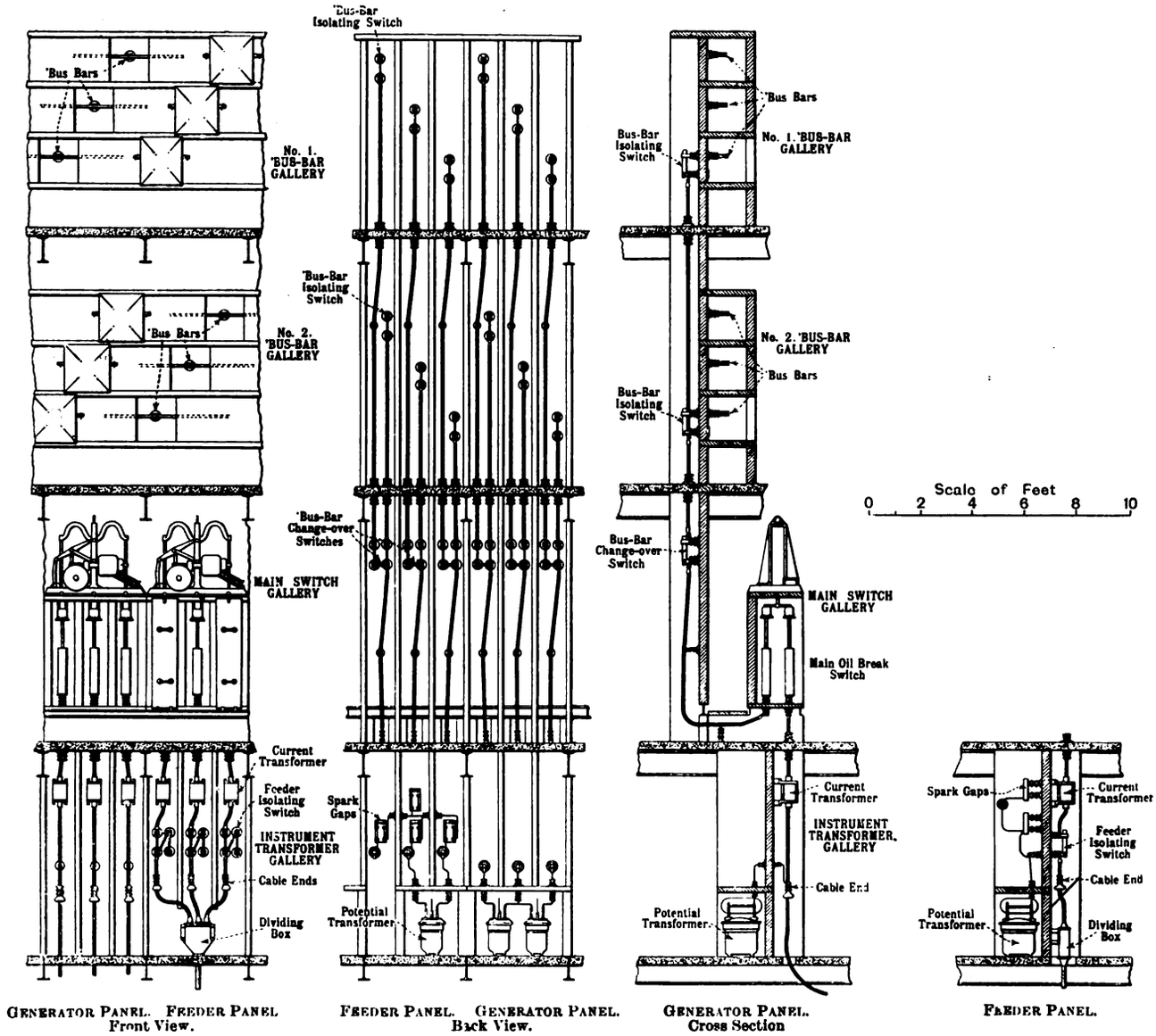
a modern board is practically a large Ferranti board controlled from a distance.

Reference to the drawings of two switchboards which have recently been installed will facilitate discussion of the essential points. Fig. 10 shows the arrangement of switch gear designed and adopted by the authors at Carville, where British Thomson-Houston switches are utilised, and Fig. 11 shows that for the five North-Eastern Railway sub-stations, where Westinghouse switches are used. Where large powers have to be dealt with, that is to say, where one switch may have to open 10,000kw. or more, the serious effect of the failure of a switch and the consequent necessity for completely sub-divided apparatus will be readily realised. In both of the above designs this sub-division is provided for not only between the various pieces of apparatus and connections, but, as may be seen from the drawings, also between the different phases of the main switch itself—in fact, the only place where two phases come together is in the potential transformer chamber. The whole board in each case is made of concrete* from 3in. to 6in. thick. In designing the switch house building it is necessary that all material should be fire-proof, and this applies not only to the building itself, but, as far as possible, to all apparatus installed therein.

It is now recognised that oil-switches are essential, and all high-tension circuits should be broken in this way—if only for the reason that opening the circuit under oil puts so much less stress on the cables and on insulation generally.* The switch chosen should be capable of breaking any current which may be met with in practice. This practically means, in emergency, breaking the whole short circuit capacity of the station. It is only, however, within very recent years that it has been possible to secure switch gear which will meet such a contingency. The 'bus bars, in common with other parts of the switch gear, should not depend on fibrous or other combustible insulation. They may with advantage be of bare copper mounted on insulators, each 'bus bar being separately enclosed in an independent chamber. The object of complete sub-division here, as in other cases, is to, as far as possible, avoid any serious trouble spreading and damaging the switch gear as a whole should the switch by any chance fail to break a short circuit.

In order to avoid all possible risk it is essential that the switches should be next the 'bus bars themselves—*i.e.*, that no apparatus of any kind should intervene between the switch and the 'bus bars. Probably one of the greatest dangers to reliability of supply, and one likely to show itself prominently in the near future, is the excessive carelessness with which cables connecting machines or feeders to the switchboard have in the past been cramped together indiscriminately in a trench or tunnel. If big currents or large powers are to



GENERATOR PANEL. FEEDER PANEL Front View. | FEEDER PANEL. GENERATOR PANEL. Back View. | GENERATOR PANEL. Cross Section | FEEDER PANEL.

FIG. 10.—HIGH-TENSION SWITCH GEAR. CARVILLE POWER STATION.

* In America brickwork has been used for similar boards, but in the cases under consideration it was found that the adoption of concrete construction resulted in securing not only a cheaper but certainly, in many ways, a better job. The first board of this type was, so far as we know, erected in the power station of the Metropolitan Street Railway Co., New York, but there the complete sub-division referred to has been carried out in the case of the 'bus bars and the switches only, the connections themselves are not dealt with in the same way. Obviously the cost involved forbids that similar precautions be taken in small sub-stations. It is therefore necessary to so arrange these small sub-stations with regard to the rest of the system that if a serious fault should occur in any one it is dealt with not by switches in the sub-station itself, but by the gear in the power station or in some large sub-station.

* Oil-switches were first used for high-tension currents by Ferranti in this country, and by Messrs. Brown, Boveri in Switzerland. Lately they have been developed (especially for large powers) by the General Electric Co. of America, and also by the Westinghouse Company.

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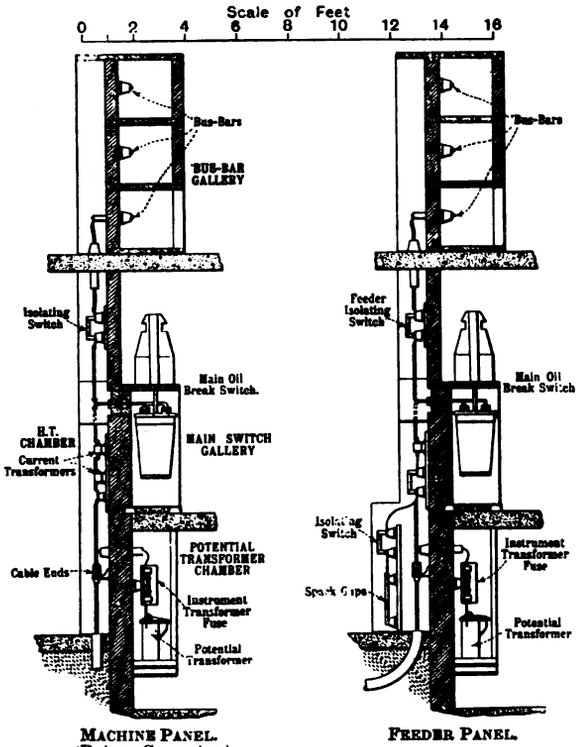
be conveyed, whether in a power station or under a motor coach, nothing short of complete isolation (or failing this several inches or feet of air space depending on the potential and power) will ensure freedom from failure or keep the damage within proper limits in



MACHINE PANEL. (Rotary Converter.) FEEDER PANEL.

FIG. 11.—SECTIONS THROUGH HIGH-TENSION SWITCH GEAR. NORTH-EASTERN RAILWAY SUB-STATIONS.

case of the failure of any part. It is not sufficient to attend to this point on the switchboard itself, it must be attended to from the machine terminals to the outgoing feeder. In the case of a power station it is unsafe to lay cables carrying large powers, whether high or low tension, even spaced some inches apart in tunnels or manholes, unless each cable is in its own duct, or in some other way protected by a properly earthed metal shield.* In order that these connections may be, as far as possible, completely sub-divided, the feeder or machine should preferably be kept directly below or opposite to the main switch. Between the switch and the machine or feeder cables the various transformers for the operation of instrument and relays should be installed. (See Figs. 10 and 12.)

All instruments should be worked through transformers, thus greatly simplifying the alternating-current switchboard problem, as recording wattmeters, power-factor indicators, ammeters, voltmeters, and relays can be (and should be) supplied from one set of transformers—so reducing the complication on the main circuits to a minimum. Although by the above method the main connections are not complicated by the installation of additional instruments, yet, for the sake of simplicity and saving in first cost, the number of instruments installed should be reduced to the lowest limit.*

The desirability of locating the machine and switch panels directly opposite their respective generators or cables has been previously referred to, but this arrangement necessarily involves a switchboard extending the whole length of the station. It is evident that the switches on such a board must be operated from some central point in the station—*i.e.*, the switches must be controlled from a distance. There are three ways of effecting this :—

(1) Electrically, as has lately been successfully adopted and developed by the General Electric Co. of America.

(2) Mechanically, as railway points are now worked from a signal cabin. In this case automatic devices must be electrically tripped.

(3) Pneumatically, simply substituting compressed air as the operating agent.

There is very little difference between the three methods so far as adapability is concerned—for reliability we prefer either (1) or (2). In each case the operating platform can be kept small, so that all the gear is under the eye of the operator. In fact, its length is really limited by the room taken up by switchboard instruments more than by any levers, switches, or valves necessary for the mechanical, electrical or pneumatic operation. Generally speaking, the longer the board the more desirable does electrical operation † throughout appear to be.

Under oil switches we have referred to the necessity for opening all circuits by the switch rather than by fuses. This means that it is almost essential that automatic overload devices should be installed, so as to operate the switches on each outgoing feeder. When automatic switches first replaced fuses, such overload devices were manufactured on the same lines as an ordinary direct-current traction circuit-breaker. This design, while entirely satisfactory in the case of an ordinary direct-current traction supply, where a momentary stoppage is of relatively small importance, is quite out of the question in the case of a power system from which not only lighting and power are supplied, but on which revolving synchronous sub-station machinery may be running. The shut down of a feeder means the shut down of a sub-station, and this is a serious matter. It was found that such circuit-breakers were apt

* The following list gives all the instruments that are absolutely essential:—Machine panel: Main ammeter on one phase, voltmeter for synchronising, field ammeter. Feeder panel: Ammeter on one phase. The recording wattmeters may be put on the machines for the reasons stated later; it is safer to put the recording wattmeters on the machines

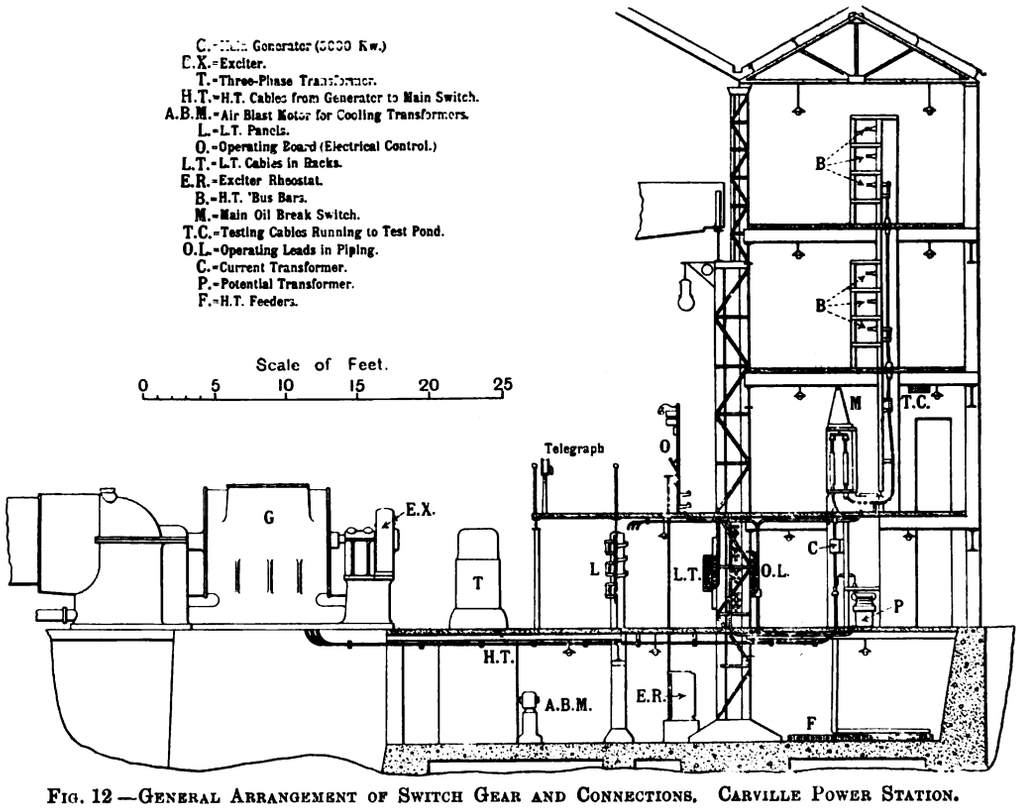


FIG. 12.—GENERAL ARRANGEMENT OF SWITCH GEAR AND CONNECTIONS. CARVILLE POWER STATION.

* Three-core cables with a complete copper shield embracing all three cores should be used for these connections when earthed iron shields are inadmissible. In both this country and the United States it was, until recently, the universal practice to run bare lead-covered cables in manholes, with the natural consequence that in the event of one of the cables failing it was no uncommon thing for all the cables in the manhole to get damaged. The authors have known lead-covered cables give way due to an incandescent lamp lying against them. Arcs are frequently started between large power cables by the fusing of some minor wires—possibly pilot wires—which had nothing to do with them.

than on the 'bus bars, as the arrangement avoids any apparatus being connected with the 'bus bars except through an oil-switch.

† It is desirable that the operating leads should be kept entirely separate from the instrument leads, and, further, that the leads for each machine should be kept separate and run in accessible positions.

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to operate with instantaneous overloads which would have cleared themselves had pressure been maintained. In order to avoid this trouble, clockwork time-limit devices were tried with equally unsatisfactory results, as, when the clockwork devices were set so as to keep the switch "in" on small short circuits such as were likely to clear themselves, they refused to open sufficiently rapidly on bad shorts, so upsetting the whole system.

It was suggested, therefore, by several engineers and manufacturers independently that what was required was an automatic device which imitated the action of a fuse—that is to say, an automatic adjustable circuit-breaker having a time lag inversely proportional to the magnitude of the overload. Various manufacturers have endeavoured to meet this condition in different ways;* but, though great improvements have been effected, it cannot yet be said that any protective devices have been perfected which can be depended upon under all conditions on a complicated system to cut out a faulty feeder or machine without affecting the working of other apparatus. Outgoing connections from the 'bus bars may be more or less satisfactorily protected as above; but, if similar overload devices are used in the machine circuits, it is practically impossible by any graduation to ensure that the feeder and not the machine circuit will open in the case of an outside short circuit, while it is equally difficult to so discriminate that the faulty and not a sound machine is cut out in the case of a short circuit occurring on one of the generators. Endeavour has, therefore, been made to fit relays which would only operate with reverse current† having a time limit inversely proportional to this reverse current, but which would not respond to any overloads or shorts so long as a positive direction of current was maintained. This latter arrangement would at first sight appear a satisfactory solution of the problem, but in practice it is very far from being so. All such reverse devices so far put to commercial use depend for their action on a potential coil. It is just when the short circuit is most severe that these devices are wanted, and the difficulty is that with a severe enough short circuit the potential may drop considerably before the faulty machine is cut out, with the result that the apparatus fails to operate.

Another objection to the present type of relay (both overload and reverse) is that in the case of a heavy fault, when the whole of the network may be affected, the cut-outs in other sub-stations than the one at the end of the faulty feeder operate and thus shut down supply; this is especially liable to happen on polyphase systems when the fault develops between two phases only or between one phase and earth; in this case all motors and transformers on the system immediately tend to pump current into the fault. The authors are of opinion that at the present time automatic protective devices require more attention than any other subject in connection with reliability of supply.

The same points which have been referred to in detail when dealing with the main board and connections apply to the low-tension apparatus and cables, though of course in lesser degree. It is certainly important that all low-tension connections should be kept entirely separate from high-tension connections or cables in order that no fault of the former may affect the latter. The authors have a strong preference for wiring on insulators as against wiring in pipes for all small wires and for all lighting work. It is cheaper, it gives less trouble in practice and any fault is more readily seen. This system, however, can only be carried out in cases where proper subdivision is resorted to and where the circuits are not crowded together.

6. Measuring Apparatus and Records.

In general, while very complete station records are kept of the data directly affecting the electrical side of the generating plant, scant attention is paid to boiler-house records so far as the factors governing the economy of the boilers are concerned. This would appear to be a mistake, as it will almost invariably be found that the boiler-house equipment will give a greater return for any trouble taken with it than will either the engine-room or the electrical apparatus. The efficiency of the electrical and engine-room apparatus are comparatively easily ascertained by fairly accurate instruments. On the other hand, tests on the boiler-house apparatus are frequently of so rough and ready a description as to at once arouse doubts as to their accuracy, and as a consequence they are taken less and less frequently. It is, however, possible, and it is certainly desirable, to get data from the boiler-house plant of very approximate accuracy. Complete records should be kept showing the performance of the various component pieces of apparatus throughout the whole process of generating electricity from coal, and an assistant with some chemical knowledge should be made responsible for the boiler-house economy and for keeping accurate data in connection therewith.

We will briefly refer to the apparatus necessary for keeping a check on the economy of the station:—

Coal-weighing Apparatus.—The coal-weighing apparatus should consist of:

(*a*) A main coal truck weighbridge for checking the railway company and the colliery.

(*b*) An apparatus for weighing the coal fed to each boiler from the overhead bunkers (if these are erected).

The latter may be used either continuously or for special tests. The weighbridge should certainly be used continuously.

Coal Analysis.—It is as important to check accurately the calorific value and the percentage of ash contained in the coal purchased as it is to check its weight, and an analysis should therefore be taken from weekly samples of the coal used.

Apparatus for Analysing Flue Gases.—Records of the flue gas composition are also of importance. There are several instruments in the market for taking continuous records, but none of them seem likely to displace the Orsett apparatus.

The Measurement of Temperature.—Ready means should also be provided for obtaining the following thermometric records:—Temperature of superheat, temperature of air-pump discharge, temperature of feed water before and after economiser, temperature of flue gases before and after economiser and at various positions along the flue.

Water-measuring Apparatus.—Continuous records should be kept of the whole of the feed water, the make-up water and the water purchased from the water company. Permanent arrangements should further be made for measuring the air-pump discharge of any one unit. This is comparatively inexpensive, yet it is to be found in very few stations. The simplest way to obtain this information is to have a two-way valve on the air-pump discharge, one way of which is connected to a special pipe leading to duplicate measuring tanks, so that the discharge from any unit may be accurately ascertained for any period of test.

Pressure Gauges.—The steam and vacuum gauges call for no remark. Draught gauges are of more importance in stations fitted with mechanical draught than they are in stations fitted with natural draught, and it is only by frequent observation that the best draught, the best thickness of fire and the best speed of stoker travel can be maintained.

Output Meters.—The wattmeters may either be placed on the main 'bus bars between the feeder panels, on each individual machine, or on each of the outgoing feeders. These meters necessarily complicate the switch-gear materially, but it is absolutely necessary to provide them. In order that it may be convenient, without alteration to the connections, to test the output of a main generating unit at any time, it would seem to be correct to place them in the generator leads. A further advantage of this is that, in a modern station, it involves fewer meters than if they be placed in the feeder cables. Power-factor indicators are only of importance where the power-factor is under control, as in the case of a station having a combined synchronous and induction motor load.

Having installed all the above instruments, the only item necessary to complete the equipment required for accurate special tests is a water resistance to absorb the energy generated by the plant under test. It is worth while providing permanent arrangements for connecting this water resistance to any generator at will.

To sum up, complete *permanent* apparatus should be provided for taking all necessary tests, thus avoiding the unreliability and uncertainty of makeshift arrangements.

Conclusion.

The function of a power station designer is to choose from standard apparatus that which best fulfils the conditions to be met, and to assemble it in the most economical way. It is only by a rigid application of this principle to the individual parts that the essential condition of low capital cost can be complied with. Electrical energy from public supply as against the provision of isolated plants is possible in this country with its relatively dense population in a way that is not possible in America or on the Continent—where industrial centres are separated from each other by wide tracts of country. Although in many ways disappointingly late, realisation during the next few years of our almost unique position in this respect is likely to have a marked effect, both industrially and socially.

* See "Protective Devices for High-tension Electric Systems," by W. B. Woodhouse, British Association, September, 1903; *The Electrician*, Vol. LI., p. 925.

† Messrs. Brown, Boveri have developed a reverse current circuit-breaker similar in type to their overload circuit-breaker. The introduction of a reliable reverse current relay will also solve the problem of cutting out a faulty feeder from the sub-station end, where two or more feeders feed one sub-station.

Newcastle Local Section of the Institution.—At a general meeting of the Newcastle Local Section of the Institution of Electrical Engineers, held on Monday, the officers for the ensuing session, as given in *The Electrician* of last week, p. 86, were elected.

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AUTOMATIC PROTECTIVE DEVICES FOR ELECTRICAL CIRCUITS.

Interesting demonstrations of various ingenious devices for the protection of electrical circuits were given by Mr. Leonard Andrews at the London office of Messrs. Cowan and Andrews on Thursday and Friday of last week. Mr. Andrews accompanied the demonstrations with short lectures, and said that in the early days of electric lighting, reverse current automatic circuit breakers were so unreliable that many engineers preferred to trust entirely to fuses or to hand-operated switches. Several serious breakdowns that had occurred during the past winter had again called attention to the necessity for some apparatus that could be relied upon to isolate the faulty generator, without at the same time cutting off a generator that was doing useful work.

One of the chief difficulties in designing a reliable reverse current circuit breaker arises from the general fall of potential that almost invariably takes place when a fault occurs on any part of a system of supply. The differential solenoid type of release is one of the greatest offenders, both as to its susceptibility to variations of pressure and also as to its small difference of cut-out pull with generating and motoring currents. The particular specimen shown by Mr. Andrews was actuated with a motoring current of 50 amperes and with a generating current of, approximately, 500 amperes, the ratio of the generating current to the motoring current being about 10 to 1. When the pressure across the shunt fell to about 50 per cent. of normal, the device was actuated by a generating current less than twice the value of the motoring current. It was thus obvious that with any appreciable variation of pressure this type of cut-out ceases to be a reverse-current circuit-breaker and becomes an excess-current device. It will, in consequence, almost certainly be operated by an excess current on the feeders, and will often cut out a healthy generator just at the time when every generator is most urgently required.

The troubles experienced with the differential solenoid type of release appear to show that the moving core used for releasing a reverse-current circuit-breaker should pull in one direction with a motoring current and in the reverse direction with a generating current, or, failing that, should have no appreciable pull with any amount of generating current. One method of attaining this result was shown in a device having a few turns of thick wire connected in series with the circuit to be controlled wound on the field-magnets of a miniature motor, and a number of turns of fine wire connected across the leads of opposite polarity, wound on the armature. When the current in the series winding is flowing in a certain direction relatively to that in the shunt, the armature will tend to rotate in a given direction. Movement in this direction is, however, prevented by a stop. Should the direction of the series winding become reversed, the armature will rotate in the opposite direction, and will thus release the circuit-breaker either directly or by closing a local circuit through the operating coil. It can, however, only be relied upon to do this so long as the armature is set at right angles to the direction of the field. Should a change of adjustment cause it to take a lead in the "breaking" direction, the effect of a heavy current in the series winding will cause it to rotate further in this direction, and so release the cut-out. As this is most likely to occur at the time of full load or when the generator is required to supply a momentary excessive current to burn out a fault on a feeder, the cutting out of the generator at this time is liable to be disastrous. To overcome this difficulty it is usual to give the armature a slight lead in the "holding-in" direction, so that a heavy current in the series winding will tend to lock the cut-out rather than to release it. But this precaution introduces another difficulty: if a reverse current is applied slowly, the cut-out will operate perfectly with possibly 5 or 10 per cent. of the full-load current. If, however, the series current is suddenly reversed from a heavy generating current to a heavy motoring current (such sudden reversal being always liable to occur when a generator breaks down), and if this heavy reversal is accompanied by an appreciable drop of pressure, the tendency of the armature to turn in the "holding-in" direction, thereby reducing the reluctance of the magnetic circuit, is so very much greater than the tendency to turn in the "breaking" direction, due to the polarity effect, that there is always a risk that this type of cut-out may fail to isolate a faulty generator. The experiments with a full-sized model of this motor type device showed that the release holds in securely with any generating current and operates with a small motoring current, so long as the potential is maintained, but holds in instead of releasing on a heavy reverse current with a 50 per cent. drop of pressure across the shunt winding.

The chief cause of the reluctance effect overcoming the polarity effect of the above device is that an attempt has been made to use a nearly-closed iron circuit. If solenoids are used to act upon an armature without a return magnetic circuit, a reliable relay may be made that entirely overcomes all the difficulties experienced with the wattmeter type. A device (B. C. D. Fig. 4) was exhibited, having a swinging ⊥-shaped pendulum, polarised by a fine wire solenoid, and the free ends of this swinging armature acted upon by two heavy coils carrying the series current. It is obvious that with the current in one direction the armature will be pulled in such a direction as to hold the relay contacts open, whereas with a reverse current the relay contacts will be closed and the circuit breaker released. One of these relays was connected up in circuit with a circuit-breaker, and it was seen that there was no tendency to operate the cut-out with a heavy forward current; on the other hand, it was released with a small reverse current, and operated equally reliably with a heavy reverse current and with a drop in pressure as low as 25 per cent. of the full load pressure.

Although the pendulum-type of relay just described works satisfactorily, there are obvious advantages in making the circuit-breaker direct acting. As the blow required to release a large circuit-breaker must be considerable, it appears almost impossible to attain this with a reverse current of less than 25 per cent. of the normal current without the aid of a closed iron circuit, and in the majority of closed iron circuit devices there is the difficulty of the reluctance effect overpowering the polarity effect under certain conditions. Mr. Andrews explained, however, that he had succeeded in making a closed magnetic circuit device in no way subject to this difficulty. This device is illustrated in Fig. 1,* and it will be seen that it is constructed on the lines of the field magnets of a Manchester-type dynamo. If the field winding on one of the limbs of a Manchester-type dynamo is open-circuited, this limb will magnetically short-circuit the remaining limb, and, as a consequence, very little flux will flow through the armature and air gaps. Further, if the direction of the current in the field winding on one of the limbs of a dynamo of this type is reversed, the tendency of the flux to circulate through the field-magnets and avoid the armature path will be even greater. In Fig. 1 the series and shunt-windings are so connected up that under normal conditions the fluxes will flow through the field-magnet limbs in series, avoiding the centre path through the movable core and air gap. Should the series current become reversed relatively to the shunt current, the fluxes will oppose each other and traverse the centre path, corresponding to the armature of a Manchester dynamo, producing a strong field across the air gap and lifting the movable core with considerable force, thus directly releasing the circuit-breaker without the intervention of a relay. Characteristic curves of this type of release are reproduced in Fig. 2. It will be seen that at normal pressure a magnetising force of 33 ampere-turns in the reverse direction is sufficient to operate the cut-out,

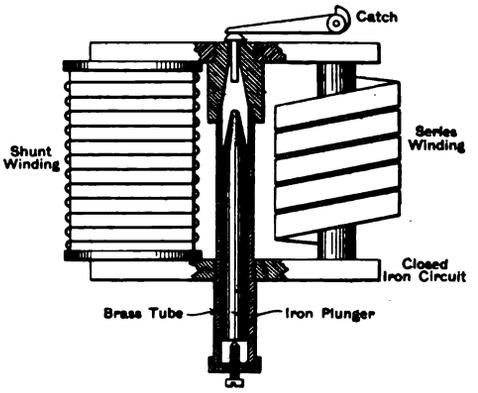

FIG. 1.—CLOSED IRON CIRCUIT RELEASE.

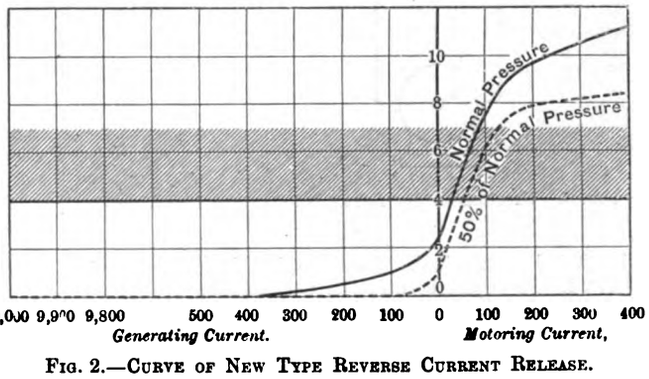

FIG. 2.—CURVE OF NEW TYPE REVERSE CURRENT RELEASE.

* The drawings with which this article is illustrated will appear in a book on electrical switchgear by Mr. Leonard Andrews, which will shortly be published by Messrs. C. Griffin & Co.

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whereas with 10,000 ampere turns in the generating direction the pull on the core is practically immeasurable. It will also be seen that this type of cut-out is not highly susceptible to a drop of potential across the shunt windings, as with 50 per cent. of normal potential the cut-out operates with a reverse current of only 50 ampere turns, and still shows no sign of releasing with 10,000 amperes turns generating current. By using a cast steel core in the shunt winding this core retains residual magnetism long enough to operate the cut-out even should the potential fall to zero. Experiments with this device showed that a powerful pull is exerted by a small reverse current, even with reduced shunt pressure, whereas the pull is immeasurable with the heaviest forward current obtainable.

All the devices referred to above may be used for alternating-current circuits; but other difficulties are met with in alternating-current discriminating devices that do not arise in connection with continuous-current systems. One serious difficulty common to nearly all alternating-current devices is that, in addition to the troubles which are liable to arise through the drop of pressure across the potential winding owing to external causes, a further reduction of the shunt current takes place owing to the inductive action of the series winding in the cut-out device upon the shunt winding. In some types, on passing a very heavy current from the series winding, the current in the shunt winding due to the applied E.M.F. is entirely wiped out by the secondary current and as a consequence the device loses all sense of direction. The device illustrated in Fig. 3 appears to overcome this difficulty. It will be seen that the device consists of a transformer wound with two primary and two secondary windings. One of the primaries, usually consisting of one turn, is connected in series with the

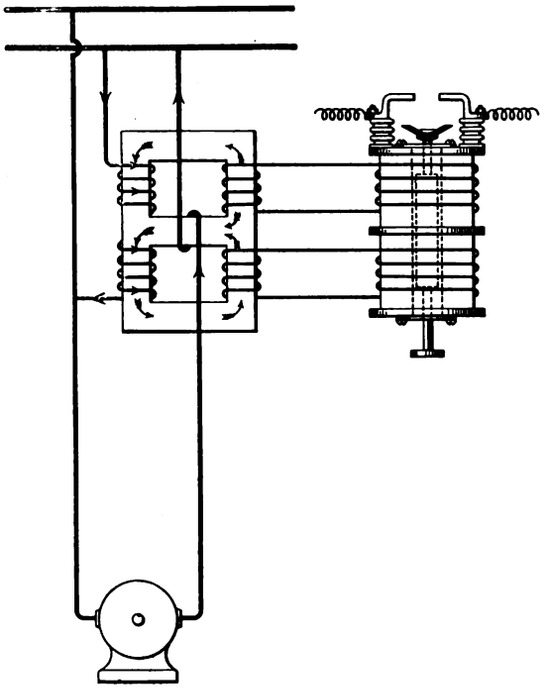

Fig. 3.—Discriminating Relay for Alternating-Current Cut-out.

circuit to be controlled. A current in this winding tends to produce a flux in the centre core of the transformer which divides equally between the two magnetic return circuits and cuts the two secondary windings equally. As a consequence the coils of the relay will both be equally energised, and the coil will neither be pulled up nor down. The potential primary winding tends to produce a flux which flows round the outer magnetic circuit, avoiding the centre path. This flux will also tend to cut the two secondaries equally. If now the combined effect of the flux due to the two primaries is considered, it will be seen that the fluxes in the upper half of the transformer oppose each other, whereas those in the lower half assist each other; as a consequence the core is forcibly held down. These conditions will be maintained so long as the generator supplies current to the 'bus bars. Should the direction of the series current become reversed, relatively to the shunt, the fluxes in the lower half of the transformer will oppose each other, and those in the upper half will assist each other, with the result that a much heavier current is induced in the upper secondary than in the lower secondary, and the core is pulled up until it closes the local circuit and operates the cut-out. There are usually connected in parallel with the respective windings of the relay, a red lamp across the upper secondary and a green lamp across the lower. These lamps indicate at a glance the direction of the current, they give an approximate indication of the amount of current flowing in the generator circuit, and they give a constant indication that the apparatus is in working order. If, for instance, an open circuit occurred in the shunt winding both lamps would glow equally on a full-load current, whereas without this indication the device might be left for some days before the defect was discovered, and if the generator controlled failed in the meantime the automatic device would fail to serve as a protection. Another argument in favour of using the lamps in conjunction with this device is that the operation of any relay device depends, to a certain extent, upon the relay contacts being kept clean, but should this happen to be overlooked and the relay fail to close the local circuit, the attendant has always a perfect indication as to which generator is failing, and he can, in consequence, operate the circuit-breaker by hand.

The experimental apparatus shown in connection with this device consisted of a discriminating transformer of the above type, mounted

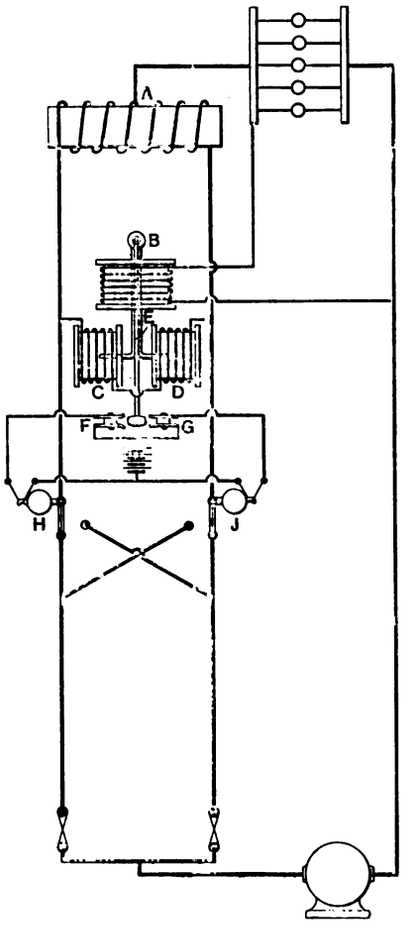

Fig. 4.—Duplicate Mains Switch Gear. Diagram of Connections.

on an oil-break circuit-breaker with loose handle attachment, and fitted with a relay and trip gear. An ammeter connected in the series circuit was mounted on the panel from which the amount of current flowing in the series circuit was observed. A voltmeter was connected across the shunt windings, and it was seen that the device worked with absolute reliability on a drop of pressure of 75 per cent. A reversible booster was provided by which the current could be increased from zero to the full load of 200 amperes, or reversed to a motoring load of 200 amperes. With a full load forward current on, the green lamp glowed at full brilliancy, the red lamp was entirely extinguished, and there was a strong pull holding the relay in an open position. When the direction of the current was reversed the green lamp went out and the red lamp glowed. With a current of 50 amperes at which this cut-out was set to operate, the relay was pulled over very decidedly, thus closing the local circuit and instantly operating the circuit-breaker. The pressure was then dropped to 50 per cent. of normal, and the cut-out operated with a reverse current of 100 amperes; again, reducing the pressure to 25 per cent. of normal, the cut-out operated with a reverse current of 200 amperes. The current in the shunt winding was entirely unaffected by a heavy current in the series winding. It will be seen, on referring to Fig. 3, that the

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flux due to the series winding tends to boost one half of the potential primary and retard the other half, and as these two windings are in a series the effect is neutralised.

Although the type of cut-out just described will apparently deal satisfactorily with any breakdown that is liable to occur on the generator board, it cannot be considered in all cases absolutely reliable for use at the distributing end of duplicate feeders to prevent the current feeding back from the healthy feeder into the faulty feeder. It is practically impossible to make an alternating current discriminating cut-out work reliably with no potential across the shunt primary. Such very severe conditions are not liable to arise at the generating end of the line, and in cases where sub-stations are fitted with motor generators and batteries, there will probably be no difficulty in maintaining sufficient pressure across the 'bus bars to operate a reverse-current circuit-breaker. In cases, however, where duplicate feeders are used for feeding sub-stations containing stationary transformers only, there is always a risk that in the event of a low resistance short-circuit occurring near the sub-station, the fall of potential would be so great that no discriminating cut-out could possibly deal with the difficulty. As a rule feeders are interconnected at the sub-station end through 'bus bars only, and, as a consequence, there is practically nothing to limit the flow of current to the faulty feeder. If instead of this the feeders are connected through a choking coil, wound entirely in one direction, with the supply to the sub-station tapped off at the centre of the choking coil, as described in *The Electrician*, Vol, L., p. 379, under normal conditions the current will divide equally between the two feeders,

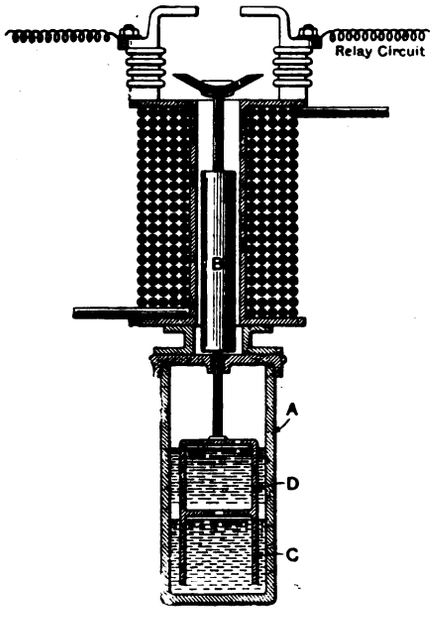

Fig. 5.—Time Limit Relay.

and will flow round the two halves of the choking coil in opposite directions, and as a consequence this coil will be entirely non-inductive. As by this device the potential of the supply cannot under any condition drop below 50 per cent. of the normal, the difficulty of constructing automatic circuit-breakers that can be relied upon to isolate a faulty feeder instantly is overcome. One method of automatically operating these circuit-breakers is shown in Fig. 4. It will be seen that this is an adaptation of the pendulum device referred to earlier. The series winding CD is in this case connected between the two feeders; as, however, there is normally no difference of potential between these feeders, there will be no tendency for current to flow from one to the other. Should one of the feeders break down, current will flow from the healthy feeder through the series coils of the relay to the faulty feeder, and as this current will have a sense of direction relatively to the shunt winding B, the relay will close the local circuit at F or G, controlling the circuit-breaker HJ on the sub-station end of the faulty feeder. The cross connections shown on the diagram are provided to maintain the choking coil A non-inductive when one of the feeders has been cut off and the supply continued through the remaining feeder only.

For demonstrating this effect a model installation had been erected, consisting of duplicate lines terminating in fuses at one end and in a specially-constructed oil-break circuit-breaker, controlled by a relay as described, at the other end, a small discriminating choking coil being used to connect the lines together. The oil-break circuit-breaker has been specially designed for this purpose. It is not dependent upon delicate catches, and is, consequently, not likely to operate when not required to do so. As a further precaution, the two switches are so interlocked that when one has been automatically opened it is impossible for the second switch to be so released; there is, therefore, no risk of the two switches being opened simultaneously and the supply being interrupted. On connecting one of the lines to earth the fuse at what corresponded to the generating station end of this line was blown, and the pressure across the lamps was reduced to about 50 per cent. of the normal. This drop of pressure only lasted, however, for a fraction of a second, as the switch operated immediately and the full pressure was restored.

During the past few months there has been a great tendency to use magnetically-operated excess circuit-breakers on high-tension transmission lines in place of fuses. It is, however, universally recognised that a magnetic circuit-breaker is not complete without some time-element device to delay its action in inverse proportion to the amount of excess current, and it is also essential that on an overload exceeding a certain amount the device should operate as instantaneously as a fuse does. A method of obtaining this result is shown in Fig. 5. The apparatus consists of a vessel, A, containing mercury and some lighter liquid, such as oil; a miniature diving bell directly attached to the operating core is immersed in the mercury. This diving bell is divided into two compartments, C and D, by a thin diaphragm, and communication is established between the upper and lower compartments through a small hole in this diaphragm. A second hole is also made in the upper portion of the diving bell. It is obvious that a certain current will be required in the solenoid to overcome the weight of the core B and diving bell. If the core is lifted slowly the air pressure on the top of the liquid in the diving bell will be equal to the pressure in the outer containing vessel, and as this pressure will be transmitted through the oil to the mercury the level of the mercury on the inside will equal that on the outside. If, however, the core is lifted more rapidly, the

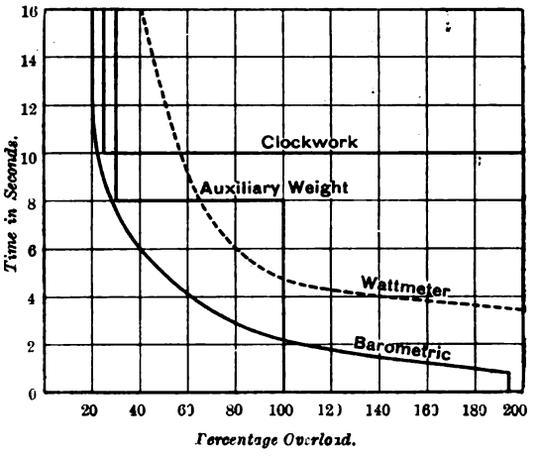

Fig. 6.—Characteristic Curves of Various Types of Time Element Devices.

liquid, after passing through the small hole in the diaphragm, is wire-drawn, and as a consequence the pressure inside the diving bell will be considerably less than that on the outside, and a column of mercury will be added to the weight of the diving bell, the height of this column depending upon the rate at which the core and diving bell are lifted. If the core is lifted instantaneously none of the light liquid will have time to flow through the diaphragm, and as a consequence a vacuum will be produced in the diving bell on the underside of the diaphragm and the whole of the mercury in this will, in consequence, be lifted instantaneously. It may appear at first sight that the apparatus would work equally well without any liquid over the mercury. This would, however, entail the use of such a very small hole in the diaphagm that there would be a risk of this becoming obstructed by particles of dust, and it does not appear that such a wide range could be obtained with the arrangement shown.

An experimental apparatus, consisting of a glass containing vessel and glass diving bell, was connected up, and when a current of about 10 amperes was switched on the diving bell lifted very slowly and took several seconds to travel through its whole range. Upon increasing the current to 15 amperes the movement was greatly accelerated, but it still took quite an appreciable time to travel through its whole range. With a current of 30 amperes, the core with the diving bell full of mercury was lifted instantaneously. Fig. 6 is a set of curves showing the behaviour of various time-limit devices which have been introduced from time to time, that marked "Barometric" relating to the diving-bell arrangement just described.

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ROYAL COMMISSION ON LONDON TRAFFIC.

Thursday, May 5.

Mr. PHILIP DAWSON, of Messrs. Kincaid, Waller, Manville and Dawson, consulting engineers, dealt with the possibilities of the electrification of London suburban steam railways. A great trouble at present, he said, was the inadequacy of terminal facilities, a question most difficult to deal with both on account of the heavy expenditure which the necessary alterations would entail and also because of the difficulties of working trains over lines belonging to various companies. After suggesting means by which improvement could be made in this direction, he pointed out that although it might be possible for tube trains to run over service lines, a difficulty had been presented by the fact that the Metropolitan District Railway Co. had adopted a continuous-current system which necessitated a third and sometimes a fourth rail. Investigations which he had made for the purpose of presenting a report to the directors of the London, Brighton and South Coast Railway convinced him that the only possible system for suburban steam railway companies was one requiring not more than one overhead conductor per track, in other words, the single-phase high-tension-alternating current system. The question as to which railways should have their suburban service electrified depended, to a large extent, upon their location. Among other lines he thought the following might be mentioned:—The London, Brighton and South Coast Railway, the South-Eastern and Chatham Railway, the South-Western Railway, the Great Eastern Railway and the North London Railway. After going in detail through the advantages of electric traction over steam traction, witness continued that under the present conditions it was practically impossible to increase the frequency of trains, for the two following reasons:—(1) Because of the greatly increased costs which an increased service of steam locomotives would entail and (2) because of the impossibility of operating these trains, owing to the mutual interference of the suburban and main line traffic, where these services had to use the same sets of metals. The greatly increased speed of electric trains, even with frequent stoppages, would enable local trains to be run between the main line steam trains without materially interfering with the latter. At the present moment electric tramways, owing to their high average speed as compared to the very low average speed of suburban steam railways, had already seriously damaged the railway companies. Electrification would change all this, as it would enable the railway companies to increase their average speed so greatly that no tramway would be able to compete for any distance over 4 or 5 miles. He thought that London was much better served with respect to the location of its termini than most large cities on the Continent and in America, and this circumstance would materially benefit the electrification problem. As regards the system of traction to be adopted universally, it was obvious that, other things being equal, the most advantageous system was the one which, without any serious modification, could eventually be extended to main lines. Railway companies had naturally shown great disinclination to instal electric traction because of the heavy capital expenditure which would be required, because in the past the science of electric traction had not sufficiently advanced to enable them to have actual figures of results, and also because tramway competition had not become sufficiently severe to compel any action on their part. Matters had now changed, however, and a great many companies were carefully investigating the subject. He was of the opinion that where railway companies showed a disinclination to act, competing companies should be encouraged. On the other hand, the railway companies themselves should be encouraged by the knowledge that if they themselves were prepared to meet the requirements of the public, schemes which could be shown to be absolutely competing would not be sanctioned. If, however, the railway companies were going to experiment with electricity by simply sandwiching a few electric trains between the local steam trains, failure was sure to result, as all the advantages of electricity would be entirely lost. The introduction of electric traction on suburban lines would practically result in doubling the capacity of the system as well as virtually doubling all the terminal facilities, owing to the shorter time required for trains to get in and out of the termini. Witness also dealt with the lower working costs of electric traction compared with steam traction, and thought that a further decrease in the operating costs of electric trains would be introduced by only having one man to drive. The Board of Trade, he thought, should take no exception to this, as, if the driver should be incapacitated in any way, the methods of control used were such that the current was immediately automatically cut off and the brakes put on. The costs of drivers' wages would also be reduced, as the man required to operate the electric train need not be a mechanic or trained man; native intelligence was all that would be required.

Mr. S. B. COTTRELL, engineer-in-chief and general manager of the Liverpool Overhead Railway, said that in his opinion overhead railways should be constructed to deal with urban traffic where there were back streets available for the purpose and where the unsightly appearance of overhead railways, as well as the compensation, would not be a serious item. In London, however, such streets were difficult to find, and the choice, therefore, lay between shallow subways and deep level tunnels. The nature of the subsoil of London, however, made it almost impossible for the construction of the former, and the use of deep level railways was therefore imperative. The remainder of his evidence consisted of the details of the traffic results upon the Liverpool Overhead Railway and the Liverpool Corporation Tramways.

Mr. H. E. JONES, president of the Institution of Gas Engineers and chairman of the Gas Companies' Protection Association, was called to show that the opening of the roadways by the gas companies in London caused practically no obstruction to traffic. On the other hand, he contended that an exceptionally large number of openings in connection with the Post Office telephone system and also by the electric lighting and tramway companies had had a most injurious effect upon the traffic inasmuch as, in the case of telephones, the contractors, presuming upon their working for a Public Department, had ignored the convenience of the public altogether in a manner which would never have been permitted in the case of a contractor for a gas company's works. With regard to the opening by electric lighting and tramway companies, all of these works had been carried out either by people not having previous experience and the necessary skill or, at any rate, having little or no regard for public convenience. Witness disagreed with the policy of providing subways to take gas pipes, &c., both upon the question of cost and the question of access. There was very great danger also to be apprehended in a subway of the description which had been frequently suggested, as in the case of a leak in the gas pipe, unless the men where near a man-hole, they most certainly would be suffocated.

Friday, May 6.

Mr. G. F. L. FOULGER, distributing engineer of the Gas Light and Coke Co., placed details of the operations of that company with respect to the opening of roads before the Commission with the object, he said, of enabling it to judge to what extent, in carrying out their statutory operations, the company might have contributed to obstructing roads, and especially the main thoroughfares. He said he thought the obstructions during the past 10 or 12 years had been largely caused by those companies and bodies who had been engaged in laying down their distribution plant for the first time—namely, the electric lighting companies and borough councils supplying electricity, and also the telephone system laid down by the Post Office authorities.

Prof. A. B. W. KENNEDY, engineer-in-chief to the Westminster Electric Supply Corp., gave evidence on behalf of this undertaking, and also on behalf of all the other London electric lighting companies, chiefly with respect to the breaking up of streets. With regard to the various suggestions for the provision of subways as a means of getting rid of the opening of streets, he thought that most of the witnesses had not fully realised the nature of the problem. In the first place, even when practicable at all, such subways were restricted to a few important thoroughfares, whereas the electrical mains covered practically all the streets in a district. Moreover, the work of all electrical undertakers came first under principal streets and, therefore, was long ago practically finished just in those streets were subways were being suggested. He did not think the present regulations with regard to notice, &c., were satisfactory, and suggested that 14 days' notice might be given for all new work and for any pavement work over 20yds. in length. Such a notice should be given to the local authorities, the Postmaster-General, gas and water companies, hydraulic power companies and the electrical companies, each one to the other, affected in the particular place concerned; in other words, the notice should be absolutely reciprocal. It should be arranged that undertakers receiving these 14 days' notices and wishing to do work of their own in the same locality should be allowed to send in a notice during that 14 days, so that the two sets of work might go on simultaneously. So far as the Westminster Company was concerned, he was glad to say they had always succeeded in working on friendly terms under the present regulations, but unless material change could be made in the regulations, it was not possible for one undertaking to co-operate with another so far as the breaking up of the roads was concerned. Reverting to the question of subways, he said there was very great danger in putting electric light mains and gas mains within the same very limited space. In considering this, or any other type of subway, he did not think that it had ever been realised what a very large amount of space was actually required for electrical mains alone. In Edinburgh he had a subway in use from one electrical power station alone, and it was 6ft. 6in. high and 3ft. 6in. broad inside. It was designed to take nothing but the cables or copper from one station only, a station not so large as, for example, the Bankside station of the City of London Company. It would be quite impossible to find within a subway of the London County Council pattern anything like room for the large quantity of electric mains, in addition to water, gas and hydraulic mains. He did not think that the provision of a central authority to regulate the breaking up of streets throughout London would be desirable in itself or of use to the public.

Mr. JOHN CONACHER, general manager of the Metropolitan Electric Supply Co., said he concurred generally in Dr. Kennedy's evidence.

The Commission adjourned.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E FOURNIER D'ALBE.]

Electric Origin of Rigidity.—An important Paper on certain developments of the kinetic theory of solids is published by W. Sutherland. He finds that the variation of rigidity with temperature is a simple kinetic phenomenon, but that rigidity itself at the absolute zero is a purely electrostatic affair. The work done in subjecting an electric doublet consisting of a pair of electrons to a small shear is half the square of the shear multiplied by the original electric energy. Thus the rigidity of a pair of electrons is identical with their electrostatic energy. This demonstrates the electric origin of rigidity at absolute zero. At higher temperatures kinetic effects have to be taken into account as well as the static effects. The author draws some interesting conclusions. The rigidity of

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a metal at the absolute zero must be the rigidity of its monatomic molecule. Atomic vibrations may be calculated and interpreted as an electro-mechanical analogue of the vibration of an ordinary magnet. The inertia of the atom corresponds to the inertia of the magnet, and the electric doublet to the two magnetic poles. The author assumes that the electric doublet revolves round the spherical atom with a velocity proportional to the absolute temperature. He denotes the electrostatic energy associated with matter per unit volume in a metal at absolute zero by W^2, and at a temperature θ by w^2, and establishes the equation

$$\frac{w^2}{W^2} = 1 - \frac{\theta^2}{T^2}.$$

where T is the melting point. The electric moment is given by the distance between the electrons, and the electrokinetic energy by the velocity of revolution. In some phenomena the total energy predominates, while in others the parts w^2 and $W^2\theta^2/T^2$ separately predominate. Each atom is equipped with an electrostatic doublet and what amounts to an electric gyrostat, both having the same axis. In a metallic conductor all the gyrostats vibrate in a field of electric force like a number of spinning tops in a field of gravity. During the vibrations it will sometimes happen that the positive and the negative electrons of two adjacent doublets come so near to one another that their attractions break up the doublets to form a new one, and liberate positive and negative electrons at about two molecular diameters apart. These in rushing together may be regarded as free, and may upset the stability of other doublets. Thus we must allow to each electron the average free time and free path postulated by Riecke. This dissociation is characteristic of the doublets in metals, and causes metallic conduction. The reason for the profound distinction between metals and insulators is that in the monatomic molecule of the metal both positive and negative electrons are in the same atom, whereas in compounds they are generally in different atoms. In a metal of varying temperature the transmission of energy is greater from hot to cold than in any other direction, because the free electron carries with it the kinetic energy of the temperature ruling where it gained its freedom, and so we have the conduction of heat.

[W. Sutherland, *Philosophical Magazine*, May, 1904.]

Electron Theory of Spectra.—Several attempts have been made to find a material system which will give rise to vibrations conformable with the formulæ given by Balmer, by Kayser and Runge, and by Rydberg. Instead of seeking to find a system whose modes of vibration are brought into complete harmony with the regularity observed in spectrum lines, H. Nagaoka discusses a system whose small oscillations accord qualitatively with the regularity observed in the spectra of different elements, and by which the influence of the magnetic field on band and line spectra is easily explicable. The system consists of a large number of particles of equal mass arranged in a circle at equal angular intervals, and repelling each other with force inversely proportional to the square of the distance. At the centre of the circle is a large mass attracting the other particles, according to the same law of force. This "Saturnian" system differs from that discussed by J. J. Thomson (see *The Electrician*, Vol. LII., pp. 805 and 823) by the latter having a uniformly-charged sphere instead of the central particle, but the Japanese physicist evidently conceived his system independently. He demonstrates its stability, and finds that the particles must be very small compared to the attracting centre, in order that the ring may not collapse when waves of high frequency are propagated round the ring. The waves producing the spectrum lines are propagated round the ring in both directions. If the moving particles are electrons, a new term is introduced into their equation of motion by the presence of a magnetic field. The waves travel round a ring in both directions, and if the magnetic field is perpendicular to the plane of the orbit, the waves travel round the ring with different velocities, and the lines appear as doublets circularly polarised in opposite directions. Each series in the spectrum of an element corresponds to a different ring of particles. The flutings of the spectrum lines are probably due to the influence of one ring upon another. The modes of vibration which contribute to the instability of the system are those associated with the higher harmonics. This evidently lies in the region of small wave-lengths, and the destruction of the system will be easier for ultra-violet light to bring about, if the system will resound to these oscillations. Hence the photo-electric effects and ionisation of the surrounding gas. The electric current in a coherer consists in the stream of electrons set free by a penetrating electromagnetic wave. The author expects to be able to shed some light on the theory of luminescence along this line of investigation.

[H. Nagaoka, *Philosophical Magazine*, May, 1904.]

Conductivity and Fluidity of Solutions.—R. Hosking showed some time ago that in a number of aqueous solutions both the specific molecular conductivity and the fluidity become zero at the same temperature—viz., – 39°C., and that the fluidity-concentration isothermals and the conductivity-concentration isothermals all cut the axis of zero fluidity and conductivity respectively at the same point, representing a concentration of 10·74 normal. The author now gives some further results obtained with lithium chloride. The conductivity of the solution may be regarded as depending on the viscosity of the medium, the size of the ionic atmosphere, and the fraction of dissociated ions in solution. The lithium ion, which moves very slowly, may be considered as the centre of a larger atmosphere than the fastly moving chlorine ion, and probably with rising temperature the atmospheres will approach the same size, as Kohlrausch has observed that with rise of temperature the velocities of the ions tend to become equal. In the case of the weakest solution, the conductivity does not keep pace with the molar fluidity as the temperature is raised, although there is no combination of the ions. It looks as if the atmosphere round the negative ion increased rapidly, while that around the positive ion remains constant or diminishes slowly.

[R. Hosking, *Philosophical Magazine*, May, 1904.]

Radiation Pressure.—J. Larmor deals by a more direct method with Poynting's discussion of the operation of a retarding force due to the back pressure of its own radiation on a moving and radiating body. For radiation to exert steady non-alternating pressure on a small body it must be of opaque material. A dielectric mass consisting of perfectly elastic elementary vibrators would not be repelled by radiation. From a perfect conductor the waves are turned back without sensible loss by degradation because the surface layer is at a node of the electric force. There is a superficial current in the conductor which gives rise to the Maxwellian repulsion by the agency of the magnetic field, while there is no sensible electric resistance, the small electric force near the node establishing the necessary current without production of heat. The conditions which here obtain for very high conductivity and short waves also hold for lower conductivity and longer waves. For long heat waves the proportionality of the absorbing powers of metals to the square roots of their specific resistances has been discovered by Hagen and Rubens, and explained in advance by Drude and afterwards by Planck. This observation carries the interesting result that the resistance coefficients are nearly the same for such heat waves as for ordinary steady currents. The emitting body being opaque, the source of the radiation is the vibratory disturbance of electrons in its surface layer. These constitute a self-damped current sheet which is pushed back by the magnetic field it produces. For the same amplitude of ionic excursions in the vibrating molecule, and for the same periodic time, the radiation emitted per unit time is proportional to the refractive index of the surrounding medium.

[J. Larmor, *Philosophical Magazine*, May, 1904.]

New Photometer.—According to *L'Eclairage Electrique*, an Italian engineer, Mr. Nisco, has devised a new photometer. It consists of a selenium cell, which, when exposed to the source of light to be tested, changes its resistance. It is stated that the resistance may vary by 10,000 ohms between darkness and full illumination, but the actual resistances and illuminations are not given by our contemporary.

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OVERHEAD MAINS.

The question of employing overhead mains for electric light and power work in this country has never received much prominence except in the case of trolley wires for electric tramways. There are two reasons for this. The first is the fact that, in the majority of towns in which electric light has been adopted, the size and weight of the low-pressure distributing mains is such that their suspension overground would not be advisable, and, so far as the high-pressure feeders are concerned, there are, of course, good reasons for discouraging overhead work in thickly-populated districts. Thus, for instance, although the overhead trolley system has been chosen for tramways in most towns in the United Kingdom, the trolley wire is almost invariably fed from underground mains. The development of electric power supply over wide areas from large electricity works, however, puts quite a different complexion on the matter. In this case, the area to be supplied frequently consists of several thickly-populated districts between which are connecting links, either rural in character or, at all events, in the nature of suburbs where overhead wires would be no disfigurement and would constitute no appreciable source of danger to the inhabitants. In these circumstances, the above reason for the non-adoption of overhead mains does not apply, and we may therefore examine the second reason which is the legal position of electricity supply undertakers in the matter. The North Wales Electric Power Bill, which has passed through the Committee stage in the House of Lords this week, will, if equally successful in the Lower House, establish a new precedent for sanctioning overhead work, so that the present is an opportune time for examining the present state of the law with regard to electric light and power mains.

Under the Electric Lighting Act of 1882, which was not modified in this respect by the Act of 1888, an undertaker desiring to employ overhead wires has first to secure the sanction of the Local Authority in its district. The undertaker has no appeal against the decision of the Local Authority, whether the latter be a Provincial Borough, an Urban District Council or only a Rural District Council. Having obtained this sanction the undertaker has then to obtain the consent of the Board of Trade and must also conform to the Board's regulations in the manner in which the lines are constructed; but the number of cases in which the preliminary sanction has been granted has been so few that the existing Board of Trade

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regulations with regard to "aerial lines" are practically a dead letter, and at present each particular case is treated by the electrical adviser to the Board of Trade upon its merits. We may mention in this connection, however, that a revision of the whole code of regulations is pending, and that the inclusion in it of new rules for overhead wires may be confidently anticipated. Even when the Local Authority is itself the undertaker, overhead lines have been used only in isolated instances—the town of St. Helens being, we believe, the only one in which there is an appreciable section of the overhead distributing main connected to the electric lighting network. The Board of Trade has also recently consented to the use of certain overhead mains by the Beckenham Urban District Council. A few non-statutory electric light companies (that is to say, companies not working under Provisional Orders) have erected overhead wires, notably at Larne (Ireland), Hampstead (London), Finchley and Northallerton. The Special Acts obtained by the majority of the electric power companies have obtained slightly wider powers, however, than those conferred under Provisional Order. Under these, the absolute veto enjoyed by Provincial Boroughs and Urban District Councils with respect to overhead wires is retained, but power of appeal to the Board of Trade is given should a Rural District Council "unreasonably" withhold its consent. In the Gloucestershire Electric Power Act, however, there is no appeal to the Board of Trade, but only to the Gloucester County Council in such an event; and in nearly all cases the County Councils have power of veto with regard to overhead lines on their main roads. No overhead mains have yet been erected under these Acts, however, but the Gloucestershire Electric Power Co. has obtained the necessary consent for some overhead routes, and the Board of Trade has approved of the plans of Mr. G. L. ADDENBROOKE, the Company's consulting engineer, in this respect.

If, however, the North Wales Electric Power Co.'s bill passes the House of Commons without material change, a new condition of affairs will be created in that part of the country. Under this Bill the Company is granted leave to erect overhead wires subject to the consent of the Borough Council, Urban District Council or Rural District Council, as the case may be, but this consent must not be unreasonably withheld in any of these three cases, and the Board of Trade is again appointed arbiter in case of dispute. This, it will be seen, considerably extends the powers of the Company as compared with previous Acts. The Company will be given an opportunity—not only in Rural Districts, but also in Urban Districts and Provincial Boroughs—to erect overhead lines, unless reasonable cause can be shown by the Local Authority why these wires should not be erected. As the House of Lords Committee, in deciding in favour of these overhead wire clauses, was undoubtedly influenced by the general character of the scheme, which differs widely from previous ones, a general review of its scope will not be out of place. Reference may also be made to the map which we publish in our special Parliamentary report this week. From the figures given before the Committee and endorsed by Sir DOUGLAS FOX, it will be seen that the project is one for water-power utilisation comparable in magnitude with some of the large "hydro-electric installations" which have been so successful on the Continent and in America. Those familiar with the picturesque country around Snowdon will remember the curious lake, Llyn Llydaw, which is passed when ascending the mountain on the eastern side from Pen-y-Gwryd. This mountain lake is situated considerably over 1,000ft. above the Nant Gwynant valley, where the power station will be erected near Llyn Gwynant. The latter lake is on the main road between Portmadoc, Beddgelert and Bettwys-y-Coed, along which a line of light railway is being constructed. It is stated that a fall of 1,150ft. will be obtainable, and that, in conjunction with a second power station at Llyn Eigiau, no less than 12,000 H.P. will be available. At present, of course, there would not be demand for so much power in the valleys around Snowdon, but by utilising overhead wires power can be distributed economically over a far wider area, offering many inducements for the establishment of works desiring to avail themselves of cheap power supply. Moreover, there are one or two quarries in the Company's area in which considerable economies could be arrived at by the substitution of electric power for hand or steam driven machinery. At Lord PENRHYN'S famous slate quarries at Bethesda, for instance, electrically-driven rock drills could be adopted with great advantage, and there are many other possible applications of electricity for pumping and haulage on so large a scale that enormous saving in power and labour could be effected. We trust, however, that in choosing the routes and general design of the pole lines, an endeavour will be made not to cause any blemishes upon the natural beauties of Snowdon and the surrounding country, for, in view of the advantages of overhead transmission in cases such as these, it is of the utmost importance that as little prejudice as possible against it should be created.

TRAM-RAILS AND RAIL BONDING.*

BY PERCY S. SHEARDOWN.

(*Concluded from page 96.*)

The "Thermit" Process.—In order to make plain the Thermit process of welding, it will be first necessary to explain what thermit is, and mention a few of its chemical characteristics.

Thermit consists of a mixture of oxide of iron and aluminium, but aluminium besides its well-known property of its light weight in the gross, has also some other very remarkable characteristics, the one which concerns the process most being its great affinity for combination with oxygen, but it cannot combine with oxygen, or what we may call rust up, at ordinary temperature like iron, but when once it is raised to the ignition temperature, the combustion is very intense, both in the temperature and light given off, and also in the heat developed.

Prof. Boys writes as follows on the heating combustion of aluminium:—

Heat of Combustion of Aluminium.—Having spoken generally of the great heat of combustion of aluminium, I shall next give some figures to make our idea more precise. Instead of comparing the heat generated by the combustion of 1lb. or 1kg. of a material, it is more convenient for the purpose of comparison to choose a number of pounds or kilogrammes that combine with 16lb. or kilogrammes of oxygen, 16 being the atomic weight of oxygen. Richards in his work on aluminium gives such a table, and the same figures may be deduced from Lupton's handy little table, from which it appears that magnesium heads the list with 145,860 large calories set free by the combustion in oxygen of 24·4kg. of magnesium. This is followed by aluminium, 18kg. of which, in combining with the same quantity of oxygen, set free 130,500 calories. The metals of the alkalies and of the alkaline earths follow close. A long long way behind come ordinary metals and hydrogen, while carbon, our best fuel, is far behind. Of ordinary metals, iron is of special interest to us. Thirty-seven kilogrammes in becoming Fe_2O_3 give out 63,700 calories, or absorb this amount of heat in being reduced again. If the reduction is effected by the action of 18kg. of aluminium, the heat developed will be 130,500–63,700 = 66,800 calories. As 71kg. of material are involved—*i.e.*, as nearly 1,000 calories are set free per kilogramme of mixture—the temperature attained must be several thousand degrees if the mean specific heats of aluminium and iron through that great range of temperature and the latent heats of fusion are at all comparable with those of ordinary materials.

Prof. Boys also mentions that Wyborg has made some calculations on the matter, and has come to the conclusion that the temperature reached in the fusion of thermit is about 3,000°C.: temperature of aluminium is 1,157; copper, 1,929; cast iron, 1,960; steel, 2,790; wrought-iron, 2,912; platinum, 3,227.

* Paper read before the Dublin Local Section of the Institution of Electrical Engineers, April 14th.

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So we see that the Thermit system of producing a welding heat is simply a chemical process or reaction, Fe_2O_3 being robbed of its oxygen by the more greedy aluminium, which becomes aluminia; the charge when put into the crucible is fired by means of a small quantity of a finely-divided peroxide of barium and aluminium, which is easily ignited with a match or by burning a little magnesium; the action takes place very rapidly, the reduction of 20lb. of thermit taking under one minute; the light produced is intense, objectionable for the eyes even in daylight.

When the reaction in the crucible has just taken place, we have the aluminia, or aluminium oxide, which is much the lighter, floating on the top, and at the bottom of the crucible, not cast iron, but wrought iron, the whole at a temperature of about 3,000°C. This heat is employed in welding in two ways: if the metal is poured from the crucible, the aluminium slag comes out first, runs into the mould formed round the article to be welded, and, coming in contact with it, chills a little and forms a kind of film round the article to be welded, which prevents the molten iron which follows from getting in contact with the article being welded; in this case the heat of the thermit is only employed. This process is employed in butt-welding pipes, angle iron, &c., where an accumulation of metal round the joint is not required, arrangements being made by clamps or other means to produce the proper pressure between the parts when welding temperature is attained.

The second method of using thermit and which is the one employed in rail welding is to run the melted thermit from the bottom of the crucible. In this case the iron comes in contact with the rails first. It will, if this process is carried out with the proper precautions, melt the surface of, and adhere to, the rails, becoming, in fact, a single piece with them, and if the slag follows the iron, it will fill up the upper part of the mould, and the whole rail from top to bottom will be brought to a high and uniform heat. Now the temperature is so great that thermit iron running in this way at once melts through the rails where it meets them. The temperature is, in fact, unnecessarily high. To reduce it, and at the same time increase the quantity of which a given charge of thermit will yield, Dr. Goldschmidt has adopted the practice of mixing with the thermit about 15 per cent. by weight of wrought iron in small pieces such as punchings. Now, thermit will be found to contain very nearly half its weight of iron, the whole of which is available as iron, so that when 15 per cent. of iron is added, the yield of thermit becomes two-thirds iron. Tramrails which weigh 100lb. to the yard require for a complete and satisfactory weld about 22lb. of thermit, and, so, nearly 14lb. of iron available to form a strengthening shoe at the joint; and shoe not bolted or clamped, but absolutely one with the rails, and though it has been melted, not of cast iron, but of what is in reality a very mild steel or melted pure iron, free from carbon and, therefore, soft and malleable.

Compared with the costly and elaborate plant required by either the electric system of welding rails or the Falk system of casting, the apparatus required for the Thermit system is conspicuous by its exceeding smallness. The outfit consists of a crucible, which is not made of the material used in ordinary crucibles which are heated from an external source, but consists simply of an inverted cone of perforated sheet-iron casing lined with 1in. or more of magnesia. The crucible is stood over the rail on an ordinary tripod placed so that when the crucible is tapped the metal will run properly into the mould formed round the ends of the rails. The moulds are simply sand moulds of the right form, such as are used in foundries. Before the moulds are put round the rail joint the ends of the rails are carefully cleaned, and if they do not butt tightly, a section of rail is driven in between them. The rails on each side of the mould are tightly gripped between clamps connected by powerful screws, and after the metal has been poured and the rail ends have been brought up to welding temperature the screws and clamps are tightened up, and by this means a pressure is obtained between the ends of the rails. In this way a butt weld is formed between the ends of the rails, which helps greatly in securing the desired rigidity.

The foregoing is the fullest description of the three processes which I have been able to write within the time at my disposal, but in closing I should like to offer a few remarks.

The Falk system of cast welding has undoubtedly been a success in the States, and was employed between 1896 and 1900, but since then this process has been apparently more or less ousted by the electric welding process. One of the drawbacks to the continued commercial success of the cast welded joint appears to have been the size of the equipment required and the fact that it came expensive unless a large number of joints could be poured at one time, which often proved inconvenient. With regard to breakages, these appeared to be small from evidence from various sources I have examined, not more than from ½ to 1½ per cent.

The electrical conductivity appears to be good, better, indeed, than the usual allowance of copper bond; the process has been employed to a certain extent on the Continent and in England—at Norwich and Coventry.

With regard to the electric welding process, this is a good example of the determination with which Americans will expend energy, time and money on any new process which they believe can be made a commercial success. The Johnson Company, who were the predecessors of the Lorain Company, are said to have expended in the neighbourhod of £200,000 in various experiments in connection with electric track welding, though up to the beginning of 1897 the process could not be called a practical success. In the earlier experiments the splicing bar was simply a short slab of steel extending out a few inches on each side of the joint, and was welded up solid, and the resulting troubles were, first, the head of the rail got so hot that it was softened owing to the heat producing a physical alteration in the composition of the steel, and, secondly, the rails used frequently fracture, the fracture practically always occurring through one of the old fish bolt holes.

Until the nature of the apparent change could be understood the company withdrew from the field and entered upon an exhaustive series of experiments. Various methods of heat treatment after the weld was made were tried and discarded. Finally, Mr. H. F. A. Kleinschmidt, in endeavouring to prevent the spread of heat after the weld is made, discovered a very simple process which entirely overcomes any change in structure of the steel, and produces a weld of the greatest toughness and strength. The process consists in making weld from a boss on a bar instead of from a flat bar. As the boss is the only portion of the bar which comes in contact with the rail, all the heat is contracted at that point. As soon as a welding heat is reached the current is cut off, and, simultaneously, a heavy pressure is exerted directly over the weld and artificial means provided for hastening its cooling while under pressure. The comparatively cold portions of the bar surrounding the boss prevent the more plastic metal from spreading, and the heavy pressure so confines it that in cooling there is no chance of coarse crystallisation. In other words, the effect is exactly the same as hammering or working the steel.

With reference to the Thermit system of welding, this is a most interesting process, and one which would appear to have a great future before it, not only for the electric welding on street rails, as this is only one of the many applications to which it has and can be put. In some of its other applications it is practically without a rival. Among other purposes for which it has been found useful are casting metal round fractures in large shafts, welding of broken bosses on rolls, repairs to broken teeth on gear wheels, for pipe welding, for use with molten iron in order to prevent blowholes in castings, to drive out gases and impurities and to render the metal more fluid in pouring, for steamship repairs, for making small castings, &c.

The credit of the invention of the Thermit process appears popularly accredited to Dr. Hans Goldschmidt, a German, and to him, indeed, belongs the credit for seeing the commercial opening for such a process and for patiently developing the same. But according to Prof. Boys, the history of thermit dates back to 1894, when Claude Vautin, of the City of London, made use of aluminium mixed with metallic oxides to effect a corresponding reduction of metals. He found on mixing aluminium in a finely-divided state that these bodies, with the mixture, when heated in the crucible to a sufficient temperature, would react as already described. Two years later Mr. Vautin appears also to have patented the method of igniting the cold mixture by the aid of either burning magnesium or by means of a special ignition powder. As far as can be ascertained, Vautin could do nothing with his invention in England, and, as usual in these cases, English manufacturers appeared blind to its possibilities. At all events, the first practical use of Vautin's mixture appears to have been made in Germany by one Robert Deissler.

Several rail joints made by this process are under test on our last extension on the Drumcondra line, and so far appear to have satisfied expectations. With regard to the process as carried out, it appeared, while making an excellent joint, that the arrangements for directing the molten metal from the crucible to the pouring hole in the mould wanted more development in order to make it perfect, as it was not uncommon for the metal to strike the head or the check rail on its way to the mould, and melting the rail where it came in contact with it.

With regard to the electric conductivity, I may say that from tests I have made the conductivity of a length of rail with a joint appeared as good, and in some cases better, than a similar length of rail without a joint.

According to the remarks one hears, it appears that it is popularly supposed that the welding of the joints on the Dalkey line is believed to have been undertaken in order to prevent what the public suppose to be a waste of current through leakage. I need hardly state to my present audience that there is no such thing as waste of electric current. All the current generated and sent out at the power station has to find its way back there; but, of course, there may be a considerable amount of waste in the pressure at the joints if the conductivity of these is not reduced to a minimum; but with the ordinary bonding processes it is quite easy to maintain good electric conductivity without depending upon fish-plates. The

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reason why the Dalkey line has been equipped with electrical fish-plates is that, when put down in 1894, although the rails were of good quality and road-bed good, the method of fishing the joints was decidedly too light for the weight of the cars and the speed at which they run. The joints became depressed, and with this and many others it was a case of prevention is better than cure. Though the permanent way department tried several remedies, such as heavier fish-plates, sole-plates, &c., the joints were still deteriorating; and it appeared as if the joints would become hopeless long before the body of the rail itself was worn out, and, consequently, the present method was used, the depressed rail-joints being raised as far as possible, or in some cases made a little higher and then welded in position and levelled off with the emery grinder. Although the bump at the joint has not entirely disappeared, it is much improved, and, moreover, as the joint is solid and the rail practically continuous with no fish-plate nuts to slack back, there is every hope that the joints, at all events, will deteriorate no further.

Before closing the Paper, I think I had better make a few remarks about what is known by some people as expansion theory, or by others, who have made experiments and found their fears relieved, known as the expansion bogey, for, otherwise, I am sure I shall have a great many inquiries as to what will happen when the rail gets heated up when we next get a summer.

It is well known that on steam railways, where the rails are subject to wide variations of temperature, care has to be taken to arrange for the expansion of the rail, and it must be remembered, first of all, that the conditions under which a railway line and a tramway line are subjected to heat are perfectly different. In the railway line the whole of the line is exposed to the heat of the sun, and except for the side grip of the wedges in the chairs there is nothing in the way of side pressure to prevent the rails from expanding or contracting throughout their whole length.

Now, with regard to the tramway rail, the tread only of the rail is exposed to the heat. Even in these latitudes, under a hot sun, the rails, when exposed, will get too hot to bear one's hands on; but it is strange when buried that the total range of temperature to which they are exposed will not exceed 15 to 20deg.

A bar of steel, when warmed 1°C., will become longer by 11 millionths of its length. It can be calculated that if a steel bar is warmed 1°C. and at the same time compressed longitudinally with a pressure of 313lb. to the square inch it will not change its length at all, and if warmed 10deg. and compressed with a force of about 1½ tons it will still retain its original length; and what is this on a steel rail that will stand a pressure of 20 to 25 tons per square inch. In practice the grip of the setts and concrete exert a greater pressure per unit length than is necessary to prevent this extension or compression except at what may be known as the free end. Of course, the grip of the setts depend, to a certain extent on the material they are grouted in with, and for this particular purpose I should say cement concrete is far superior to pitch, which, being a liquid or semi-liquid, will yield to a continuous pressure, but in practice, probably even on a hot day before the rails could have moved to any extent the evening would have come on and the rails cooled down again.

With regard to buckling, the setts on each side of the roadway and the holding of the setts on the bottom flange proves quite enough to prevent the rails from shifting in this way. The only place where I should consider it dangerous to have solid joints on tramway rails laid in the usual method would be at the apex of a curved bridge such as one might meet over a canal or river, especially where there were long lengths of straight line on either side of the bridge, as under such conditions it is quite possible that the rails might rise from the road bed; but the prevention in this case is obvious—*i.e.*, leave the joints on the bridge unwelded, and, if possible, provide for expansion joints at these places.

A brief discussion followed the reading of the Paper.

Prof. THRIFT referred to the difficulty in many people's minds as to the expansion of rails, and pointed out that with rails welded by the electrical method expansion of the rails would only result in the diminution of the tension on the joint, and asked whether tests had been made of the strength of welded joints.

Mr. GILLIES said he observed that the temperature attained in the Lorain system was so high that the abutting rail ends sometimes melted, and this was a difficulty that would have to be dealt with. He thought that an objection to this system was that in a new equipment no power would be available for welding. He asked whether any difficulty was experienced in the water-cooling of the jaws, and whether the circuit-maker was of special design.

Mr. W. TATLOW asked for the relative costs of the three methods and a comparison with that of copper bonds.

Mr. SHEARDOWN said in reply that the electrically-welded joint was far stronger than the rail itself. He said that the Dublin United Tramway Co. had had about 4,000 joints made and only five fractures had occurred. In these five cases the fractures occurred in the rail itself outside the joint, but obviously the strength of the joint depended greatly on the material in the rail itself. No difficulty, he said, was experienced in securing an adequate circulation of cooling water, and the circuit-breakers were of the standard type. In respect of cost, he gave the following figures:—The Lorain system costs 25s. per joint, and a guarantee of at least 2,000 joints has to be given to the Lorain Company. The company, however, does not remove and replace setts, nor carry out the preliminary clearing necessary before the application of the sand blast; and the additional cost for this work amounts to about 10s. per joint. The Falk system costs £1 per joint, and in this case also a guarantee of 2,000 joints is required, with the same work excluded as by the Lorain Company. The Thermit system also costs £1 per joint, the cost of the thermit being 1s. per pound, or in large quantities 10d.

THE SOUTH-WESTERN POLYTECHNIC.

Last Friday night, May 6th, Lord Cadogan distributed the prizes and certificates to the students of the evening and day classes of the South-Western Polytechnic, Chelsea. Afterwards Mr. R. C. Antrobus (who occupied the chair) presented Mr. Tomlinson, who retires from the post of Principal, with an address, accompanied by a testimonial, on behalf of the governing body.

This annual prize distribution—the eighth, by the way—was made the occasion of the formal opening of some new buildings, including a great hall, a bricklayers' workshop, photographic rooms and extensions to the mechanical and electrical laboratories. Before giving a description of the latter as they now stand, reference may be made to the conversazione, which took place last Saturday. An interesting programme had been prepared for the visitors, who appeared in large numbers and evidently fully enjoyed and appreciated the various scientific demonstrations, gymnastic and musical displays and the various exhibits. As might be expected, the lectures on radium by Mr. S. Skinner, the new principal, attracted special attention. The exhibits in the physical laboratories included some beautiful demonstrations with Crookes tubes and Röntgen-ray photography was successfully carried out in another part of the building. Of equal interest were the numerous experiments and demonstrations simultaneously going on in the electrical, mechanical, chemical and other departments.

Amongst the exhibits was a variable speed gear by Mr. L. Hampson. This ingenious device consists of a four-throw crank, which, by means of suitable connecting rods, sets four arms into a rocking motion. Each arm carries a sliding block, which can be moved up and down the rocking arm by a suitable lever arrangement. These blocks are connected by rods to four free-wheel devices, mounted side by side on the axle, which it is intended to drive at variable speeds. The rocking motion is transmitted from the arms by way of the blocks and the connecting rods to the free-wheel devices. One crank only would obviously impart to the driven axle an intermittent motion, but the action of four cranks, displaced by 90deg. from one another, results in a practically uniform rotation. The four-throw crank is assumed to be driven at a constant angular velocity, and the angular velocity of the variable-speed axle is gradually varied through the whole range of operation by moving the blocks on the rocking arms up and down in the way indicated. If the blocks are at the extreme end of the arms, for instance, the arc through which the free-wheel device is rocked is a maximum, and the speed is at its highest. If, on the other hand, the blocks have been moved quite near to the fulcrum of the rocking arms, then the arc of oscillation, and consequently the speed of the axle, is small.

The following is a brief description of the mechanical and electrical departments of the polytechnic as at present extended:—

In the boiler house there are two large boilers and one small boiler of the vertical type, used for experiment only. One of the large boilers is of the Lancashire type, and capable of evaporating 5,000lb. of steam per hour. It is fitted with Meldrum's forced draught. The other, a dry-back marine type of boiler, has an evaporative capacity of 9,000lb. of water per hour. It is worked with induced draught, and is provided with a Green economiser. Water is fed into the boilers by three feed pumps—viz., a Pearn compound Cameron, a Weir and a Worthington duplex pump.

In the engine room and the mechanical laboratory are some six steam engines and three gas engines, each fitted up with the various auxiliary arrangements necessary for obtaining indicator diagrams, for applying brake tests, and so on. Each steam engine has a separate condenser, and one of the gas engines is fitted with magneto-ignition. Amongst these engines is a 70 H.P. Willans compound engine, directly coupled to a semi-enclosed Lahmeyer dynamo. Another steam generator set consists of a 35 I.H.P. Allen compound tandem engine and a Lahmeyer dynamo. Most complete arrangements have been made for testing these sets in all manners, both when running condensing and non-condensing. A number of fuel calorimeters and similar apparatus, as well as an apparatus by Lahmeyer for testing the relative qualities of lubricating oils, are provided.

An electrically-driven fan, a 50-ton Riehle testing machine, a 5-ton Olsen bending machine and other similar apparatus provide ample means for the student to supplement experimentally his

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theoretical knowledge of various branches. Some lathes and machine tools are also to be found in the mechanical department.

The electrical department is divided into various rooms, according to the work carried on. There is a large laboratory, a smaller laboratory for more advanced students, a dynamo room, two photometer rooms, a wiring shop and two workshops. The large laboratory, which may be used by some 100 students simultaneously, is fitted up with a home-made switchboard, from which the various testing tables may be fed with current from the mains running through the building, or from a small accumulator battery, or from any dynamo which is running. This room is well equipped with the usual apparatus and instruments for carrying out all customary electric measurements. Of electric meters, both of the continuous and alternating-current type, there is quite a number. The electric equipment also includes some traction permeameters, a Ewing curve tracer, a Carpentier hysteresis meter, a secohmmeter and so on. In the smaller laboratory is a set of standard measuring instruments, including a Kelvin balance.

The dynamo room is equipped with the usual electric machines, instruments and appliances, and the way in which the various things have been grouped, so as to allow of each machine and instrument being coupled (mechanically or electrically, as the case may be) to any other, is specially noticeable. Some 20 electric machines are to be found in the dynamo department, and the sectional drawings of most of them, together with their principal electrical dimensions, are hung near them on the wall. These 20 machines include all well-known types of continuous-current and alternating-current motors and dynamos. A 6kw. motor-generator, used for furnishing single-phase, two-phase or three-phase current at frequencies ranging from 25 to 100 cycles per sec., is of special interest. The continuous-current motor has a speed variation of 4 to 1, and, in order to minimise sparking, auxiliary poles, wound with a number of series turns, are placed in between the poles proper. This set is equipped with a pneumatic speed indicator, consisting of a number of radial tubes, which are directly rotated by the motor shaft, and a vacuum gauge. The air in these tubes is expelled by centrifugal force, and the vacuum thus created is a measure of the speed of rotation. There are also a number of transformers, including one made by the students themselves.

CORRESPONDENCE.

COMPLETION OF THE PRACTICAL SYSTEM OF UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been called to a letter from Prof David Robertson, at p. 25 of *The Electrician* of April 22nd, containing proposals for the completion of the "practical system" of units; and I have found it well worthy of careful study. The proposed changes involve—

I. The selection of units of mass, length, time and magnetic permeability that will give the ohm, volt, &c., without the introduction of arbitrary multipliers; and

II. So altering the units of permeability and permittivity as to make Heaviside's "rational" formulæ applicable.

Problem I. can be directly attacked in the following way:—

Let the required units be m grammes, l centimetres, t seconds, and a permeability μ times that of vacuum. t must be 1 to satisfy the relation between the coulomb and the ampere.

The ohm is 10^9 C.G.S. units, and is also $lt^{-1}\mu$ times the C.G.S. unit; hence

$$l\mu = 10^9. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The coulomb is one-tenth of a C.G.S. unit, and is also $m^{\frac{1}{2}}l^{\frac{1}{2}}\mu^{-\frac{1}{2}}$ times the C.G.S. unit; hence

$$m^{\frac{1}{2}}l^{\frac{1}{2}}\mu^{-\frac{1}{2}} = \tfrac{1}{10}, \quad \text{and} \quad ml\mu^{-1} = 10^{-2}. \quad . \quad . \quad . \quad (2)$$

(1) and (2) give, by multiplication,

$$ml^2 = 10^7, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

a condition which is satisfied by $m = 10^3$, $l = 10^2$—that is, by the kilogramme and metre.

(1) with $l = 10^2$ gives

$$\mu = 10^7. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Hence, with the kilogramme and metre, we are to employ a unit of permeability 10^7 times the permeability of vacuum; and the permeability of vacuum must be called 10^{-7}.

Again, the capacity in vacuo of a sphere of 1cm. radius is $(3\times10^{10})^{-2}$ of 10^9 farads, or is $\frac{1}{9}\,10^{-11}$ farads. The capacity of a sphere of 1 metre radius is 100 times as great, or is $\frac{1}{9}\,10^{-9}$ of a farad. But the capacity of this sphere (since its radius is the unit of length) is numerically equal to the permittivity of vacuum, which is, therefore, $\frac{1}{9}\,10^{-9}$.

As regards problem II.; if Q is the numerical value of a certain charge of electricity in the ordinary system, and Q′ its numerical value in the "rational" system, we have, for the mutual repulsion of two such charges, at distance r, the two expressions Q/Kr^2 and $Q'/4\pi K'r^2$; K and K′ denoting the permittivity of the medium in the two systems. As the repulsion is a force, and is estimated by momentum divided by time, its numerical value is the same in the two systems; hence the two expressions are to be equated, and we have $Q^2/K = Q'^2/4\pi K'$.

We wish to retain the coulomb as unit of charge; hence Q and Q′ are identical, and we have $K = 4\pi K'$. The new numerical value K′ for a given medium will, therefore, be $1/4\pi$ of the old value K, and the permittivity of vacuum is to be changed from $\frac{1}{9}\,10^{-9}$ to $\frac{1}{36\pi}10^{-9}$. This agrees with Prof. Robertson's calculation.

Exactly similar reasoning applies to the mutual attraction or repulsion of two magnetic poles, the permeability μ taking the place of the permittivity K. For the unit of pole-strength or quantity of magnetism to remain unchanged we must have $\mu = 4\pi\mu'$.

The new numerical value μ' for the permeability of a given medium will be $1/4\pi$ of the old value, and the permeability of vacuum will be changed from 10^{-7} to $1/4\pi10^{-7}$. This result differs from Prof. Robertson's.

When the "rational" values of permittivity and permeability are employed, in conjunction with the kilogramme, metre, and second, the capacity of a condenser is area/thickness × permittivity; and the induction B within a long helix carrying a current is (ampere-turns per unit length) × permeability.

I have verified the statement that when the units employed as fundamental are coulomb, metre, kilogramme, second, there will be no fractional exponents in the dimensions of the electrical and magnetic units; and I incline to the adoption of the coulomb rather than the ohm because a specified number of grammes of silver is a more matter-of-fact thing than a resistance. Moreover, it does not vary with temperature, as a materialised resistance does.

The name *kram* would not do for *kilogramme*; it sounds too much like *gramme*. The best name is *kilog*, and the name *metre* might with advantage be shortened to *met*. It would then neither clash with *meter* in the sense of gas meter, voltmeter, &c., nor with the *metre* of poetry.—Yours, &c.,

Ealing, May 9. J. D. EVERETT.

MUNICIPAL APPOINTMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have had the privilege of being chosen as one of the "short list" for several borough electrical engineer appointments, and I wish to protest against the publication of the names and other particulars of such selected candidates. In my opinion, such applications are private and confidential, and publication, except in the case of *the* successful candidate, is a distinct breach of confidence. The result may be very serious friction between a candidate and his present employer, and the knowledge of such a possibility will, doubtless, cause many a suitable man to refrain from applying, and so prove a distinct disadvantage to the authority advertising.

The writer does not expect that this letter will result in the practice being discarded, but he asks you, Sir, to consider the question of refusing the use of your columns for such a purpose.

To those who may be answering advertisements of this class, he suggests that they endorse their application "Private and Confidential."

Another matter against which I wish most emphatically to protest is the appointment of men at a salary lower than that advertised. Only last week the writer was interviewed, and two of the candidates were asked if they would accept a lower sum; one at least agreed, and was duly appointed. This, Sir, I submit is a most immoral proceeding, happily infrequent, but several such instances have come to my knowlege.

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Personally, I should not have accepted the lower salary had I had the option, and when I say that the only item towards the expenses allowed was the railway fare, and that in my case the journey could not be made in less than two days, it is clear that the unsuccessful candidates were induced to incur expenses and inconvenience without having a chance of being in the running.—Yours, &c., MODULUS.

May 10.

PARLIAMENTARY INTELLIGENCE.

NORTH WALES ELECTRIC POWER BILL.

OVERHEAD WIRES PERMITTED.

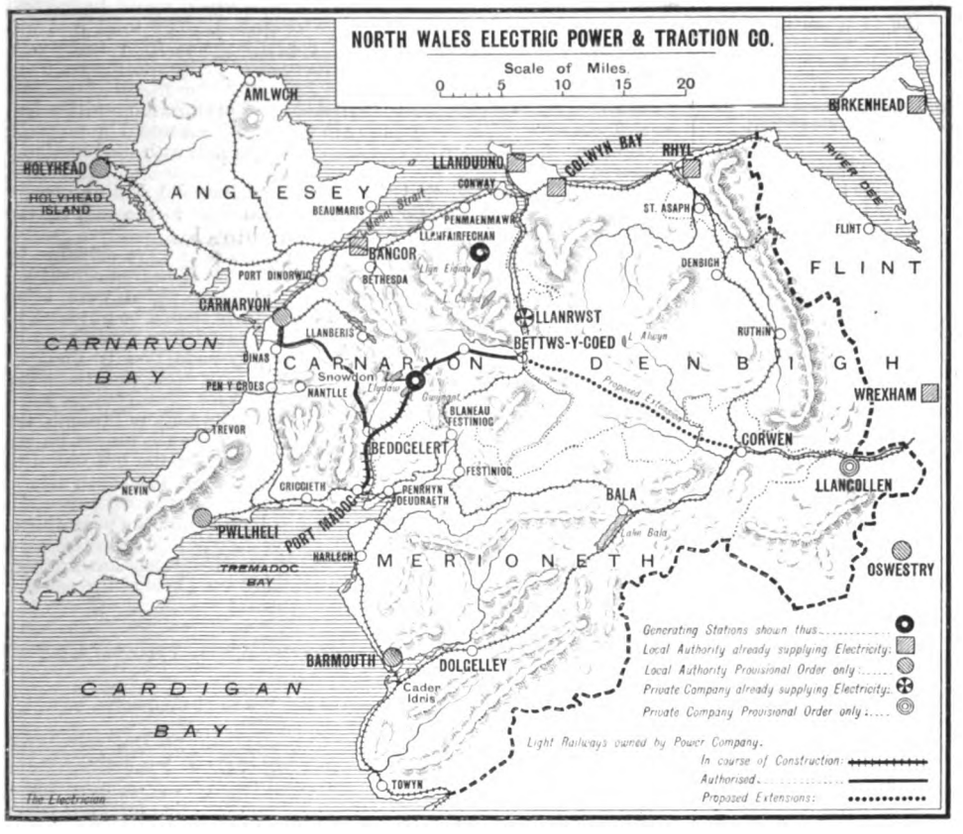
The consideration of this bill by the Committee of the House of Lords presided over by Lord Clifford of Chudleigh was continued on Friday last week.

Mr. HUXTABLE, of the firm of Messrs. Haynes, Blythe and Huxtable, solicitors to the bill, who was the first witness, was cross-examined by counsel for the opponents as to the publication of the prospectus of the company and the arrangements between the promoters and the Portmadoc Company. He detailed the list of subscribers, most of whom he knew personally, and all of them, he said, were persons of financial stability. Lord Penrhyn was in favour of the scheme, and the clause granted to him was merely to protect his rights as a landowner. If the company could sell its current at an average price of 1½d. per unit, a dividend of 30 per cent. could be paid. This was a good return if the company could earn it, but it did not follow that sufficient energy would be sold to secure such a return. As the limited liability company already formed had power to subscribe to the capital of the Parliamentary company for which powers were now sought, the control would be in the hands of the limited liability company, but it would have to conform to all the restrictions placed upon the parliamentary company. The power station at Llyn Llydaw would be on the lands of the limited liability company, but the one at Llyn Eigiau would be the property of the statutory company. The main object in issuing the prospectus of the North Wales Electric Power and Traction Co. was to fulfil the regulations of the Companies Act of 1900 and also those of the Stock Exchange and was not largely to secure subscriptions. As had already been stated in evidence, subscriptions from the public to any extent were not anticipated. With regard to overhead wires, a clause had been given to the Carnarvon County Council giving it a right to be heard as to the matter in respect of main roads.

The CHAIRMAN said the Committee were of the opinion that some such clause should be inserted in the bill.

Mr. E. N. HUMPHREYS, an accountant at Chester who has been employed by the promoters to discover the possible power users in the northern parts of the area, said there was a very general disposition to welcome the company. In Anglesey, gas was between 5s. and 6s. per 1,000 cubic ft., yet, nevertheless, a large number of gas engines were being used. The local authorities were prepared to take electric light at a reasonable price. The general result of his enquiries was that there would be a very good demand for power. With regard to the position of local authorities within the area already having a supply of electricity of their own, he considered that by their taking a supply in bulk from the company, many of them would be helped out of their present bad financial position.

Sir DOUGLAS FOX, one of the engineers to the promoters, said that when he was first consulted as to the generation of the electrical energy for the South Snowdon, Portmadoc and Beddgelert Railway, he at once realised that the promotors had not grasped the fact that there was an enormous water power available. He pointed this out to them, and the result was that they had taken £90,000 capital in the present concern. He approved the estimates and concurred in the evidence of Messrs. Ferranti, Swinton and Harper. He considered that the boundary of the scheme should remain as it was, so that it would march with that of the North-Western Electricity and Power Gas Co. for the purpose of a mutual supply of current later on. This latter would be in the public interest. The proposal to leave out the small portion of Flintshire which was included in the bill he could not understand, as it would leave that small portion of territory between the two power companies unprovided for. The mileage of tramways and light railways which it was proposed to work was 20 miles, and owing to the steep gradients it would be impossible to work them by any other power than electricity. This had been proved before the Light Railway Commissioners.



Mr. BAGGALLAY, K.C., in stating that this was the case for the promoters, said that the opposition of the Carnarvon County Council had been settled with, as also had that of the Conway Corporation and Penmaenmawr, the latter only retaining the right to discuss clauses.

The opposition to the scheme was then gone into.

The Hon. J. D. FITZGERALD, K.C., addressed the Committee on behalf of the Flint County Council, the Rhyl Urban District Council and the St. Asaph Rural District Council, all of whom, he said, objected to being included in the area of the company. No substantial reason had been put forward for overriding the views of the local authorities. No witnesses had been called for the promoters from this district, and it was practically admitted that there were no possible customers there to-day.

Mr. H. LLOYD, K.C., for the Conway Corporation and the Colwyn Bay Urban District Council, also objected to inclusion in the area on the ground that those places were residential districts and seaside resorts. Dealing with the question of overhead wires, he emphasised the point that in no power bill ever yet passed had Parliament put urban district councils under the condition that the promoters sought here—viz., that their consent should be dispensed with at the discretion of the Board of Trade. It had always been done in the case of rural district councils, but he resisted being put in the same position as the latter.

Mr. RAM, K.C., for Penmaenmawr, said that the only point between the promoters and himself was on the question of overhead wires, and he asked to be put upon the basis claimed by Mr. Lloyd.

Earl of LAUDERDALE: Would not the appeal to the Board of Trade safeguard you against any of the dangers?—No, I think not, my lord, because the Board of Trade would not know the particular circumstances of the district.

Mr. BAGGALLAY pointed out that this was not so, as Mr. Ram could, at the Board of Trade inquiry, use the same arguments as those he was using now, supported by local evidence. He was not producing any evidence now.

Mr. RAM replied that the proposal of the promoters was to alter the present state of the law on this point. He had a veto at present, and he wanted to retain it.

Mr. M. WHITE then addressed the Committee with regard to cutting out Llandudno from the area of the company.

Mr. KEEN argued to the same effect for the Carnarvon Corporation.

After a short deliberation,

The CHAIRMAN said that the Committee found the preamble proved. In answer to a question, his Lordship stated that this decision included the question of overhead wires.

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LONDON COUNTY COUNCIL TRAMWAYS AND IMPROVEMENTS BILL.

On Friday Mr. Compton Rickett's Committee of the House of Commons resumed consideration of this bill. Tramways No. 4 and 10 were dealt with.

Mr. ERSKINE POLLOCK, K.C., for the promoters, described the two lines in question. No 4 is a double beginning near Goose Green, in the East Dulwich Road, joining a tramway terminating at the point which was authorised in 1902. The route of the new line was along the East Dulwich-road to the south, over the deserted line of the London, Dulwich and Camberwell Tramways Co. for a short distance, and ending at Peckham Rye, near Stewart-road. The length of the line would be 1 mile 3·18 chains, and the estimated cost was £42,050. The consent of the Camberwell Borough Council had been obtained, and a question of the statutory width of the road at a certain point along the Rye had been settled. There was opposition from the frontagers, however. Line No. 10 commenced in Lordship-lane from the termination of a line authorised in 1902, and continued to Forest Hill station. The cost of the tramway would be £51,000, and that of the widening £21,250. but the Camberwell and Lewisham Borough Councils would pay one-third of the latter. The only opposition here, also, was by frontagers.

Evidence was called as to the sufficiency of the estimates, widenings, &c. The service proposed is a six-minute through service from Forest Hill to all the southern approaches to the Thames bridges.

Mr. LEWIS COWARD, K.C., for the frontagers on both lines, protested against the construction of the lines on the ground that not sufficient public advantage would be gained to justify the destruction of the amenities of a quiet residential district.

On Monday the evidence of the frontagers against the line was heard. The chief point of the evidence was that, in the view of the witnesses, the line would not repay the cost of construction, and that, if constructed, it would considerably depreciate the value of property in the district.

The Rev. A. DREW, vicar of St. Andrew's Park, Peckham Rye, declared the tramway to be the most stupid proposal ever put forward by the London County Council, which, he added, was saying much.

Mr. MOON, K.C., on behalf of the London County Council, said that they were willing to allow the London, Camberwell and Dulwich Tramway Co. to run over the reconstructed line at present in the hands of the company upon arbitration terms.

The CHAIRMAN announced that the Committee were unanimous that tramway No. 10 should be passed. With regard to tramway No. 4, this would be passed subject to the insertion of a clause for the protection of the London, Camberwell and Dulwich Tramways Co., and also on the condition that certain extra road widenings were made. Continuing, he said that a report had been received from the Home Office as to the effect upon the present congested condition of the Westminster terminus which the sanctioning of new lines would have. It was impossible for the Committee to interfere with the rights of the London County Council in this respect, although it was one upon which it might make suggestions. Such a suggestion might have application to other portions of the bill also, and therefore it was a matter which could not be decided offhand.

Mr. POLLOCK, for the Council, thought the action of the Home Office was without precedent, and appeared to be something of an attempt to dictate a course of proceedings to the Committee.

The CHAIRMAN said he did not think the Committee could resent the action of the Home Office, as it was only put forward as a suggestion for the consideration of the Committee in the interests of the public.

Mr. POLLOCK then opened that part of the bill relating to tramways Nos. 11, 12 and 13, which were in Deptford and Lewisham. The cost of tramway No. 11, in connection with which there were extensive widenings, would be £109,710, and of the widenings £104,000. The line would be a double-line track, 2 miles 5 furlongs in length, beginning near the junction of Park-road and Standstead-road in the borough of Lewisham, and terminating in the Lewisham High-road by a junction with tramway No. 12. A third of the cost of the widenings would be borne by the Deptford and Lewisham Borough Councils. Tramway No. 12 was 1½ miles in length, coupling up Lewisham with New Cross, and would cost £58,000 for the tramways and £22,500 for the widenings, to which also the local authorities contributed. No. 13 was about 1 mile long, running from High-street, Lewisham, to High-road, Lee. It would cost £45,000, and the necessary widenings would incur the expenditure of an additional £131,000, to which, however, the Lewisham Borough Council would contribute.

Local evidence in favour of the lines was then taken.

On Wednesday, evidence in favour of tramways Nos. 11, 12 and 13 was taken, the witnesses including Mr. G. S. Warmington, the Mayor of Lewisham.

Mr. FITZMAURICE said that the statutory width of 9½ft. between rail and kerb would not be obtained where one of the lines passed under the railway bridge in Brockley-lane, but this was only for a distance of 60ft., and the contraction would amount to 2½ft. on one side only. Although the Borough Council had expressed a wish that the road should be widened, their assent had been obtained without this being a condition.

Mr. ROSKILL, K.C., then addressed the Committee on behalf of the frontagers with regard to tramway No. 11, making the usual arguments against the disturbance of the amenities of the district and the general non-utility of the line.

The CHAIRMAN, referring to the Home Office report referred to above, said that the Committee would not take upon themselves the responsibility of establishing a precedent for a "deal" between promoters and the House of Commons in relation to a bill already passed on consideration of something to come. Such a precedent should be established by the House itself. For the information of the House, however, he would at some later stage ask for evidence from the Home Office as to the effect of the sanction of these new lines upon the Westminster terminus. The Committee found the preamble of the bill proved with regard to all the Lewisham sections—*i.e.*, tramways 11, 12 and 13, with the condition that under the Brockley railway bridge the lines should be interlaced so as to secure the statutory 9½ft. on both sides.

Mr. MOON, K.C., then described tramways 15 and 16, which were in the parishes of Woolwich and Plumstead.

Mr. FITZMAURICE stated that for a space of 583yds. along the length of Woolwich Arsenal there would only be a space of 1½ft. between the cars and the railings.

The CHAIRMAN stated that the Committee did not view this narrow space with great favour.

On Wednesday, the Committee sanctioned this line with the condition that there should be 3ft. between the cars and kerb alongside the Arsenal, and also that the Woolwich Tramways Co. should be safeguarded against any alterations in their line until terms of purchase for the whole undertaking were settled. Tramway No. 16, which was unopposed, was also sanctioned, with the condition that an undertaking given to the Police and Sanitary Committee when the Erith Tramways bill was passed last year to make a junction with those lines should be fulfilled.

Mr. ERSKINE POLLOCK then dealt with tramway No. 5, which was a double line connecting up the north and south systems of the London County Council tramways, via the Blackwall Tunnel. The line would begin in Trafalgar-road, Greenwich, by a junction with the existing tramways there, and terminating in the East India Dock-road by a junction with the Commercial-road tramways, which would be the first portion of the northern system to be electrified. The total cost was estimated at £75,710, and the only opposition was from frontagers. The police authorities, however, put forward objections to the tramway through the tunnel.

After hearing evidence, the CHAIRMAN said that the Committee had decided not to sanction the tramway in the tunnel, but would be prepared to hear further evidence if it was decided to proceed with the remaining portion of the tramway.

Mr. POLLOCK replied that the Council certainly did desire to go on, and that, in view of the Committee's decision as to the tunnel, the frontagers had withdrawn their opposition.

Mr. HENRY, Chief Commissioner of Police, who gave evidence by request of the Committee, spoke with regard to the increased congestion at Westminster Bridge in view of the new lines which were being sanctioned, and suggested that the terminus there should be put back to the east of York-road. This had been put forward by a predecessor of his, but had always been objected to by the London County Council. If his suggestion were carried out, it would mean that the terminus would be set back for a distance of 90yds.

Yesterday it was stated that, as the proposed tramway through the Blackwall Tunnel did not go beyond the approach to the tunnel on the north side, the lines proposed under this section of the bill would be confined to a short extension of the existing lines on the south side of the river, stopping at the entrance to the tunnel there.

The CHAIRMAN said the committee formally passed the preamble of this portion of the bill.

The question of a small road widening at Nine Elms having been decided in favour of the Council, this concluded the whole of the sections of the bill.

MIDDLESBROUGH, STOCKTON AND THORNABY TRAMWAYS.

This bill came before a Committee of the House of Commons, of which the chairman was Mr. Henry Hobhouse, on Monday.

Mr. BALFOUR BROWNE, K.C., who appeared for the promoters, with Mr. Roskill, K.C., Mr. Lewis Coward, K.C., and the Hon. Evan Charteris, said that the bill proposed extensions of the existing tramways which were owned by the Imperial Tramways Co., totalling some 5 miles. The new lines would commence with a junction at the existing terminus in Middlesbrough, and continue eastwards through Ormesby, South Bank and Grangetown, stopping at Eston Grange Station on the North-Eastern Railway. At two points along the route level crossings would be abolished and bridges substituted. At the point where the line ran into Grangetown there was a subway already existing, under the railway, and this would be reconstructed so that the tramway could run through it. All the necessary consents of the local authorities had been obtained. The opposition to the bill was chiefly from owners of toll gates along the road where it was proposed to put the tramways. Practically the road was in the hands of private owners, who received a revenue from the tolls, and at present there were three gates where a toll had to be paid. The proposal of the company, although a new one with regard to tolls, was a fair one, he thought. The bill asked to be allowed to take an easement over the roads, and to make compensation to such an extent that the tolls now charged to private vehicles should not be charged to the tramways. At the close of counsel's speech several objections were taken by the opponents on technical grounds to the bill proceeding, the argument being that the consent of the road authorities had not been obtained.

Mr. BALFOUR BROWNE said that he did not admit that the private owners of the road in question were road authorities, but even if this were so, he had the necessary two-thirds consent.

On Wednesday the Committee decided that the necessary consents had been obtained, and that the bill should proceed.

Mr. HUGH BELL, an ironmaster of Middlesbrough, gave evidence in favour of the tramways. He said that some years ago a syndicate had been formed by himself and all the private road owners who now opposed the bill to construct these tramways. If this proposal had been proceeded

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with it would have meant a change of cars at Middlesbrough. Mr. Clifton Robinson, however, had agreed with the syndicate to take over their proposals and to pay £1,500, the expenses which had been incurred. An agreement to this effect was signed last year, and if the lines were sanctioned they were to be constructed within five years.

Cross-examined by Mr. TALBOT, he said he thought the best way out of the difficulty with regard to the tolls was a reasonable composition between the promoters and the owners.

Mr. CLIFTON ROBINSON, managing director of the Imperial Tramways Co., who are the owners of the line, detailed the history of the undertaking and gave figures to show the increase of passengers since the advent of electric traction. Last year 96,000,000 passengers were carried over the existing lines. With regard to the present extensions, the bridge over the railway at the boundary of Middlesborough, which it was proposed to build, would abolish a most dangerous level crossing, and the tramway company were building this at an expenditure of £22,000. The lines would cost some £90,000 to construct.

Local evidence was then called in favour of the tramways.

Yesterday, the case for the opponents was gone into.

Mr. ERSKINE POLLOCK, K.C., for Middlesbrough Coporation, said that although only 325yds. of the proposed extensions were inside Middlesbrough, he must ask for protective clauses. These would relate to the question of the diversion of the roadway over the bridge, the supervision of the borough surveyor, and so on, but his preamble opposition was in respect of the terms of purchase. The bill proposed a term of 30 years, purchase to take place as a going concern. The Corporation of Middlesbrough had power to purchase the existing lines within the borough in 1918, and what he asked was that the small addition in Middlesbrough now sought should be purchased at the end of 21 years under the terms of the Tramway Act of 1870, or if the Corporation desired to purchase it in 1918, it should be so purchased as a going concern.

Mr. CLAUD BAGGALLAY, K.C., for the owners of the Middlesbrough estate, one of the owners of the toll rights upon the road where the tramways are proposed, asked the Committee to state that it should be left to an arbitrator to decide what amount per car should be paid as toll. If this was not sanctioned he should ask that it should be left to an arbitrator to decide what compensation should be arranged.

REJECTION OF CLAUSE AUTHORISING COMPETITION WITH A POWER COMPANY.

RADCLIFFE TRAMWAYS AND IMPROVEMENT BILL.

The Police and Sanitary Committee of the House of Commons, presided over by Mr. Heywood Johnstone, considered this bill on Monday. Mr. Wedderburn, K.C., appeared for the promoters with Mr. Keen, and the only opponent, the Lancashire Electric Power Co., was represented by Mr. Baggallay, K.C.

Mr. WEDDERBURN, K.C., in opening, said that Part II. of the bill dealt with tramways, and Part IV. related to electric supply. The bill proposed to construct certain new tramways in addition to those authorised by the Radcliffe Tramways Act of 1900. These latter lines had not, in accordance with the Tramways Act of 1870, been commenced within a year and completed within two years of the passing of the 1900 Act, but an agreement had been come to with the Bury Corporation as to the working of the whole of the tramways undertaking. The effect of this was to lease the undertaking for 30 years, the Radcliffe Urban District Council constructing the permanent way and supplying the electrical energy, and the Bury Corporation electrically equipping and working the tramways. He would therefore ask the Committee to confirm that agreement. Clause 46 asked for powers to supply electrical energy to tramway undertakings adjoining Radcliffe. The cost of the whole of the lines would be £79,394, and it was proposed to spread this over 30 years, the period of the lease. Part IV. of the bill, under clause 45, empowered the District Council to supply electrical energy in "bulk" to authorities outside the district. It was against clauses 45 and 46 that the Lancashire Electric Power Co. were appearing. An application had been received by the Radcliffe District Council from the Whitefield District Council for a supply, and it was felt that, being in a position to do so, the Radcliffe Council should have the authority to supply electricity in "bulk." Clause 45 was an ordinary one and had been inserted in several bills last year. The Lancashire Electric Power Co. was not in a position to supply electrical energy, in the first place, and in the second place he contended that the company had no monopoly in this area.

Mr. BAGGALLAY, K.C., for the Lancashire Electric Power Co., said he would not contest clause 46 if it were restricted to the connecting links proposed by this bill.

Mr. WEDDERBURN agreed to this, but still asked for clause 45, giving power to supply electrical energy for general purposes in "bulk" outside Radcliffe.

Mr. MILLS, the clerk to the Council, proved the preamble of the bill.

Mr. W. ROTHWELL, engineer to the Council, stated that the electricity works of the Radcliffe Council would be opened in about a month. The proposal under clause 45 was really a proposal to extend the boundaries to Radcliffe, and it was considered that it would be advantageous for the electricity works if a supply in bulk could be given in the manner asked.

Mr. F. E. GRIPPER, for the Lancashire Electric Power Co., said the contract for the first generating station of the company in Radcliffe amounted to £400,000, and the buildings would be complete in September. The attempt of the Radcliffe Council was to pick out the best districts around their area and leave the company to be obliged to supply in the more unremunerative areas in the locality.

Mr. BAGGALLAY, in addressing the Committee, said that a similar clause to the present clause 45 had been struck out of the Willesden and Wood Green bills last year. He contended that the proper sphere of trading for a municipality was, *prima facie*, within its own area. The question of rate-aided competition also came in in a discussion of this question.

Mr. WEDDERBURN, in reply, quoted precedents in the other direction, and argued that the Lancashire Company or any other power company had no monopoly in their areas. The Lancashire Company could not supply electricity any cheaper than the local authority, and it was, therefore, desirable that the traders should have the cheapest supply.

After a short deliberation,

The CHAIRMAN said the Committee did not intend to decide whether or not electric power companies had a monopoly in their own area. Each case must be decided upon its merits. In the circumstances of this case, the Committee would restrict the operation of clause 45 to the district of Ainsworth. If the district of Outwood was added to the area of Radcliffe later on, it should apply also in that case. With regard to Whitefield, the Committee did not think the clause should be allowed,

SUPPLY OF ELECTRICITY BILL.

This bill, which was read a first time in the House of Lords on April 28, and was given in full on p. 102 of our last issue, is down for second reading in the House of Lords to-day (Friday).

OTHER ELECTRICAL BILLS.

A number of bills of electrical interest were before the Unopposed Committee of the House of Lords last week, and they were all, with the exception of one, reported for third reading. The *Bournemouth Corporation Tramways Bill* seeks to construct tramways and tramroads, to extend the time for the construction of authorised tramways, to run omnibuses within and beyond the borough and to enter into agreements with the Christchurch Corporation for working tramways, &c. The *Lothians Electric Power Bill* authorises the incorporation of a company for establishing electricity works for the supply of electricity in bulk in the county of Midlothian (excluding Edinburgh, Leith, Stow, Heriot, Fala and Soutra) and portions of the counties of Haddington, Peebles and Lanark. The sites scheduled for generating stations are at Kingsknowe, Lasswade, West Linton and Auchengray. Some particulars of a possible amalgamation with the Fife Power Co. were given in our issue of Jan. 8, p. 462. With regard to the agreements between the company and the local authorities Lord Balfour of Burleigh thought that further consideration was necessary, and a decision was postponed. The *Derbyshire and Nottinghamshire Electric Power Co. Bill* takes powers under its bill to acquire from undertakers provisional electric lighting orders and to apply for and carry into effect such orders, to authorise alteration of capital and increase of borrowing powers, to pay interest out of and commissions on issue of capital, to subscribe to capital issue of and lend moneys to other companies, &c. The *Leicestershire and Warwickshire Electric Power Bill* seeks to extend periods limited by 1902 Act, to remove restrictions as to erection of generating stations, to acquire provisional orders and electricity undertakings, to pay interest or dividends on shares during construction, &c.

The *North-Western Electricity and Power Gas Bill* was dealt with by the Unopposed Committee of the House of Commons on Friday last week. Power is sought to acquire additional lands for generating stations, to remove restrictions as to the erection of stations, to acquire electricity undertakings by agreement, &c.

In the House of Lords on Thursday last week the *Clyde Valley Electric Power Bill* was read a third time. On Monday the *Wolverhampton Corporation Bill* was read a second time, and the *Leicestershire and Warwickshire Electric Power* and *Derbyshire and Nottinghamshire Electric Power Bills* were read a third time and passed. On Tuesday the *Baker Street and Waterloo Railway Bill* was read a second time. *The West Riding Tramways Bill* was read a third time and passed.

In the House of Commons on Monday the *Lancashire Electric Power Bill* was read a second time. On Tuesday the *Crystal Palace Gas Bill* was read a third time and passed.

A number of electric lighting provisional order confirmation bills have been dealt with during the past week. Bills to confirm orders relating to *Barry*, *Gainsborough*, *Kirkby-in-Ashfield* and *Glastonbury* have been passed by the Unopposed Committee of the House of Commons and reported for third reading. Other bills relating to an extension of the *Huddersfield* area, *Bishop Auckland*, *Sunderland*, *Bath Rural*, *Chippenham*, *Newquay*, *Penzance*, and *Tavistock* have been passed by the Standing Orders Committee and reported for second reading in the House of Commons.

The *Glasgow Corporation* has been granted a provisional order under the Private Legislation Procedure (Scotland) Act for an extension of its tramway system. The new lines are some 9 miles of single track in length and will run along the Barrhead and Kilmarnock Roads.

METRIC SYSTEM (WEIGHTS AND MEASURES) BILL.

Lord Belhaven's Committee of the House of Lords resumed the hearing of evidence in connection with this bill last week.

Mr. H. H. CUNYNGHAME, C.B., assistant secretary in the Home Office, spoke as to the difficulties which might arise if clause 6 were allowed to remain in. This clause perpetuated the provisions of earlier acts to the effect that all contracts not made out in conformity with the metric system were void. Such a provision was very dangerous. If every contract not based on the metric system were to be absolutely void, the act might become very unpopular. The opinion of the Home Office was that a reasonable fine would be sufficient to cause the act to be

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enforced. He should like to see a provision that all weights and measures in shops should conform to the metric system.

A number of witnesses were then called representing the agricultural industry, who expressed various opinions as to the utility of the system. The Committee subsequently sat in private.

TUNBRIDGE WELLS TELEPHONE CHARGES.

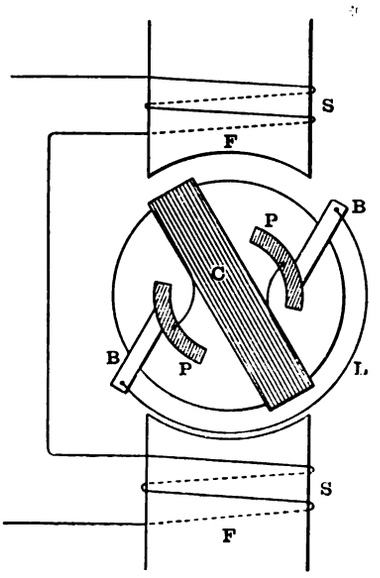
In the House of Commons on Friday last week, Mr. GRIFFITHS-BOSCAWEN asked the Postmaster-General whether his attention had been directed to the fact that, notwithstanding that it was laid down in the licence of the National Telephone Co. that they may not charge a rental of more than £6 per annum for exchange facilities in the Tunbridge Wells area, they were demanding from their subscribers a sum of £6. 5s. per annum, on the ground that the 5s. represented the stamp duty; and if so, would he state whether such action was a contravention of the terms of their licence, and whether the company had the right to take away a subscriber's instrument if the subscriber refused to pay the additional 5s.

Lord STANLEY, in a printed reply, said that the National Telephone Co. was under no obligation, so far as its licence was concerned, to limit the charge in the Tunbridge Wells area to £6 per annum. The limits of charge for an unlimited local exchange service were £10 and £5 17s. 6d., and the company might, under its licence, charge any sum within those limits. The agreement between the Corporation of Tunbridge Wells and the company for the transfer of the Corporation telephone system did, he understood, contain a provision as to the company's future charges to subscribers who had joined the Corporation system, but he was not prepared to offer an opinion as to the effect of that agreement in relation to the demand of the National Telephone Co. that stamp duty on agreements for an exchange service shall be paid by subscribers.

A NEW SINGLE-PHASE MOTOR.

An interesting patent for "Improvements in Single-phase Alternate-current Motors" (No. 3,705, November 7, 1903), has just been published. The patentees are Messrs. Crompton & Co. and Rudolf Goldschmidt. The following is the complete specification:—

As single-phase alternating-current motors as hitherto made have not been so satisfactory as continuous-current motors, or as three-phase alternate-current motors as regards starting torque, the object of this invention is to provide a single-phase alternate-current motor which shall



have a much larger starting torque than those hitherto made and more nearly approaching the starting torque of a continuous-current series-wound motor. To obtain this object, some single-phase alternate-current motors have been made in the past fitted with commutators. By our invention we obtain even a better starting torque than in motors of this class, with the advantage that we do not have a commutator, but only a collector with a small number of parts, and which must of necessity give sparkless collection.

Our invention is based on the well-known law, in accordance with which a closed coil of conducting material placed in an alternating magnetic field will set itself in such a position as to enclose the smallest possible number of lines of magnetic force. A closed coil, C (Fig. 1), suspended, pivoted or mounted on an axle within a two-pole magnetic field, FF, excited by an alternating current in the coils SS, so that its plane makes an angle with the direction of the lines of force, will have a current induced in it and a force exerted upon it tending to set it with its plane parallel to the lines of force. When the coil is moved into this position the inductive action ceases and the current in the coil falls to zero.

In order to obtain continuous rotation, the circuit of the coil must be automatically broken as soon as the plane of the coil lies parallel to the lines of magnetic force. This can be done without fear of sparking, as no current flows in the coil when it is in that position. The breaking or opening of the circuit may be effected by means of a collector ring consisting of two segments, PP, to which the two ends of the coil are connected and which rotate with the coil.

In the case of a coil placed in a two-pole magnetic field each segment should subtend an angle of about 90deg. Two brushes, BB, connected together electrically, either directly through the lead L, or through resistances, choking coils or condensers, and placed (in the case of a two-pole magnetic field) at opposite ends of a diameter, must be provided and fixed so as to rub on the two segments of the collector ring. These brushes must be so placed, and the exact angle subtended by the segments of the collector ring must be such that the coil C will be short-circuited, or partially short-circuited, by the brushes BB whilst passing through any two opposite quadrants of a circle, and will be on open circuit while passing through the other two quadrants.

If sufficient momentum is provided in the revolving coil itself, or parts attached to it, to carry it through that part of its revolution in which it is on open circuit, such an apparatus will constitute a simple form of single-phase alternate-current motor, in accordance with our invention.

In order to avoid the disturbing effect of the armature reaction the poles of the field magnet may be split, in the middle, by an air or other non-magnetic gap, or a short-circuited winding be inserted in them.

In order to be independent of momentum for obtaining continuous rotation, and in order to avoid all electrical and mechanical irregularities, we prefer to employ several rotating windings, or coils, instead of one. These coils would be situated equidistant from one another, and the segments of their collector rings and the brushes belonging thereto would be so situated, relatively to one another and to the coils, that the coils become short-circuited or partially short-circuited as soon as they enter under the poles of the magnet, and are open-circuited again as soon as they pass the centre point of the poles of the magnet.

The actual construction of the machine may either take a form similar to that of a continuous-current machine—*i.e.*, a magnet ring of laminated iron with a number of inwardly projecting laminated poles and a cylindrical armature having a core of laminated iron with the coils mounted thereon, or it may take the form of an alternate-current induction motor, having the primary, or exciting, winding spread out over the inner circumference of an annular magnet and with a cylindrical armature rotating therein, having a laminated iron core, with the coils mounted thereon. With certain numbers of armature coils it is unnecessary to have as many collecting rings as coils, as the segments belonging to the several coils may be combined into a single subdivided collecting ring.

For simplicity only a two-pole magnetic field has been mentioned herein above, but in carrying out our invention we may also use field magnets with more than two poles. We have also only made mention of cylindrical armatures, but armatures of the disc type, or of the hollow cylinder type, may also be used in carrying out our invention; and although we have only spoken of the armature revolving, we may in carrying out our invention arrange the motor to have a stationary armature and revolving field.

The claims are:—

1. The construction and use of single-phase alternate-current motors having armatures consisting of a coil or coils, with or without a laminated iron core, the said coils being capable of rotation in a magnetic field excited by an alternating current, and so arranged that the coil (or each coil if more than one) is, or are, short-circuited or partially short-circuited during a part of each revolution only, substantially as and for the purpose described above.

2. The construction and use of single-phase alternate-current motors having armatures and magnetic fields as described with reference to claim 1, but in which the armatures are fixed and the fields revolve.

LEGAL INTELLIGENCE.

Metropolitan Electric Supply Co. (Ltd.) v. Marylebone Borough Council.

This case was mentioned to Mr. Justice Buckley in the Chancery Division on Friday last, when defendants applied for an extension of time until June 20 for performing their obligations under the judgment against them for the specific performance of their agreement to take over the electric lighting of the borough.

Mr. FLETCHER MOULTON, K.C., stated that the bill now before Parliament would shortly be passed, and that the London County Council had agreed to the proposed loan. Defendants offered to pay £5,000 down and £5,000 on or before June 20.

Mr. CRIPPS, K.C., for plaintiffs, agreed to the proposed extension of time, and said plaintiffs were wishful to proceed amicably, but called the Court's attention to the fact that, since the last application for extension of time, they had spent large sums on the works which would be for the benefit of the defendant Corporation, and that the balance of the capital expenditure owing by the defendants amounted to £28,752, and it was anticipated that a further £10,000 would be expended by June 30.

His lordship extended the time, defendants to pay the two sums of £5,000 as offered.

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New St. Helens and District Tramways Co. (Ltd.) v. the Assessment Committee of Prescot Union.

In the High Court on Monday, the Lord Chief Justice, Mr. Justice Wills and Mr. Justice Kennedy heard an appeal against a poor-rate made on June 9, 1902, on the company's land and tramways in St. Helens. The appeal was to the general Quarter Sessions for the county of Lancaster, but by consent a special case was agreed for the opinion of the High Court. Appellants were rated for land and tramways, 10 miles 44 chains, at a gross estimated rental of £3,165 and a rateable value of £2,110. The company are lessees from St. Helens Corporation of certain electric tramways. The generating station, cables, wires, poles, &c., had been provided by the Corporation, who also supplied electric power to other companies than appellants, and also to two pumping stations of the Corporation by means of the same electrical equipment, and by means of cables and wires through which appellants' cars derived their source of supply. These additional supplies were given through those cables without the knowledge or consent of appellants, but after they became aware that the wires were being used by the Corporation for the purpose of supplying current to other consumers they wrote calling attention to the fact that the cables which were laid for the purpose of the tramway system were being used for suppplying other companies, and asked what allowance the Electricity committee proposed to make to appellants. The reply was a resolution that "The tramways company be allowed an annual rebate of £3 in respect of such user." The quarterly accounts of the Corporation to Sept. 30, 1902, showed that an allowance of £5 was made to appellants in respect of the supply of current to one of the outside consumers for 20 months, but no allowance was made in respect of four other cases. The tramway poles were in some cases used for attaching lamps to light the public highways, but the cables and wires for lighting the lamps were independent of those used for supplying power to appellants' cars. The appellants had no control of the generating station, and all the equipment is kept in repair by the Corporation. On behalf of appellants it was contended that they were not in occupation of the posts, cables and wires or any part of the equipment through which electrical power was supplied to the tramcars. For respondents it was contended that appellants had, in fact, the exclusive and paramount control of the whole electrical equipment; that the poles, wires, cable and equipment were annexed to and formed part of the tramways of which appellants were rateable, and, therefore, the net annual value thereof ought to be taken into consideration in determining the annual value of the tramway and premises.

The question for the Court was whether appellants were rateable in respect of the post, wires, cables and equipment, and whether the net annual value thereof ought to be taken into consideration in determining the net annual value of the appellants' premises. If the Court decided in the negative it was arranged that the rate should be amended as follows:—The gross estimated rental to be reduced to £1,500 and the rateable valueto £1,000. If otherwise, the rate was to be confirmed or the Court make such order as it thought fit.

The LORD CHIEF JUSTICE held that the Corporation and not the appellants were the occupiers of the poles, wires, cables and equipment, and, therefore, the rate must be reduced to the sum agreed upon. The other judges agreed.

Leave to appeal was granted.

Smith v. Pare.

In the King's Bench Division this week, Mr. Justice Lawrance and a special jury have heard an action, brought by Dr. E. A. C. Smith, specialist in electro-therapeutics, against Mr. W. L. Pare, to recover charges for professionally attending defendant's wife and damages for assault. Defendant admitted the assault, and counterclaimed for damages for alleged unskilful treatment.

Mr. DUKE, K.C., said plaintiff was a medical man who had for many years devoted his attention to the application of electricity, and particularly to the action of X-rays in the treatment of cancer. He attended defendant's wife for six weeks, partly in London and partly at St. Leonards, and his claim was for 100 guineas. He had been assaulted by the defendant, and claimed damages. Defendant counterclaimed for damages, alleging that his wife had been improperly treated, that X-rays were used without his consent and had caused her pain and injury, and that he had incurred great expense for medical attendance and nursing. The learned counsel described the state of affairs in relation to the health of Mrs. Pare when plaintiff was called in as desparate, and said that the X-rays were used with the hope of effecting a cure. The treatment was gradually having the desired effect, and was, in fact, the sole method that could have had any beneficial effect at all. The "burns" which resulted from the treatment were a possible and very probable incident of such treatment.

Dr. A. H. GREGG, superintendent of the X-ray department of St. Thomas' Hospital, said that X-rays had been proved to have a beneficial effect on external symptoms of cancer, and he was aware of a few cases where they had mitigated the pain of internal cancer, but he had never known of a case of cancer being cured by them.

Dr. HENRY HUXLEY, for the defence, said he had been Mrs. Pare's medical attendant for 12 years. He did not consent to the X-ray treatment. He raised no objection to the high-frequency treatment because he knew it could do no harm, although it would have no good effect on cancer. There was no evidence yet of X-rays having any beneficial effect on deep-seated cancer. The X-ray treatment might destroy external cancer. He refused to meet plaintiff because he thought he must have known of the circular advertising his treatment, and in the medical profession advertising was a breach of etiquette and regarded as disreputable.

Sir VICTOR HORSLEY said Mrs. Pare had a growth of a suspicious nature, but it certainly was not cancer. Mr. Pare asked him if high-frequency currents would do his wife any good, and he said that in his opinion they would do neither good nor harm. It was a well-ascertained fact that X-rays were absolutely useless for internal cancer. The utmost that could be expected from the exposure of the nodules to the rays was that they might shrink and disappear where they were local and superficial. He had used X-rays for superficial cancer of the skin. His experience was that with internal cancer they neither mitigated the pain nor altered the course of the malady.

The case was concluded yesterday, when

The jury found that defendant did not consent to the X-ray treatment, and that the treatment was improper, negligent and unskilful. For the assault they awarded plaintiff 40s., and on the counterclaim awarded defendant £100.

As defendant had paid in 40s. in respect of the assault, judgment was entered for him both on the claim and counterclaim, with costs.

National Electric Traction Co. (Ltd.)

In this matter, before Mr. Justice Buckley on Tuesday, counsel stated that petitioners' debt had been paid, and he asked leave to withdraw. This was agreed to; but another creditor supporting the petition was ordered to be substituted, and the petition will come on next week.

Bradford Tramways and Omnibus Co.

In the Chancery Division on Tuesday, Mr. Justice Buckley held that Mr. J. W. Courtenay was entitled to prove damages for breach of contract in the liquidation of this company. It appeared that in January, 1900, the company entered into a contract with Mr. Courtenay, allowing him, on payment of a certain rent, to advertise on the vehicles of the company. The tramways had been at the time leased by the Corporation to the company, and the lease expired at the end of January, 1903. The Corporation, under a special Act of Parliament, determined the lease about a year before the contract would have expired, and Mr. Courtenay had, therefore, lost the benefit of the lease and his three years' contract with the company.

Mr. BUCKMASTER, K.C., for the liquidator, submitted that the performance of the contract having become impossible by the passing of the Act of Parliament, the contract could not be enforced against the company as the act had relieved them of responsibility.

Campion v. Mossman.

The Under-Sheriff of Yorkshire (Mr. E. Gray) and a jury sat at Leeds Town Hall last week to assess damages in an action for libel by the borough electrical engineer of Dewsbury (Mr. R. H. Campion) against Mr. T. S. Mossman, of Sheffield.

Judgment had already been obtained, and Mr. HUGHES, who represented plaintiff, explained that defendant described himself on his card as a consulting engineer and agent of an oil company. Up to the beginning of 1903 the company had supplied oil to Dewsbury electricity works, the defendant acting as agent in the matter. The committee, acting upon Mr. Campion's advice, decided to place the order with another company. When the order for oil for which defendant was agent was stopped he continued to call for orders, and was refused. That seemed to have affected defendant, who had published the libel complained of at a local inn. Defendant wrote on a piece of paper as follows:—"Points requiring explanation. Electrical engineer receiving 10s. per cask on vacuum oil. Joints of machinery becoming heated and worn out. Investigations essentially necessary." That was handed from one person to another, and soon became the talk of the town, to Mr. Campion's great annoyance. So public did the matter become that eventually the chairman of the Gas, Water and Electricity committee heard of it, and after inquiries, the piece of paper was produced to him in the presence of the councillors. He summoned a special meeting of the committee in December last, and plaintiff was called upon for an explanation. The matter was thoroughly investigated and the charge was found to be absolutely baseless. The libel was a wicked and baseless one, and he (Mr. Hughes) asked for such damages as the jury thought his client was entitled to. Mr. Campion would be willing to hand over the money to some local charity.

Counsel for defendant said the facts were not in dispute. Defendant had acted in a thoroughly honourable manner. He had no malice or ill-feeling against plaintiff, and had no idea that the paper complained of might be construed as an aspersion upon his character. With regard to damages, he did not think plaintiff was entitled to a penny, having regard to his attitude. Defendant had agreed to give an apology.

The jury assessed the damages at £12, and judgment was given for plaintiff for this amount, with costs.

Teece v. Corlett Electrical Engineering Co. (Ltd.)

At Wigan County Court last week Judge Bradbury delivered his reserved judgment in this case, which was heard by him last month. Plaintiff (on his son's behalf) sought to recover £14. 1s. 2d. for 11 weeks (and 18s. 2d. costs) alleged to be due from the company under following circumstances:—Plaintiff's son (John Harry Teece) was apprenticed to the defendant company in July, 1902. He worked at Newcastle, and while putting up a small electric lighting installation at a house a piece of his chisel flew off and struck him in the left eye and he was unable to work for a time. It was contended for plaintiff that he was engaged at a weekly

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wage, and as he had had no notice defendants were obliged to give him (plaintiff) notice before they could escape responsibility.

Defendants pleaded that plaintiff having by the accident become incapable of doing work he had by that fact put an end to the contract, and, therefore, he (plaintiff) could not sue for wages.

Judge BRADBURY, in his judgment, referred to the cause of the injury and to the interview between Teece and plaintiff's manager (Mr. Kirk) at Newcastle, when Teece informed Mr. Kirk he would return to work as soon as his eye was better. Mr. Kirk, in the meantime, paid the wages then due to Teece. One would naturally say (continued the Judge) that the Workmen's Compensation Act would apply to such a case. Under that act plaintiff would have got half his wages. But plaintiff was not working on, in or about his master's factory, but at the time of the accident was working away on other premises, the act consequently did not apply. At first sight it seemed rather a startling proposition that a man was entitled to recover full wages, although under the Compensation Act he could only have got half his wages. His Honour found, first, that the incapacity for work was of a temporary character, and, second, that no notice was given by defendants terminating the contract of employment. He held that illness of a temporary character, causing temporary incapacity to work, did not put an end to a contract. There was a distinction in law between disease causing permanent and total incapacity and injury causing merely temporary incapacity. In the former case the contract was at an end, but temporary illness and incapacity did not end the contract of employment. In the latter case, however, the contract could be determined by notice. Consequently, he held that the contract, not having been determined by incapacity or by notice, remained in full force, and there must be no suspension of the weekly payments by reason of plaintiff's illness and inability to work. Plaintiff was entitled to his full wages for the period sued for (Dec. 3, 1903, to Feb. 19, 1904), or 11 weeks at £1 a week. The payment was for 11 weeks' wages at 23s. a week, but the odd 3s. was an allowance for expenses, and plaintiff was not entitled to that.

Judgment was entered for plaintiff for £11 and costs. Stay of execution was granted, and leave to appeal was given.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A junior assistant for physics is required at Merchant Venturers' Technical College, Bristol. Particulars from the registrar. See advertisement.

Middlesex Education committee require an electrician to be responsible for the gas engines and dynamos at polytechnics in the county and for the care of electrical plant, also to assist in taking some of the electric light wiring classes. Salary £150 per annum. Applications to Mr. B. S. Gott, Guildhall, Westminster, by June 1.

An arc lamp expert and salesman is required for London district. See advertisement.

A man is wanted to take charge of a country house electric light installation, with gas engine. See advertisement.

Oldham Tramways committee require a traffic superintendent. Salary £120. Applications by 17th inst.

Mr. J. S. Ker, B.Sc. (Edin.), A.M.I.C.E., Wh.Sc., of Carlisle, has been appointed head of the department in Mechanical Engineering at Woolwich Polytechnic; Mr. R. T. Smith, B.A. (Cantab.), late Foundation Scholar of St. John's College, Wh.Sc., of London, acting head of the department of Mathematics and Experimental Physics; and Mr. G. Melland, M.Sc., A.R.S.M., F.I.C., F.C.S., of Swansea, head of the department of Chemistry and Metallurgy.

Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board have appointed Mr. H. Taylor chief inspector of tramways, Mr. W. Amber, Wakefield, station superintendent, and Mr. G. E. Shepherd mains superintendent.

Mr. R. D. Binsted of the General Post Office, London, has been appointed controller of the Telegraph Department, Edinburgh, in succession to Mr. J. W. Plackett, promoted.

Mr. George A. Lister of Bath has been appointed assistant lecturer and demonstrator in electrical engineering at the University of Birmingham.

Mr. W. J. U. Sowter, of Dorchester, has been appointed resident electrical engineer at Bray, Ireland, at a salary of £200 per annum.

Mr. H. A. Harding, draughtsman at the Bermondsey electricity and destructor works, has been appointed chief assistant electrical engineer to Leatherhead Electricity Supply Co.

Mr. J. Helme, of Barrow-in-Furness, has been appointed assistant electrical engineer at Nelson.

Mr. J. R. Baker, of Bolton, has been appointed electrical and gas engineer and surveyor at Malvern at £400 per annum.

EDUCATIONAL NOTICE.

An interesting report upon the special schools for ship engineers, which have been of late years established in Germany, has been prepared by Dr. F. Rose, H.M. Consul at Stuttgart, and is now issued. The particulars include a review of the aims and objects of these schools, the course of study, the mechanical and electrical equipment of the schools, the time devoted to the various subjects, fees and cost of living of the students, &c. The studies include electrotechnics, mathematics, physics and chemistry, and details of these subjects of instruction accompany the report, which is of particular interest at the present time.

Alleged Criminal Libel.—At the Mansion House (London) on Monday, before the Lord Mayor, John Henry Callcott, engineer, was charged with unlawfully and maliciously publishing defamatory libels, concerning Mr. Albert Henry Wood, electrical engineer, Victoria-street, Westminster, London. It was stated that defendant had been in the prosecutor's employ as general foreman. Prosecutor had executed several large electric light installation contracts, and defendant had to supervise the men and keep particulars of time and materials expended on the various jobs, &c. In February defendant asked for a bonus in respect of some work done, but Mr. Wood told him he was not entitled to a bonus, and he was subsequently dismissed for disobedience. Plaintiff had to take proceedings against Callcott to obtain possession of certain time-sheets. Afterwards defendant's solicitor wrote to prosecutor making a claim for £124, and it was now alleged that defendant subsequently wrote to prosecutor enclosing copies of three letters which he said he was going to write to some gentlemen. In these letters defendant made statements with regard to the quality of some of the work done on certain contracts, and with regard to the time which the work occupied, which statements were the libels complained of. Defendant, instead of sending the letters to the prosecutor, posted them by mistake to Messrs. Bolton & Co., prosecutor's solicitors. Defendant reserved his defence, and the Lord Mayor committed him for trial, accepting bail in two sureties in £50 each, or one in £100.

Asylum Lighting.—Negotiations are proceeding between Dublin Corporation and the Richmond Asylum Board for the supply of electric energy by the Corporation to the Asylum.

Messrs. Lacey, Sillar and Leigh have been instructed by Cheshire County Council to prepare specifications for electrical plant, wiring, &c., for Parkside Asylum, Macclesfield.

Barnsley.—The Council have given notice to the local gas company of their intention to discontinue using (and have asked the company to remove) 140 public gas lamps, for which will be substituted 54 arc lamps. Application has been made for sanction to a loan of £6,067. 18s. 9d. for extensions to electric lighting mains, &c.

The chairman of the Electricity and Lighting committee (Councillor Brady) stated, at the Council meeting on Tuesday, that the electricity department had now a balance in hand of £964. 16s. 3d., and had decided to make a discount of 2½ per cent. to customers for lighting who paid within a month. The committee asked permission to place £500 of their profits to reserve. With the proposed increase in arc lighting, the committee would be able to charge £9. 10s. per arc light instead of £12. 10s. as at present. The present cost of the 140 gas lamps, including hire of standards, was £229 per annum; the cost of the 54 electric lamps, including standards, would be £346 per annum, a difference of £57, but they would get about five times the light, and increase the revenue of the electrical undertaking by £429 per annum. The capital cost would be £750.

Birkenhead.—The accounts of the electric lighting department for the year ended March 31 show income from sale of current £10,720. 4s. 4d., meter rentals £635. 6s. 9d., motor rentals £29. 19s. 2d., miscellaneous £33. 8s. 2d., total £11,418. 18s. 5d. Generation expenses £2,820. 14s. 7d., cost of distribution £276. 19s. 6d., maintenance of public lamps cost £261. 2s. 10d., rents, rates and taxes were £495, management expenses £697. 17s. 9d., and interest charges £83. 1s. 8d, leaving a gross profit of £6,784. 12s. 1d. Interest amounted to £2,964. 15s. 10d., sinking fund £1,775. 14s. 4d., and stock redemption fund £658. 1s. 7d., leaving £1,386. 4s. 4d., which has been transferred to renewals account.

Traffic receipts of the tramways department were £54,672. 1s. 8d (against £51,078. 5s. 7d. in previous year); advertising and miscellaneous receipts brought the total to £55,945. 18s. 7d., against £52,559. 4s. 9d. Management and traffic expenses were £24,382. 5s. 5d., electrical expenditure £7,844. 2s. 8d., and surveyor's expenditure £2,521. 0s. 11d., leaving £21,198. 0s. 7d. Interest absorbed £10,665. 5s. 9d., sinking fund £8,750. 13s. 4d., and the net balance (£1,883. 8s. 10d.) has been transferred to renewals account. The total capital outlay is £356,617. 9s. 8d.

Blackburn.—At the meeting of the Town Council last week, the estimated loss on the tramways for the past year was put at £4,900 against £4,075 in the previous year.

Bo'ness.—The Secretary for Scotland has refused to sanction a loan of £25,000 for electricity works.

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Bournemouth.—The borough engineer and surveyor and the borough electrical engineer are to report further on the proposal to provide additional generating plant at the municipal electricity works.

Bradford.—The authorities of this enterprising Yorkshire town have prepared a great attraction for Whitsuntide and the ensuing months up to October in the form of an exhibition specially devoted to the industries of the Bradford district. In addition to the instructive character of the exhibition, the entertainment aspect of the show has not been lost sight of. Facilities for reaching the exhibition from all points, and for getting about the exhibition grounds, have been amply provided for. There are a considerable number of electrical exhibits, as might be expected, as the exhibition is likely to result in a considerable extension of electric lighting and power installations in a district, where this method of driving machinery and tools is already in high favour. Messrs. Fattorini & Sons have loaned the electric clocks throughout the buildings and grounds, Mr. J. A. Steinthall the hospital electrical fittings, the Brockie-Pell Company the arc lamps, and Messrs. A. J. Harris & Co. and the Phœnix Dynamo Co. the electric motors on the stands. The electrical installation in the grounds and buildings has been carried out by Bradford Corporation electrical department.

Steps are being taken to obtain the sanction of the Board of Trade to the alteration of the gauge of the Mid-Valley light railway from 3ft. to standard gauge, to ensure through traffic at Pately Bridge. Estimated cost, £7,000.

Brighton.—An inquiry was held here last week into the application of the Corporation for permission to borrow £10,000 for electricity supply, £4,000 for changing the pressure of supply in a portion of the borough and £6,000 for purchasing electric motors to be let out on hire.

The deputy town clerk (Mr. HUGO TALBOT) said that the first portion was required for work to be done in continuation of similar work carried out in other parts of the borough, and in respect of which a loan had already been sanctioned for 10 years; the period asked for the present loan was 25 years. The work had been rendered necessary by a rearrangement of switchboards in connection with the new electricity works at Southwick. For purposes of economy it was necessary that the work should be carried out this spring, and a portion of the work had already been completed at a cost of £1,000.

The electrical engineer (Mr. J. CHRISTIE) said the change-over would effect a substantial economy.

There was some opposition by ratepayers, and Mr. HEWITT opposed the principle of charging the work to capital expenditure, contending that it should come out of revenue. He also said that nothing was allowed for depreciation of plant at the North-road works, and those works had been thrown out of use by the Southwick station.

Mr. CHRISTIE, however, denied this.

The INSPECTOR said he thought it probable that if the loan was granted it would only be for 10 years.

In reply, Mr. TALBOT admitted the growth of the borough's indebtedness, but a great part of the debt had been incurred for remunerative undertakings, of which the electricity undertaking was one of the chief. The electricity works during 13 years had been the means of £13,961 being applied to relief of rates. Charging the cost of the present work to capital account was absolutely justifiable, as it was a charge incurred to save a much larger charge which would have had to be charged to capital expenditure. With regard to a Government auditor, a select committee had not reported in favour of that. He pointed out that the Brighton accounts had the advantage of a professional audit of a satisfactory description. As to depreciation, the Council considered that no further fund was required in that particular instance. With reference to the £6,000 for electric motors for hiring to consumers who could not purchase motors, that would be a source of considerable profit to the Corporation, inasmuch as they led to a greatly increased output of electricity during the slack hours of the day. Some £3,443 worth of these motors had already been bought.

There was some opposition to this portion of the application.

Newhaven Rural Council have informed the Corporation that they would be willing to enter into negotiations for the supply of electric current for Rottingdean and Ovingdean if Brighton Corporation is willing to take over the present electric light undertaking at Rottingdean and arrange for an outfall for the sewage from Ovingdean.

Shoreham Harbour Trustees have disapproved the plans submitted by Brighton Corporation for laying electric cables under the harbour at a depth of 2ft. below the mud, filling up to the level of the harbour bed with concrete.

Bromsgrove.—On Wednesday the Council assented to the North Worcestershire electric lighting provisional order.

Canterbury.—The net profit on the past year's working of the electricity undertaking was £812. 8s. 9d. A new battery of accumulators is to be purchased.

Cape Colony.—Mr. E. J. Cattell, Board of Trade correspondent at Cape Town, gives the following list of goods, for which there is very little sale in the district:—

Fine sizes of wire—21 W.G. and finer, 0·032in.=0·8128mm. in brass, copper, bronze, nickel, steel, aluminium, &c. Dynamo brushes, and copper gauge for the manufacture of same. Pure tin and special alloy fuse wires. Silk and cotton-covered instrument wires in copper and German silver. Flexible incandescent lamp cords. Flexible silk cords for electric bells. Bell and telephone wires, &c.

Coal-cutting Machinery.—A recent report by the United States Consul at Newcastle (New South Wales) is to the effect that machinery is fast taking the place of hand labour in the coal mines of that district. At one colliery, where some 250 miners were formerly employed, the number has decreased to those only who are working on the machines or in following up by blasting, drilling and timbering, the hand pick for coal-winning being entirely abolished. Coal-cutting machines are also being introduced at the Northern Extended, Sneddon and Teralba mines, and the owners of the Stockton, Pacific and Rhondda collieries are about to introduce coal-cutting machines. The majority of these machines are of American manufacture.

Colchester.—The net profit of the electricity undertaking for the year ended March 31 was £1,280. 17s. 4d., of which £780. 17s. 4d. has been carried to reserve and renewal account, and the balance in relief of rates.

Companies to be Struck Off Register.—Notice is given in the "London Gazette" that the following will be removed from the register of joint-stock companies in three months if cause is not shown to the contrary:—

Colwyn Bay Elec. Light & Power Co.	Italian Elec. Light and Power Co.
Elec. Mainten. & Accessories Synd.	Leeds, Wakefield, Dewsbury and
Electrical Navigation Protection Co.	District Electric Tramways.
Fermoy and District Electricity Co.	Pollard Electrical Engineering Co.
Fleet and District Electricity Co.	Tramway Trolley Co.
Hedges, McKrell and Taylor.	Volta Synd.

Coventry.—It was stated at the last Council meeting that there would be no deficiency in the electricity department accounts for the past year. In 1902-3 the loss was £466.

Customs Decisions.—Under a recent decision of the New Zealand Customs authorities, electric motors, when declared to be for use on or with machinery admitted free or machinery liable to 5 per cent. duty, are to be treated as part of the machinery for which they are imported. Poles for electric tramways are to be rated as electrical machinery and appliances, and bear a 10 per cent. duty.

Under the United States Customs tariff it has been decided that carbon sticks, intended and adapted for electric lighting, but requiring to be cut into shorter lengths and to have their ends shaped before use, are dutiable as "carbon not specially provided for, not decorated" at 35 per cent. duty ad val.

Darlington.—The Council recently abandoned a scheme for wiring premises on the easy payment system, and have now opened negotiations with a company for "free" wiring of premises in the district.

Dover.—The Council have authorised the payment of £164,028. 10s. 11d. as the cost of acquiring the undertaking of the Dover Electricity Co. (Ltd.)

Dundee.—The Corporation have adopted the recommendation of the Electrical committee to increase the salary of the electrical engineer (Mr. H. Richardson) by £100 per annum.

Electric Railway Signalling.—The Great Western Railway Co have arranged to equip a section of their main lines at Didcot with a system of electrically-controlled signalling. Accumulators charged from an adjacent power station will be supplied at each signal post.

Exhibition.—A public electrical exhibition will be held at the Worple Hall, Worple-road, Wimbledon, from 18th to 28th inst. The exhibition is being promoted by the District Council's electricity department, of which Mr. H. Tomlinson-Lee is chief engineer.

Fatality.—A child named Irving, three years of age, met with a fatal accident on Wednesday on the electric line belonging to the North-Eastern Railway Co. between Newcastle and Benton. The accident appears to have been due to the boy straying along the line from a level crossing. He was rendered unconscious and died within an hour of the accident.

France.—Electric tramways between Rennes and Miniac (St. Malo) will, it is anticipated, be extended in 1905 to St. Malo, passing through St. Servan. The work of construction is expected to be commenced in October or November next. A new electric tramway is also under consideration from Rennes to Grand Fougeray, and another line to Redon. The town of St. Servan is now lighted electrically.

Gillingham.—An inquiry was held on Tuesday into the application of the Council for sanction to borrow £20,000 for electric lighting extensions.

German Trade in 1903.—Readers interested in the statistics of German trade may be recommended to peruse the report by Mr. Consul J. Schwabach on the trade of Germany for 1903, just published. The report deals very fully with the position of German trade and industry, and gives data tending to show that the revival of trade in Germany, which set in at the close of 1902, has continued almost uninterruptedly up to this date. With regard to the electrical industry, Mr. Schwabach refers to the amalgamations of the principal German elec

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trical undertakings which have taken place during the past year. Much space is devoted to Germany's steel trade, and reference is made to what Mr. Schwabach describes as the "turbine craze," which has set in in Germany and which promises to be a feature of engineering enterprise in the future, especially in relation to shipping. Currency is given to the report that the leading German shipping companies, including the North German-Lloyd and the Hamburg-American lines, are about to fit out some of their vessels with turbines. A table shows that the number of electricity works in Germany supplying current for lighting and power purposes increased from 766 in 1901 to 868 in 1902.

Hackney (London).—The Finance committee have passed estimates amounting to £8,910 for extensions of the electric lighting mains. The insurance on the electricity and dust destructor works has been increased from £55,000 to £70,000. The Electricity committee have increased the wages of fitters from 38s. to 39s. per week, with a further advance of 1s. at the end of six months. The hours are to remain as at present (52 per week) and sick pay and holidays are to be continued.

Hertfordshire.—The County Council have appointed a sub-committee to consider the question of the construction of light railways.

Horwich.—The Council have decided to apply for a provisional electric lighting order.

Hove.—Hove Electric Lighting Co. have offered to supply electric current in bulk to the Corporation at 4½d. per unit for the first hour and 1½d. after; discount 10 per cent. if 250,000 units be taken in 12 months.

Islington (London).—At the Council meeting on Friday, the recommendations of the Electric Lighting committee, given in our last issue, were adopted, and it was decided to light additional thoroughfares with arc lamps at an estimated cost of £240.

Leicester.—Major Pringle and Mr. A. P. Trotter officially inspected the new municipal electric tramways on Wednesday.

Light Railways.—The Axminster and Lyme Regis Light Railway Co. intend to apply to the Light Railway Commissioners for authority to raise additional capital. Objections to the Commissioners, 54, Parliament-street, London, S.W.

The Maidstone and Faversham Junction Light Railway (Extension of Time) Order has been submitted to the Board of Trade for confirmation. Objections by 28th inst.

The Board of Trade have granted an extension of 12 months to construct the Nuneaton Light Railway.

London County Council.—At Tuesday's meeting electric lighting loans were made to Battersea, £11,042, and St. Pancras, £19,000.

Greenwich Tunnel.—Expenditure was sanctioned of £900 for the purchase of an additional motor-generator for lighting this tunnel.

Telephone Conference.—Messrs. H. A. Harben, R. Spokes and W. B. Yates were selected to represent the Council at the conference on the proposed transfer of the National Telephone Co.'s undertaking to the Post Office, which is shortly to be held at the Guildhall.

Louth.—The Electric Lighting committee, having considered the draft agreement with the National Electric Construction Co. for the erection of electricity works, the period of the company's lease has been reduced from 25 to 20 years.

Manchester.—An inquiry was held on Friday into the application of the Corporation for sanction to a loan of £135,000 for electricity supply, including £94,490 for additional mains, £10,000 for development of the motor-hiring scheme, and £21,575 for further lighting and traction facilities in the city and several of the adjacent districts.

Mr. J. H. Boardman (representing the Manchester, Salford and District Property Owners' Association) said the city's indebtedness was £21,000,000, that there was a heavy increase of rates in prospect, and that property owners felt that the present was not an opportune time for making additions to the capital expenditure of the Corporation.

The Deputy Town Clerk explained the various puposes for which the Council required to borrow money.

The chairman of the Electricity committee (Mr. Howarth) gave particulars of the growth of the electricity department. For the year ended March 31 last, the consumers numbered 5,171, the equivalent 8 c.p. lamps 607,451, and the revenue was £261,850. Within the last two years the output of electricity, owing in a large measure to the heavy demand for traction, had increased by 176 per cent. and last year was 28,950,000 units. Since the establishment of the department in 1893, £173,419 had been set apart as a sinking fund, £50,688 had been placed to reserve, and £52,963 handed over to the city fund. The total (£277,070) represented the aggregate profit made by the department. No charge had ever been made against the rates by the department.

The Tramways committee have decided to grant £5,000 additional (£55,000 altogether) in relief of city rates.

Margam.—The Local Government Board will defer consideration of the Council's application for a loan of £15,000 for electricity supply until a decision has been arrived at upon the question of the advisability of establishing municipal electricity works or of taking current in bulk from the South Wales Electrical Power Distribution Co. The Council have now decided to apply for sanction to a loan of £5,600 for a smaller scheme, which includes public and private lighting in the main streets and public lighting in the side streets.

Mexico.—It is announced that an American syndicate is negotiating for the purchase of the horse tramways in the city of Hermosillo, State of Sonora, for $2,000,000 Mexican currency, previous to converting the lines to electric traction.

Municipal Insurance.—Glasgow Tramways committee recommend the Council to accept the offer of the Scottish Employers' Liability and General Insurance Co. to insure the tramways department against claims under the Employers' Liability Act, the Workmen's Compensation Act and at common law, for a premium equal to 5s. per cent. (less 5 per cent) on the estimated wages of £260,000 per annum.

The Glasgow special committee on a proposal to establish a fire insurance department, have appointed delegates to obtain information as to the systems of fire insurance adopted by the London boroughs, and to report as to the best method by which corporate property could be insured by Glasgow Corporation.

Municipal Telephony.—The Telephone committee recommended Glasgow Corporation last week to consider whether the municipal departments of the Corporation, other than the Fire Brigade and Police Offices, requiring telephones for public service should not take such telephones from the Corporation Telephone department.

The chairman (Mr. J. Alexander) said it was simply an inquiry, as the committee considered it necessary they should take some cognisance of the matter. He held in his hand a list of rentals paid by Corporation departments to the National Telephone Co. (about £1,000); 13 offices had nothing but Corporation telephones.

Bailie Murrel characterised the proposal as one of the most remarkable ever brought before the Corporation—viz., that the National Company's telephones should be thrown out of the Corporation departments. The object was to make it impossible for ratepayers who had only the National telephone to communicate with the Corporation departments, and, by doing so, compel them to give up their National telephones and take the Corporation telephone instead. That was a proposal to injure another system. Was it one that any respectable body should adopt? He believed that the Corporation telephone department would be a success if placed on a commercial footing, but it would never be put right by the adoption of such a proposal. He moved the previous question.

Bailie Shaw Maxwell said that for all purposes of a public character the Corporation telephone service had already attained a position of sufficient magnitude to meet the requirements of the situation. The Corporation were not getting the same rebate as the public got from the National Company.

Mr. Bruce Murray, asked in the name of Liberty, that citizens should be allowed to conduct trade and enterprise unhampered by the Corporation. Three years ago a similar motion was nearly carried, which would have put many members of the Corporation to great inconvenience.

Mr. H. Alexander maintained that in no circumstances was boycotting justifiable. They were paying £600 for National telephones, and nearly £300 for special wires in connection with the Fire Brigade. The latter were introduced before the Corporation wires were in existence, and were likely to be there for a long time. No man was more sensible than he was that the National Company condescended to small things, but the proposal under consideration he declared to be contemptible. There was one way of defeating the National Telephone Co. in Glasgow, and only one, and that was by giving a better service.

Mr. Bilsland said that, in carrying on their enterprises, whether their opponents were unfair to them or not, the Corporation should always conduct them on the principle of kindly rivalry. The National Company had come to stay, whether the Corporation had telephones or not, and he had always advised those who had the National Company's instruments to have a second one, as it would be found of advantage to them in their business.

Mr. W. F. Anderson said they might shrink from war, but that was necessary sometimes. Bailie Maxwell had only brought the matter forward after much provocation. He contended that the National Company had in various ways attempted to injure the Corporation.

Mr. Alexander expressed a desire to withdraw the minute, but this was not allowed, and ultimately four voted for the motion, 47 for the amendment, and eight declined to vote.

Portsmouth Telephone commitee report a profit on the past year's working, but the accounts have not yet been audited by the borough auditors.

Newport.—The Council have received the report of the Local Government Board on the recent inquiry into the Council's application for sanction to a loan of £60,500 for electric lighting and power supply extensions:—

The Board intimates that the expenditure on the power station (£45,250) must be regarded as expenditure for tramways, and that the question of sanctioning a loan for those was one for the Board of Trade to deal with. With respect to the balance, the Local Government Board would sanction a loan, less the amount of debt outstanding on works which would be superseded.

The Tramways committee have now decided to apply to the Board of Trade for sanction to the above loan of £45,250.

North-Eastern Railway.—This company announce that the electric train service, which has been in successful operation for some weeks between Newcastle-on-Tyne and Ryton will be extended to Benton on Monday next, a 15-minute service being given.

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Norwich.—Tuesday the General Purposes committe will recommend that Norwich Electric Tramways Co. be allowed to take advertisements for the tramcars on condition that one-fourth the gross receipts from such advertisements (up to £600) is paid to the Corporation and half the receipts exceeding £600.

Nottingham.—The receipts from the Corporation tramways for the past year were the same as for the previous year (£18,000), out of which £5,000 was to be applied to sinking fund. The electricity undertaking shows a net profit of £8,800, of which £6,000 has been carried to reserve.

Paisley.—The first portion of the electric tramways was officially inspected yesterday.

Patent Amendment.—The Mica Insulator Co. (Ltd.), Empire Works, Blackhorse-lane, Walthamstow, London, N.E. (late of Stansted, Essex), seek leave to amend specification of letters patent No. 10,430 of 1892 granted to Robert Wood "for an improvement in electrical insulating sheet." Particulars of the proposed amendment are set out in the "Illustrated Official Journal (Patents)" of May 11, and notice of opposition must be given within one calendar month from that date.

Portsmouth.—The Electric Lighting committee submitted at his week's Council meeting the report of Mr. E. Manville on the electricity supply station (abstracted in our issue of April 29) which recommended that certain alterations and additions be made to the condensing plant, piping, &c., at an estimated cost of £5,000. Sanction for borrowing of this sum has been applied for.

The chairman (Ald. Ellis) said for some years past they had not had sufficient sea water for condensing. The proposal to provide a tank had been a failure. They required 400,000 gallons of water per hour at the station, and the only course open was to put down a pipe of sufficient magnitude. It was now proposed to lay a 30in pipe. The past year had been the most successful one they had experienced. The number of units generated this year was considerably over 3,000,000, last year only about 2,500,000. The total revenue was £41,175, against £35,280 last year. The expenditure (excluding interest and sinking fund) to produce that increase did not come to £700. There had been a great many economies by their new superintendent (Mr. W. S. Foale) who had saved £300 during the year in the boiler house, and a proportionate amount in the outdoor staff. There had been at the same time a considerable increase in the lighting.

Postal Telegraph Clerks' Grievances.—On Wednesday Mr. W. Rutherford, M.P., introduced a deputation of about 30 Unionist members to the Postmaster-General (Lord Stanley) to draw attention to a number of grievances as to pay, promotion, &c., of which postal telegraph clerks complain.

It was stated that the rates of pay and other conditions of employment, especially between 25 and 30 years of age, were less favourable than those of telegraphists in Continental countries, that the pay was less than the average given to mechanics in England, that there was extreme irregularity in the hours of work, and that the premises in which the telegraph clerks worked were in many cases insanitary.

Lord STANLEY said that most of the points urged were dealt with in the report of Sir E. Bradford's committee, which would at once be carefully considered, with a view, as far as possible, to adopting its recommendations. He hoped to lay the report in due course before Parliament. He would consider, in the meantime, among other points, how far the factory inspectors could be called in to advise as to the sanitary condition of postal telegraph offices, &c.

Railway Telegraph Superintendents.—A meeting of the Railway Telegraph Superintendents' Association was held on Tuesday at York, and during the day the members inspected the installation of the Hall automatic signalling between Alne and Thirsk. The party was conducted by Mr. C. H. Ellison, telegraph superintendent of the North-Eastern Railway.

Reading.—The accounts of the tramways department for the year ended March 31 show gross receipts from the electric tramways of £21,165. 6s. 8d. and expenditure £12,348, 18s. 10d., including power expenses £2,478. 9s. 11d., traffic expenses £6,240. 12s. 10d., repairs and renewals £1,307. 15s. 7d. and general expenses £2,322. 0s. 6d., leaving a gross profit of £8,816. 7s. 10d. With receipts from the horse cars the total net revenue was £10,078. 3s. 5d, and after providing for interest and sinking fund, &c. (£10,620. 13s. 10d.) there was a net deficit of £542. 10s. 5d.

In a report by the tramways engineer and manager (Mr. W. Binns) on the working of the tramways since the conversion from horse to electric traction at July 22 last, it is stated that the fracturing of axles interfered with the traffic, there having been at one time as many as 11 cars in the sheds from this one defect, and 59 axles have been replaced to date. The number of car-miles run was 555,540, and the passengers carried numbered 4,889,270, receipts averaging 9·08d. per mile, or 1·03d. per passenger carried. The total operating expenses (£12,463. 10s. 1d.) worked out at 5·34d. per car-mile run. The cost of generation of electrical energy was 0 85d. per unit. The consumption of current per car-mile was 1 unit, against an aveage of 1·33 units for 40 other tramway systems.

The Board of Trade have sanctioned the borrowing of £4,460 for a period of 15 years for electric tramcars.

Ravensthorpe.—The Yorkshire Electric Power Co. will shortly commence cable laying in this district.

Rochdale.—Mr. E. M. Lacey (Messrs. Lacey, Sillar and Leigh) has been appointed consulting engineer in connection with the proposed extensions of plant at the electricity station. It has been decided to adopt the three-phase system of supply to sub-stations on the Heywood and Littleborough routes.

Rhyl.—The Council will apply for sanction to a loan of £2,610 for laying a new feeder, distributor cables, &c.

St. Anne's-on-the-Sea.—During year ended March 31 the electricity department sold 483,992 units of current, compared with 115,555 in the previous year. There are now 249 consumers, against 173 last year.

Sale.—The borough electrical engineer (Mr. C. J. Wood) reports that the equivalent of 4,553 8 c.p. lamps is now connected to the mains. The receipts for the past year were £692, and working expenses £555. The total expenditure, including interest and sinking fund, exceeded the receipts by £200.

Siam.—It is again announced that there is a good opening in Siam for electrical apparatus and fittings. Especially is there a demand for artistic lamps, it is stated.

South Africa.—The "British and South African Export Gazette.', says:

Recent shipments from New York to South Africa include 137 cases of electrical machinery and material.

It is stated that the consulting engineer to the Salisbury (Rhodesia) Municipality has authority to open negotiations with companies willing to undertake the supply of electricity in the town.

The loan for the municipal electric tramways at Bloemfontein has been successfully floated. Messrs. Robert Hammond & Son are consulting engineers for the scheme.

A Customs Ordinance recently enacted for Mombasa (East Africa) provides that railway, tramway and road material shall be admitted free of duty.

The "Transvaal Leader" and the "Cape Times" have adopted in their printing works electric power plants.

Of the imports of electrical machinery into South Africa last year the Transvaal's share was £120,302, an increase of £32,451 over 1902.

Southwark (London).—On Wednesday the Electric Light committee reported that the special sub-committee appointed to inquire into the general working of the electric lighting undertaking, had investigated a number of complaints made from time to time by consumers as to the variation of voltage, price of electric current, &c. After consultation with the resident engineer (Mr. J. R. Blaikie) and obtaining a return of consumers to date, the result of the sub-committee's investigations had been that they had passed the following resolution:—

That this committee express their dissatisfaction with the management of the electric light department and recommend their committee to take steps that will ensure the better management for the future.

The Electric Light committee then requested Mr. Blaikie to make any observations he might wish on the sub-committee's report.

Mr. Blaikie replied that he had no desire to throw himself into direct antagonism with the sub-committee, but if he were able to show their conclusions were incorrect, he attributed the error to their lack of experience in electric light matters. The report of the sub-committee into the general working and supervision of the electric light station stated that the inquiries had been more particularly directed to complaints of consumers and the methods of dealing with them. In Mr. Blaikie's opinion that subject covered the whole scope of the inquiry—it resolved itself into a collection of evidence as to complaints, a discussion as to the cause of complaints, and finally an expression of opinion that the chief official did not realise the responsibilities of his position, and was lacking in skill, energy and judgment. With regard to the complaints which had been investigated, they were of such a nature that it was, speaking generally, a matter of opinion whether they were worthy of minute investigation. The Council would be aware that a private company was competing in the same district. The residents, therefore, had a choice of two electric light supplies. In some instances they knew that the company's price was more favourable, and yet the Council had secured a number of the company's consumers. The loss of some consumers was anticipated in the report of the sub-committee appointed to consider the desirability of reducing the charge and introducing a flat rate. Certain consumers did not really pay, and only served a temporary purpose in the early years when the capital was abnormally large. The system of charging automatically favoured the desirable consumers, the others would sooner or later revert to gas. In conclusion, Mr. Blaikie dealt briefly with the financial aspect of the electric lighting business in Southwark.

The Electric Light committee stated that they had given the whole matter full and careful consideration, and had arrived at the conclusion that the inquiry had revealed a state of inefficiency, and a want of commercial tact and administrative ability on the part of the resident engineer, which rendered it necessary, in the interests of the undertaking, that a change in the management should take place, and they accordingly recommended

That the resident engineer be given three months' notice to terminate his appointment.

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The chairman of the committee (Mr. NEWMAN) in moving the adoption of this report, stated that he entirely dissented from the recommendation. Their resident engineer (Mr. Blaikie) had come to them with the highest character, and was in no way to blame for the non-success of the undertaking. In his opinion success was now within measurable distance, but even if it were not it was unfair to attempt to ascribe failure to one man, in order to whitewash the committees who were responsible for five or six years.

Mr. ATTENBOROUGH pointed out that in September last, when Mr. Blaikie was seeking another situation. the late mayor gave him a testimonial for ability, tact and energy, and paying him a high compliment for his control and management of the undertaking. They were doing a great injustice to the head of a department, but Mr. Blaikie had his living to get and if the insulting recommendation was withdrawn he would resign within three months.

Other members urged that if the course of action proposed by the majority of the committee was adopted, municipal trading would be injured, as professional gentlemen of good abilities would hesitate to accept places where they might be made the scapegoats of ignorant committees.

Mr. DAVIES moved an amendment that the consideration of the matter be adjourned for a month to give Mr. Blaikie an opportunity to resign, and this amendment was carried by 23 votes to 18.

Mr. NEWMAN said it was to be distinctly understood that Mr. Blaikie felt he was not in the wrong, and that his offer to resign was conditional on the withdrawal of the committee's recommendation.

Spen Valley Electric Tramways.—Cleckheaton District Council have decided to lodge a protest with the Board of Trade against the application of the British Electric Traction Co. to waive the construction of a line from Cleckheaton to Hartshead Moor, which was included in the company's provisional order.

Liversedge District Council have also decided to protest against the application of the company to abandon the line from Hightown Heights to Cleckheaton.

Stalybridge.—The Joint Tramways and Electricity Board have reduced the price of current for lighting from 4½d. to 4d., and for power on a sliding scale from 2½d. to 1d.

Stamford.—The Council have instructed the Urban Electric Supply Co. to erect and maintain five arc lamps as an experiment in public electric lighting.

Stepney (London).—During the year ended Mar. 31 £45,838. 5s. 6d. was spent on capital account upon the electricity undertaking, making a total of £199,129. 6s. 10d. The working expenditure was £13,823. 16s. 11d., against £10,125. 16s. 9d. in the previous year. An analysis of the various items was given in our issue of April 29. The gross receipts were £26,616. 14s. 2d., against £19,625. 10s. 6d. The credit balance of £12,814 is reduced to £5,936 by payment of interest and sinking fund, and it is intended to write off £1,038 from capital, compared with £2,833 last year. This amount, with the £1,038, represents the whole of dead capital to date with the exception of dormant house services. The balance (£4,897) is to be added to £1,603, the reserve created last year. The Electric Light committee has the revision of the tariff under consideration.

Sunderland.—The Corporation will oppose the Electric Lighting Provisional Orders (No. 3) Bill which would enable the County of Durham Electric Power Distribution Co. to supply energy in Southwick and other districts inside the Parliamentary borough of Sunderland, but outside the municipal area.

Swinton and Pendlebury.—The Board of Trade have sanctioned the borrowing of £26,889 for the purchase of the Manchester Carriage and Tramways Co.'s tramway undertaking in the district, repayable in 21 years.

Swiss Imports.—Electrical apparatus to the value of £110,200 was imported into Switzerland in 1903 (compared with £82,000 in 1902). The United Kingdom stood for £2,300 of these imports in 1902.

Tariff Changes —It is announced that the Spanish Government has appointed a Commissfon to prepare a scheme of revision of the existing customs tariff.

Tiverton.—The Council have sealed the contract with Frank Suter & Co for the erection and maintenance of electricity works.

Torquay.—The Council adopted last week the Electric Lighting committee's report recommending the adoption of a site (the third one selected) for the electricity works.

Tramway Managers' Congress.—The half-yearly meeting of members of the managers' section of the Municipal Tramways Association of Great Britain was opened at Bradford yesterday, and will be continued to-day. Mr. C. R. Bellamy, general manager of the Liverpool tramways, who is president of the Association, presided. To-day there will be a conference between the Executive committee of the Association and the committee of the Institute of Municipal Accountants on the subject of "The Standardisation of Tramway Accounts."

Transvaal.—Imports into the Transvaal of electric cables, wires and fittings for the month of January, 1904, were valued at £9,000, compared with £4,000 in January, 1903.

West Ham.—On Tuesday, the electrical engineer (Mr. W. Bullock) reported to the Council receipt of an inquiry from Messrs. Tate & Co., of Silvertown, asking if electric current could be supplied to them by the Council for power, and at what rate for a consumption of 500,000 units per annum. The ultimate consumption would probably exceed 1,500,000 units per annum.

He had quoted 1d. per unit, which the company regarded as rather high. They were certainly not prepared to pay that price on a consumption of 1,500,000 units per annum. He had gone into the question of supplying the firm with continuous current for power, but owing to the great distance of the company's works from the generating station (4,800yds.) the cost of conveying power would be very heavy. If, however, the Council were prepared to seriously consider a scheme of supplying manufacturers in the district with power by continuous current (and he strongly advised doing so), then the question of Messrs. Tate's supply (from its financial aspect) would take a more favourable turn.

On the recommendation of the Electricity committee the electrical engineer was authorised to continue the negotiations, and to circularise manufacturers as to the supply to them of energy for power on the continuous-current system at 500 volts.

The electrical engineer further reported that, owing to breakdown of a special transformer provided for the Borough Theatre lighting, the supply to that building failed at 7:25 p.m., and was restored at 7:55 p.m. A week previously supply in another place failed for 1 hour 57min. owing to an iron stake being driven through a cable.

It was agreed to continue the ordering of cable supplies from the British Insulated and Helsby Cables (Ltd.) on the following (amended) conditions:—

Contractors to base their price for cables on the assumption that the market price of electrolytic copper is £60 per ton and the market price of lead £12 per ton; contractors to state the increase or decrease in price per mile of cable for each 10s. increase or decrease in the market price of electrolytic copper, and for each 5s. increase or decrease in the market price of lead at the time when instructions are received from the electrical engineer to supply any quantity of cable required.

Cable extensions to the estimated amount of £500 were sanctioned.

The Corporation propose to institute a bonus scheme for motormen and conductors. Those most deserving are to receive £1 a month, with £5 for the man who secures the bonus six times in 12 consecutive months. Motormen will become entitled to the bonus for immunity from accidents, and conductors by the neatness of their cars and freedom from complaints.

Willesden.—On Tuesday the electrical engineer (Mr. E. T. Ruthven Murray) submitted a comparative statement with the object of demonstrating the inexpediency of adopting a flat rate in lieu of the maximum demand system Last quarter (January to March) 92·37 per cent. of the consumers paid 6d per unit and under for their supply, and 82·90 paid 5d. and under. Only 5·76 per cent. paid 7d. and over.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Kilmarnock Corporation invite tenders for overhead equipment, trolley wires, poles and brackets, &c., rolling stock, wiring of generating station and car shed. Specifications, &c., from the town clerk, Mr. W. Middlemas. Specifications and drawings can be seen at, but not obtained from, the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, London, S.W. Tenders to the town clerk before noon May 28. Further particulars are given in an advertisement.

Kilmarnock Corporation also invite tenders for tramway permanent way construction, excavations, concrete foundations, steel rails, fishplates, and special work, &c. Tenders to the town clerk (Mr. W. Middlemas) before noon May 17.

Exeter Corporation invite tenders for the construction of permanent way and paving (including copper bonding) of about 4 miles of tramway, single line, with passing places; overhead electrical equipment of lines and car-shed; supplying and laying insulated cables and stoneware conductors; and for supply and delivery of 12 double-deck single-truck motor cars. Specifications, &c., may be inspected but not obtained at the offices of the consulting engineer (Mr. J. Edward Waller, M.Inst.C.E.), 29, Great George-street, Westminster, S.W. Specifications, &c., can be obtained and plans inspected, after 18th inst., at the office at the city engineer and surveyor (Mr. Thomas Moulding), Municipal Offices, Southernhay West, and at the offices of the city electrical engineer (Mr. H. D. Munro), New North-road. An advertisement contains further particulars. Tenders to the town clerk (Mr. George R. Shorto), Southernhay West, Exeter, by noon June 9.

Brighouse Corporation invite tenders for laying cables (including supply, delivery and erection of all materials and accessories therefor). Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Sillar and Leigh), 78, King-

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street, Manchester, and 2, Queen Anne's-gate, Westminster, London, S.W., and can be obtained from the latter office. Tenders to the town clerk (Mr. James Parkinson), Town Hall, Brighouse, by May 19. See advertisement.

Warrington Electricity committee invite tenders for supply and erection of four mechanical stokers, water softener and purifier at their electric light station. Drawings can be seen at the offices of the electricity department, and specifications, &c., may be obtained from the borough electrical and tramways manager (Mr. F. V. Mathias), Howley, Warrington. Tenders to chairman of committee, Town Hall, Warrington, by noon May 30. See also advertisement.

Sunderland Corporation require one 500kw. three-phase induction motor-generator for traction purposes. Specifications, &c., from the borough electrical engineer (Mr. John F. C. Snell, M.Inst.E.E.). Tenders (addressed to the chairman of Electricity and Lighting committee) to the town clerk (Mr. Fras. M. Bowey) by 12 noon May 27. See also advertisement.

London County Council invite tenders for the supply and erection of two continuous coal and ash conveyors (gravity bucket type) at the Greenwich electricity generating station and for the maintenance of same for 12 months. Further particulars are given in an advertisement. Specifications, &c , at the County Hall, Spring-gardens, S.W. Tenders, addressed to the clerk of the Council (Mr. G. L. Gomme), by 10 a.m. June 14.

The *May-Oatway Fire Appliances (Ltd.)*, 92 and 94, Paul-street, London, E.C., invite tenders for wiring various installations set out in an advertisement in another column. Tenders close 18th inst. Electrical contractors willing to make a speciality of fire alarm signalling with direct brigade connection should communicate with t he company.

Pontypridd District Council invite tenders for motors. Specifications from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, S.W. Tenders, addressed chairman of the Electric Lighting and Tramways committee, Council offices, Pontypridd, by noon June 4. See also advertisement.

Johannesburg Council invite tenders for insulated cables and bare overhead conductors and certain accessories. Specifications, &c., after May 30, from the consulting engineers (Messrs. Mordey and Dawbarn), 82, Victoria-street, London, S.W. Tenders must reach Messrs. Mordey and Dawbarn by noon July 4. An advertisement contains additional information.

Shanghai Municipal Council invite tenders for a concession for constructing and working about 24 miles of electric tramways on the trolley system in the streets of Shanghai. Particulars from the Council's London agents, Messrs. John Pook & Co., 63, Leadenhall-street, E.C., where also plans of Shanghai may be inspected. Tenders to the secretary of the Municipal Council, Mr. J. O. P. Bland, Shanghai, China, not later than noon July 30. An advertisement contains further particulars.

The Lords Commissioners of the *Admiralty* are prepared to receive proposals from persons willing to submit for competitive trial range-finders, both large and small, for naval use. Conditions, &c., will be furnished to bona fide inventors or manufacturers of such instruments on application to the Director of Navy Contracts, Admiralty, London, S.W. Full descriptions of the range-finders proposed must be sent in by June 30.

Canterbury Lighting committee invite tenders for one Lancashire or dry-back marine boiler, superheater and steam pipes, one 300kw. steam dynamo, switchboard and connections, and extensions to economiser. Tenders to the town clerk (Mr. Henry Fielding) by June 1.

Hornsey Town Council invite tenders for condensing plant, water cooling apparatus, pipe work and valves, water softener and purifier, switchboard and connections. Tenders to the town clerk (Mr. F. D. Askey), 99, Southwood-lane, Highgate, London, N., by 10:30 a.m. May 30.

Partick Town Council invite tenders for a water-tube boiler, economiser, feed pump, hot-well tank and pipe work, condensing plant, oil separator, cooling tower and c.i. pipe and tank work. Tenders to the town clerk (Mr. James Donaldson) before noon May 24.

Royton and *Crompton* District Councils invite tenders for overhead equipment and cables. Tenders to chairman of the Tramways committee, Town Hall, Royton, by noon May 28.

Stretford Electricity committee invite tenders for a 400kw. steam-driven generator. Tenders to Chairman, Council offices, Old Trafford, Manchester, by May 18.

Walthamstow District Council require tenders for supply of tramcars. Tenders to Mr. C. Sydney Watson, clerk and solicitor, Town Hall, Walthamstow, by 5 p.m. May 20.

The Metropolitan Borough of *Hackney* invite tenders for electricity supply mains (feeders and distributors). Tenders to deputy town clerk (Mr. W. A. Williams) before 4 p.m. May 26.

Handsworth District Council invite tenders for lighting feeders, mains and road work. Tenders to the clerk (Mr. H. Ward) before noon May 25.

Rochester Corporation invite tenders for the construction of permanent way of tramways and overhead line work. Tenders by June 3.

Mexborough District Council invite tenders for two 100kw. steam dynamos. Tenders to the clerk (Mr. J. W. Hattersley) by May 21.

St. Pancras (London) Council invite tenders for Welsh and other steam coal for their electricity stations. Tenders by noon May 31.

Pietermaritzburg Corporation require six completely-equipped electric tramcars (double-deck single-truck type), to be delivered within three months, and one completely-equipped water sprinkler, to be delivered within one month. Tenders, addressed to Messrs. Ford Bros., 12, Southampton-street, Fitzroy-square, London, W., by noon May 16.

The *Siamese* Government invite tenders for the supply of tramway material. Particulars from Messrs. Barr, Thomson & Co., Kilmarnock, to whom application should be made by firms desirous of tendering.

Tenders are invited for the supply to the Committee of Port Works, *Almeria* (Spain), of a motor launch, to cost not more than £750. Tenders have to be in by June 6. The "Madrid Gazette" for May 7 contains fuller particulars, and a copy of the translation from the Spanish can be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall Street, London, E.C.

Tenders are invited for the electric lighting of Villanueva de la Serena (*Spain*). Tenders will be adjudicated on June 25. See "Madrid Gazette" of May 8 for further particulars.

The Board of Trade has received from the Egyptian Ministry of Public Works copy of an order for the supply of telegraph stores, which has been forwarded by the *Soudan* Government to Col. J. H. Western, R.E , C.M.G., Broadway-chambers, Westminster, London, S.W., as follows :—

220 miles galvanised iron wire, 7/12 S.W.G.; 11,000yds. No. 16 S.W.G. galvanised iron wire for binders; 1,500 arm bolts, 8in. by ⅝in., and screws 3in.; 3,000 cup arm insulators; 3,000 insulators for arms, with washers complete ; 1,500 round fir poles, 4in. diameter at top, 5½in. diameter 9in. from butt, 18ft. long, creosoted ; 3,000 oak arms, 20in. by 2¼in. by 2¼in. These stores are to be delivered at Suakim between Oct. 1 and Dec. 1, 1904.

TENDERS RECEIVED AND ACCEPTED.

Christchurch (New Zealand) Tramway Board have, after consideration of the tenders submitted for the construction of electric tramways, accepted the tender of the New Zealand Electrical Construction Co. at £249,876. Forty-three tenders were received for the chief sections and eight for the complete work. The latter were :—

New Zealand Elec. Con. Co.	£249,876	Macartney, McElroy & Co.	£368,700
Do. do.	258,325	Brush Co.	266,961
Do. do.	245,909	Noyes Bros.....	262,647
Do. do.	244,502	J. G. White & Co.	256,165

The remainder of the tenders were for sections of the work only, and the Board found that it would be best and cheapest to accept one tender for the whole work.

London County Council have received tenders for the supply of 7,000 electric lamps (British make) :—

Sunbeam Lamp Co. (*accepted*)	£235	10	5*
General Electric Co.	280	6	3*
Sir Hiram Maxim Electrical and Engineering Co.	248	15	0*
Mackey's Electric Lamp Co.	244	11	8*
Edison and Swan Co.	237	14	2

* 2½ per cent. discount.

Reading Corporation have accepted the tender of Dick, Kerr & Co. for the supply of six bogie tramcars, and one water cart at £4,169. 19s. Tenders were also received from the British Thomson-Houston Co. (£4,302. 15s. and £4,277. 4s.), the British Westinghouse Co. (£4,360. 3s. and £4,489. 3s.), Witting, Eborall & Co. (£3,942, for tramcars only), Brush Co. (£4,541 and £4,529), and Griffith and Biliotti (£4,909, for tramcars only).

Birmingham Corporation have placed an order with the British Westinghouse Co. for three-phase generating plant of an aggregate capacity of 3,000kw., consisting of one 1,500kw. rotating-field 25-period 5,000-volt generator, running at 166⅔ revs. per min., and three similar machines of 500kw., each running at 250 revs. per min.

Belfast Corporation have accepted the tender of Messrs. W. Coates & Son for electric light wiring, fixing telephones and bells at the new City Hall at £2,975. 10s.

Harrismith (Orange River Colony) Municipality have accepted the tender of the British Insulated and Helsby Cables (Ltd.) for high-tension concentric feeder and other cables, and that of the British Westinghouse Co. for transformers.

Messrs. Harris, Lee & Co., who have obtained the concession for the electric lighting of Heilbron (Orange River Colony), have placed all orders for the plant in England, and hope to complete the installation in three months.

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West Ham Corporation have placed orders for three Simplex smoke preventers at £35 each, and with Messrs. Estler Bros. for a Harvey patent automatic electric tramway signalling apparatus at £18. 10s., plus £10 for erecting.

Belliss and Morcom have obtained (through Dick, Kerr & Co.) a contract for a 720 H.P. engine for direct-coupling to a 500kw. Dick-Kerr generator for Stockport, and for a 720–864 H.P. engine for direct-coupling to a 600kw. Peebles generator for Partick.

A third pair of dynamos (150kw. each) and two 250kw. two-phase alternators have been supplied from England for the Johannesburg municipal electricity works.

Birmingham, Tame and Rea District Drainage Board have accepted the tender of the British Thomson-Houston Co. for electricity generating plant at £7,977, and that of Lea & Sons for power station buildings at £3,968.

Hackney (London) Electricity committee have placed an order at £102. 15s. with Cook and Hammond for a set of maps 10ft. to the mile, giving details of electric lighting mains.

Hackney (London) Electricity committee have also accepted the tender of Reavell & Co. for a portable motor-driven air compressor at £65.

Deptford (London) Council have placed an order with the Hart Accumulator Co. for the alteration of the battery and for the supply of new cells for the electric lighting of the new town hall.

Hubert Davies and Spain, who have secured the contract for the equipment of Kroonstad (Orange River Colony) electricity works, have placed orders for the generating plant, &c., with British firms.

Messrs. Isaac Storey & Sons, Empress Foundry, Manchester, have received from Preston Corporation the contract for condensing plant, cooling tower and pipework for their tramway generating station.

Among recent contracts obtained by Laurence Scott & Co. are orders from the Admiralty for 24 dynamos for battleships and 12 motors for use in firing torpedoes on board ship.

Tiverton Town Council have accepted the tender of Manning & Sons for the erection of electricity station buildings at £1,490.

Wigan Corporation have accepted the tender of Messrs. Edw. Wood & Co. for the erection of tramcar sheds.

Gillingham (Kent) Council have accepted the tender of the British Thomson-Houston Co. for electricity and prepayment meters.

Rochdale Gas and Electricity committee have accepted the tender of W. T. Glover & Co. for cables.

BUSINESS NOTICES.

Messrs. W. T. Bowie & Co., of Glasgow (wire ropes, rope-ways, cranes, &c.), and Messrs. Rubery & Co., Darlaston, Staffs. (bridges, girders, columns, roofs, &c.), have appointed Mr. Herbert W. Umney, M.I.Mech.E., 46, King William-street, E.C., their agent for London and district.

Messrs. Eugene Morand and A. W. Curtis (trading as Curtis and Morand), electrical engineers, 95, Station-street, Birmingham, have dissolved partnership.

Messrs. J. W. Cutler and Walter Wardle (trading as Cutler, Wardle & Co.), electrical engineers, Manchester, have dissolved partnership. Debts by Mr. Wardle, who continues.

Messrs. T. Toward & Co., engineers and boiler makers, Newcastle-on-Tyne, have dissolved partnership so far as regards Mr. J. Meek. Debts by Messrs. T. and W. Toward, who continue.

LIQUIDATIONS, BANKRUPTCIES, &c.

As already announced, special resolutions were passed and confirmed on Nov. 17 and Dec. 4, 1903, for the voluntary liquidation of the British Schuckert Electric Co. (Ltd.) Claims against the company to the liquidator (Mr. A. Jacob), Clun House, Surrey-street, Strand, London, W.C., by June 30. See also advertisement.

A meeting of the Tramway and General Appliances Co. (Ltd.) will be held on June 7 at 7, Waterloo-street, Birmingham, to receive an account of the winding-up.

A meeting to receive an account of the winding-up of the Electrical Luminiscriptor Co. (Ltd.) will be held on June 15 at 10, Walbrook, London, E.C.

A meeting of the Coventry Lighting and Engineering Co. (Ltd.) will be held at 23, Bayley-lane, Coventry, on June 8 to receive an account of the winding up.

David Todd Cameron, electrical and mechanical engineer, Magdala-villas, Saltash (formerly of St. Budeaux and Devonport), has been adjudicated bankrupt. The first meeting of creditors will take place on May 20 at Athenæum-terrace, Plymouth, and the public examination on May 31 at the Town Hall, East Stonehouse.

The estates of Brown, Scott & Co., and of Robert Fyfe Barr, jun. (sole partner), electrical and engineers' furnisher, 196A, St. Vincent-street, Glasgow, have been sequestrated. Meeting to elect trustee and commissioners will be held on 18th inst. at the Faculty Hall, St. George's-place, Glasgow.

A second and final dividend (2s. 3d.) is payable 14th inst. at 26, Corporation-street, Birmingham, in the failure of J. F. Worthington and G. Nuttall (trading as J. Worthington & Co.), electrical engineers, Foundry-street, Halifax, and a first and final dividend of 12s. 6d. in the separate estate of G. Nuttall.

Claims against G. Jackson and D. Smith, electrical engineers, 6, Annetwell street, Carlisle, by May 24 to Mr. K. J. Hough, 34, Fisher-street, Carlisle.

Mr. R. J. Ward, 2, Clement's Inn, London, W.C., has been appointed trustee in the failure of C. A. Smith (trading as C. J. Smith), electrician, 23, King-street, Regent-street, and 6, Granard-road, Wandsworth Common, London.

At Leeds Bankruptcy Court on Tuesday the examination was concluded of Percy James Murley, electrical engineer, formerly of Park Row, Leeds, and Brook-street, Bradford. Liabilities £146.6s.9d., deficiency £91. 4s. 3d.

A deed of arrangement and assignment having been executed by Lionel J. Allbright (trading as Allbright & Co.), electrical engineer, 30, Regent-circus, Swindon, claims are to be sent by May 13 to Mr. J. Baker, Eldon-street, House, London, E.C.

Sale by Auction.—Mr. Henry Sherley-Price (of Wheatley Kirk, Price & Co.) has been appointed by the Court to sell by public auction in one lot as a going concern, at the Mart, Tokenhouse-yard, London, E.C., on Tuesday, May 31, at one o'clock prompt, the extensive freehold and well-equipped car-building works known as the Castle Car Works, Hadley, near Wellington, Salop, together with the whole of the fixed plant and machinery and trade connection. An advertisement contains further information. Particulars and further information from the receiver and liquidator (Mr. H. D. Eshelby, F.C.A., of Messrs. Harmood Banner & Son), 24, North John-street, Liverpool; of Messrs. Gribble, Oddie, Sinclair and Johnson, solicitors, 38, Bedford-row, London, W.C., or of the auctioneers, 46, Watling-street, London, E.C., and Albert-chambers, Albert-square, Manchester.

Plant, &c., for Sale.—About 300yds. of 19/16 cable, a new earth indicator, field rheostat, &c., are advertised for sale by Messrs. T. E. Evans & Co., 126, Bute Docks, Cardiff.

Messrs. Hooker and Harris, Retreat-place, Hackney, London, have for sale some electric lighting plant. See advertisement.

Mr. J. Light, Wolverhampton, has for disposal a Robey steam engine, suitable for driving a dynamo. See advertisement.

A 9in. horizontal Waverley turbine, coupled direct to a Mather and Platt dynamo, a 4 B.H.P. shunt-wound motor, with starting switch and resistance, are advertised for sale in another column. Applications to Mr. John MacEwan, contractor, Wishaw.

Motor Starting Panel.—Messrs. Geipel and Lange, 72, St. Thomas'-street, London, S.E., are introducing a new form of motor starting panel of the Ward-Leonard type. The panel carries one double-pole switch, two single-pole fuses, one motor starter and one field rheostat. The motor starter is of the S.K. "fool-proof" type, and this is fitted with a "no-voltage" release that opens the circuit-breaker independently of the contact arm, and so prevents the resistance being cut out too rapidly. This new type of panel is specially arranged to meet the demand of consulting engineers that a certain amount of speed regulation shall be obtained on the motor by means of one of the fields. An interlocking lever is provided to prevent the starting arm moving until all resistance has been cut out of the field.

Imports.—The following are the values of imports to this country during April:—

Electrical machinery, £39,588 (an increase of £820 compared with April, 1903); telegraph cables and apparatus, £1,281 (decrease £1,361); other electrical goods and apparatus, £58,937 (decrease £2,927). The totals for the four months ended April 30 were respectively £178,924 (decrease £44,115), £10,527 (decrease £15,112) and £266,997 (increase £34,099).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from May 4 to 10, with the ports of destination:—

Aden, £72. *Africa*—Alexandria, £325; Cape Town, £532; Delagoa Bay, £515; Durban, £50,394 (including £43,000 telegraph cable); East London, £375; Port Elizabeth, £33. *Argentina*—Buenos Ayres, £80. *Ascension*—£1,178 (telegraph material). *Australasia*—Auckland, £110; Melbourne, £402; Otago, £18 (telegraph material); Sydney, £679 (including £87 (telegraph material); Wellington, £1,367. *Belgium*—Ostend £21. *Brazil*—Rio Janeiro, £5,374 (telegraph material). *Ceylon*—Colombo, £45. *China*—Shanghai, £106. *Cochin China*—Saigon, £9. *Germany*—Hamburg, £12. *Gibraltar*, £98. *Holland*—Amsterdam, £177. *Hong Kong*, £347. *India*—Bombay, £132; Calcutta, £1,694; Karachi, £106

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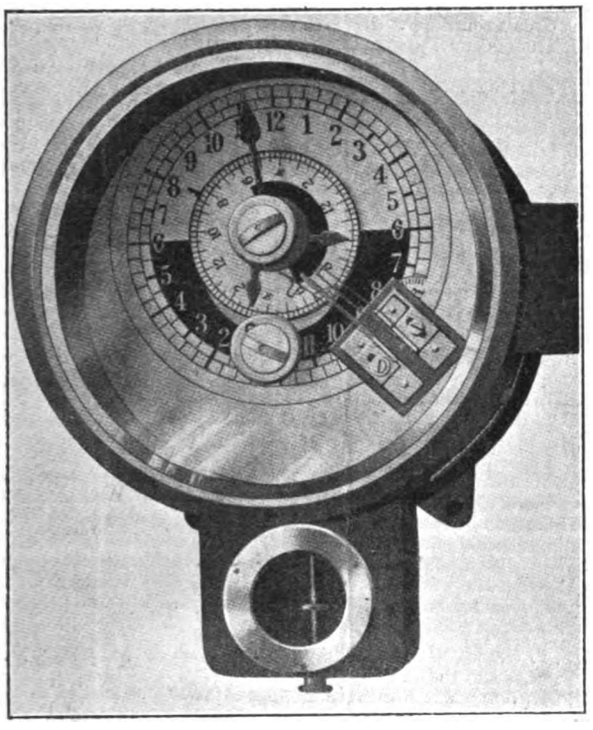
Italy—Spezia, £18. *Japan*—Nagasaki, £295; Tokyo, £402; Yokohama £1,548. *Portugal*—Lisbon, £21. *Russia*—St. Petersburg, £671. *Siam*—Bangkok, £298. *Straits Settlements*—Penang, £428; Singapore, £4,116. Total £71,980, against £8,892 for the corresponding week last year (May 6 to 12).

Catalogues.—A new pamphlet on electricity meter testing is issued by the Electrical Co., 121-125, Charing Cross-road, London, W.C. The pamphlet takes the form of a test-room handbook, and consists of the following sections;—"Notes on Testing and Apparatus for Calibrating Electricity Meters," "Setting Meters to Work," "Using Test Terminals," "Formulæ for Testing," "Hints on



E.C. Tariff Clock.

Country," &c. The illustration above represents a "Tariff Clock" manufactured by this firm, and intended for automatically switching-in and switching-off the tariff meter at certain hours of the day, on what is called the double tariff meter system (one price for daylight hours and another price for night hours). The apparatus can be used on either direct or alternate current circuits. The system is only applicable to watthour meters.

Messrs. Witting, Eborall & Co., Temple Bar House, London, E.C., have just issued a new list (No. 105) dealing with controllers, and price lists for this apparatus, which can be supplied for direct and for three-phase motors. The lists are fully illustrated.

Messrs. Graham, Morton & Co., Leeds, have prepared a list of works undertaken by the company for corporations at home and abroad. The particulars include the Dublin Corporation electric power works, which were described in *The Electrician* recently, and also works for Leeds Corporation tramway department, Battersea Council electricity department, Bradford Corporation electricity department, Oldham Corporation electricity department, and steel buildings for the generating station of the Harrismith Town Council (Orange River Colony). Other works described in the particulars are the elevating and conveying plant at Waltham Abbey for the War Office authorities; coal conveyors, overhead bunkers and accessories for Bootle Corporation; ash conveying and elevating plant at the New Kleinfontein Gold Mining Co.; and similar plant for the refuse destructor works at Bloemfontein for the corporation of that city.

The Union Electric Co., of 151, Queen Victoria-street, London, E.C., have ready a new circular dealing with the "Miniature" arc lamp for direct and alternating currents. These lamps, made for both indoor and outdoor use, are of 1½, 2 and 2½ amperes capacity, requiring respectively on the supply main 150, 200 and 250 volts per lamp.

A new list of polyphase induction motors is issued by Messrs. Griffith and Biliotti, John-street, Adelphi, London, W.C.

Messrs. Beanland, Perkin & Co., of Leeds, are issuing particulars of a new double hack saw. The saw can be fitted with a ½ H.P. electric motor and automatic cutoff switch.

J. and P. plant is illustrated in a print to hand from Messrs. Johnson and Phillips, showing one of the electric power generators supplied by the firm to the North Eastern Steel Co.'s works at Middlesbrough.

The National Electric Co., Milwaukee, U.S.A., forward a catalogue of direct-current generators and motors, illustrating standard types of these machines.

The Lecture Agency, the Outer Temple, Strand, London, W.C., send us a datebook specially compiled for lecturers, secretaries of societies and others who have to make engagements a long time in advance. The book should prove a useful pocket companion.

A new revised list of lampholders, ceiling roses, cutouts, switch plugs, wood blocks, &c., has been issued by Mr. G. Braulik, 217-218, Upper Thames-street, London, E.C.

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

February, 1, 1904.

2,397 R. Carnegie and A. Reeves. Rotherham. Renewable centre and self-lubricating trolley pulley for electric tramcars.
2,420 W. A. Daggett. Trolleys for electric cars.*
2,433 H. Leitner and R. N. Lucas. Byfleet. Regulating dynamos.
2,434 H. Leitner. Byfleet. Secondary batteries.
2,438 A. S. Adler. Automatic switches.*
2,449 B.T.-H. Co. (G.E Co., U.S.). Emergency brakes.
2,450 B.T.-H. Co. (G.E. Co., US.). Controlling switches.
2,451 B.T.-H. Co. (G.E. Co., U.S.). Photometric apparatus.
2,452 and 2,453 B.T.-H Co. (G.E. Co., U.S.). Alternating-current motors.
2,454 B.T.-H. Co. (G.E. Co., U.S.). Combined circuit breakers and starting rheostats.
2,455 B.T.-H. Co. (G.E. Co., U.S.). Control of alternating-current motors.
2,456 B.T.-H. Co. (G.E. Co., U.S.). Machines for treating filaments for electric lamps.
2,457 G. Wright and H. M. Acly. Switches. (Date applied for, Jan. 31, 1903, date of application in U.S.)*
2,458 H. M. Acly. Brush holders for dynamo-electric machines. (Date applied for, Jan. 31, 1903, date of application in U.S.)*
2,459 E. E. F. Creighton. Compensating systems for alternating electric current generators. (Date applied for, Jan. 31, 1903, date of application in U.S.)*
2,466 and 2,467 H. Aron. Clockwork electricity meters.*
2,471 M. Latour. Compound excitation of collector alternators. (Date applied for, Feb. 2, 1903, date of application in France.)*
2,480 L. Thurnauer. Switches.
2,494 R. Friedlander. Shields for X-ray and like tubes. (Date applied for, March 9, 1903, date of application in U.S.)*
2,495 M. von Recklinghausen. Electric, gas or vapour lamps.
2,496 P. C. Hewitt. Apparatus for producing oscillatory currents. (Date applied for, Feb. 9, 1903, date of application in U.S.)*
2,497 M. Cummins. Controllers for electric motors.
2,504 H. Rosenfeld. Contact shoe for electric railways.

February 2, 1904.

2,511 C. Curwen. Automatic fire alarm systems.
2,512 W. E. Groves. Birmingham. Electrical joint boxes.
2,558 J. V. Payne and D. Poupart. Device for automatically switching off current in an overhead trolley wire immediately it is broken.
2,580 E. Weintraub. Rectifying alternating current. (Date applied for, Feb. 2, 1903, date of application in U.S.)*
2,581 B.T.-H. Co. (G.E.Co., U.S.). Machines for making stems for incandescent lamps.
2,582 B.T.-H. Co. (G.E. Co., U.S.). Synchronism indicators.
2,583 E. Bergtheil. Insulation of conductors.
2,602 D. Levy. Interchangeable electric display apparatus. (Date applied for, Feb. 10, 1903, date of application in U.S.)*
2,614 H. G. Prested. Terminals for batteries.

February 3, 1904.

2,644 Verity's Limited and G. O. Donovan. Birmingham. Clutch coupling for detachably securing arc lamps.
2,674 C. Talbot, Limited (Adolphe Clement, France). Electric generators.
2,676 O. Schaefer (Hermann Bastians and Ottmar Wehrmann, Germany). Electric couplings for arc lamps.
2,707 E. Wilson. Electrostatic wattmeters.
2,715 B.T.-H. Co. and E. J. Murphy. Arc lamps.
2,717 A. L. Smallpage. Clutch for facilitating drawing of cables through pipes.
2,733 B. Gáti. Call system of telephonic installations.
2,734 B. Gáti. Multiple telegraphy.

February 4, 1904.

2,750 F. J. Smith and W. J. Smith. Supporting overhead wires.
2,751 L. J. Aron. Birmingham. Electricity meters.

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2,752 F. H. Royce and E. A. Claremont. Manchester. Starting apparatus and methods of controlling continuous-current electromotors.
2,757 R. Kennedy and D. R. Kennedy. Leeds. Secondary batteries.
2,766 G. Irving. Nottingham. Electric light fittings.
2,767 C. W. D. Bourne. Rochdale. Switches.
2,797 R. A. Mills. Ignition-control switch.
2,800 E. Canziani (A. Perego, Italy.) Simultaneous telephony over telegraph lines, block signalling lines and lines for the transmission of electrical power.
2,801 P. Schauer. Magneto-electric sparking devices.
2,814 W. G. von Huffel. Screw-like rotary switch for resistance boxes, switchboards and the like.

February 5, 1904.

2,849 N. D. Phillips. Automatic switch for controlling electric motors.
2,865 J. D. White. Printing telegraph receivers.
2,899 J. B. Struble. Electric signalling systems for railways. (Date applied for Feb. 13, 1903, date of application in U.S.)*
2,930 F. M. Lewis. Electro-motors of the induction type.
2,939 H. R. Bullock and F. Roche. Electrical ignition appliance*
2,945 I. B. Birnbaum. Microphones or transmitters for telephonic apparatus.

February 6, 1904.

2,948 W. B. Duddell. Wattmeters.
2,958 A. E. Porte and T. Tomlinson. Dublin. Electrical controlling devices.
3,000 G. Laird and J. P. Todd. Controllers for electric motors and other apparatus.
3,007 W. Goulton. Electric signs and apparatus therefor.
3,010 C. J. Ross and B. C. Matthews. Electric traction on a road contact system.
3,022 H. Hirsch. Connections for electricity conductors.*

February 8, 1904.

3,040 A. Eckstein and F. G. Bell. Manchester. Inter-communication telephone system.
3,045 F. H. Hall and C. Hall. Birmingham. Make-and-break contacts for induction coils.
3,059 J. Scoit and W. Clark. Newcastle-on-Tyne. Electrical fire alarm.
3,072 G. H. Nash and T. E. Eachus. Enfield. Cutouts for conductors.
3,087 H. M. W. P. Johnson. Apparatus for amalgamating and coating metals or alloys of metals with metals or alloys of metals by electricity.
3,101 W. S. Bruce. Apparatus for rapidly making, breaking and varying the circuit through the coils of induction or similar apparatus.

February 9, 1904.

3,169 F. T. Cash. Suspension chain for electroliers.
3,205 W. C. Fisher. Electrical measuring instruments and apparatus.
3,211 H. E. Bradley and E. F. Bowen. Electric railway systems.
3,212 H. H. Lake (James Soule Wilson, U.S.) Flexible conduits for conductors.*
3,216 W. T. Henley's Telegraph Works and W. H. Nichols. Fuse box for cables.
3,221 S. G. Brown and A. R. Hardie. Telegraph apparatus.*
3,236 W. G. Wilson and Wilson and Pilcher. Tremblers for circuits.
3,242 P. Zigonzo. Rotating field motors.*
3,243 L. C. H. Mensing. Arc lamps.
3,244 E. Ducretet. Induction transformer for wireless telegraphy receiving stations.*
3,246 H. Röver. Apparatus for the distant transmission of the movements of a needle.*
3,251 C. E. Blood. Prevention of arcing in electrical apparatus.

February 10, 1904.

3,264 J. Bush. Combination switch and fuse.
3,276 F. Tomlinson. Liverpool. Galvanic curative appliances.*
3,292 R. Sinclair. Glasgow. Electric lighting for shops, &c.
3,300 R. H. Pearson. Bath. Automatically-reversing trolley of an electric car.
3,323 G. C. Downing (Merritt Gally, U.S.) Telephonic repeating system*
3,325 H. P. Hartog. Connecting up telephones for intercommunication system.
3,328 A. P. Lundberg and G. C. Lundberg. Switches.
3,334 L. H. Walter. Wireless signalling.
3,337 P. A. J. Lapeyrade. Dynamos. (Date applied for, Feb. 10, 1903, date of application in France.)*
3,342 P. R. Kappie. Liverpool. Telegraph apparatus.
3,344 La Société de Champrobert & Cie. Liverpool. Electric transmission of power for autocars and automobiles. (Date applied for, Feb. 11, 1903, date of application in France.)*
3,356 E. Chandoir. Electric and other lifts.
3,357 G. C. Marks. (Jules Guenet, France.) Rapid trembler for induction coil.

February 11, 1904.

3,385 D. Murray. Automatic telegraph transmitter.*
3,388 E. D. Hopcroft. Birmingham. Making electrical contacts for obtaining rectilinear reciprocating action.
3,414 C. C. Hewett. Breaking circuit in overhead wires of electric tramways and railways and apparatus therefor.
3,416 W. A. Snapp, R. Volland and Louisa Calvert. Sparking plug.
3,426 W. Duncan, R. MacDiarmid and E. B. Bates. Switches.*
3,429 R. W. Leach. West Bromwich. Electrical tube welding machine.
3,431 J. E. Kingsbury. (Western Electric Co., U.S.) Telephones.*
3,440 W. Heatley. Joints for conductors for telephonic and other uses and apparatus therefor.
3,449 M. N. Campiche. Electric clocks.
3,453 G. Jones. Construction of secondary battery.
3,454 G. Jones. Electric lamps for use in mines.
3,460 L. Andrews. Manchester. Reverse current circuit-breakers and indicators for alternating currents.
3,471 T. H. Marsh. Charging of accumulators for electric ignition and other systems.

February 12, 1904.

3,492 J. H. Tucker. Birmingham. Fixing covers to switches.
3,508 J. Macfee. Subscribers' call signalling devices for telephone exchange systems.
3,523 A. Friedlaender. Berlin. Hand telephones.
3,540 F. Conrad. Alternating-current wattmeters. (Date applied for, Feb. 20, 1903, date of application in U.S.)*
3,547 W. Kingsland. Switches.
3,560 T. D. Ingram and L. Phillips. Combined coin-actuated clock and circuit controller.*
3,564 J. Thomas and Toncox, Limited. Connecting wires to mechanism.
3,577 E. J. Hardy. Birmingham. Hand-operated switch for motor sparking apparatus.
3,581 E.E.L. Syndicate and G. Sweetser. Incandescent lamps.
3,588 and 3,589 B.T.-H. Co. (G.E. Co., U.S.) Alternating-current motors.
3,590 B.T-H. Co. (G.E. Co., U.S.) Means for controlling electric motors.
3,603 H. Leitner and R. N. Lucas. Byfleet. Controlling apparatus for electric circuits.

February 13, 1904.

3,631 W. G. Heys (Varley Duplex Magnetic Co., U.S.) Manchester. Circuit controllers for induction coils.*
3,640 A. B. Chatwood. Keighley. Steadying direct-current arc lamps.
3,643 J. Scott. Liverpool. Electric light baths and therapeutic appliances.
3,657 T. W. Le Tall (Cooper Hewitt Electric Co., U.S.) Gas or vapour electric lamps.
3,660 R. Hennig. Magneto-electric ignition for internal combustion engines.*
3,665 B.T.-H. Co. (G.E. Co., U.S.) Motor controllers.
3,666 B.T.-H. Co. (G.E. Co., U.S.) Switches.
3,677 M. Latour. Regulators for alternating-current motors. (Date applied for Feb. 14, 1903, date of application in France.)*
3,690 P. A. Spalding. Anti-vibration hangers, especially applicable to Nernst lamps.
3,691 H. Sefton-Jones. (Hermann Schor, France.) Electric-bell circuits and switches.
3,692 W. A. Heyes and L. O. Heyes. Liverpool. Electric bells or gongs.
3,694 F. Ortega. Liverpool. Coherer for wireless telegraphy. (Date applied for Feb. 16, 1903, date of application in Spain.)*

February 15, 1904.

3,704 C. P. Grew. Current collector for conduit electric tramways, railways and the like.
3,722 F. H. Bostock. Nottingham. The Ajax—to be applied to electric trams and motor cars.
3,746 A. Reichwald. (Duisburger Maschinenbau A.G., late Bechem and Keetman, Germany.) Magnetic devices for gripping and releasing for use with cranes and the like.*
3,768 D. W. Penrose and M. Hankin. Electrical heating and resisting apparatus.
3,774 H. I. Wood. Vapour electric lamps. (Date applied for, Feb. 14, 1903, date of application in U.S.)*
3,787 A. A. Shobe and W. Embley. Electric railway systems. (Date applied for, April 10, 1903, date of application in U.S.)*
3,790 C. A. Keller. Electric furnaces.*
3,798 O. Imray. (Johann Heinrich Ludwig Guken, Germany.) Means and apparatus for supplying electrical energy for train lighting, &c.
3,809 A. J. Fuller and M. H. Bennett. Safety electrical cutout.

February 16, 1904.

3,826 Pontite Limited and Silvius de Pont. Manchester. Insulating materials.
3,840 J. Klinkenberg. Glasgow. Controlling apparatus for electric motors.
3,847 C. A. Allison (Hooven-Owens-Rentschler Co., U.S.) Dynamo-electric machines.*
3,856 B. Gáti. Coherers.
3,882 J. Deutsch. Dynamos.
3,884 B.T.-H. Co. (G.E. Co., U.S.) Alternating-current motors.
3,885 G. Wright and F. C. Nicholls. Electrical switching systems. (Date applied for, Feb. 16, 1903, date of application in U.S.)*
3,886 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control systems.
3,891 H. H. Lake (Riccardo Arno, Italy). Electric energy meters.
3,896 and 3,897 C. H. Merz and B. Price. Method of and means for protecting apparatus on alternate-current systems.
3,612 La Société l'Industrie Verrière et ses Dérivés. Apparatus for regulating electric current. (Date applied for, Feb. 17, 1903, being date of application in Belgium.)*
3,913 H. J. Keijzer. Process and apparatus for generation of electric energy.*
3,925 W. Hocken and T. Hocken. Redruth. Attaching battens to cable drums.

February 17, 1904.

3,935 Seacombe Pressed Brick and Tile Works, W. H. Wilson and F. P. Jones. Liverpool. Electric cable troughs.
3,950 N. P. Billing (N. Pemberton). Tilting electric lamp shades by a counterweight.
3,955 W. Harrison. Salford. Making and breaking contact with automatic electrical circuit breaker.
3,960 T. J. Watkinson. Sheffield. An electrical automatic fog signal.
3,979 C. Rutherford. Derby. Clock for regulating electric or other light.
3,994, 3,997, 4,000, 4,001, 4,002, 4,003, 4,134 H. C. Lewis (G.E. Co., U.S.) Electrodes for arc lamps.

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SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each

1903.

11,418 LAKE (General Incandescent Arc Light Co.) Regulators for alternating series arc light systems.
11,579 GREENFIELD. Anodes for electrolytic operations.
11,649 CAROLAN (G.E. Co., U.S.) Lightning arresters.
11,997 GUY. Joints for tubular metallic telegraph and like poles.
12,526 DIESELHORST and MARTIN. Manufacture of cables.
20,547 EHRET II. Arm supporter for telephones and the like.
26,273 KOHLER. Controlling devices for electric motors.
28,147 HILLYER. Electrically operated points for electric railways.

1904.

2,466 ARON. Clockwork electricity meters.
2,504 ROSENFELD. Contact shoe for electric railways.
3,212 LAKE (Wilson). Flexible conduits for conductors.
3,242 JIGONZO. Rotating field motors.
3,246 ROVER. Apparatus for indicating electrically at a distance the movement of a needle.
3,276 TOMLINSON. Galvanic curative appliances for human use.
3,746 REICHWALD (Duisburger Maschinenbau A.G., late Bechem and Keetman). Magnetic gripping and releasing device for use with cranes, hoists and the like.
3,847 ALLISON (Hooven, Owens, Reutschler Co.). Dynamo-electric machines.
4,353 HOFFMANN. Electric vibrating apparatus for massage purposes.

COMPANIES' MEETINGS AND REPORTS.

Great Northern Telegraph Co. (Ltd.)

At the recent meeting at Copenhagen the CHAIRMAN (Mr. F. Zahle) said that during 1903 10 of the company's cables in Europe were interrupted 15 times, and six cables in the Far East 11 times. In Europe the cable steamer "H. C. Örsted" (replaced in December by the "Pacific") was on active service for 80 days, and the cable steamer in the Far East, the "Store Nordiske," for 208 days, of which 74 were for the account of other administrations. Their second cable steamer for service in the Far East, which had been named the "Pacific," was completed in November, and made her trial trip to their complete satisfaction. She had twin screws and powerful engines, a speed of more than 12 knots, and was able to effect cable repairs in depths up to 3,000 to 4,000 fathoms. As the Eastern Extension Telegraph Co. also employed their steamers for the maintenance of their cables in China, they had agreed with that company to keep the "Store Nordiske" and the "Pacific" for joint account, which, of course, would reduce their expenses in connection with the ships. The "Pacific" was retained in Europe during the first months of the present year in order to replace the "H. C. Örsted" whilst the latter was undergoing a complete overhauling. The "Pacific," therefore, left Copenhagen only on April 9 for London, where she will fill up her tanks with spare cable for the depot at Woosung. The united efforts of the Russian Administration and the company to improve the working of the Wladiwostock lines had at last been crowned with success. During the latter half of 1903 the service by that route left little to be desired as regards both quickness and correctness in transmission. That applied also to the working of the Peking–Kiachta–Irkutsk route, which during the whole of last year transmitted the limitrophe Russo-Chinese traffic, as well as the service telegrams of the company between Europe and China, with remarkable celerity and regularity. Thanks to the opening of this route for general traffic on Feb. 23, they were in a position to obviate the inconvenience caused by the closing of their two cables between Wladiwostock and Nagasaki on account of the war, and to transmit the traffic between Europe and the Far East as though nothing had happened. The Russian Government did not exercise any kind of censorship on traffic passing over the new route. The recent International Telegraph Conference had adopted new rules for code language and for the charging of cipher language which were very advantageous to the public, but most prejudicial to the telegraph administrations. Their company had also to submit to tariff reductions which, though anticipated for some time, nevertheless exceeded their intentions. The laying of the new American cable connecting San Francisco with the Philippine Islands (Manila), touching at Hawaii, Midway and Guam, was successfully completed in the beginning of July. In order to prevent the American company from extending their competition to the traffic with Europe it became necessary to introduce reductions at once. The combined effect of the tariff reductions and of the loss of the American traffic, which naturally has taken the new, more direct and less expensive route, was an immediate decrease of their receipts, averaging in the beginning £10,000 a month. If the total diminution of the traffic revenue, compared with the preceding year, had nevertheless been limited to about £12,000, it was only due to their increased receipts during the first half of the year and to the considerable Government and Press traffic called forth by the complications in the Far East towards the end of the year. Now that war between Russia and Japan has broken out it would, however, be a mistake to rely too much upon a continuance of that increase of the traffic, whilst, on the other hand, the danger to which their cables and telegraph lines are exposed is only too evident. Their two cables between Wladiwostock and Nagasaki, which formed a direct connection between the territories of the two belligerents, were closed on Feb. 9, and, although they had been able from Feb. 23 to substitute the route via Peking–Kiachta–Irkutsk for the one via Wladiwostock, the security of the new route would depend upon the chances of war. Passing through Mongolia it was, fortunately, as yet far from the theatre of war, but might be exposed to other dangers. Three of their cables in the Far East connected Japan with China and Korea; one of them (between Tsushima and Fusan) had always been worked by the Japanese Administration, whilst the other two (between Nagasaki and Shanghai) were in their own hands and were still intact. All those cables were, unfortunately, exposed to the risks of war. Their agreements with the British Government for landing and working in the United Kingdom of their Scandinavian cables expired in 1903. Negotiations had been carried on for their revision and prolongation. The Government would place at their disposal a third wire between London and Newcastle, which would be very useful, as it would enable them to provide a quicker service; but so far they had not succeeded in obtaining a prolongation of the agreement beyond 1910, when their corresponding concessions from Denmark, Sweden and Norway would expire. Without taking into consideration the possibility of a general conflagration, it was evident that their lines, both in Europe and in the Far East, were exposed to uncertain vicissitudes. The present state of affairs in the Far East could not be compared with that existing in 1894 during the war between Japan and China, nor with that in 1900-1901, when China was invaded by the allied forces. At those times the whole world was interested in preserving the cables, and even in extending them, whilst now both belligerents were interested in the telegraphic isolation of their adversary. The first proof of that was the closing of the cables between Wladiwostock and Nagasaki and the interruption of the cable between Chefoo and Port Arthur, belonging to the Russian Government, but partly worked by their company. The question was, How long would their other cables be safe? In those circumstances they had considered it their first duty to increase the dividend equalisation fund in order to guard against the consequences of the contingency of their most important sources of revenue running dry. The fact remained, however, that for the third time during the last 10 years exceptional events had come to their succour, this time to compensate them, temporarily, for a portion of the losses which, from July 1 next, will inevitably result from the tariff reductions agreed upon by the London Conference. Those compensating influences permitted them, nevertheless, to increase the dividend (12½ per cent.) by a bonus of 2½ per cent. They had chosen that form in order to indicate clearly the extraordinary and transient nature of the increase.

[A fully-illustrated description of the new cable steamer "Pacific" will appear in *The Electrician* for May 20.—ED.]

ASBESTOS AND ASBESTIC CO. (LTD.)—At the meeting on Wednesday, the chairman (Mr. T. F. Manville) said that the directors had made an arrangement with the H. W. Johns-Manville Co. whereby the English branch of that firm's business was placed under the management of their general manager and secretary, Mr. H. J. Joseph, and the general office expenses had been equally shared. Those expenses would be further shared next year with the British Johns-Manville Co. also, who handle the electrical business of the H. W. Johns-Manville Co.

AUCKLAND ELECTRIC TRAMWAYS CO. (LTD.)—At the meeting on Monday the chairman (Mr. C. G. Tegetmeier) saidthat at the commencement of the year they had about 9 miles of line in operation; at the end of October the system was fully operated. The traffic receipts amounted to £81,772, of which £80,306 was in respect of electric traction. From Jan. 1 until April 22 last the receipts amounted to £33,622, while for the corresponding period of last year they were £19,276. During the year they carried 13,535,611 passengers. The total expenditure to Dec. 31, in connection with the electric construction and reconstruction of lines, was £506,835. During the current year further expenditure would be necessary. A number of additional cars would have to be provided, the first instalment of which would shortly be dispatched to Auckland, and arrangements were being made for the extension of the power plant. The cost of the Remuera extension had also to be provided. Since the report was issued they had received telegraphic advice from Auckland that, on a poll of the ratepayers, the resolution of the city council, extending their tenure of the tramways within the city by two years had been confirmed. That gave them until June 1, 1932, in respect of the city lines, and June 1, 1934, in respect of the suburban lines, and, in the event of the purchase of the line by the local authorities at or after these dates, the price to be paid was the value of the undertaking as a going concern.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—The chairman, at the meeting on Tueday, said that the net profit of £28,057 was substantially better than that of the previous year, and would be sufficient not only to pay the preference dividend for the year in full, but also to provide a dividend on the ordinary shares. The board, however, deemed it more prudent to strengthen the general reserve. Explaining the disappearance of the item "depreciation reserve fund" from the balance-sheet, he said it was always intended to be a liquid fund readily realisable in case of emergency. That meant investing in Government, Corporation and other gilt-edged stocks. As the increase of business required more working capital they had been realising those particular securities for working capital. Only a portion of the investments had been so realised at Dec. 31, and the remainder had been merged in "shares and debentures," which accounted for the increase of that item. They had given up the manufacture of the Universal engine, and had adopted instead an improved type of reciprocating engine.

CALLENDER'S CABLE AND CONSTRUCTION CO. (LTD.)—The directors' report for 1903 states that the profit was £52,647, which, with the balance from 1902 (£24,480), made £77,127. After deducting interest, preference dividend, appropriation for depreciation of plant and machinery (£11,4·0) and for depreciation of office furniture (£191) the available balance was £46,456. The directors recommend an ordinary share dividend of 10 per

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cent. (10s. per share), whereof 5s. was paid on Nov. 1, and a bonus of 2s. 6d. per share, carrying forward £24,581. The output of the factory was slightly in excess of that of 1902, but once again severe competition was experienced in all branches, with the result that the prices obtainable were still further reduced, leaving but small margin of profit. The company suffered severely from the unprecedented rainfall of 1903, whereby the cost of carrying out street work and cable laying was considerably enhanced. Heavy expenses were incurred at the factory at Erith from the same cause. Those two items caused an abnormal expenditure, amounting to many thousands of pounds, which had been met out of the year's profits. In the last few weeks there had been a distinct tendency towards better trade, and although competition continued very keen, and prices were still low, there was some hope of better results during the present year. During the past year considerable progress had been made in the supply of electricity over large areas, and there was little doubt that as soon as the various power companies in which the company was interested were at work, great developments would take place in the use of electricity throughout Great Britain, and the directors were more convinced than ever that the policy which they had adopted with regard to those electric supply companies was the right one. During last summer circumstances arose with the Anchor Cable Co. (Ltd.) which, in the judgment of the board of that company, rendered it advisable that their business should be disposed of to one of the larger cable makers, and negotiations were entered into with Callender's Company. After examining the property, and considering the possibilities of their factory at Leigh, the directors completed arrangements by which they acquired the whole of the shares of the Anchor Company. The original board retired, and the directorate of the Anchor Company was now almost identical with that of this company. For various reasons it had not been considered necessary as yet to amalgamate the two concerns, but to run the Anchor Company separately, and that course would be followed for the present. In addition to the purchase of those shares, the company had found the working capital which was necessary for the Anchor Company. The total amount of that investment and advance was £72,696. A special loan had been obtained from the company's bankers to enable that to be done; but at an early date it might be advisable to take the requisite steps for clearing that off. The property at Erith was now valued at £318,951.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—An extraordinary meeting was held yesterday (under the presidency of Mr. H. Wolfenden) to consider a resolution reducing the capital of the company from £1,000,000 to £941,090 by the cancelling of paid-up capital which has been lost or is unrepresented by available assets. The chairman said about £9,000 loss had been incurred at the factories at Broadheath, Walsall and Kalk and at the depot in Parliament-street, London, £44,000 loss was revealed by the re-valuation of stocks in 1901; £4,000 was represented by debts owing by the company and not appearing in the accounts and bad and doubtful debts owing to the company. Altogether £58,472. 16s. 1d. was lost prior to the present board coming into power in 1901. Income for 1902 and 1903 had not met expenditure by £4,026. 17s. 8d. The proposal to reduce the B shares by £2. 10s. per share would provide for £58,910 of this deficit, leaving a balance of £3,589. 14s. 7d. to be provided out of current earnings. Their business generally was progressing satisfactorily, and the directors hoped to show a marked improvement during the current financial year to June 30 next. The resolution was carried with one dissentient. A vote of thanks to the chairman and directors terminated the proceedings.

TRACTION AND POWER SECURITIES CO. (LTD.)—The report for 1903 states that the past year has not been favourable to securities of electrical undertakings. The City and North-Eastern Suburban Electric Railway Bill, in the promotion of which the company was interested, was thrown out in Committee. The directors also assisted in the formation of a company to carry out a system of electric tramways and lighting for Rangoon, but it was not considered advisable to concede the low terms by which the next tender secured the concession. The costs of joining in those undertakings, including those of one other smaller proposition (£2,524), have been charged to revenue. The directors have postponed the issue of £1,000,000 in preference shares, and have written off the expenses thereof (£2,645). The balance of the year's revenue (£4,833) is carried forward.

WESTERN TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended Dec. 31 last shows that the revenue amounted to £222,020. 6s. 11d. and the working expenses to £93,140. 7s. After providing £13,578. 18s. for debenture stock and debenture interest and sinking fund, and £2,622. 3s. 9d. for income tax, there is a balance of £112,678. 18s. 2d.; added to £2,639. 16s. 3d. brought forward, making £115,318. 14s. 5d. First and second interim dividends, amounting to £62,379, have been paid, and after transferring £30,000 to general reserve, and £18,000 to maintenance ships' reserve, there is a balance of £4,939. 14s. 5d. to be carried forward. The revenue includes £11,808. 6s. 6d. dividends upon the company's investments in other telegraph companies, and £6,632. 13s. 6d. interest on reserve fund investments.

WEST INDIA AND PANAMA TELEGRAPH CO. (LTD.)—The directors report for the half-year to Dec. 31, shows that the amount to credit of revenue is £32,399. 13s. 7d., against £31,062. 17s. 6d. for the corresponding half-year of 1902. The expenses have been £25,243. 8s. 1d., against £20,679. 4s. 5d., leaving £7,156. 5s. 6d., to which is added £1,854. 18. 6d. interest on investments and £2,068. 9s. 1d. brought from last account, making £11,079. 13s. 1d. The payment of 6s. per share on account of arrears of first preference dividend will require £10,368. 18s., leaving a balance forward of £710. 15s 1d. The revenue account has been credited with £1,485. 15s. 11d., a balance after the closing of the accounts attendant upon the loss of the ss. "Grappler," and also with £1,500 accumulated after adjustment in respect of income tax. The expenses of repairing cables during the half-year amounted to £10,251. 7s. 6d., or £2,576. 10s. 2d. in excess of those for the corresponding period, attributable to a larger quantity of cable having been used in repairs. A further £934. 0s. 11d. has been charged to reserve for cable used in the partial renewal of the St. Lucia–St. Vincent section, which was interrupted by volcanic disturbances in May, 1902, and after being repaired, again interrupted by the same cause in the following September. After much difficulty this repair was successfully completed in February last.

WILLANS AND ROBINSON (LTD.)—A meeting was held on Wednesday to enable a poll to be taken on the subjoined resolution:—"That subject to Mr. J. C. Peache entering into an agreement to devote the whole of his time and attention to the service of the company (with such exceptions as may be arranged) he shall be remunerated by a fixed salary of £2,000 per annum, together with a contingent share of profits calculated as follows:—viz., in respect of every half-year in which the net profits of the company for such half-year shall be sufficient to pay a dividend at the rate of 7 per cent. per annum upon the amounts paid or credited as paid upon the ordinary shares then called up (after paying the prescribed dividend upon the preference shares, and arrears thereof if any) an amount equal to 8 per cent. of the remainder of such profits shall be paid to the said James Courthope Peache. Also that the remuneration of the proposed director should be provided from the fees paid to the existing board, but it is hereby declared that this is only an expression of opinion of this meeting and not a binding direction to the board."

The Chairman (Mr. MARK ROBINSON) announced that he had received an intimation from Capt. Sankey that he wished to withdraw his request for a poll, but as this request had been made by seven shareholders it was impossible to stop the poll being taken. The effect of the approval of the resolutfon would be that Mr. Peache, who had already been appointed a director, would take over the technical direction of the work with the approval of the board. The board entirely approved of the appointment of Mr. Peache, and had given effect to the recommendations of the advisory committee by allotting to Mr. Peache certain functions.

At the close of the poll Mr. Robinson said there was a great deal of work to be done before the result could be announced. There were between 60,000 and 70,000 votes for and about 100 votes against the resolution. A circular would be sent to the shareholders announcing the result when this had been accurately ascertained.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (April 21, 1904). Price of silver 25⅛d. per oz. (May 12). Consols $90\frac{5}{16}-90\frac{7}{16}$ for money, $90\frac{3}{8}-90\frac{1}{2}$ for account; 2½ per cent. annuities $90-90\frac{1}{4}$ (May 12). Consols Pay Day, June 1; Stocks and Shares Continuation Days, May 25 and June 8; Ticket Days, May 26 and June 9; Pay Day, May 27; Mining Share Carry-over Days, May 24 and June 7.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—Particulars will be found on another page of the offer of 120,000 ordinary shares of £5 each in the above company which are offered by the River Plate Trust Loan and Agency Co. (Ltd.), and form part of a total issue of 170,000 of such shares. The price of issue is £5. 10s., payable £1 on application and £4. 10s. on or before June 15. The shares rank for dividend from Jan. 1 last. The shares now offered were issued fully paid as consideration for the conversion of the company's system of tramways in Buenos Ayres from horse to electric traction. The Anglo-Argentine Company's concession is for a period of 99 years from January, 1900. Although electric traction was adopted on these tramways for only a portion of the year 1903, the net receipts for that year showed an increase of £91,122 over 1902 (£154,568, against £63,446), and 6 per cent. dividend was paid on these shares for 1903. A marked improvement has, it is stated, taken place in the receipts during the present year, and an increased dividend is anticipated. A lengthy extract from the directors' report for 1903 is given in the announcement which appears elsewhere, and shows that, notwithstanding the increased receipts for 1903, the working expenses were lower than for 1902. The company's entire system consists of about 100 miles of tramways, of which 13 miles is double track. The subscription list for the shares now offered opens on Monday, May 16, and closes for town and country on or before Wednesday, May 18.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The quantity of electricity sold in the company's districts during the quarter ended March 31 is estimated to realise about £37,925, compared with £32,077 for the corresponding period of 1903.

CRAIGPARK ELECTRIC CABLE CO. (LTD.)—At the meeting last week, the chairman said, owing to the dislocation of the works, there was little profit on the year's working, but they were able to keep up the production.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed May 18 a special settling day in the further issues of 10,000 £5 fully-paid ordinary shares, and 10,000 4½ per cent. £5 fully-paid cumulative preference shares of the *Charing Cross and Strand Electricity Supply Corp. (Ltd.)*, and have ordered the same to be quoted. The committee have been asked to appoint special settling days in, and grant quotations to, 250,000 4½ per cent. second debenture stock of the *British Electric Traction Co. (Ltd.)*, and a further issue of 2,520 5 per cent. £10 fully-paid cumulative preference shares and 2,500 £10 fully-paid ordinary shares of the *Potteries Electric Traction Co. (Ltd.)*

URBAN ELECTRIC SUPPLY CO. (LTD.)—Letters of allotment for the issue of £200,000 4½ per cent. first mortgage debenture stock of this company have been posted.

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CASTNER-KELLNER ALKALI CO. (LTD.)—For year ended March 31 the net profit (after liberal expenditure in keeping up works, plant, &c.) was £42,020. 18s. 1d., which, with £13,151. 16s. 11d. brought forward, makes £55,172. 15s. Deducting interest (£10,375. 10s. 8d.), the available balance is £44,797. 4s. 4d. The directors recommend that £15,000 be appropriated to depreciation reserve, that a dividend of 4 per cent. be paid, leaving £11,797. 4s. 4d. to be carried forward.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL CO. (LTD.)—The directors' report for 1903 states that no material alteration has taken place, except that the amount standing to debit of profit and loss has been increased by £3,080. 13s., which includes £1,000 balance of premium on debenture stock. The general charges are less than those of the previous year. Loan from bankers is £4,000 more. The figures of the Metall Company are not satisfactory, as trade in Germany during the year was slack. In consequence, low-priced work had to be executed, with the result that the margin between cost of copper and selling price of finished articles showed a further decrease. The amount written off for depreciation and repairs and maintenance of plant (£2,700) is large, and it has also been deemed advisable to write down the value of the finished and half-finished goods in stock at the end of the year a further £2,700. Expenditure of 158,650m. (£7,932) was incurred during the year on new works. The new machine referred to last year is not yet completely erected owing to delay by the makers in America and delay of the makers of gearing, &c., in Germany, but the work of erection is now almost finished. Owing to unfavourable financial conditions it was impossible for the directors to carry through the debenture stock conversion, and the debenture-holders will be asked to agree to a further postponement of three years. Patents have been granted in Austria and Germany for an improvement in the company's process.

GLOBE TELEGRAPH AND TRUST CO. (LTD.)—The net revenue for the year to April 30 (after deducting expenses) was £203,010. 7s. 3d., or, with £3,071. 10s. 5d. brought forward, £206,081. 17s. 8d. From this there has been distributed £131,917. 1s. 6d. in interim dividends, leaving £74,164. 16s. 2d. The balance dividend on the preference and a dividend of 5s. per share on the ordinary shares is recommended, making 5½ per cent. (tax free). £3,057. 10s. 9d. is carried forward. The company's holding in West African Telegraph Co.'s shares, the balance of the holding in Western Telegraph Co.'s 4 per cent. debentures, also 500 shares in the American Telegraph and Cable Co. have been sold and most of the proceeds invested in other suitable telegraph securities.

LYMINGTON ELECTRIC LIGHT AND POWER CO. (LTD.)—The total connections have increased from 6,124 to 8,211 8 c.p. lamps during the past year. Including £252. 18s. 4d. from last year, the profit was £986. 18s. 11d. Interest, &c., required £521. 16s. 5d., and the proposed dividend of 4 per cent. will absorb £323. 16s. 10d.

MARKET DRAYTON ELECTRIC LIGHT AND POWER CO. (LTD.)—According to the directors' report, the total connections have increased from the equivalent of 1,981 to 4,759 8 c.p. lamps, and it was found necessary to have a new engine set and a new boiler laid down. The net profit was £396. 12s. 3d., and there was also a balance in hand of £82. 1s. 4d. brought forward from the previous year. £40 has been written off preliminary expenses, and £360. 7s. 9d. carried to reserve. The report was adopted at the meeting on Saturday, over which the chairman (Mr. R. C. Donaldson-Hudson), presided.

NORTHWICH ELECTRIC SUPPLY CO. (LTD.)—This company, which has a share capital of £25,000 in £5 shares, is inviting applications for the balance of 1,371 shares.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

CHURCH STRETTON ELECTRIC SUPPLY CO. (LTD.) (80,857)—Reg. May 4, capital £10,000 in £1 shares, to adopt an agreement with Church Stretton Land Co. (Ltd.) and to carry on at Church Stretton, Salop, or elsewhere the business of suppliers of electric light, constructors and fixers of cables, wires, lines, accumulators, lamps and works, generators, accumulators, distributors and suppliers of electricity, contractors for lighting of streets, markets and buildings, electricians, mechanical engineers, &c. First directors, Hon. H. P. Mostyn, G. H. Dorrell and Hon. G. E. Hill-Trevor. Reg. Office, 18, Adam-street, Strand, London, W.C.

KENDAL AND GENT (LTD.)—Reg. April 22, capital £100,000 in £5 shares, to acquire the business carried on by A. H. Baldwin and E. Harper, under the style of Kendal and Gent, and to carry on the business of brass-founders and finishers, metal workers, mechanical and electrical engineers, machinists, machine and engineering tool makers, engine builders, boiler makers, &c. A. H. Baldwin and E. Harper are permanent governing directors. Reg. offices, Victoria Works, Gorton, Manchester.

OULTON BROAD ELECTRICITY CO. (LTD.) (80,824)—Reg. April 30, capital £5,000 in £1 shares, to acquire business of electric light and power suppliers, electrical and general engineers, &c., carried on by Messrs. Barber, Croft & Co., and to carry on the business of an electricity company. First directors, R. S. Stranack, H. Johnson and B. Barber.

MORTGAGES AND CHARGES.

BRITISH ELECTRIC TRACTION CO. (LTD.) (49,855)—Trust deed, dated April 21, 1904, to secure £250,000 2nd debenture stock (with power to issue further stock, ranking pari passu, up to half subscribed capital for time being) has been registered. Property charged, company's undertaking and property, present and future. Trustees, Electrical and General Investment Co.

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—Issue on April 14 of £10,600 debentures, part of series created Feb. 18, 1904, to secure £100,000. Property charged, company's undertaking and property, present and future, except uncalled or unpaid capital. Holders, T. E. Hodgkin, J. W. B. Pease and Admiral H. Cleveland. No trustees. Previously issued of same series, £10,000.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 7	1,219	+ 259	49	58,928	+ 12,084
Airdrie	April 29	187	...	12	2,282	...
Ayr Corporation	,, 30	284	- 11	50	18,492	+ 109
Barnsley	,, 29	168	- 2	17	2,698	- 166
Barrow	,, 29	147	+ 89	13	1,817	+ 1,107
Bexley District Council	May 5	196	...	30	4,937	...
Birkenhead	,, 8	980	+ 6	...	...	...
Birmingham Corporation	,, 7	958	...	16	5,141	...
*Birmingham Tramways Co.	,, 7	5,879	+ 403	18	98,461	+ 5,135
*Blackburn Corporation	,, 6	866	+ 142	6	5,531	+ 848
Blackpool Corporation	,, 5	551	+ 185	5	3,594	+ 302
Blackpool and Fleetwood	,, 7	320	+ 58	19	4,635	- 254
Blackp'l, St. Anne's & Lytham	,, 5	252	+ 253	27	4,925	+ 4,346
Bolton Corporation	,, 8	1,698	+ 87	6	10,076	- 40
Bournemouth Corporation	,, 4	978	+ 48	5	5,688	+ 369
*Bradford Corporation	April 30	4,000	+ 666	5	23,369	+ 4,127
	May 7	5,566	+ 2,370			
Brighton Corporation	,, 8	786	- 81	5	4,789	- 48
Brisbane Tramways	Mar. 28	2,461	+ 174	12	27,484	- 505
*Bristol Trams & Carriage	May 6	4,943	+ 425	24	111,507	+ 4,422
*Buenos Ayres & Belgrano	April 10	3,496	+ 560	25	79,529	+ 4,368
Burnley Corporation	May 7	984	+ 251	6	6, 65	+ 1,422
Burton Corporation	,, 8	307	...	40	13,258	...
Calcutta Tramways Co.	,, 7	R35,439	+ R4,977	19	R656,015	+ R90,700
Camborne-Redruth	,, 9	98	- 11	1	98	- 11
Cardiff Corporation	,, 7	1,920	+ 190	5	10,469	+ 481
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 7	6,950	- 12	19	131,780	- 1,040
Chatham & Dist. Lt. Rys.	,, 5	607	+ 102	18	9,520	+ 1,667
City & South London Rly.	,, 8	2,846	- 156	19	57,949	- 1,840
Cork Electric Trams Co.	,, 5	484	- 67	18	7,264	- 285
Darwen Corporation	,, 6	284	+ 15	5	1,193	- 96
Devonport & Dist. Trams	April 29	481	+ 60	17	7,988	+ 1,116
Dover Corporation	May 7	188	- 18	6	1,117	- 94
Dublin & Lucan Railway	,, 8	115	+ 25	19	1,852	+ 109
Dublin Southern District	,, 6	958	+ 155	¶19	80,877	+ 1,699
Dublin United	,, 6	4,088	+ 101			
Dudley—Stourbridge	April 29	825	+ 109	17	13,071	+ 589
Dundee Corporation	May 4	861	+ 64	...	...	...
East Ham Council	,, 7	740	+ 172	5	4,084	+ 542
Gateshead & Dist. Trams	April 29	858	+ 87	17	14,758	+ 762
Glasgow Corporation	May 7	14,243	+ 956	49	667,785	+ 60,980
Glossop	,, 7	111	...	18	1,798	...
Gravesend—Northfleet	April 29	235	+ 43	17	3,797	+ 595
Gt. Northern & City Rly.	May 7	923	+ 6	12	11,218	...
Greenock & Port Glasgow	April 29	534	- 20	17	8,147	+ 617
Halifax Corporation	,, 27	1,294	+ 129	5	6,975	+ 439
	May 4	1,455	+ 850			
Hartlepool Tramways	April 29	266	+ 86	17	4,287	+ 425
Huddersfield	...	...	...	...	...	...
Hull Corporation	May 7	2,037	+ 827	5	11,101	+ 1,060
Ilford District Council	,, 7	454	+ 166	5	2,527	+ 396
Ilkeston Corporation	,, 4	141	...	...	...	...
Ipswich Corporation	,, 7	401	...	5	2,329	...
Isle of Thanet Co.	,, 7	405	- 7	...	...	...
Kidderminster & District	April 29	111	+ 8	17	1,782	- 84
Kirkcaldy Corporation	May 4	209	- 20	18	3,786	...
Lanarkshire Trams Co.	,, 5	630	...	18	10,611	...
Leeds Corporation	,, 7	5,484	+ 817	6	84,144	+ 2,667
Liverpool Corporation	April 30	10,072	+ 202	18	173,810	+ 3,953
*Liverpool Overhead Rly.	May 9	1,594	- 19	19	29,507	+ 91
*London County Council	April 30	10,684	+ 2,230	§4	47,435	+ 9,790
Lowestoft	...	...	...	...	...	...
Manchester Corporation	May 7	11,602	+ 699	5	58,714	+ 711
Mersey Railway	,, 7	1,659	+ 170	18	26,506	+ 6,832
Merthyr	April 29	178	+ 3	17	3,325	+ 195
Middleton	,, 29	308	- 8	17	4,514	+ 71
Nelson Corporation	May 7	108	+ 51	6	684	+ 823
Newcastle-on-Tyne Corp.	,, 7	3,642	+ 522	18	62,935	+ 8,187
Newport (Mon.)	,, 7	478	+ 171	5	2,603	+ 677
Oldham, Ashton & Hyde	April 29	557	- 1	17	8,677	- 504
Oldham Corporation	,, 24	1,167	...	8	8,967	...
	May 1	1,130				
Perth (W. A.) Elec. Trams.	,, 6	1,388	+ 205	18	24,718	+ 3,804
Peterborough	April 29	197	+ 7	17	2,056	- 232
Poole and District	,, 29	287	+ 36	17	4,321	+ 26
Portsmouth Corporation	May 7	1,703	+ 215	†6	9,980	+ 1,030
Potteries	April 29	1,854	+ 322	17	28,314	+ 2,388
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rotherham	April 29	83	- 3	17	1,051	+ 84
Salford Corporation	May 9	3,685	+ 656	6	22,015	+ 2,687
Sheerness	April 27	49	- 24	17	806	- 225
Sheffield Corporation	May 8	4,279	+ 410	§6	28,370	+ 539
*Southampton Corporat'n	,, 5	919	- 15	...	...	...
Southend Corporation	,, 4	273	+ 24	5	1,414	+ 145
Southport Tramways	April 29	294	- 26	17	4,435	+ 253
S. Staffordshire Trams.	,, 29	788	- 60	17	12,922	+ 137
Stockport Corporation	May 6	528	+ 282	5	2,551	+ 975
Sunderland Corporation	,, 8	1,121	+ 93	5	6,316	+ 108
*Swansea Trams	April 29	480	+ 28	17	8,056	+ 289
Taunton Trams	,, 29	48	- 10	17	836	- 66
Tynemouth and District	,, 29	242	+ 13	17	3,788	- 181
Tyneside Trams Co.	May 4	337	+ 80	18	5,318	+ 794
Wallasey District Council	,, 7	669	+ 91	§5	3,664	+ 125
Walsall	,, 7	454	...	18	8,519	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 5	741	...	10	5,017	...
Weston-super-Mare	April 27	69	- 2	17	623	- 40
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 29	359	- 7	17	5,899	- 274
Worcester	,, 29	262	+ 102	12	3,111	+ 1,264
Wrexham	,, 29	105	- 19	17	1,809	- 79
Yorkshire Woollen District	,, 29	600	+ 242	17	9,190	+ 3,972

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days. ¶ Plus 3 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Shar.	Last Dividend	Name.	Price Wed., May 11.	Rate per Cent. Yielded £ s. d.	Dividend Due.	Business, Week to May 11. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4¼—5¼	4 17 7	April, Oct	5 1/16	4 15/16
St.	6%	Do. Permanent 6% Deb. Stock	127 —132	4 11 11	..	..	..
t.	34/2	Auckland Elec. Trams 5% Deb. (red.)	98 —100	..	..	99½	99½
10	10/0	Barcelona Tramways Ord.	6 —8	6 5 0	..	7½	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 6	..	..	..
100	5%	Do. 5 per Cent. Debs.	96 —99	5 1 9	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	3/16—7/16	..	..	..	..
1	..	Do. 5% Cum. Pref.	1/16—1/4	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1¾—2¼	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	..	..	..
St.	4½%	De. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	100	..
10	8%	Bristol Tramways and Carriage Ord.	18 —19	4 4 2	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 18 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	99 —102	5 17 8	..	100	..
St.	5%	Do. Pref. Ord. Stock	99 —102	5 0 0	..	101¼	101¼
10	5/0	Do. 5% Cum. Perp. Pref.	10¼—10¾	5 11 7	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102¾—104¾	4 6 7	..	102½	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	9 —9½	8 8 5	..	9⅜	8⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	10 —10½	5 14 4	Feb, Aug	10¼	9⅞
St.	5/0	Do. 5 per Cent. Perpetual Debs	115 —118	4 5 6	..	117	116½
5	3/0	Buenos Ayres and Belgrano Ord.	2⅜—2⅞	5 3 9	..	2⅜	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼—5⅝	5 4 4	..	5½	5⅜
5	3/0	Do. "B"	4⅜—5⅛	5 14 4	..	5	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	4 19 6	..	101	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	96 —101	5 0 0	..	..	..
5	3/6	Calcutta Tramways	7 —7½	4 0 0	..	7⅛	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —109	4 3 7	..	..	..
1	1/0	Cape Electric Tramways Shares	2 —2½	7 11 1	..	2⅛	2 1/16
St.	4%	Central London Ordinary Stock	92 —95	4 4 2	June, Dec	94⅛	93½
St.	4%	Do. 4 per Cent. Pref. Stock	98 —101	3 19 9	..	..	..
St.	4%	Do. Deferred Stock	85 —88	4 11 3	..	..	..
100	4%	Do. 4 per Cent. Debs.	110 —113	3 10 9	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½ —5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2%	City and South London Rly. Con. Ord.	50 —52	4 11 4	Feb, Aug	52	50½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 8	Feb, Aug	..	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 —109	3 13 5	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	99 —102	4 18 3	..	101	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8½	Gt. Northern & City Rly. Prf. Ord. (4%)	5½—6½	4 12 2	..	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	9½	..
10	10%	‡ Imperial Tramways Ord	18 —19	5 5 8	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¾—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	1½%	Liverpool Overhead Railway Ord.	4½ —4¾	3 1 1	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	4 0 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11 —11½	4 7 0	..	11 1/16	11 1/16
St.	4%	Do. 4% 1st Mort. Deb. Stock	101 —103	3 18 5	..	102⅛	102
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	1/16—1/8	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	3/16—1/4	5 0 0	..	1/4	3/16
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 5 0	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 —2	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 —102	4 18 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 —106	4 5 11	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	90 —93	3 7 7	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	100	99
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	12/6	Anglo-American	49 —52	5 12 4	F,My,Ag,N	..	..
St.	25/0	Do. Preferred	94 —96	6 0 0	F,My,Ag,N	95½	94½
St.	2/0	Do. Deferred	7¼—7¾	1 5 10	F,My,Ag,N	7⅞	..
100	$2	Commercial Cable Capital Stock	175 —185	4 6 6	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93 —95	4 4 6	Jn Ap,Jy,O	95.	94
10	7/0	Cuba Submarine Ord.	7½—8½	8 8 5	Feb, Aug	8⅜	7⅞
10	10/0	Do. Preference 10 per Cent.	15½—16½	6 1 8	Feb Aug	15½	..
5	2/0	Direct Spanish Ord.	2¼—3¼	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	99⅝—102⅝	4 9 3	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10¼	6 3 10	Ja,Ap,Jy,O	10⅛	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	98 —101	4 9 1	Jn, Dec ..	..	..
St.	26/0	Eastern Ordinary	125 —130	5 7 8	Ja,Ap,Jy,O	129	126
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 —89	3 18 8	Ja Ap,Jy,O	88⅜	86⅜
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104 —107	3 14 9	May, Nov	105⅜	105
10	2/6	Eastern Extension	12 —12½	5 12 0	Ja,Ap,Jy,O	12⅜	12 1/16
t.	4%	Do. 4 per Cent. Deb. Stock	104 —107	3 15 6	Feb, Aug	105½	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	99 —102	3 19 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞—101⅞	3 19 3	May, Nov	100½	..
10	20/0	Great Northern (of Copenhagen)	25 —26	5 15 6	Jan, July	25½	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —101	4 9 6	June, Dec	..	..
25	37/6	Indo-European	40 —43	5 16 3	May, Nov	..	..
100	4%	Pacific&Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec,	..	..
10	2/0	West African Telegraph Shares	5 —6	1 13 4	..	..	..
2½	..	West Coast of America	⅞—1	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 10	Jan, July	..	..
10	..	West India and Panama	3/16—5/16	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	5¼—6¼	9 12 0	May, Nov	6½	6
10	..	Do. 6 per Cent. 2nd Pref.	4¼—5¼	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 18 4	Jan, July	..	..
100	3/0	Western Telegraph	12½—13	5 7 8	Mr,Jn,O,D	12¾	12⅝
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 17 9	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	100 —103	3 17 8	..	102	101¾
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	9 —9½	5 15 8	Ja Ap,Jy O	9½	9
10	3/0	Do. 6 per Cent. Pref.	12⅜—13¼	4 10 6	Ja Ap,Jy,O	13⅛	12⅝
8	4/0	Reuter's	6¾—7¼	5 6 8	April, Oct	7⅛	..
100	6%	Submarine Cables Trust (Cert.)	117 —122	4 18 4	April, Oct	118	..

Shar.	Last Dividend	Name.	Price Wed., May 11.	Rate per Cent. Yielded £ s. d.	Dividend Due.	Business, Week to May 11. Highest.	Lowest.
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	4½—5½	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	103 —105	5 14 10	..	104½	103⅝
St.	5%	Do. Def. Stock	88 —91	5 10 10	..	89	88
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 —13	4 12 4	Feb, Aug	11½	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5½	4 15 3	Feb, Aug	..	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 —99	3 11 5	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 —104	3 17 10	..	103½	103½
..	..	Do. Do. Prov. Certs. 70% to bepd.	28 —30	..	..	29½	..
1	0/8½	Oriental	1/16—1/8	6 6 8	April, Oct	1/16	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1/16—1/8	5 12 11	..	..	..
5	3/0	United River Plate	5½—6	5 16 8	July.....	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¾	4 15 3	June, Dec	5	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 —106	4 15 10	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord. (f.p.)	3/16—7/16	..	..	..	..
1	0/8½	Do. 7% Cum. Pref.	1 —1½	5 12 0	..	1 1/16	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. &con.)	117 —122	3 14 4	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	12	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10¼	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10¾—11½	5 4 4	..	11	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	10¾—11½	4 5 1	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	..	..
5	3/0	Calcutta Electric Supply Ord.	6¾—7½	4 9 8	..	7 1/16	6 15/16
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	107 —110	3 14 1	..	107½	107
5	4/0	Charing Cross & Strand Electric Sup.	7¼—7¾	5 3 3	Feb, Aug	7⅜	7 7/16
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 5 9	Feb, Aug	5 1/16	5 1/16
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅜—5	4 10 0	..	..	..
5	1/7	Do. Do. (1903)	4⅜—5	..	..	4 1/16	..
St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 10	..	105	..
5	3/6	Chelsea Electric Supply Ord.	6½—6¾	4 1 5	March ..	6½	6 1/16
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —110	4 3 0	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10½—11	4 10 11	Feb, Aug	10¾	10⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅜	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	..	..
10	4/0	County of London Elec. Supply Ord.	7 —8	5 0 0	..	7 1/16	7 1/16
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106 —109	4 2 11	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	99 —102	4 8 3	..	100¼	100¼
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	90 —95	..	..	93	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 8	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 8 0	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
5	5/0	Hove Electric Lighting Ord.	7¼—8¼	5 0 0	..	..	..
St.	..	I. of W. Elec Lt. & Power 4½% Db. St. (red.)	102 —104	..	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm. Prf.	1/16—1/8	..	..	..	..
5	7/0	Kensington & Knightsbdge Ord.	11½—12½	4 16 0	..	11⅞	..
5	6%	Do. 6 per Cent. 1st Pref.	6¾—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Knghtsbdge Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	103½	..
8	..	London Electric Supply Ord.	1¾—1¾	..	..	..	..
5	3/0	Do. 6 per Cent Pref.	4¾—5	6 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb,	95 —98	4 2 11	Mr,Jn,S,D	..	..
10	9 6	Metropolitan Electric Sup. Ord.	19 —20	4 7 6	April, Oct	19⅜	19⅛
5	1/4½	Do. 4½ per Cent. Cum. Pref.	5½—5¾	4 2 6	..	5¾	5 7/16
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 —100	3 11 0	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
10	6/0	Notting Hill Electric Ord.	12½—13½	4 8 11	March....	12⅝	..
5	4/0	Oxford Electric Ord.	5½—6½	5 13 0	March ..	5 7/16	5½
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 3	..	..	..
1	..	Rand Electric	1 3/16—1 5/16	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	98 —101	4 9 1	April, Oct	..	..
5	..	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	14 3/16	..
5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	8 1/16	8¼
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	97½	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3 —3½	5 14 3	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	3/0	South London Electric Supply Ord.	3⅜—4¼	3 10 7	..	3 15/16	3¾
5	2/6	Urban Electric Supply Ord.	4⅜—4¾	5 2 6	..	..	..
5	2/6	Do. 5% Cum. Pref.	4⅝—4¾	5 2 6	..	..	..
5	7/0	Westminster Electric Supply Ord.	12¼—13½	5 0 0	Mar, Sept	12 1/16	12 1/16
5	2/6	Do. 5 per Cent. Cum. Pref.	6¼—6¾	3 14 0	..	6½	..
		ELECTRIC MANUFACTURING &c.					
5	4/0	British Insulated & Helsby Cables Ord.	5¼—5⅜	6 19 2	July, Feb	5 7/16	..
5	3/0	Do. 6 per Cent. Pref.	5¼—5⅜	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —105	4 7 0	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	102	..
6	3/0	British Westinghouse 6% Pref.	3⅜—4¼	7 1 2	..	3 15/16	3¾
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	90 —93	4 7 0	..	91½	90
2	..	Brush Electrical Engineering	1—1	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1—1½	..	Mar, Sept	1½	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	78 —78	5 17 8	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	10¼—11¼	6 10 5	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 8	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅞—1	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	97	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¾—2¼	6 13 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96 —99	5 2 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7¾—8¼	..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5 —5¼	5 9 1	..	5 1/16	..
St.	4½%	Do. 4½% Deb. Stock	102—104	4 7 2	..	..	..
		Edison & Swan United ("A" Sh.) (£3 pd.)	½	..	Feb, Aug	..	..
		Do. (£5 paid)	1—1¼	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	74 —79	6 6 7	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5¾—6¼	5 12 0	H'lf-yearly	6	5¾
5	3/0	Do. 6 per Cent. Cum. Pref.	5¾—5¾	5 2 2	..	5 13/16	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 5 2	..	106⅜	..
2	1/2½	Electric Construction Co.	1⅜—1⅝	7 2 10	Jan, July	1½	..
2	2/9	Do. 7 per Cent. Cum. Pref.	2¾—3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—9¾	5 2 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18¼—19½	5 2 7	Feb, Aug	19 1/16	18⅞
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	36/0	Telegraph Construction & Mainten'ce.	34 —37	6 9 10	Mar, July	37	35½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
5	..	Willans and Robinson Ord.	2 —3	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3 —4	..	Apr, Oct	3½	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	90 —96	4 5 9	May Nov	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

THE Marylebone Borough Council's electric lighting Bill has now passed the House of Commons and, having passed the Committee stage in the House of Lords on Monday, was read a third time in the Upper House yesterday afternoon. As there is no reason to anticipate that Royal Assent will be withheld, the Bill has become law to all intents and purposes. The Bill is for the purpose of authorising the Marylebone Borough Council to borrow money in order to take over the Marylebone portion of the Metropolitan Electric Supply Co.'s undertaking. The history of the matter has been a long one. When the high valuation fixed by the umpire after the recent arbitration proceedings was made known, legal difficulties were raised which have delayed the acquisition of the loan by the Council, although it was impossible to evade the liability to purchase. Then an endeavour was made to come to better terms with the company, but no arrangement could be arrived at satisfactory to both sides. Offers were also considered from the Westinghouse Company and from the General Electric Co. to relieve the Council of part or whole of the undertaking, but these were also refused, and the Council finally came to the conclusion that it had no option but to buy the undertaking in accordance with its original intention, although at a price far higher than it had anticipated paying when it agreed to the purchase by arbitration.

AN unsuccessful attempt was made in the House of Commons to obtain the insertion of the "Bermondsey" clause in the Bill, but it was fortunately frustrated, and elicited a clear statement from Mr. BONAR LAW on the attitude of the Board of Trade with regard to this clause. This has already been alluded to in our columns. A modification of the "Bermondsey" clause has been accepted by the Council, however, in which, apparently, the terms of the "Bermondsey" clause are to be followed after the undertaking has been in operation under the Council's administration for three years. We may point out that the wording of the clause, which we print in another column, is not as clear as it might be with respect to the time these three years are to be reckoned from. After the expiration of this period the accounts are to be examined annually, and if there is a deficit the Council will have to raise the price charged per unit. We fear that, in view of the large capital expenditure, electric light in Marylebone will not be cheap for many years to come.

THE proceedings at the Conference on the telephone question at the Guildhall yesterday, a special report of which we publish on another page, show that the Local Authorities in London are not all agreed as to the advisability of the Government purchasing the telephone system of the country forthwith. The fact was insisted on by some speakers that the Government would have to pay more now than it would have to in 1911, when the greater part of the National Telephone Co.'s licence expires, but too much may easily be made of this point. A valuation made now would surely be on the basis of a going concern with a seven-years' lease of life, and there is no reason why a proper actuarial estimate should not be arrived at which would be quite satisfactory. One speaker was wrong in stating that the Company could make its own terms, for the Company's own licence clearly gives the Government powers of compulsory purchase in 1904. Not only is there prospect of a more efficient service if the telephone system is placed under one control, and in the hands of a department having such wide-reaching powers as the Post Office, but there is also a possibility that the cost of the service to the subscribers may be considerably reduced. At present one-tenth of the subscription paid by the telephone

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renter on the National Telephone Co.'s systems and the municipal systems is paid over to the Government; and it should even be possible to reduce the rates by more than 10 per cent., for the wider powers of the Postmaster-General would effect economies in sums paid for wayleaves and money expended on the maintenance of costly house top systems of overhead conductors.

SHAREHOLDERS of the West India and Panama Telegraph Co. received an unpleasant reminder of the fearful Martinique disaster of 1902 at the fifty-fourth ordinary general meeting of the Company held on Wednesday. It will be remembered that the Company's cable-ship "Grappler" was lost as a result of the volcanic eruption, and since that time operations have been carried on with a view to repairing the cable in the neighbourhood of St. Pierre. Some of the cable picked up was found to be in shreds, with the gutta-percha core cut and broken. Whilst the ship was at work it was noticed that Mont Pelée was continually smoking and steaming, and, having the loss of the "Grappler" and the recent narrow escape of another vessel off St. Vincent still fresh in their memories, the Company decided to abandon, for the present, all attempts at restoring communication until safer and more peaceful times. The Chairman further informed the shareholders that when the repairs were again taken in hand a deviation of route and an expenditure of 50 or 60 nauts of new cable would be involved.

THE decision of the Shoreditch Borough Council to fix the price of steam supplied to the electricity department by the refuse destructor, is another striking proof of the difficulties which must inevitably arise when the two departments are compelled to work in conjunction. It is proposed to take an eight hours' test, using coal-fired boilers only, and from the figures so obtained to determine the cost of coal at existing contract prices for every unit generated. When working with both coal and refuse combined, it will then be necessary, in order to estimate the value of the refuse as fuel, merely to subtract from the total units generated the units due to the coal consumed, and multiply the remainder by the figure per unit obtained from the test. The Electricity Committee are of the opinion that the latter figure will be in the neighbourhood of 0·9d. per unit. From the committee-man's point of view, perhaps, the arrangement would be an admirable one, but, unfortunately, steam has not always a fixed value for the electricity department. If the latter had a load-factor of 100 per cent. then a definite price might be assigned to each pound of steam supplied if the supply were constant. Moreover, the top loads of the two departments do not coincide, and it is, therefore, unfair to demand the full price for steam which is not wanted, but which must be disposed of because the destructor happens to be working at full pressure. The point is admittedly a knotty one; many central station engineers would be inclined to place a *minus* sign before the figure representing the value of the destructor steam per unit generated.

THE letter which we publish in another column from a correspondent in Madrid, calls attention to the successful financial results that have been obtained with overhead electric lighting networks in that country. Although the cases are limited in which water powers, even as small as he mentions, are available in England, there may well be some small towns beyond the reach of power companies in which the erection of a simple water-driven electricity works and a network of overhead wires would be worth while; and, certainly, in many places in Wales, Scotland and Ireland the matter should be worth consideration. The chief difficulty is the small head available. Very small steam-driven works will seldom pay their way in remote villages, for there the cost of coal is excessive, and the economy arrived at in utilising overhead lines would not always compensate this. We are glad to notice, however, that more attention is being paid to overhead wires, and are able to record another case this week in which their adoption has been decided on. At Crediton, in Devonshire, a townlet of some 4,000 inhabitants, a resolution of the Urban District Council refusing permission for overhead wires has just been rescinded, on the representation of the contractors who desire to put down electricity works that an insistence on the employment of underground mains would increase the cost of the scheme so much as to prevent its being carried through.

THE case of "Smith *v.* Pare," reported in our last issue, has aroused some comment in medical and other scientific circles, not on account of the main issue of the case—which was simply whether there had been wrong diagnosis and unskilful treatment by Dr. SMITH—but in view of the evidence given by the expert witnesses who were called in. Three witnesses, including Dr. GREGG, superintendent of the X-ray department at St. Thomas' Hospital, and Sir VICTOR HORSLEY, stated that, while beneficial effects could be obtained with the X-ray treatment in the case of superficial cancer, it was ineffectual when applied to cases of internal cancer. The question as to whether the more penetrative γ-rays from radium would be serviceable in this direction is still open, however, and there would seem to be room for experiment in this direction. Unfortunately, experiment is difficult, for the serious burning of the skin, which often results from too prolonged an exposure to X-rays, is also occasioned by the rays from radium, and, moreover, the rays which will destroy an internal growth may also destroy useful tissue. Medical men should not overlook the fact, however, that the γ-rays of radium, while possessing in general the same properties as X-rays (in fact, it is not improbable that they are "hard" X-rays), are far more penetrative. There may, therefore, be several useful applications for them.

THE unfortunate fatality which occurred on the newly-"electrified" portion of the North Eastern Railway on Wednesday last week will probably be viewed with alarm by a large section of the general public. A boy, only 3½ years of age, crept through a railing, got on to the permanent way, and, stepping on the live rail, was killed. At the inquest the jury returned the usual verdict, and expressed the opinion that the line should be more efficiently protected; the coroner also intimated his intention of personally communicating similar views to the Home Office, independently of the jury. Apart from any question of efficient protection by the railway

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company, even if the line had been worked by steam it is not unlikely that an accident would have occurred; it is not surprising that a child, 3½ years old, if left to its own devices, should, sooner or later, get into trouble. It is to be hoped, however, that the railway companies using the third rail will adopt a more effective form of fence than the simple railing which protected the line in this case, and the question of abolishing the gates for pedestrians at level crossings is also worthy of consideration.

A BLUE BOOK has just been issued containing reports and correspondence relating to the expediency of maintaining the Royal Indian Engineering College at Cooper's Hill. As long ago as 1895 a Committee was appointed to inquire into the expenditure necessitated by the maintenance of the college, and their opinion was that it should be discontinued. A similar opinion was set forth in a report by the Board of Visitors in 1901, and now, owing to a further report of the 1903 Committee, it has been finally decided to close the institution. It appears that the cost to students and to the Government is excessive; so much is this felt by the former that the number has fallen off considerably, and great difficulty is experienced in securing recruits from the proper classes of society. The Committee consulted various institutions and colleges, and found that training equally as good as that given at Cooper's Hill could be obtained from other sources and at considerably smaller cost. They are of the opinion that it is not good for an educational institution to be under Government control, and, in short, they advocate the abolition of Cooper's Hill and the selection of candidates for Indian service from outside sources. It is recommended that the college be closed in September, 1904. The Government of India have written to the State Secretary for India protesting, but in his reply Mr. BRODRICK upholds the findings of the Committee. We trust that, in order to make the policy of the Government consistent, they will contribute a subsidy to some of the leading technical colleges, and institute scholarships for the most promising students who desire to be trained for Indian appointments.

Underground Sub-stations.—An error occurred in our editorial notes on this subject last week. In the second note on p. 125 the minimum size for a transformer chamber which we quoted should have been 4ft. square instead of 2ft. square.

Institution of Electrical Engineers.—The annual general meeting of the Institution of Electrical Engineers has been postponed from May 26 until June 6.

Thunderstorm at Bristol.—A heavy thunderstorm passed over Bristol on Monday. Lightning struck several houses in Clifton and the adjoining suburbs, and in one instance two children were thrown down, but escaped with a shock.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Dakar—Konakry	May 13, 1904
Gibraltar—Tangiers	May 17, 1904

Institution of Electrical Engineers' Benevolent Fund.—The sixth annual general meeting of contributors will be held at the Institution offices, 92, Victoria-street, London, S.W., on the 27th inst., at 5 p.m. The statement of accounts to be submitted shows investments £1,550, balance at bankers £366. 18s. 11d., petty cash 10s. 5d.—total assets £1,917. 9s. 4d.

Dublin Local Section of the Institution of Electrical Engineers.—At the annual general meeting of the Dublin Local Section, held last Friday, the following officers were elected for the coming session:—

Chairman, Mark Ruddle. *Vice-Chairman*, P. S. Sheardown. *Other Members of Committee*, Prof. Barrett, J. W. Boucher, P. Blissett, Wm. Brown, A. T. Kinsey, A. E. Porte, S. Robinson, Prof. Thrift, A. W. Whieldon. *Hon. Sec.*, William Tatlow.

A pair of silver salvers were afterwards presented to the hon. secretary, Mr. Wm. Tatlow, on the occasion of his marriage.

The New Institution Secretary.—At the meeting of the Institution of Electrical Engineers on Thursday, May 12, the secretarial chair was occupied by Mr. G. C. Lloyd for the first time. In introducing Mr. Lloyd to the members, the President (Mr. R. Kaye Gray) said it was only right to say that since the lamented death of Mr. McMillan, Mr. Rowell and Mr. Tree had carried on the duties in such a way as would please everyone, and no doubt they all had noticed that the affairs of the Institution had been carried on quite as usual during the interregnum. He thought he should make this announcement public, as sometimes the people who did the work did not get properly recognised.

The Electro-Harmonic Society.—The annual general meeting of the Electro-Harmonic Society, to receive the statement of accounts for the 18th season, to elect officers for the 19th season, and to transact the ordinary general business of the Society, will be held on Wednesday next, at 4:30 p.m., at the Institution of Electrical Engineers, 92, Victoria-street, Westminster. Members of the committee are requested to meet at 4 p.m. for the election of new members and for other business. During the past season 103 new members have been elected and placed on the register. In the same period the Society has lost six members by death, 30 have resigned and seven have been struck from the register for non-compliance with Rule 9. The membership roll now contains 446 names, and there is a credit balance of £44. 8s. 11d. to the end of the season 1903-1904.

Wiring Practice in South Africa.—As recently announced in these columns, the Cape Town local section of the Institution of Electrical Engineers has drawn the attention of fire insurance companies, architects and electrical consumers generally to the urgent need for raising the standard of electrical installations in South Africa. In their opinion this result can be best obtained by (1) the employment, in all cases, of a properly qualified electrical engineer to draw up specifications in accordance with the rules of the Institution of Electrical Engineers, to supervise the carrying out of the work and, on its completion, to furnish his signed certificate; (2) by periodical inspections (at least once every year) by some competent engineer; (3) by requiring all wiremen employed on electrical installations to be duly licensed by some competent body, such licence only being granted after due examination, and being liable to withdrawal; and (4) by the adoption by the fire insurance companies of a discriminatory tariff in favour of premises in which the electrical installations are thus satisfactorily inspected.

A New Honorary Member.—At their last meeting, the Council of the Institution of Electrical Engineers elected Major-Gen. C. E. Webber (retired), R.E., C.B., an honorary member of the Institution. The other honorary members are:—Dr. Henry Wilde, F.R.S.; the Right Hon. Lord Kelvin, O.M., G.C.V.O., F.R.S.; Dr. J. Wilson Swan, F.R.S.; M. E. Mascart, Membre de l'Institut de France; and Prof. Antonio Pacinotti, of Pisa. Major-Gen. Webber, who is now 65 years of age, was one of the founders of the Institution of Electrical Engineers in 1871, and is a Past-President. He obtained his commission in the Royal Engineers in 1855, and, after much active service, was appointed Director of Army Telegraphs with the Nile Expedition of 1884-85, until invalided in May, 1885, when he retired with the honorary rank of major-general. In 1870 Major-Gen. Webber was placed in command of the 22nd and 34th companies of Royal Engineers for service in the Postal Telegraph Department, and he was appointed divisional engineer first of the Eastern and after-

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wards of the Southern Division of the Postal Telegraphs. He has been established for some time past as a consulting electrical engineer, and is a director of several leading electric supply companies. He has read numerous Papers before the Institution of Electrical Engineers, and is a frequent speaker in the discussions at the meetings.

Obituary.—We regret to record the death on the 9th inst., at Haslar Hospital, of Sub-Lieut. Douglas George Anderson, son of Mr. Kenneth Anderson, of Swanage, Dorset, and grandson of the late Sir James Anderson. The deceased had been serving on the Mediterranean stations in H.M.S. "Niad," and was invalided home, arriving in the "Exmouth" the previous week. Lieut. Anderson was making satisfactory progress when a recurrence of Malta fever supervened, and he passed away suddenly in his sleep. He was possessed of a fine physique and was a keen sailor, and probably kept at work too long, owing to unwillingness to go on the sick list. The funeral was attended by a large number of naval officers and men, and the coffin was borne on a gun carriage from the hospital to the cemetery. The service was conducted by the Rev. H. C. Backwell, chaplain of the naval barracks of which the band was also in attendance. After the usual three volleys, fired by a party from the "Victory" and other ships, the "Last Post" was sounded.

We have also to announce the death of Mr. Frank Rutley, late lecturer on Mineralogy at the Royal College of Science, which took place on Monday.

Royal Society Conversazione.—At the Royal Society conversazione on Friday last there were only few exhibits of electrical interest, the biological element being on the whole the most predominant. Prof. Fleming showed an effective adaptation of Seibt's resonator to the metrical study of stationary electric waves on spiral wires, the positions of the nodes and loops being made evident by numerous vacuous tubes which glowed brightly or dimly in the high-frequency field near the spiral, and the number of these nodes and loops being varied by the use of a variable inductance in the exciting circuit. Col. Crompton showed a selection of electrical instruments of precision, including electric micrometers and a spherical electrostatic voltmeter. The National Physical Laboratory had on view a "microphone-buzzer," which is used for producing from continuous-current a nearly pure sinusoidal alternating current such as is needed in the measurement of small inductances and capacities; and also an apparatus for investigating by means of buried thermo-junctions the temperature distribution in the field coils of electrical machinery. Messrs. Hibbert and Dick exhibited the parts and the materials of Edison's secondary battery for automobiles. Dr. A. B. Green displayed photographs illustrating the photo-actinic rays emitted from bacteria after exposure to the radiation from radium. Finally, Mr. Sherard Cowper-Coles demonstrated the action that occurs between metals at temperatures much below their melting points, an action which, in the so-called Sherardising process, is being applied to the coating of iron with zinc by heating the iron in zinc dust.

Institution of Electrical Engineers' Visit to America.—The arrangements for the Institution's visit to America in the latter part of this summer are in a forward state. It is proposed that the party should sail on the White Star s.s. "Republic," this being the only steamer on which accommodation for the whole number can be found. The steamer sails from Liverpool on Thursday, August 25th, and is due on Friday, September 2nd, at Boston, where it has been arranged to visit several places of interest. The party will arrive at New York on September 4th, and will remain together until Saturday, September 24th, when it disperses. During this time the party will visit New York, Schenectady, Montreal, Niagara Falls, Chicago, St. Louis, Pittsburg, Washington and Philadelphia. An outline of the complete itinerary of the visit was published in *The Electrician* of May 6th, p. 88, the only alteration being that under the present arrangements Boston will be visited at the commencement of the tour, and not on September 22nd, as formerly arranged. This latter date is, in consequence, at present unassigned. Ladies will be heartily welcomed and, wherever possible, special arrangements will be made for their entertainment while the members are engaged in visiting works. With the exception of ladies travelling with members, the party must necessarily be restricted, as usual, to the members of the several classes in the Institution. It is anticipated that, including first class fares on steamers and railways and ordinary hotel expenses, together with a contribution towards the expenses of the Institution, the cost of the tour will be about £80 per head. But, as this sum does not include incidental expenses, such as gratuities, which are under the personal control of each individual, a further sum of at least £10 should be allowed for, exclusive of the cost of wines and the like. As on previous visits, all arrangements for travelling on the American continent and for hotel accommodation will be attended to, and further details regarding these points will be given at a later date.

Darlington Tramways.—Trial trips have been made over a portion of the Darlington Corporation's electric tramway lines, and it is expected that the entire system, comprising $3\frac{7}{8}$ miles of double track and $\frac{5}{8}$ mile of single track, will be opened to the public in a few days. The gauge is 3ft. 6in., the steepest gradient 1 in 14, and the sharpest curve has a radius of 60ft. Girder rails, weighing 90lb. to the yard, are employed, and they serve, together with two feeders, as a return. The overhead equipment includes side poles, span wires and centre poles, the trolley wire being No. 00 S.W.G. Contractors for this part of the work were the British Electric Equipment Co. and Messrs. J. G. White & Co. Two sizes of feeders are employed, having a section of 0·25 sq. in. and 0·20 sq. in. respectively. They are of the paper-insulated lead-covered type, laid solid in wood troughs underneath the footpath, and were supplied by Messrs. W. T. Glover & Co. Energy at 550 volts is supplied by the Corporation's electricity department at $1\frac{1}{4}$d. per unit. There are 16 cars of the single-deck combination type, by Messrs. G. F. Milnes & Co. Each is fitted with two Westinghouse motors driving by single reduction gear having a ratio of 1 : 4·85. The motors are specified to develop 25 B.H.P., and, in a 30 minutes' test the temperature rise is not to exceed 117°F. when running at a speed equivalent to 7 miles per hour. Hand, slipper and electric emergency brakes are provided, and the cars are also fitted with "Tidswell" lifeguards. The cars are divided by two partitions into three compartments, the two end ones being for smokers; there is seating room for 28 passengers in each car. The smoking compartments, holding six passengers each, are open at the ends, and the windows behind the seats in these smoking compartments may be raised or lowered. Some of the principal dimensions of the cars are: Length over collision fenders 28ft., overall width 6ft. 6in., and wheel base 6ft. Messrs. Kennedy and Jenkin are consulting engineers, and Mr. J. R. P. Lunn is the resident engineer and tramways manager.

Wireless Telegraph Notes.—*The Times* special correspondent, who has been supplying that journal with reports of the war by means of a De Forest apparatus which he has on board the steamer "Haimun," sent on Monday a lengthy explanation of the absence of news through his medium during the past few weeks. He at once states that it has not been due to any failure of the apparatus. It appears that on April 17th he returned to Japan for the purpose of coaling, but just when on the point of leaving again, a message from the British Minister at Tokio informed him that the Japanese military requested that the "Haimun" should not proceed north of the Chifu–Chemulpo line until further notice. In spite of protests he could not get this rescinded, but on May 10th he was informed that the limit of restriction had been reduced to the Liau-tie-shan Channel and Pillar Rock line. Although this hardly improved his position, he immediately sailed, but when about 100 miles out, a typhoon carried away the main topmast, to which was attached the wireless apparatus. The delay in putting back to refit amounted to 36 hours. The "Haimun" is now at sea again, but it is not deemed advisable to disclose its approximate position.

A Reuter telegram from New York states that on Friday of last week when the Cunard liner "Campania" was off Nantucket, an inquiry by wireless telegraphy from the *Tribune* reached Mr. Marconi, who was on board, regarding the success

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of his experiments with a daily news service at sea. He replied: "Results satisfactory for immediate inauguration."

According to American contemporaries, at a recent meeting of President Roosevelt's cabinet a discussion took place on the desirability of control by the Government of wireless telegraphy. The opinion was expressed that it would be desirable, if not, indeed, absolutely necessary, for the Government to control, at least in a supervisory way, the operation of wireless telegraphy, particularly along the coast. It was pointed out that, in the event of a war with a foreign nation, it might be necessary in defence of the nation for officers of the United States to have charge of these stations, as a means of assurance to the Government that no communication was established with vessels of the enemy's fleet, and that the system was not employed to the detriment of United States interests.

Eddy Currents in Cable Sheaths.—Mr. G. L. Addenbrooke, discussing the Paper by Mr. M. B. Field on this subject, concluded in our issue of April 29th, refers to the experiments which he undertook at Messrs. W. T. Henleys's Telegraph Works nearly 2½ years ago, and to which he referred in the discussion on Messrs. Constable and Fawssett's Paper. Though these experiments were intended chiefly to go into the question of dielectric hysteresis, yet, nevertheless, in the course of the experiments effects were observed of the character alluded to by Mr. Field. One set of cables had a bare lead sheath and were coiled on drums. An attempt was made to measure the dielectric losses in this cable between the inner conductor—the cable being a concentric one—and the lead sheath. The losses were, however, found to be so considerable that it was evidently useless to continue the experiment in this form. The lead evidently acted as the secondary of a transformer sufficiently for heavy and considerable losses to take place in it. This shows, Mr. Addenbrooke points out, that lead-covered cables carrying alternating currents should not be laid in metallic connection with conductors which may form a return circuit. Another observation was as follows:—Several measurements having been made on lengths of cable which were unarmoured, an armoured length was substituted, and in this the losses were uniformly higher than in similar cable made of the same materials, but which was unarmoured, the cables being concentric in both cases, and the tests taking place between two conductors. At 3,000 volts the power-factor was 1·45 per cent., while for a similar voltage and periodicity with armoured cable the power-factor was 1·62 per cent. Experiments were made at other voltages with somewhat similar results. Mr. Addenbrooke had no opportunity of making a similar set of tests on three-phase cable under similar conditions, but he expects that in such a case the effects would be somewhat greater. Mr. Addenbrooke concludes:—

Of course, in these experiments the current flowing through the cable was merely the current used for electrostatically charging it, and consequently the effect would be very small. With the actual currents flowing in practice through the cable it is quite possible that the effects might be very appreciable. The only way to determine them, it seems to me, would be to take a length of cable having a non-inductive resistance at one end in which the energy of the current passed through the cable would be dissipated. If then a steady alternating current were passed through the cable, and simultaneous measurements could be taken at both ends, both of the current and watts lost, deducting the calculable loss in the conductor of the cable, it ought to be possible to arrive at any other losses which might take place. I would be happy to give any assistance in my power in the conducting of such a set of experiments, as I think it would be for the general benefit of the industry that they should be made.

Junior Institution of Engineers.—On Thursday evening, May 12th, a visit was paid by the Junior Institution of Engineers to the Great Northern, Piccadilly and Brompton Tube Railway works, the party numbering about 100. They were received by Mr. A. F. Baynham, resident engineer of the South Kensington to Holborn section. The railway is an amalgamation of the Brompton and Piccadilly Circus Railway and the Great Northern and Strand Railway. The Brompton and Piccadilly Circus Railway, which was sanctioned in 1897, extends from a junction with the Metropolitan District Railway west of Earl's Court station to Holborn at the upper end of the new County Council street. It there forms a junction with the Great Northern and Strand Railway, which was authorised in 1899, to King's Cross and Finsbury Park. The two lines were amalgamated by Act of Parliament in 1902. The new railway forms part of the Sub-District express line, sanctioned in 1897, between Earl's Court and Mansion House as far as South Kensington, where an underground station will be provided below the existing one. The line then passes along the Fulham-road to its junction with the Brompton-road to a station to be named "Brompton Road Station," almost adjoining the Oratory. Thence it proceeds up the Brompton-road to a station at the upper end of Sloane-street and along Knightsbridge to Hyde Park Corner, where a station will be provided adjoining St. George's Hospital. The line then proceeds along Piccadilly to Piccadilly-circus, with stations on the way in Down-street and in Dover-street. At Piccadilly-circus there will be a station for interchange with the Baker Street and Waterloo Railway, under which line the railway crosses at a depth of 108ft. from the surface of the road. The line then proceeds along Coventry-street to another interchange station with the Charing Cross, Euston and Hampstead Railway in Charing Cross-road, opposite the Hippodrome; thence along Long Acre, with a station adjoining Covent Garden, to Holborn, Russell-square, under King's Cross railway station, and thence under the Great Northern Railway as far as Finsbury Park. The works were commenced in the early part of 1902, and more than half the tunnelling has been completed. The ordinary "Greathead" shield was used at first; but, after the works had been in progress for a short time, an improvement on it was made by fixing an electrically-driven excavating wheel at the face of the shield, which obviated the necessity of the clay being excavated by hand to permit the shield to push forward. This appliance has proved to be a great success, and is now in use over the whole of the line. With the original "Greathead" shield the maximum number of tunnel rings completed in any week was about 40, whereas with the new rotary excavating machine as many as 72 rings have been inserted per week. This machine is at work at Brompton-road station, where two shafts each 23ft. in diameter have been sunk to a depth of about 60ft. from the surface, for the provision of four lifts. Temporary connections have been made between the foot of these lifts and the railway tunnels. Both the up and down station tunnels have been completed, each being 21ft. 2½in. internal diameter.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, May 20th.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read "Practical Notes on the Running of Motor Cars and Cycles," by Lieut. W. G. Windham, R.N. (King's Messenger).

ROYAL INSTITUTION.

9 p.m. Evening discourse: "The Radiation and Emanation of Radium," by Prof. E. Rutherford.

SATURDAY, May 21st.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

2 p.m. Visit to the Great Northern and City Railway Works. Meet at Moorgate-street station.

THURSDAY, May 26th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at the Society of Arts, John-street, Adelphi. Paper to be read: "High-speed Electric Railway Experiments on the Marienfelde–Zossen Line," by A. Siemens. [The Annual General Meeting has been postponed until June 6th].

FRIDAY, May 27th.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "The Law of Action between Magnets and its bearing on the Determination of the Horizontal Component of the Earth's Magnetic Field with Unifilar Magnetometers," by Dr. C. Chree, F.R.S.; (2) "On the Ascertained Absence of Effects of Motion through the Ether in relation to the Constitution of Matter on the FitzGerald–Lorentz Hypothesis," by Prof. J. Larmor, Sec. R.S.; (3) "On Coherence and Recoherence," by Dr. P. E. Shaw and Mr. C. A. B. Garrett.

ROYAL INSTITUTION.

9 p.m. Evening discourse: "The Progress of Oceanography," by His Serene Highness Albert Prince of Monaco.

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THE STALYBRIDGE, HYDE, MOSSLEY AND DUKINFIELD TRAMWAYS AND ELECTRICITY BOARD.

On May 14th the first set in the generating station of this system was put into operation, together with the motor-generator sets in the first of the four sub stations from which current is supplied to the tramway network. A car was run on those portions of the routes which could be fed from the Dukinfield sub-station, and a service will be inaugurated almost immediately. The remaining sub-stations will, it is anticipated, be completed in about three months, when a formal opening of the entire system will be made.

The Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board Act was obtained in August, 1901, and full details of the foundation of the scheme were given in *The Electrician*, Vol. XLVII., pp. 285 and 330. On January 1, 1902, Mr. A. H. Gibbings, who had been appointed engineer-in-chief, commenced the design of the scheme which has now been successfully inaugurated.

The total area of operation covers 11,399 acres, and has a population of about 100,000 inhabitants. It is situated east of Manchester, and is bounded by the following towns and urban districts—viz., Ashton-under-Lyne, Guide Bridge, Audenshaw, Denton, Stockport, Woodley, Mottram, Hollingworth, Greenfield, Saddleworth, Lees and Hurst, having a population of over 180,000. Stalybridge is about 7 miles from Manchester, and the tramways will be in direct communication with the Manchester Corporation tramways through Ashton-under-Lyne, to which town the Manchester trams now run. The Board's system is also in immediate touch, though no physical connection is made, with the Oldham, Ashton and Hyde tramways, the Ashton-under-Lyne Corporation tramways, the Stockport Corporation tramways and the Glossop tramways.

The main generating station contains six Lancashire boilers having a total evaporative capacity of 60,000lb. per hour, and built by Messrs. Tinker, Shenton & Co. These supply steam to three 750 H.P. triple expansion engines by Messrs. Yates and Thom, to which are directly coupled three 500kw. Dick, Kerr alternators, generating 6,000 volts, three-phase, at a frequency of 40 ~ per sec. There are also three 75 H.P. Belliss high-speed engines, driving exciters built by Messrs. J. P. Hall & Co. Current is transmitted to four sub-stations, where it is transformed by means of Witting, Eborall motor generators, and then distributed in the form of continuous current to lighting and tramway feeders. Each of the four towns has a complete network of lighting mains. In each of the sub-stations there is a Tudor battery of 270 cells, having a capacity of 3,000 ampere-hours and a maximum discharge rate of 400 amperes.

The tramway track consists almost entirely of single line, with turnouts, the exception being three-quarters of a mile of double track in Stalybridge. The route length of track is 21 miles 390yd., of which 6 miles 667yd. is double line. The gauge is the standard 4ft. 8½in., this being uniform with the gauge of the adjoining tramway systems.

The charge per unit for lighting purposes will be 4d.; the charge for motive power and electric heating, &c., will be at the maximum rate of 2d. per unit, with a sliding scale of rebates down to 1d. per unit. These prices will probably be reduced as soon as a demand has arisen. The tramways department will be charged 1½d. per unit for all electric energy supplied for that purpose. No charge, either as rental or otherwise, for meters, cut-outs or switches on service connections will be made.

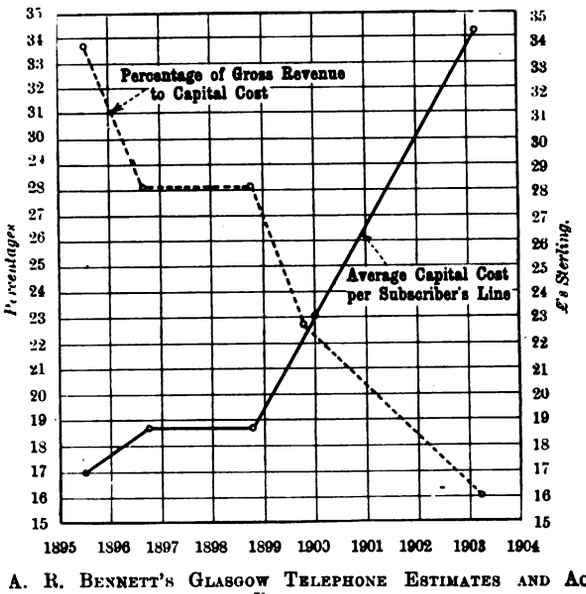
The Board has also adopted a scheme for hiring out motors from ½ H.P. to 20 H.P., and a large demand is anticipated. Here, again, the charges usually made for fixing and periodical inspection are merged in the rental.

Royal Society.—The Bakerian lecture was delivered yesterday afternoon by Prof. E. Rutherford, F.R.S., on "The Succession of Changes in Radio-active Bodies." Several Papers were down for reading in title, including "The Spectrum of the Emanation of Radium," by Sir William Ramsay, K.C.B., F.R.S.

CORPORATION TELEPHONES.

The discussion on Mr. A. R. Bennett's Paper on the above subject was concluded on May 11th at the Glasgow Local Section of the Institution of Electrical Engineers. An abstract of the Paper and of the first day's discussion was published in *The Electrician* of April 22nd.

Mr. H. L. WEBB reopened the discussion with a reference to Mr. Bennett's explanation of the excess of capital expenditure over the estimates at Glasgow, Mr. Bennett having stated that this was on account of the very large number of spare pipes laid. At May 31, 1903, there were, said Mr. Webb, 32 miles of spare duct out of a total of 127 miles. This was 25 per cent. of surplus duct, by no means excessive. The total value of the 32 miles of spare duct was about 6 per cent. of the total capital cost. The effect of this spare duct on the cost of the system seemed to have been over-estimated in the Paper. He then exhibited the curve below, which, he said, showed the various estimates made by Mr. Bennett from time to time for a telephone system for the Glasgow Corporation and the actual results at the present time, as nearly as they could be ascertained from the published accounts and statistics. The diagram also gave a curve for the ratio of gross income to capital expenditure. The estimates started in 1896, when the average capital cost per subscriber was placed at £17, and the rate at £5. 15s., giving a percentage of gross revenue to capital cost of nearly 34. In 1897 the estimate of average capital cost per subscriber became £18. 16s., and the rate £5. 5s., bringing the percentage of gross receipts to capital down to 28. This estimate, Mr. Bennett had maintained, was correct up to some time in 1899. In 1900 the estimate became £23. 1s. per subscriber, and the rate remaining at £5. 5s., the percentage of gross income to capital



MR. A. R. BENNETT'S GLASGOW TELEPHONE ESTIMATES AND ACTUAL RESULTS.

dropped to 23. At the present time the actual average capital cost per subscriber's line was over £34, and the percentage of gross income to capital expenditure was 16. Mr. Webb then referred to a statement in the Paper that the largest number of pairs that could be got into a cable of 2·75in. diameter, with No. 20 gauge conductor, was 217. 400-pair cable, with No. 20 conductor, 2·75in. diameter, had been, he said, standard practice for some years. In these corporation telephone systems, he believed a multiplicity of sizes of cables was used, and the cables were pieced out by two, three, four, five and even eight-way joints, so as to taper down to a very small number of pairs at the distributing points. This was a very wasteful and expensive way of laying out a telephone distribution system. It involved frequent changes at the joints and much spare plant through the whole length of the conductors. The modern method was multiple distribution—large main cables, with distributing cables branched off in multiple at different points. This gave great flexibility, as the same pair of conductors could be picked up at any one of several different points. It enabled the use of large main cables, and it gave the spare capacity where it was wanted—viz., in the distributing plant. He concluded his remarks by mentioning some more of the objections to the call-wire system. The Glasgow Corporation telephones within the short space of three years since the adoption of the call-wire system had six different methods of operating:—(1) Call-wire call and call-wire call-off; (2) call-wire call and push-button call-off; (3) push-button call and push-button call-off; (4) magneto call and push-button call-off; (5) magneto call and magneto call-off; (6) automatic signalling on the party lines. This must lead to many cases of bad services daily.

Mr. GILL, chief engineer to the National Telephone Co., said that he did not regard iron pipes as a protection to lead-covered cables against electrolysis. A cable lying in an iron pipe was in contact with the pipe in places, and became part of a composite conductor consisting of pipe and lead sheath. The current density in the different parts of the

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composite conductor varied at different localities—*e.g.*, at a joint in the pipe the current would flow into the sheath, and after the joint was passed there would be a flow in the opposite direction. In a lecture to the Incorporated Gas Institute, Mr. Swinburne had dealt with the resistance of pipe joints. Thus, if the pipe were damp inside, there would be electrolysis, if the conditions as regards traction or other currents were there. Mr. Gill then exhibited a piece of cable sheath from a cable, which had been laid in an iron pipe, and was damaged, not by electrolysis, but by a fault developing in the traction system, and pointed out that the same laws as to distribution of current and potential applied as in this case. He asked the author to give particulars of the differences of pressure between the pipes and rails and of the currents in the lead sheaths before and after he bonded the pipes to the rails.

The CHAIRMAN (Mr. Chamen) asked whether the pipes were bonded in the case of the specimen which Mr. Gill exhibited.

Mr. GILL said they were not bonded to the rails. He then turned to the question of exchange equipment, dealing first with a remark by the author on the fallibility of relays, with which he did not agree. The relays used for telephone work, and recently adopted for telegraph work, were of quite a special type, and experience showed that they might be safely used. He had had the record for the last 12 months examined in respect of four central battery exchange equipments. Each of these exchanges had been in operation for a number of years. One for five years. In these there was, of course, an increasing number of relays in use throughout the year, and the average number of cut-off relays (the type referred to in the Paper as worked off the test circuit) in use in the four exchanges was 6,700. During the 12 months there was an aggregate of 178 faults on these relays, equivalent to 0·026 faults per relay per year, or to a fault on each relay in 37½ years. If the line relays were added, they had altogether 13,400 relays, with faults equivalent to 0·02 faults per relay per year or one fault on each relay in 50 years. Then he came to the remarks as to series jacks, which he could not think the author had put forward seriously. He could conceive no circumstances likely to arise which would warrant jacks with series connections being fitted in an equipment for, say, over 1,000 lines. For small equipments, series jacks might quite properly be used, but this had been done in central battery equipments for some years. Then as to the "ring-through" system. The author had stated that this had been adopted to a large extent in Sweden, Norway, South Africa and on the Continent. But he (Mr. Gill) had visited Stockholm last year. There, there were two competitive systems—the Almänna (company) and the Riks (Government). The former had magneto calling and clearing, the signals being lamps operated by relays, while the other had magneto calling and clearing, and a method of passing calls to a non-busy operator on the lines of the old express system. He had also visited Copenhagen, where they had magneto calling and clearing, as well as Brussels, where there was the central battery system. St. Petersburg had the central battery system being fitted; Moscow, something like the Riks system in Stockholm, but with a central battery either just done or being fitted; Paris, magneto call and clear; Vienna, the same, but with lamps as signals; Buda-Pesth, central battery; Lisbon, central battery; Berlin and Hamburg, magneto calling and clearing. In Germany the Post Office had decided to instal central battery. There was also a number of smaller towns in which central battery was working or being installed. As regarded South Africa, he understood that Cape Town and Johannesburg had the ring-through system; Durban, with lately a call-wire, was now having central battery fitted. In December and January last he had visited the United States and Canada for the purpose of studying the telephone work there. He had inspected systems in New York, Boston, Montreal, Toronto, Buffalo, Chicago and Brooklyn. At all these he had seen central battery apparatus working except at Montreal and Toronto, and at those towns apparatus of that type was in course of construction. Toronto, indeed, was partly changed over. He learned that altogether in the Bell Companies alone in the United States there were relay equipments at work or under construction for 381 exchanges to the extent of 646,980 subscribers' lines. The ultimate capacity of these equipments was 1,440,760. In the United Kingdom the central battery plant was either in commission or construction for the company with which he was connected to the extent of over 45,000 direct exchange lines equipped, and the Post Office had similar apparatus for 31,000 direct lines. The speaker then contrasted the marked differences between system and system belonging to the corporations, and even between exchange and exchange in Glasgow, with the central battery equipments designed some four or five years ago, and practically modern and efficient to-day. Those corporations which had embarked upon the telephone business did so at a date when much experiment and pioneer work, upon which vast sums had been expended, had been done. It was quite possible for them to enter into possession of knowledge and experience which had cost them nothing, but nevertheless one saw them to-day undergoing the experiences through which the telephone companies had passed years ago. The outcome was quite clear and unmistakable. In a short time—if, indeed, it was not already visible in the proposed abolition of the call-wire in Glasgow—the systems there and in the other cities mentioned must be reorganised upon a proper footing, and the infraction of what were now well-known cardinal principles would reap its due reward in the very serious wastage which those cities would have to face.

Mr. J. E. KINGSBURY said he had had an opportunity at the Institution in London, in 1896, of discussing the call-wire system and flat boards, and he did not think that anybody who read his remarks as reported in the *Journal* would expect him to be surprised at the statement in the Paper that there was some probability of the call wire being abandoned in Glasgow. He would confine his remarks to the ring-through system, which, he contended, was not invented by Mr. Bennett. It had been brought into use with battery call in 1880 by Mr. J. Poole. The speaker then proceeded to mention cases in which the ring-through system with magnetos had been used prior to 1891, the date at which Mr. Bennett claimed to have invented it. He then quoted from a report of 1880 in which the advantages of direct calling were set forth, but urged that the conditions had so changed as to make the claim untenable. In some cases 80 per cent. of the calls went to another exchange, and the call was not to a subscriber but to the servants of the telephone administration. He regarded as a fallacy the idea that if a subscriber was responding to another subscriber's ring he would respond more promptly. Quick or slow response was a matter of habit. The opportunity given for a subscriber to re-call another was a very serious matter to the people supplying the service. A subscriber connected with exchange A who was in communication with a subscriber connected with exchange B, must necessarily use the junction wire between A and B. If the line were used for an average of five minutes double the number of lines would have to be provided, compared with an average use of 2½ minutes. The facility to remain connected and re-call at pleasure had a tendency to tie up two subscribers' lines. If other subscribers wanted either of those two whilst they were thus engaged, the administration was doing work twice over that ought to be done only once. What telephone engineers of the past had to do was to make a choice between two evils, which were illustrated by instructions issued to subscribers on the ordinary magneto system (1883) and the Bennett ring-through system (1903). What had other engineers been doing all these years? Had they allowed a pearl beyond price to slip through their fingers? He thought they had proceeded upon lines which had been the best, although it was useless to overlook the fact that they had had serious difficulties to contend with. These difficulties had now been very largely overcome.

Mr. EASTMAN, of the Glasgow Corporation Telephone department, said that the call-wire system was introduced into Glasgow by the Telephone committee, as it was at that time best known to subscribers, and had a considerable vogue in this country as short a time back as four or five years. In addition to this, the switchboard in connection with the call-wire system was of such a simple and at the same time excellent construction as to lend itself to alteration or to the introduction of other systems. At the time at which a decision was come to by the Telephone committee as to the system to be installed in Glasgow, he considered that there was no proved modern system which could with satisfaction have been introduced. Sunderland had been installed in 1895 or 1896 with a common battery system and was not at all satisfactory. The relays in use by the telephone company at that time were always giving more or less trouble. Being an old National man, he thought he could speak with some authority. The trouble had been due to the relay either failing to respond or failing to make proper contact in the local circuit, which meant that no signal was received by the operator. Even to-day a great deal of trouble was experienced with relays, though they had been considerably improved, and the perfect relay had yet to be introduced. In most of the modern systems one or more relays were necessary in connection with each line. From an engineering point of view, he did not for a moment defend the call wire, but at the same time he certainly considered that Mr. Webb was wrong when he contended that no supervision of the service was possible. In the call-wire distributing board at present used by the department, a supervisor could tap every operator's position, and ascertain what is going on, and a shorthand clerk also did a certain amount of tapping on these positions, taking full details of the conversations taking place between the operators and subscribers. Again, should an operator become too busy it was possible to take a portion (say a third) of her subscribers from her, and transfer them to an operator who was less busy. The chief advantage of the non-ring-through system was its cheapness. It was curious that those who condemned municipal telephony because it was cheap, showed inconsistency in advocating a cheaper arrangement. The same remark applies to the common battery speaking, which was cheaper than the use of local batteries, but not necessarily more efficient. His experience of the common battery system was that when the line is speaking well it spoke very well indeed, but the speech was extremely variable, depending to a large extent on the number of subscribers connected and the condition of those lines. The only advantage in installing lamps was that they took up less space on the switchboard. In actual operation they saved no more time than a well-constructed mechanically-replaced indicator combined with the local jack, and which had the advantage of making a certain amount of noise when falling, and so attracting the operator's attention should her eyes not be immediately fixed on the signalling apparatus. Although in recent years lamps for switchboard purposes had been greatly improved, they still gave a great deal of trouble by burning out at an inopportune moment. An indicator, on the other hand, if well-constructed, very seldom got out of adjustment and took far less current to work it than did the lamp. No perfect system of telephones had yet been introduced, each existing system having its advantages and disadvantages. The advantage of the call wire was quickness in getting the operator, and the subscriber could always know where he was. The disadvantages were that one fault might perhaps affect as many as 20 subscribers, though these could be readily transferred to a breakdown board. The call wire also left means of signalling at the mercy of irresponsible persons, who considered it a joke to hamper operating work as much as possible. In the call-wire system the fact of the subscriber's line breaking down in insulation to the slightest degree meant that his line, for a time at least, would be inoperative. Referring to Mr. Webb's figures for magneto-working in New York, he said that we could lead them on this side of the water, as in a system of some 4,500 subscribers working on the same principle he had personally taken tests in which the average time in calling to receiving an answer from the

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called subscriber was 16 seconds, against Mr. Webb's 27·6 seconds, and the average time for clearing was 11 seconds, a total of 27 seconds, compared with Mr. Webb's 44·7 seconds. He might say that this test was spread over many months. The latest and most up-to-date systems were not always the newest or the best, a reversion to an old idea being sometimes necessary.

Mr. ROBERT ROBERTSON (chairman elect of the Glasgow Local Section), speaking as a telephone subscriber, said that he had three different connections on the National Telephone system, each one operating by a different method. On the one he had to use the push-button for calling-on and the push button for calling-off. In the second case, he had to ring the exchange to call-on and to ring the exchange to call-off, and in the third case the calling-on and the calling-off was done automatically by the lifting off and the replacing of the telephone instrument. From the point of view of the subscriber that was a very serious objection, because it led to mistakes happening unless he was constantly on the alert to remember which of his instruments he was using.

The CHAIRMAN (Mr. Chamen), having spoken briefly, called on Mr. Bennett to make his reply.

Mr. BENNETT, after alluding to the position and status of the various speakers, stated that, when advising local authorities on telephone matters, he had always been at great pains to point out whatever difficulties existed, and on two occasions it had fallen to his lot to point out to municipalities that it would be inadvisable to begin telephone schemes in their towns. Both those municipalities had followed his advice. He then referred to the timed calls in New York mentioned by Mr. Webb, and confirmed Mr. Eastman's opinion that the system in New York, which the central battery system replaced, must have been an atrociously bad one if the average time taken to get a connection was 45 seconds. If the central battery system reduced that to 23·7 seconds it was certainly a great improvement, but it was slower than the average on the Glasgow Corporation exchange, and slower than any corporation exchange. Records of tests taken over the Corporation lines showed that it was most exceptional for a connection in competent hands to take as long as 23 seconds. He had looked over the records from 1902 backwards, and had found it very unusual for 23 seconds to elapse from the time of being called and hearing the voice of the subscriber, so that an average such as they were content with in New York would not be considered good work in Glasgow. He was the first to admit that the call-wire had drawbacks, yet he found that, when properly worked, the call-wire system was beyond all comparison quicker than the central battery system. He and his assistant, Mr. McPhee, had tested the Post Office central battery service in London, and found that the service was at least twice slower than in Glasgow. In Glasgow one could very frequently get a connection and hear the wanted subscriber in from five to seven seconds after putting down the call-wire key; but, of course, to obtain this result, it was necessary to use the system intelligently and obey the instructions faithfully. The speaking on this central battery system was far inferior to the speaking on the Glasgow, Portsmouth or Brighton Corporation systems. Then in the central battery system there was a difficulty about which subscribers complained very much: when a connection was made, the subscriber got a tremendous crack in the telephone. Then there was no secrecy in the central battery system. The operator, by just a small motion of her finger, can put herself into the line. It was true that one could not eliminate the operator altogether if the multiple switchboard was used, because the operator might plug in at a distant part of the board on the multiple, and so get in, but one could avoid and did avoid the home operator plugging in, or cutting herself into the line. At the small switchboards like those in use in Bearsden, Milngavie, Cambuslang and so on, they had a device which made it absolutely impossible for the operator to cut in and hear. In these residential suburbs that was of very great importance. Coming to Mr. Gill's remarks as to relays, Mr. Bennett again expressed the opinion that no relay could be infallible. It was a very delicate piece of apparatus, especially when so many hundreds and thousands of them must be crowded into a small space. Central batteries for signalling were all right, but not for speaking. In Portsmouth, Swansea and Brighton he had taken the central battery for signalling, but had never ventured upon it for the speaking yet, and he must see very much better results from the American battery system before he did do so. The upkeep of a central battery system was greater than with the old Western Electric series multiple. The central battery system had certainly the great advantage of automatic signalling. That was to say, it left little opportunity for mistakes or omissions on the part of the subscribers. Within the last three months the National Telephone Co., had fitted up a new switchboard at Brighton, but, strange to say, it was not the switchboard which Mr. Gill had recommended that evening. The National Telephone Co. had also neglected, when they reconstructed Glasgow, to put the American system in. They had put in what was practically a ring-through system. With the National Telephone system in Glasgow, the subscriber called the exchange by pressing a button, and then was put through and could ring the subscriber he wanted, and without producing any signal at the exchange. When the subscriber was done, he pressed the button and that gave the ring-off, and that ring-off could not be confounded with a ring on. It was really the ring-through system which he (Mr. Bennett) had introduced practically a great many years ago. He had written the Paper very hurriedly, and had forgotten for the moment that Mr. Poole had brought out the system which was put into use at Manchester a good many years before he (Mr. Bennett) did so. The great fault of Mr. Poole's system was that it was too complicated and it was not a practical system. His own system had had this merit, for at the date at which it had been brought out it had enabled the old instruments they had in the subscribers' offices to be used. Mr. Poole's system required different instruments, and to adapt that would entail scrapping all the instruments in use. The Brighton system had the advantage, at least, that it was far less complicated than the American plan. It gave no rude shocks to the subscriber, and it enabled the subscriber to call the exchange by lifting off a 'phone and to clear by putting the 'phone on. On the central battery system the operator just before she connected you gave a short ring to the called subscriber, and then put you through. If the called subscriber did not hear the bell or answer quickly, you were in the position of standing at your instrument and not getting any answer; and, not understanding what the position was you were perfectly hopeless. You had to ring-off and get the operator again, and say, "I cannot get so-and-so. Will you give him another ring?" On the Glasgow system, on the other hand, if he did not answer the first ring of his bell, you could ring on until you get him, and that was a very considerable advantage. Then the Brighton system also notified the operator that the connection was effective. If the called subscriber did not reply the operator knew it, and, if she had time, she could take steps to find out the reason, and endeavour to remedy the fault. Since the reading of the Paper, the balance-sheet at Portsmouth had been placed before the Telephone committee and showed a net profit of £1,250 on the first year's working, after paying interest on sinking fund, besides which a sum of £60 was carried to reserve to meet possible bad debts, so, really, there was a net balance of £1,310. The capital expenditure on March 31 was £29,100, which worked out at considerably less than £20 per instrument, so that the net profit was equal to more than 4 per cent. on the capital invested. Mr. Kingsbury and Mr. Webb had given evidence in Portsmouth at the Local Government Board inquiry. Mr. Kingsbury had said that he did not see how the business could be a financial success, and Mr. Webb had said that he did not think that the rates could possibly be remunerative. The call-wire system, with all its defects, had done something for Glasgow. At the telephone inquiry in 1897 it was given in evidence that the telephone could not be obtained in Glasgow under £10 per annum, and that only within half a mile of the Exchange, while in Govan and other outlying places as much as £25 per annum had to be paid. At the present day the National Telephone Co. were advertising a payment of 1d. per day to enable anyone to be connected with the National Telephone service. That meant 25s. a year. Mr. Webb had referred to spare pipes, and had made a calculation which showed that the value of spare pipes was a very small matter. In saying that a large amount of unremunerative capital had been expended, he (Mr. Bennett) had not meant spare pipes alone; he included the thousands of miles of wire in them, and the spare accommodation at the switch rooms, at the poles and in various other directions. The speaker then referred to Mr. Webb's diagram. The estimate in 1896 had not been made by him and the 1897 estimate was made up for a special purpose. It was an estimate showing what the existing systems in Glasgow ought to have cost the National Telephone Co. There were practically 5,000 subscribers in Glasgow, and to meet the requirements of the Telephone committee he had submitted an estimate for 5,000 lines, but at the inquiry he had said that, if the Council proceeded with the scheme, he would not recommend the system of 5,000, but suggested a very much larger scheme. When the time came they decided to go in for a very much larger scheme and they called for another estimate, which was considerably higher. Then Mr. Webb had said that even the last estimate had been exceeded. That was true, and for this reason. When they began there was a great row in Glasgow about cutting up the streets, and cables were asked for that would last a good many years. Underground lines were required to the suburbs and the estimate had only allowed for overhead wires, so that the extra expenditure was accounted for by a change of plan. Mr. Webb had said that in America 400 pairs had been the standard for a long time. But this increased the electrostatic capacity, which meant a reduction of speaking efficiency considerably, especially over long-distance lines. As a matter of fact, in Glasgow, to meet the special requirements for the future they had a cable of 3in. diameter containing 600 pairs, but that cable was not nearly such an efficient cable for speaking as the one with only 312 pairs.

The CHAIRMAN here called attention to the lateness of the hour, and Mr. Bennett agreed, on the advice of the chairman, to send in the remainder of his remarks for the *Journal*.

The meeting then adjourned.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Mechanical Drawing." By F. E. Powell. No. 21 Model Engineer Series. (London: Percival Marshall & Co.) 6d.

"Patents." No. 20 Model Engineer Series. (London: Percival Marshall & Co.) 6d.

"A Technological and Scientific Dictionary." Part 2. Edited by G. F. Goodchild and C. F. Tweney. (London: George Newnes.) Price 1s.

"Die Radioaktiven Stoffe nach dem Neuesten Stande der Wissenschaftlichen Erkenntnis." By Dr. Karl Hofmann. (Leipzig: Johann Ambrosius Barth.) 2m.

"Handbuch der Physik." 2nd. edition. 6th Vol. 1st. half. Optik I. By Dr. A. Winkelmann. (Leipzig: Johann Ambrosius Barth.) 14m.

"Die Entwickelung der Materie." (Translation of Frederick Soddy's Wilde Lecture.) By G. Siebert. (Leipzig: Johann Ambrosius Barth.) 1904. 1.6m.

"Die Gefahren der Elektrizität im Bergwerksbetriebe." By B. Baum. (Berlin: Julius Springer.) 4m.

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THE CABLE STEAMER "PACIFIC."

The c.s. "Pacific," which left for Shanghai on April 30, is the latest ship of its class, having been built for the Great Northern Telegraph Co. as an addition to its cable-repairing fleet. She is a steel spar-decked twin-screw steamer of 1,570 gross tonnage and 728 tons net register, with engines rated at 1,700 I.H.P. Fig. 1 is a general view of the ship, and Fig. 3 gives an elevation, and plans of the three decks. The main dimensions of the vessel are: Length between perpendiculars at water line, 260ft.; breadth (moulded), 35ft. 6in.; breadth to spar deck, 23ft. 6in.; height 'tween decks, 7ft. 6in. The specified maximum speed fully loaded is 12 knots, and the ordinary working speed 10½ knots. During the trials 13 knots was attained. Messrs. Bürmeister and Wain of Copenhagen were the builders of the ship, and also supplied and fitted the main engines, Messrs. Johnson and Phillips supplying and fitting the cable gear.

Three cable tanks have been provided, the main tank being 31ft. 6in. diameter, and the forward and aft tanks 26ft. and 28ft. respectively. They will hold about 450 miles of deep sea cable—say 1,000 tons. When the vessel left the docks her cable tanks were nearly full, containing cables of various classes supplied by the Telegraph Construction and Maintenance Co., Henley's Telegraph Works, and Hooper's Telegraph and India Rubber Works; that from the latter was re covered rubber-core. This core had been laid thirty years ago in some of the oldest cables of the Great Northern Company,

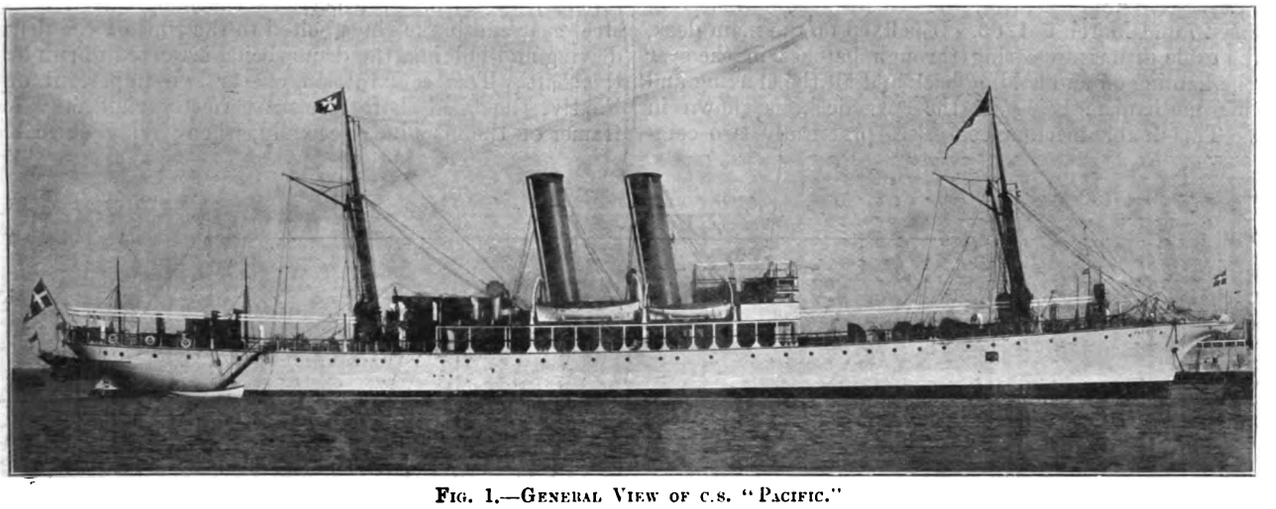

FIG. 1.—GENERAL VIEW OF C.S. "PACIFIC."

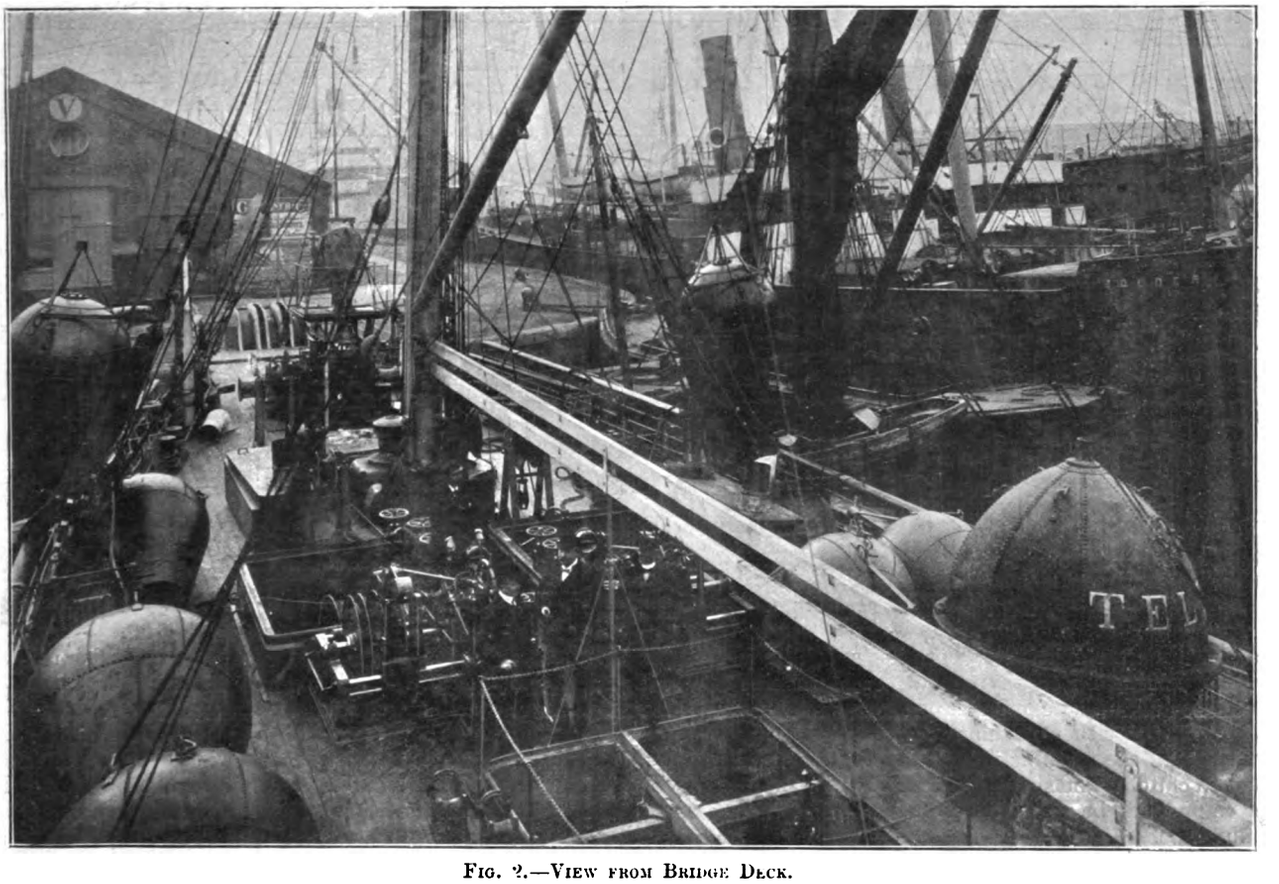

FIG. 2.—VIEW FROM BRIDGE DECK.

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and when picked up it was found that, although the armouring needed renewal, the rubber-core itself was in excellent condition in most cases. The steel cones in the centre of the tanks are employed as fresh-water cisterns. The hatches of the tanks are fitted with girders carrying bell mouths, and all tanks are provided with the usual crinolines, &c.

The double-combined picking-up and paying-out machine, which is placed forward of the forward tank, is very similar to that supplied by Messrs. Johnson and Phillips for the Eastern Extension Australasia and China Telegraph Co.'s c.s. "Restorer" and "Patrol," described in our issues of February 27 and March 6, 1903. It is fixed on the main deck, with the cable drums appearing through hatches in the spar deck, the hauling-off and holding-back and all the starting and operating mechanism being on the spar deck, as shown in Fig. 2. This double machine comprises practically two complete and separate machines, both of which may be used either for picking up or paying out, each machine having a separate engine. These engines are arranged so that both may be geared to either machine when it is desired to make a heavy lift, and the machine is built in such a way, and so provided with clutches and sliding wheels, that in case of emergency either engine may be used with either machine, thus reducing to a minimum the risk of a total breakdown.

As will be seen from Fig. 4, the engines are placed one at the forward end and one at the aft end of the machine, which arrangement the makers find most conducive to a compact machine. They are double-cylinder engines, with cylinders 8in. diameter by 8in. stroke; the slide valves are balanced, and, with an initial pressure of 180lb. per square inch, each engine is capable of developing easily 110 B.H.P. when running at a speed of 300 revs. per min., giving a total of 220 B.H.P. for the machine. With this power the machine is easily capable of lifting a weight of 25 tons at the rate of 1 knot per hour, but it is also geared for speeds of 2½ and 4 knots per hour, at which speeds it will lift 10 and 6¼ tons respectively. The gear when first installed was thoroughly tested under all the loads and speeds above mentioned, and we understand that it proved itself in every way equal to the specification.

The cable drums are 5ft. 8½in. diameter (3 fathoms circumference) by 21in. wide between the flanges, and they have steel gear and brake rings bolted to the rims of the drums for driving and holding, the drums being arranged to run loose on the shaft. This construction effects two important objects: Firstly, the fixed shaft forms a perfectly rigid stay for the frames of the machine; secondly, when paying out cable, the only parts of the cable machine which need be running are the drums and the holding-back gear. The main brakes consist of steel straps, with elm blocks encircling the brake ring, on which they are made to close by means of a double-threaded screw actuated by hand wheel through the medium of a worm gear, giving a very fine regulation for the lighter strains, and at the same time providing enormous holding power when necessary. To the back of each strap is fitted a water service pipe, with nozzles at intervals to direct water between the joints of the brake blocks and right on to the face of the drum, forming an efficient cooling arrangement for the brakes when paying out. Both brakes can be coupled on to one drum when required to give extra holding-back power. We are informed that at the steam trials the brakes held the maximum load of 25 tons, and the actuating mechanism

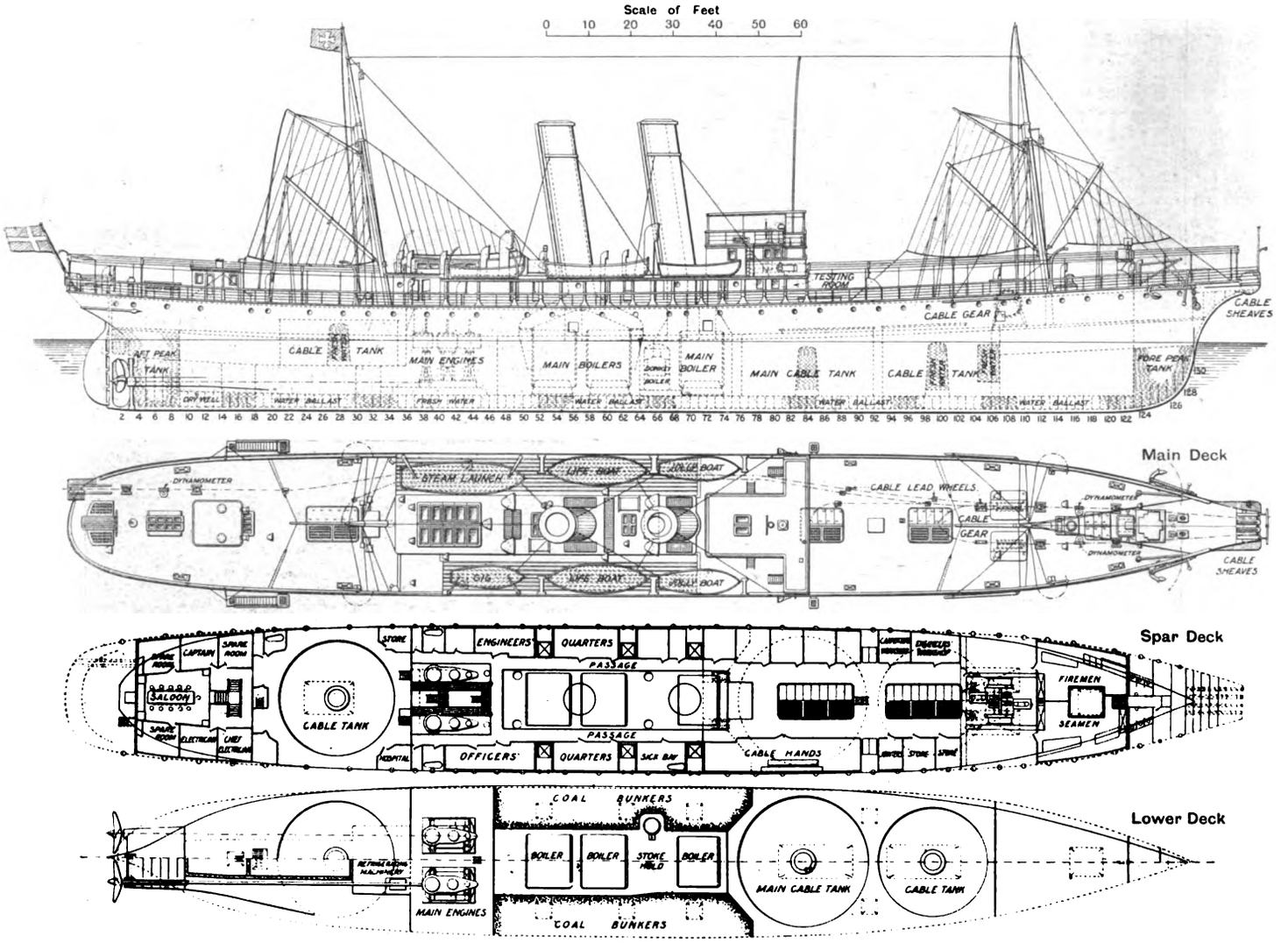

FIG. 3.—GENERAL ARRANGEMENT OF C.S. "PACIFIC."

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enabled this load to be lowered easily and under perfect control, a very essential condition on a machine of this nature.

The hauling-off and holding-back gears stand on the spar deck and are driven from the geared drums by means of chain drives through a friction strap and "free wheel" arrangement, in accordance with Messrs. Johnson and Phillips latest practice, this making the drive practically automatic—viz., hauling when working in the pick-up direction and free-wheeling in the pay-out direction, thus avoiding the necessity of putting

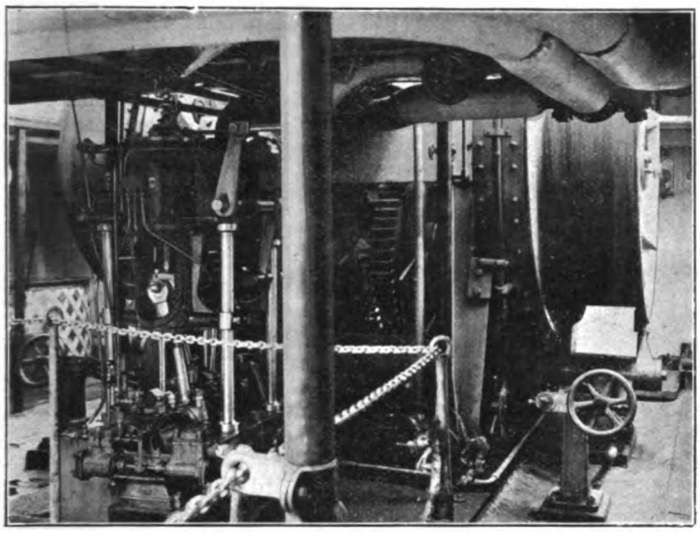

FIG. 4.—VIEW OF CABLE GEAR ON 'TWEEN-DECK.

clutches in and out of gear at every change in the direction of running, as is necessary on the old system. The haul off sheaves may be traversed across the faces of the drums by means of a screw gear to lead the cable to any position on the drum, and this operation may be performed while the machine is working.

As we have before stated, practically the whole of the actuating gear can be operated from the spar deck. The two

FIG. 5.—VIEW OF BOWS, SHOWING CABLE SHEAVES.

main brakes, two steam stop valves, and the two reversing gears are all within reach from one position. The hand wheels for putting the fast, medium and slow speeds into gear, and for coupling up the drums or brakes, the levers for putting the hauling off gear into action, and all necessary regulating gears are conveniently placed.

The lubrication of the parts of the engines is provided for by means of pipes and oil boxes attached to the engines, but all parts of the main machine are lubricated from the upper deck by means of pipes connected to screw-up grease lubricators, by which means grease may be forced into the bearings.

There is no separate paying-out machine aft on this vessel at present, but a space has been provided so that it may be added when required. In the meantime, all paying out would be done from the forward machine, special provision having been made so that a cable may be paid out aft when necessary.

The bow and stern gears were constructed and supplied by Messrs. Johnson and Phillips, and their suggestions as to the building into the ship, combined with the suggestions of the owners and the shipbuilders, has resulted in a graceful bow (Fig. 5). There are three sheaves in the bow gear, each 4ft. 3in. diameter, all of U section, as specially requested by the owners. These sheaves all run loose on a fixed shaft, cast-iron whiskers or guards being provided between each sheave and at the outsides to prevent the cable from getting out of the sheaves. These whisker castings are bolted to steel girders which are built into the ship, and the shell plating is brought up and carried out to meet the curved whisker castings, a very difficult job, but ably carried out by the shipbuilders. The stern gear has only one sheave, which is 3ft. 2½in. diameter. This is provided with whiskers, and built on girders, similar to the bow gear, but it is not connected with the hull plating as in the case of the bow gear.

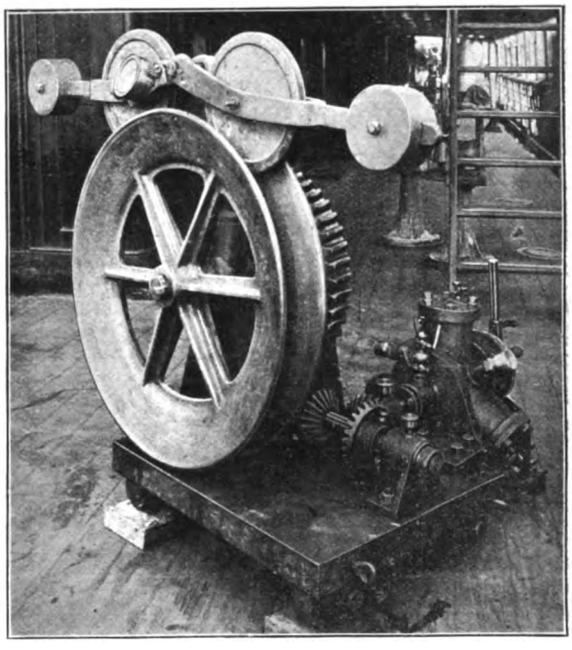

FIG. 6.—STEAM HAULING GEAR.

For registering the strains on the cables as they are paid out, three dynamometers are provided, these being fitted with Messrs. Johnson and Phillips' arrangement of internal spring, which, coming into compression as the moving part of the dynamometer comes down, gradually reduces the effective weight, thus allowing very low as well as very high strains to be registered without need of adding or removing weights. The usual leads, consisting of A frames and V sheaves, are provided at each side of the dynamometers and at the forward part of the gear, while single and double roller leads on pedestals are provided to lead the cable from the tanks to the machine.

For hauling the cable from the picking-up machine to the cable tanks, and for turning over the cable from one tank to another, Messrs. Johnson and Phillips have supplied one each of their portable steam and electric hauling gears (Figs. 6 and 7). The former consists of a V hauling sheave in cast-iron frames and standards, driven through the medium of bevel and worm gear by means of a Brotherhood three-cylinder engine, the steam being conveyed to the engine by means of flexible metallic tubing from stand pipes in the deck. The electric hauling gear as regards the sheaves, standards, bedplate and

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worm gear is the same as the steam gear, but it is provided with a 6 B.H.P. Johnson and Phillips totally enclosed water-tight motor, working at a pressure of 110 volts, and running at a speed of 1,200 revs. per min., the resistance box and controller being separate. The current for this is provided by one of the dynamos in the engine room. The switchboard is placed in the deck house at the after end of the engine room, with connecting leads to a terminal box outside the deck house, another cable branching from this to a terminal board at the forward end of the testing room. A portable length of cable is provided to connect the machine to either terminal board, so that the gear may be used either forward or aft.

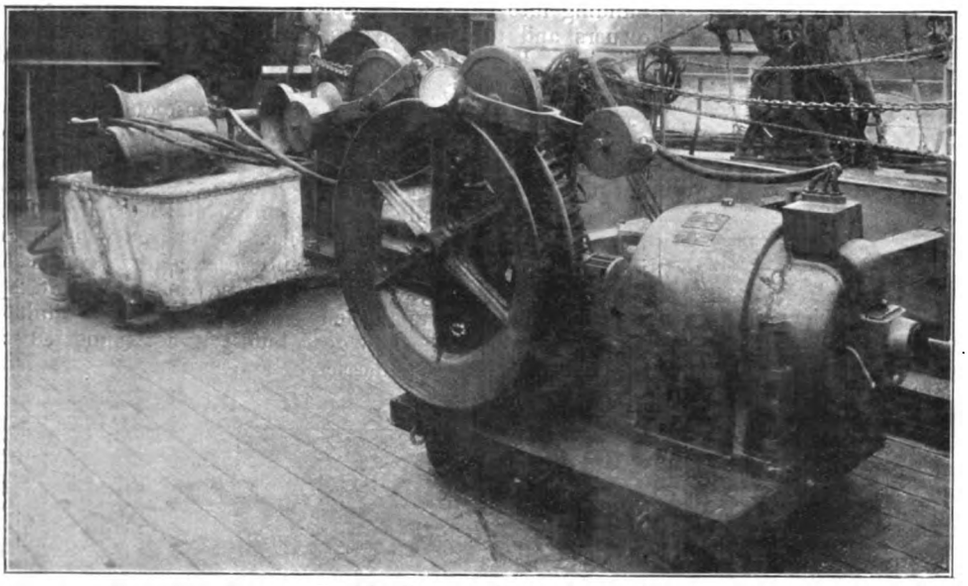

FIG. 7.—ELECTRIC HAULING GEAR.

The plant in the main engine room is conveniently arranged. Each of the two triple-expansion engines has its low-pressure cylinder placed between the other two to avoid vibration. The condensing plant and feed-water arrangements are efficiently designed. A centrifugal circulating pump is used, and the air pump is driven from the piston-rod of the same engine. The air-pump suction is from the top of the condenser (which is of the Weir type) direct through the feed-heater to the boilers. The feed heater is heated by the exhaust steam from the auxiliaries. There are two Weir feed-pumps and two auxiliary pumps for service purposes.

The whole ship is liberally provided with electric light, and there are electric fans in all the cabins, and a search-light. The generating sets which supply these as well as the motors driving the work-shop, are placed in a conveniently accessible position in the engine room, instead of being stowed away in an awkward corner, as so often happens. Two steam dynamos are provided. One of these, for the day-load, can supply 45 amperes at 110 volts, the other 200 amperes at this pressure. The smaller set was made at the "Titan" works in Copenhagen, the larger by Messrs. Siemens and Halske.

The electrical equipment of the ship also includes an excellent loud-speaking telephone installation, and the engine room telegraph, with a head and stern indicator. The latter is controlled by two simple friction collars, one placed on each propeller shaft, and fitted with electrical contacts, so that an electrical signal is given on the bridge in which direction the engines are running.

Steam for all the engines is provided by three single-ended marine type boilers, arranged to use liquid fuel if desired, and one donkey boiler. There is a vacuum ash-hoist. The coal bunkers can store 300 tons, and storage for liquid fuel is also provided.

The testing room (Fig. 8) is placed under the bridge, and is well equipped with all instruments likely to be necessary. With the exception of the two Sullivan galvanometers all these have been made at the Great Northern Company's own factory. To prevent vibration each galvanometer is placed on thick felt mats laid in a shallow box. The latest practice has been followed with regard to the lamps for the galvanometer spot, these being small electric lamps placed in tubes. They are supplied from small portable accumulators.

The general accommodation on board the vessel is shown in Fig. 3. There is a comfortable saloon, and the arrangement of the officers', engineers' and electricians' quarters, as well as those for the crew, leaves nothing to desire. There are steam heating arrangements as well as electric fans in all the cabins, and a refrigerating and cold storage plant ensures that the inner comforts will also be provided for. A commodious engineers' workshop has not been forgotten, this containing a lathe, shaping machine, drilling machine and emery wheel, all driven by an electric motor. Adjoining this is a carpenters' shop. The ship is provided with a steam launch, 32ft. long, two lifeboats, two cutters and a dinghy. Wellins' patent davits, which are employed, simplify the raising and lowering of these, so that they can be manipulated by two men only, if necessary, with the utmost celerity, and the arrangement for disengaging the chocks is especially ingenious.

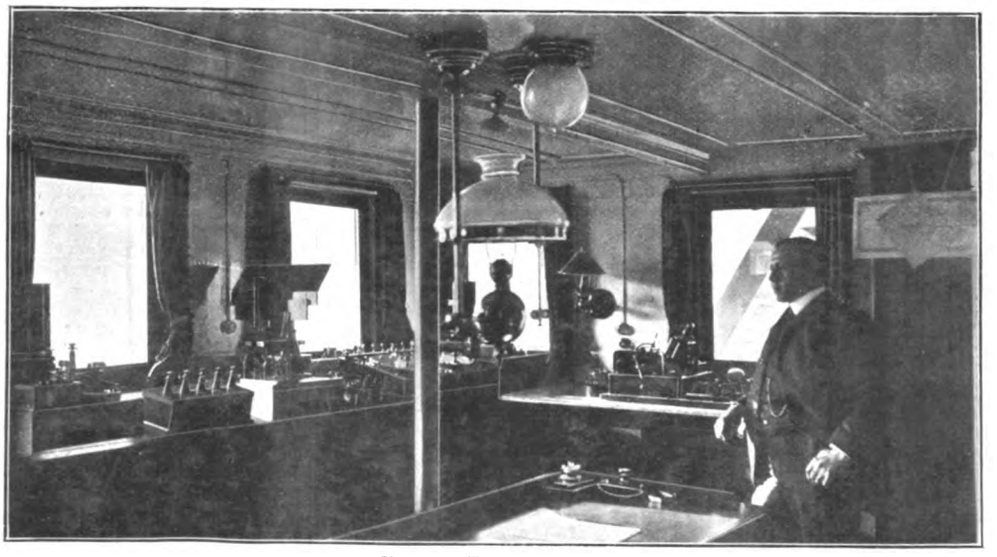

FIG. 8.—TESTING ROOM.

A full equipment of cable stores is carried by the vessel, consisting of buoys, grapnels, centipedes, mushrooms, buoy

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and grapnel rope, chains, &c. The grapnels and centipedes are of various forms for rocky, sandy or muddy bottoms, as the case may be. Among them is the Johnson and Phillips "sliding-prong" centipede (Fig. 9), the prongs being of cast steel just slipped on to a square mild steel shank. The advantage of this centipede is that a broken prong is easily replaced. Another useful grapnel is the Johnson rock grapnel (Fig. 10), the prongs of which have strong spring attachments and are well protected by a steel conical shield. Should a prong come in contact with a rock it will recede under cover of the shield, or rather, the shield, owing to the strain on the prong, comes forward and knocks the prong off the obstruction, enabling the grapnel to clear itself. The construction is such that if the cable is once hooked it will not get off again even though the prong does come in contact with a rock and get knocked back. The usual Lucas sounding machine is provided, and also a compact little Clausen sounder, which is an application

Fig. 9.
Sliding Prong Centipede.

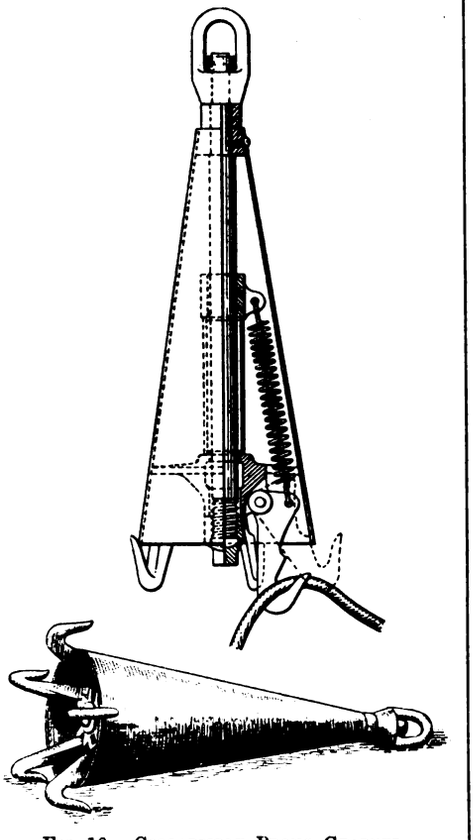

Fig. 10.—Collapsible Prong Grapnel.

of the principle of Lord Kelvin's sounding machine. The water at the bottom is pressed in against the pressure of the air in a U tube. A non-return valve prevents the escape of the water on lifting the sounder, and the depth is then read off by by the height of the water in the tube. There are two U tubes, one reading from 5 to 150 fathoms, the other from 10 to 250 fathoms.

The captain of the vessel is Mr. H. C. A Petersen, the first officer Mr. Carl Tofte, the chief engineer Mr. Herman Petersen, and the chief electrician Mr. Rasmus Black. Our best thanks are due to these gentlemen and also to Mr. Esskildsen of the Great Northern Telegraph Co. for their courtesy in showing us over the vessel, and also to Mr. F. C. C. Nielsen, representative in England of the Great Northern Company, and Messrs. Johnson and Phillips for placing all possible information as well as drawings and photographs at our disposal.

N-Rays.—At the scientific meeting of the Royal Dublin Society on Tuesday, Mr. F. E. Hackett, B.Sc., announced that he had successfully repeated a number of experiments with Blondlot's N-rays, using the differential method with two screens mounted at an angle to each other.

LEICESTER CORPORATION ELECTRIC TRAMWAYS.

On May 18th the newly-constructed Leicester Corporation electric tramways were formally opened for public use by Mr. Councillor Samuel Flint, the chairman of the Tramways committee. The population of Leicester is now over 220,000, and has more than trebled itself during the last 40 years. The rateable value is over £1,000,000, and the area of the borough, which was extended in 1891, is 8,586 acres, being nearly 5 miles from north to south, and about 4 miles from east to west.

In 1872 the Leicester Tramways Co. (Ltd.) was formed, and with the consent of the Corporation under an agreement of 1873 obtained powers by provisional orders under the Tramways Act, 1870, to construct horse tramways; the first line was opened for traffic on December 24, 1874. In 1877 an Act of Parliament was obtained by the company which provided that the period after the expiration of which the Corporation might purchase the tramways should be 21 years from the time of the passing of the Tramways Orders Confirmation Act, 1873, and under the Tramways Act of 1870 the Corporation could, within six months after the expiration of this 21 years, and within six months after the expiration of every subsequent seven years, by notice in writing, require the promoters to sell them their undertaking.

The Council, in 1897, obtained the Leicester Corporation Act, which empowered them, when they acquired or constructed any tramways, to work the same, and take tolls and provide the requisite buildings, plant, &c. In 1899 a Tramways committee was appointed by the Council, and this committee appointed a sub-committee, which, with Mr. E. George Mawbey, as chief engineer, and Mr. James Bell, the town clerk, made exhaustive investigations as to the construction and working of different systems of tramways. As the result of these investigations, a report embodying the scheme of electric traction now being carried out was prepared and issued in November, 1900. An important recommendation was the construction of the central electric traction power station close to the Leicestershire Canal, on a site adjoining one of the Corporation refuse destructors, a portion of which site already belonged to the Corporation, the remainder being subsequently purchased from the Leicestershire Navigation Co. The canal afforded an ample supply of water for condensing purposes, and coal could be delivered direct by canal from the Derbyshire and Nottinghamshire coalfields. Leicestershire coal could be shot into barges from the railway trucks and delivered to the site by canal cheaper than it could be carted across the town.

In 1901, the Tramways committee having recommended this scheme in its entirety, Mr. E. Manville, of the firm of Messrs. Kincaid, Waller, Manville and Dawson, was appointed to report on the scheme, chiefly with regard to the system to be adopted and as to an independent central power station or a combined power station. Mr. Manville recommended the whole scheme as previously submitted to the Council, and it was afterwards adopted. At the same time the Council agreed to the purchase of the tramway company's undertaking for £134,000, and Mr. Manville's services were retained as consulting engineer during the progress of the works.

The Parliamentary estimate was £537,000 for track, power station buildings, machinery and equipment, main and district car depots and equipments, feeders, ducts, tramcars, land, &c., and £113,000 for street improvements, bridge widening and side paving, making a total of £650,000.

Permanent Way.—The scheme sanctioned by Parliament comprises 19 miles 3 furlongs of double track and 3 miles 5 furlongs of single track, being over 42 miles of equivalent single track. The construction of the permanent way and the laying of the feeder conduits was commenced by the Corporation staff in April, 1903, and about 33 miles of track was completed in April last. There are no excessive gradients, the steepest being 1 in 16 for a distance of about 50yds. It has been necessary to lower the roadway under seven of the railway bridges, in one case as much as 2ft., in order to obtain sufficient headroom for double-deck cars. This work was carried out at considerable expense, necessitating the lowering of gas and water mains, the diversion of sewers, and in one instance the underpinning of the abutments of the bridge. The sharpest curve on the system is 37ft. radius to the centre of the track. A minimum radius of 40ft. for all curves was aimed at, and, with one or two exceptions, has been attained. The distance from centre to centre of tracks of the permanent way, with side-pole construction, is 8ft. 1in., giving 3ft. 4½in. from gauge edge to gauge edge between tracks, and for centre-pole construction 10ft. 11½in., giving 6ft. 3in. between tracks. Standard 4ft. 8½in. gauge has been adopted. The rails, which are in 45ft. lengths, weigh 100lb. per yard for the straight running track, the grooves being 1⅛in. wide. Those for the curved track of a radius of 1 chain or under weigh 105lb. per yard, the grooves being 1¼in. wide. Both classes of rails are 7in. deep and 7in. across the flange. Fish-plates weigh 54lb. per pair, and are 2ft. in length, each pair being drilled for six 1in. diameter fish-bolts, fitted with Ibbotson's patent lock nuts. Cooper's patent

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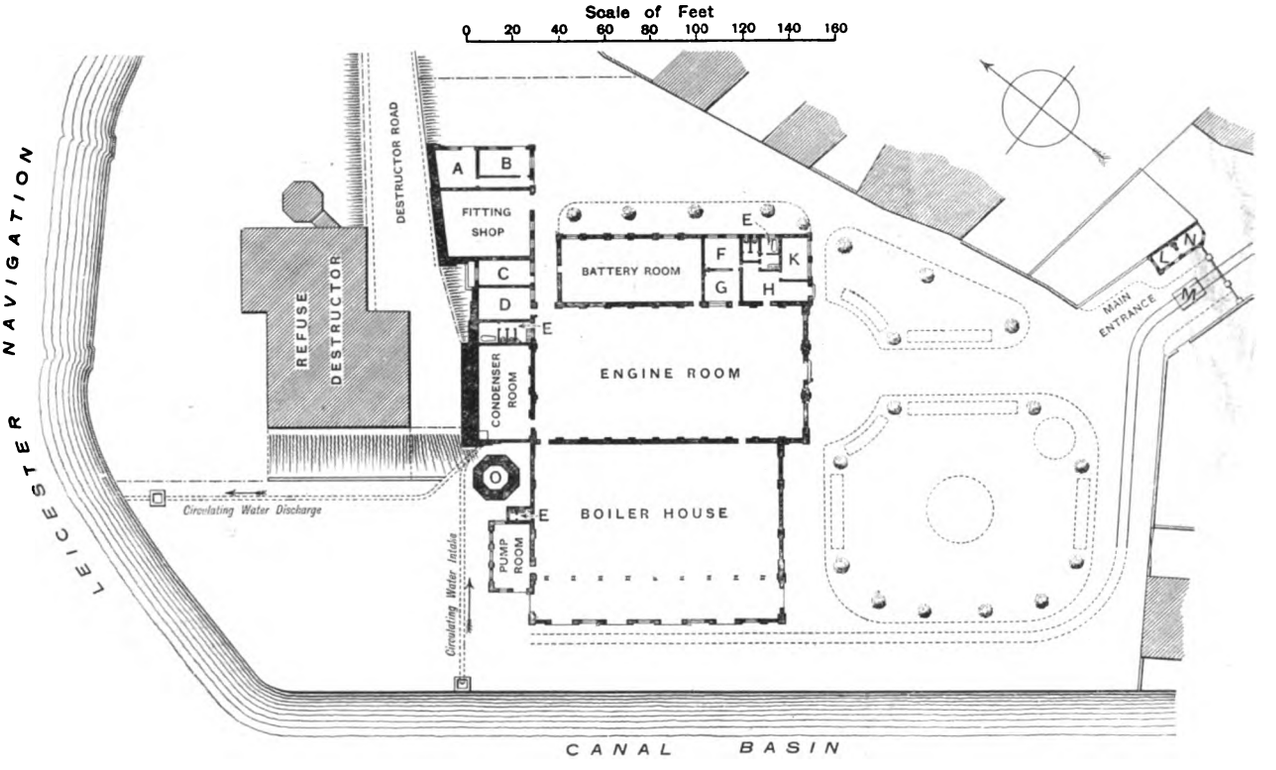
anchor, 2ft. long, has been used on all joints throughout the work, each joint being secured to the rails with 12 ¾in. diameter steel rivets (except on special track work where bolts are used), the riveting being done by the patentees. No intermediate joints have been used excepting round curves. Tie-bars of 2in. by ⅝in. flat steel section have been placed 7ft. 6in. apart, with Messrs. Bayliss, Jones and Bayliss' patent ends, each bar being secured by four nuts, one on each side of the web of each rail. The composition of the steel for the rails is as follows:—Carbon, between 0·40 and 0·55 per cent.; manganese, under 1 per cent.; phosphorous, not exceeding 0·07 per cent.; sulphur, not exceeding 0·07 per cent.; silicon, not exceeding 0·07 per cent. The composition of the steel for the fish-plates is similar, except that the percentage of carbon is between 0·25 and 0·35.

In laying the permanent way, the ground was excavated to the required depth, and the rails laid and packed up on wedge-shaped blocks of concrete, 10in. square at the base and 8in. square at the top. Where bad ground was met with, or the surface worked up owing to inclement weather, these blocks were again supported on circular blocks of concrete, 6in thick and 18in. in diameter, to distribute the weight over a greater area. When the rails were truly levelled up, a concrete foundation, composed of six parts of granite gravel and destructor clinker to one part of best Portland cement, was then laid, a space of about 1in. being left under the rails for the centre of the town by the tramway staff at the same time as the track laying at a total cost of about £27,000 when completed. The lowest tenders received were for foreign rails and fish-plates, but the committee determined to accept the lowest of the English tenders—viz., that of the North-Eastern Steel Co., of Middlesbrough. This selection has been amply justified, the rails having been supplied fully up to the specification, and giving every satisfaction. The bolts, nuts, tie-bars and copper bonds have been supplied by Messrs. R. W. Blackwell & Co. All special track work has been the product of Messrs. Hadfield's Steel Foundry Co., and there are a large number of interesting examples of this special work. The standard points adopted are 12ft. long, with tongues 7ft. 6in., and embodying Hadfield's latest improvements. All the points and crossings are made thoughout of Hadfield's patent "Era" manganese steel, each casting having a manganese steel renewable centre. For equilateral loops, points 12ft. long, having a radius of 200ft., have been adopted, with a crossing 8ft. 6in. long, and an angle of 1 in 6. All the loops have a lead of 36ft. 10in. to ensure easy running. For side loops the points are 12ft. 6in. long, with a radius of 150ft, the crossing being a 1 in 6, with a lead of 38ft. 6in.

Cross-overs are left-handed, and a standard 100ft. radius point 12ft. long is used with a 1 in 5 crossing 7ft. 6in. long. The cross-overs



BLOCK PLAN OF GENERATING STATION.

A. Electrical Stores. B. Engine Stores. C. Mess Room. D. Test Room. E. Lavatory, &c. F. General Office. G. Engineer's Office. H. Hall. K. Enquiry Office. L. Weigh Office. M. Weighbridge. N. Time Office. O. Chimney Shaft.

packing, great care being taken to make the concrete perfectly solid for a space of 6in. on each side of the flange of the rails. The space between the concrete and the rails was then very carefully packed by means of beater picks with 6 to 1 fine concrete in a semi-dry condition. The total depth of concrete under the rails is 7in., and under the paving 6in Short lengths of interlacing track have been used on certain routes, this being done in one case in order that the cars might pass under the centre of an arched railway bridge, and thus obtain the maximum headroom. In addition to a liberal supply of drain boxes, all the movable points have a 4in. diameter spigot cast on to the drainage box, which is trapped and connected to the sewer. The drains from these boxes pass through a disconnecting chamber in which a silt pit is formed before being connected to the sewer. During the laying of the track the borough engineer frequently had the anchor rivets cut off, the bonds and fish-plates removed and the rails lifted, in order to see if the rails were solidly packed up, and so carefully was this process watched that in no single instance were the rails found to have been imperfectly bedded.

Generally, the track has been paved with 5in. by 3in. granite setts from the local quarries, except in the centre of the town, where 9in. by 4in. by 3in. jarrah and karri hard wood blocks were used. The granite setts were laid on a bed of gravel and grouted up with pitch. The wood blocks were laid on 1in. of cement screeding. A considerable quantity of side paving was laid down in

are 60ft. and 75ft. long, and the movable point is placed in all cases on the left-hand side; the car thus has all the points as trailing, making a continual tread run for the wheel. Lay-outs, including the cross-overs and loops, have been constructed on the floors at Hadfield's works, and all curves, as far as practicable, are spiralised. No trouble has been experienced in fitting the work on the road; this was particularly the case with the Clock Tower junction, which is said to be the largest tramway junction in the United Kingdom. The total weight of this lay-out was over 100 tons, but it was so carefully designed that it was laid by the Corporation staff in 10 days. It comprises 10 running tracks, and forms the heart of the whole system. Where the traffic will be heaviest, connected movable points have been adopted. At the car shed fan, standard 60ft. radius points have been used, all being 9ft. long (an exceptional car shed length), and the crossings are of the same design as upon other lay-outs. Cooper's patent anchor joints have been used upon all the special track work. The fact that all the points and crossings are of the leg type, has facilitated the use of the standard fish-plate and the laying of the work on site. The bonds used are of the solid copper Crown type of 4/0 B. & S. gauge. Two bonds are inserted at each rail joint. The track is cross-bonded every 40yds., and the way every 80yds. Where special track work occurs the castings are connected to adjacent rail ends by 30in. bonds, and are also bridged by long bonds joining rail to rail.

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Overhead Electrical Equipment.—The design of the centre, span and side bracket-pole ornamentation is original, and was prepared by Mr. Mawbey in conjunction with the Leicester Art School. Span-wire construction has been adopted generally, but where streets and roads are wide enough centre poles have been introduced. In the centre of the town, where suitable attachments could be obtained, poles have given way to rosettes, except at junctions, these being erected on poles throughout. Nine side-bracket arms, each 17ft. 6in. long, have been used on one short length and also on the siding to the power station. The poles are of two grades, A and B, the former being used on the straight and the latter on the curves at junctions and for anchorage. Their weights are 840lb. and 1,180lb. respectively. The total length is 31ft., made up of three sections shrunk together. The poles are planted 6ft. in the ground, the foot resting on a concrete template 6in. thick, which in turn is bedded on 6in. of cement concrete, the space around the pole being filled in with cement concrete of suitable thickness to suit the nature of the ground. The pole bases are 6ft. 6in. high, the greatest diameters being 16in. and 18in. respectively for the two sizes. The trolley wire is 3/0 B. & S. gauge throughout, except at the car depots, which are wired with 1/0; the span and guard wire are of galvanised steel 7/12 and 7/16 respectively. Flexible bowstring suspensions and double insulation have been adopted throughout. One important feature and advantage is that the trolley wire is, with a few exceptions, suspended over the centre of the track, a deviation of 3ft. only being allowed. "Ætna" insulation, and line fittings of extra strong design, have been used throughout, the insulator bolts being of drop forged mild steel screwed ¾in. Ears 18in. in length have been used on the straight and 24in. on the curves. Special double and single pull-offs are employed on all junctions and curve work, the distance between the bolt and the eye being 5in. Galvanised iron thimbles have been used wherever eyes have been spliced in either span, pull-off, anchor or guard wires. The connecting cable between the section and feeder pillars and the line is 61/20, insulated with pure and vulcanised rubber, lead-covered and double braided, and is carried from the pillar to special drawing-in boxes at the foot of each of the section poles, and thence up the inside of the pole, the pole being bushed with gun-metal bushes top and bottom. From the top bushes of the pole the cables are carried to the trolley wires along the span or bracket as the case may be, and served with P and B tape, a copper ferrule being sweated to the end of each cable and clamped into the section insulator.

In the car depots the trolley wire is carried in a neat pitch pine troughing running the entire length of the shed, and suspended from the roof trusses by wrought-iron clips. The main car depot is supplied by a separate feeder direct from the power station arranged so that when the rest of the system is shut down the depot may be run off the battery. When the lines pass under railway bridges the trolleys are carried in troughing suspended from the underside of the bridges in such a manner that it is impossible for a passenger even by leaning over the car rail to touch the "live" wire. Telephone and other wires crossing the routes have been removed wherever practicable, so that very little guard wire has been erected. Special arrangements were made whereby the National Telephone Co. have placed the whole, and the Post Office the bulk, of their wires underground. Four sizes of section and feeder pillars are used. These are fitted with white marble panels carrying quick-break switches, kicking coils, Garton lightning arresters and safety fuses. Each pillar is also fitted with an ebonite panel carrying the test and telephone terminals, and all holes in the panels are bushed with ebonite. A specially-designed telephone shutter operated by a separate key is attached to each pillar, and is so arranged that it is unnecessary to open the pillar in order to use the telephone, the jack being inserted from the outside; this prevents accidental contact with live fittings when using the telephone. One telephone instrument is carried on each car. Two negative feeder pillars are erected to meet present requirements, approximately 1,100yds. and 2,700yds. respectively from the power station. All section and feeder pillars, and the poles up which the feeder cables have been carried, are bonded directly to the rails by a 4/0 copper bond, to prevent the possibility of their becoming "alive" owing to break-down of insulation. The whole of the equipment, including poles, wires, section and feeder pillars, &c., has been supplied and erected by Messrs. R. W. Blackwell & Co.

Feeder Cables, &c.—All cables have been supplied and drawn in by Messrs. W. T. Glover & Co., and the stoneware conduits for the feeders and pilots are of the patent self-centering type with composition joints, supplied by Messrs. T. Wragg & Sons, the total quantity being equivalent to about 80,000yds. of single way. The contractors for the cables state that none of the cables have been damaged whilst being drawn through the conduits. Chambers are built of brindled bricks in cement, and made as water-tight and gas-tight as practicable. The work of laying the conduits and the construction of the drawing-in chambers was carried out by the Corporation workmen. About 80yds. separates the drawing-in chambers, which are fitted with ventilating covers, and designed with a view to future extensions. Bell-mouths are built into the wall where the conduits enter and leave the chambers; conduits are laid at the side of the track. The cables are single conductors, insulated with diatrine impregnated paper and lead-covered. At intervals of approximately ¼ mile the lead covering of the cables is earthed to the rails by bare copper bonds.

Three negative feeders have been carried to different points of the system, and are connected to the rails through special feeder boxes. Brass labels are tied to the cables in the boxes, and indicate size, voltage and termination. The sizes of the feeders range from 0·1 sq. in. to 0·5 sq. in., the total length being over 20 miles. A complete system of telephone and pilot cables is also drawn into separate ducts along each feeder route. All lead-covered cables terminate in the basement of the power station, connection being made to the switchboard with fire-resisting cable of Messrs. Glover's latest type. In addition to the feeder cables terminating on the switchboard with fire-resisting cable, the entire back connections and cable work in the station is also of this description. All feeders and pilots were submitted to a pressure test of 1,000 volts alternating current for one hour, which proved in every way satisfactory. They were then tested for insulation resistance, and in each case gave infinity.

Main Car Depot.—The main car depot stands on a site of about 4¼ acres, and is in close proximity to the generating station. It does not abut on the main road, a space 100ft. deep having been reserved for building purposes. The buildings consist of the car shed proper, fitting shop, carpenters' shop, painters' shop, armature room, blacksmiths' shop, brass and general stores, mess room, recreation room, caretaker's house, offices, committee room, boiler house, stables, cart shed, motor house, men's lavatory, oil stores, &c. The exterior is faced with red sand Stock bricks and Derbyshire stone dressings. The car shed proper consists of three bays, each 35ft. 1½in. span, and containing three tracks, accommodating altogether 55 cars. The rails are supported throughout on piers, thus forming pits 4ft. 6in. deep under the whole area, excepting for a short space at each end. Entrances to the car shed and shops are fitted with Kinnear rolling blinds. The fitting shop averages 130ft. long, 41ft. 6in. wide and 25ft. high to the eaves. It contains two tracks and will accommodate eight cars, the rails being supported on piers as in the car shed. Space has been reserved on one side of this shop for a complete equipment of electrically-driven machine tools, including a 12in. and 6in. lathe, wheel turning lathe, radial drill, &c. Provision has also been made for an electrically-driven overhead crane. In the carpenters' and painters' shops there will be a complete equipment of wood-working machines with the necessary benches. These two shops are divided by two Kinnear rolling blinds, and together will accommodate 10 cars. Two small district car sheds have been erected on the same lines as the main car depot, each containing two tracks, with pits underneath, for accommodating six cars; an office and small mess room is attached to each.

Cars.—The 59 cars are of the double-deck single-truck type with reversed stairways, and have been supplied by Messrs. Dick, Kerr & Co. The seating capacity of each car is 22 inside and 34 outside, and the overall dimensions are 27ft. 6in. over fenders by 6ft. 10in. width over sills. Floor frames are built of well-seasoned oak and the platforms are supported on four steel angles which are bolted to the underside of the main flooring. A system of truss rods is provided to keep the car bodies from hogging, and also to pull up the platforms should they show a tendency to sag. The cars are mounted on Brill trucks, which carry two Dick-Kerr motors, each rated at 25 H.P. The controllers are of Messrs. Dick, Kerr & Co.'s "Magnetic Shield" blow-out type, and the car wiring has been carried out on the "Short" system. Wheels have wrought-iron centres with steel tyres shrunk on, and were supplied by Messrs. John Baker & Co. They are 31¾in. diameter. Hudson and Bowring life-guards of the swinging-gate type have been fitted under both platforms, and under test were found to be very efficient. As the gradients in Leicester are comparatively slight, only the usual hand and electrostatic brakes have been fitted. On several of the cars, the new patent "Leicester" folding step has been fitted for practical trial, to meet the suggestions of the Board of Trade, who point out that the efficiency of the life-guard is often impaired by the steps, which are liable to strike a person falling in front of the car before the life-guard can come into action. This step is designed to fold up when the gate is closed, and it is practically impossible for it to be raised when the gate is open. Owing to the automatic device with which it is provided it is equally impossible to keep the gate closed without having the step raised. This arrangement overcomes any difficulty which might arise from passengers attempting to leave the car at the forward end before there has been time to get the step into place. Special means have been adopted to ventilate the interior of the cars, a constant circulation of fresh air being obtained by means of hinged sashes at the ends and sides of the car. The top deck is fitted with special "dry" seats of the multi-slat type. One riser in each reversed stairway is perforated with circular holes by which the motorman's view is comparatively free, in spite of the reversed stairways. A cover is also provided so

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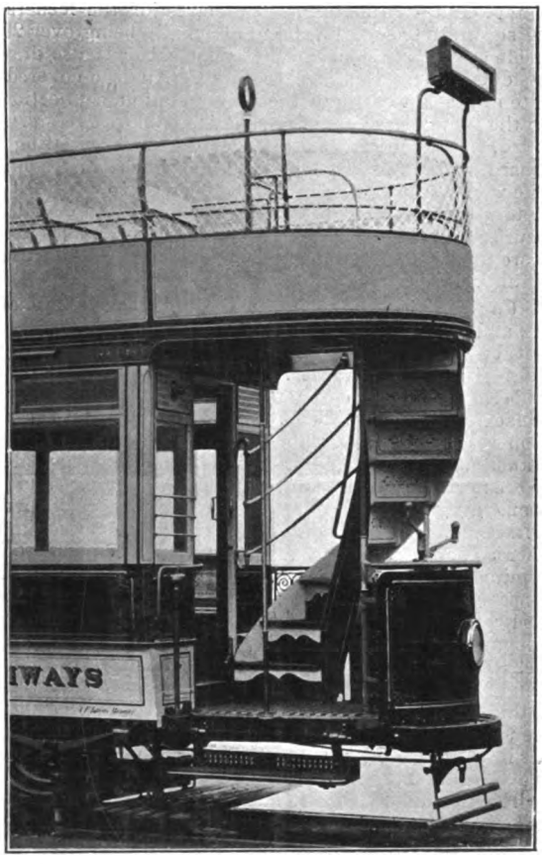
that the perforations may be left open or closed at will. Mechanical bells are used, and are operated by means of a brass rod running the entire length of the car, and fitted with lever handles; they can be operated from either end of the top deck. Route indicators on the illuminated blind principle have been supplied by the English Electric Co.



End of Car, showing "Leicester" Folding Step and Reversed Stairway.

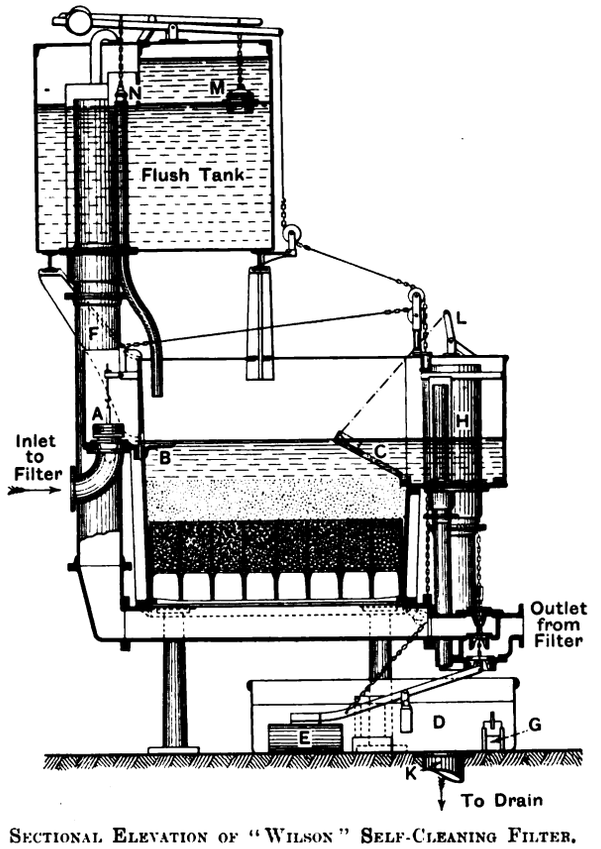
Power Station.

Buildings.—The buildings are faced externally with red sand Stock bricks and Derbyshire stone dressings. The boiler house is 108ft. long and 77ft. wide, providing accommodation for eight boilers, four of which have already been installed. A stoking floor 18ft. wide extends the full length with an ash tunnel underneath Provision has been made, in designing the stanchions, for the future installation of coal bunkers and conveyors over the stoking floor; at present the stoking floor is covered with a temporary corrugated iron roof. Coal will then be delivered by barge alongside the boiler house, lifted by a crane fixed at the north-western end into a conveyor, and conveyed into the coal bunkers. The conveyor will be continued round and through the ash tunnel for the removal of ashes. The engine room is 118ft. long, 60ft. wide, and 40ft. high to the eaves. It is lighted mainly from the top by means of Rendle's patent glazing; the only side lights are bull's eye windows above the traveller rail. This room is well ventilated by means of centre hung casements in the lantern light. Accommodation is provided for the three 500kw. sets now installed, with sufficient extra space for a 1,000kw. set. The engine room is lined internally up to the height of the traveller rail with glazed tiles having patent keyed backs, moulded tiles being carried up to a height of 6ft. to form a dado and round all the arches, with moulded faïence blocks under the traveller rail. The entrance hall and floor of the engine room, except the space reserved for the extra set, have been laid in mosaic by Messrs. Diespeker.

The condenser room is 42ft. by 23ft., and the floor is 11ft. below the level of the engine-room floor. It is lighted entirely from the roof, and is provided with a 5-ton overhead travelling crane. All trusses for the roofs, except those for the battery room and offices, are constructed of flat steel bars and plates throughout, except the rafters, which are of T section. The chimney stack is octagonal in shape, faced with Whitwick pressed bricks. The foundations were carried down to a depth of 17ft. into the solid red marl, and the stack is 186ft. high, the external diameters being 20ft. at ground level and 11ft. at the top. The internal flue is 8ft. 6in. in diameter throughout; it has an independent firebrick lining 9in. thick for a height of 70ft., the remainder being 4½in. thick. For a height of 110ft. to the top the cavity is omitted. The cast-iron cove is constructed in eight sections, each section weighing about 1 ton. The contractors for the main building were Messrs. Richardson & Son.

Boilers.—For generating steam there are four boilers of the Lancashire type by Messrs. Yates and Thom; each boiler is 33ft. long by 8ft. 6in. diameter, with two flues each 3ft. 5ft. diameter, and is constructed for a safe working pressure of 160lb. per square inch, the shell plates being $\frac{13}{16}$in. thick, flue plates $\frac{19}{32}$in. thick and end plates $\frac{3}{4}$in. thick. Each shell is in five rings of one plate each, and the boilers were tested satisfactorily to 260lb. per square inch. Hopkinson fittings and mountings are employed, together with Bennis stokers. Messrs. Yates and Thom have supplied the steam ring main, which consists of wrought-steel tubes with flanges welded on. There is a very complete arrangement of separators so as to thoroughly drain the system in every direction. Feed pipes are also of wrought steel with flanges screwed on, the ends of the pipes being riveted over in the recesses formed in the face of the flange, the arrangement admitting of the feed being maintained to any or all the boilers either direct or through the economiser; Kennedy meters are employed in the usual way. The feed is taken from the hot well, and in order to get rid of the emulsified oil a special plant has been installed.

Separation of the oil from the condensed steam is effected by the Davis-Perrett patent electrical process, of which we hope to give full details in an early issue. In this process the water passes through a series of tanks connected up in parallel, and is subjected to the action of an electrical current, the result of which is to destroy the emulsion and form a flocculent precipitate, which can then be easily removed by subsequent filtration, leaving the water absolutely pure. The electrical portion of this plant has been supplied by Messrs. Davis-Perrett & Co., and the filters used are the Wilson patent automatic self-cleansing filters made and supplied by Messrs. Masson, Scott & Co., who have erected the entire plant. The water



Sectional Elevation of "Wilson" Self-Cleaning Filter.

enters the filter at the point AB through holes in the side plates by the bend-pipe indicated. It passes through the sand medium and stones, and leaves the filter by the outlet valve. The outlet valve is shown closed, but during the filtering operations this valve is, of course, open to allow the water to leave the filter. As the surface of the filter becomes coated with impurities the level of the water gradually rises, since it enters the filter more rapidly than it passes through the sand, owing to the obstructions. When it reaches the top it overflows a syphon-pipe, H, shown on the drawing, and through this syphon it descends rapidly into the float chamber D underneath. In this float chamber is a float fixed on to a lever. The water raises the float, and by so doing it closes the outlet valve by which the unfiltered water escapes from the filter, and at the same time allows the water from the flush cistern above to flow

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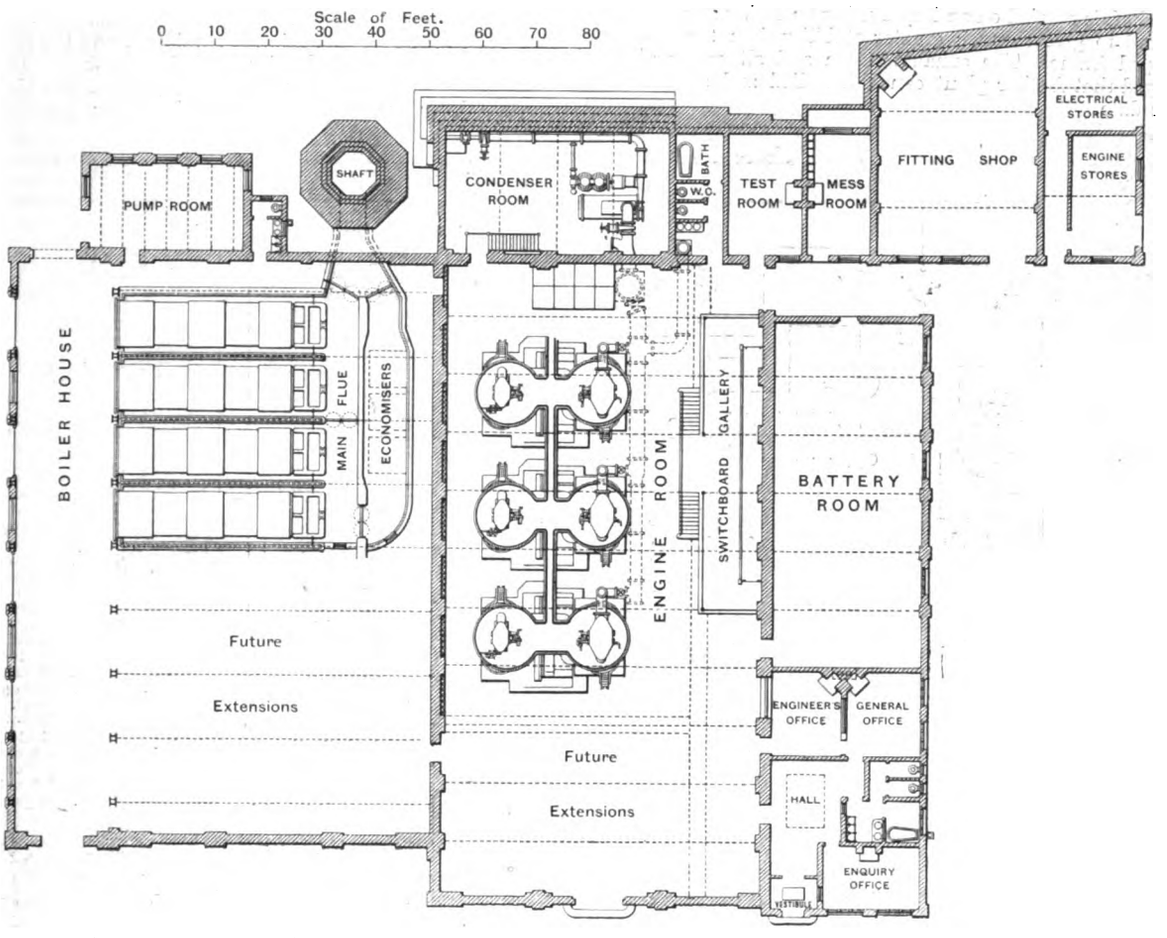
down very rapidly into the underside of the filter. The water, descending with considerable force, presses upon the air in the underside of the cells, forcing it up through the sand, which is thus broken up and thoroughly washed by the water as it rises up through the medium. The sand would escape from the filter except for a board, C, extending right across the filter, which, being fitted as a float, rises as the water rises in the filter, and prevents the sand from passing out. When the flush water is exhausted, the operation of washing is complete. The water escapes from the float-chamber D, and the float E falls again to the bottom of the chamber. The outlet valve is again open, and the ordinary operation of filtering is proceeded with. The whole operation only takes about three minutes, and while this is going on the collecting tanks are sufficiently large to receive the water passing from the electrical tanks, so that the continual passage of the water is not interfered with. When the filter resumes filtering operations after the wash it empties the collecting tanks of the amount of water accumulated during the wash.

The feed pumps were manufactured by Messrs. Hall & Sons, and are of their vertical direct-acting type.

there is nothing to prevent the engines taking excessive overloads, even beyond the full range of the cut-off gear. Each cylinder rests on two massive cast-iron standards with bored guides for the main piston rod cross-head; these standards are covered in with cast-iron plates in such a way as to enclose the moving parts.

The flywheel is 16ft. diameter, and weighs about 25 tons, and is keyed on to the Siemens-Martin steel crankshaft alongside the generator, to which it is also coupled by means of turned bolts fitting in a flange cast on the boss of the flywheel and passing through holes bored in the generator arms. The vertical standards are coupled across by two cast-iron entablature beams, which, besides serving to tie the high-pressure and low-pressure cylinders together, also carry the upper platform. The pistons are of cast-iron fitted with Ramsbottom rings, and have bands of white metal to increase their wearing properties, while the piston rods are made of Siemens-Martin steel secured to the pistons by means of a large nut and cottered into the cross-heads in the usual way. Wrought-iron is employed for the connecting rods, the top ends forming a jaw having a pin shrunk in to suit the cross-head, and the bottom end being of the marine type with a palm end forged on the rod, and a mild steel



PLAN OF GENERATING STATION.

Engines.—The engines are of Messrs. Yates and Thom's vertical cross-compound Corliss condensing type, having cylinders placed at opposite ends of the crankshafts with the crankshafts at right angles. The cylinders are 22in. and 44in. diameter respectively, with a 3ft. stroke, and the engines are intended to run at 95 revs. per min. Each engine is capable of dealing with a normal load of 500kw., with a steam pressure on the stop valve of 160lb. per square inch, and an overload of 25 per cent. for two hours, or 50 per cent. overload temporarily. The cylinders are of the built-up type with separate ends and barrel; the valves are of the Corliss double-ported type, and are placed in the cylinder ends. By this arrangement one half of the cylinder end forms a steam box. The high-pressure barrel is steam jacketed with boiler-pressure steam. Messrs. Yates and Thom's trip-gear is employed in conjunction with the valves, the closing being accomplished by powerful spring dash-pots. Exhaust valves have a plain vibrating motion, derived, like the motion for the steam inlet valves, from eccentrics fixed on the crankshaft. Very sensitive governors are fitted to the engines, and there are also special safety stop arrangements which stop the engines if they exceed 10 per cent. above the ordinary working speed, or in the event of any failure of the governing gear, while at the same time cap. Steps of cast steel lined with Babbitt's metal are secured between the palm end and the cap by means of strong bolts. A very complete system of lubrication has been supplied to these engines, consisting of two ram pumps worked by a drag shaft from the main cranks, and delivering oil under pressure to all the main bearings about the engines. The eccentrics are enclosed in planished steel covers, with oil throwers attached to the shaft, which prevent any tendency for oil to creep along the shaft. This arrangement ensures a very clean engine, and the maximum amount of efficiency, the oil being used over and over again.

Condensing Plant.—A surface condenser, capable of dealing with 25,000lb. of exhaust steam per hour, along with the exhaust steam pipes and accessories have been made for Messrs. Dick, Kerr & Co., by the Mirrlees Watson Company. Exhaust steam from the engines is led into a common exhaust main running along one side of the engine house and then to the condenser house; a branch from this pipe leads to a vertical atmospheric pipe, which is fixed to the outside wall of the building, and terminates in an improved form of exhaust head and silencer. By means of an automatic atmospheric relief valve, the exhaust is discharged into the atmosphere should the vacuum fail. Before reaching the condenser the exhaust steam

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passes through the oil separator. The surface condensing plant consists of a set of twin electrically-driven air pumps of the Edwards patent type and a centrifugal circulating pump. These are both driven by a double-wound series parallel motor, manufactured by Messrs. Dick, Kerr & Co. The condenser, which has 2,500 sq. ft. of cooling surface, is designed on the counter-current system, the exhaust steam and cooling water each passing twice through the full length of the condenser and in opposite directions. Suitable baffle and diverging plates are arranged so as to distribute the steam over the entire surface of the tubes. The covers can be removed for cleaning purposes without disturbing any pipe joints. The air pumps have barrels 18in. diameter by 10in. stroke, and run at a speed of 100 revs. per min. The centrifugal pump is capable of delivering 1,500 gallons per minute, and is regulated by means of a series parallel controller. The centrifugal pump is directly connected by a flanged coupling, and the air-pumps are driven by single-reduction gearing having machine-cut teeth. A small plunger pump is carried on the air-pump bed-plate and driven from a crank disc mounted on the end of the crankshaft. There is another small pump driven by chain gearing, which draws the oil and water from the oil separator and discharges it into the waste oil tank. The air-pump crankshaft is carried on an improved form of frame, which has been designed to give a much greater stability than the usual form of A-shaped frame. The exhaust steam and all water piping is so arranged that further plant can be installed and connected up at a future date.

metallic shield blow-out device; and the ammeters and voltmeters are of the "Sector" illuminated dial type.

Battery.—The battery is composed of 240 cells of the standard Tudor pattern, capable of giving 600 amperes for one hour or 900 amperes for short periods, and can be charged normally at 270 amperes or at 450 amperes for short periods. The cells are in lead-lined boxes resting on glass oil insulators; the stands are entirely of pitch pine without any metal fastenings, and they rest on large porcelain oil insulators to ensure perfect insulation of the whole battery from earth.

Automatic Reversible Booster.—This set consists of a shunt-wound motor, fed from the 'bus bars, and a differentially-excited booster, directly coupled on one bed-plate. The booster is connected in circuit with the battery, and is used for raising the 'bus bar pressure to the amount required for charging the battery or for raising the pressure of the battery when discharging. It is rated to give a current of 250 amperes at 130 volts on the charge, and 600 amperes at 70 volts on discharge. The machine is capable of dealing with an overload of 25 per cent. at any pressure between 20 and 70 volts, and delivers the above-mentioned currents at any pressure between zero and the maximum pressure indicated. A shunt-wound motor, working at 500 volts and running at a speed of 650 to 700 revs. per min., is employed, and the set is provided with the necessary auxiliaries, switchgear, &c. One of the main features of this system is the use of the Thury automatic pressure regulator for automatically maintaining a constant load on the

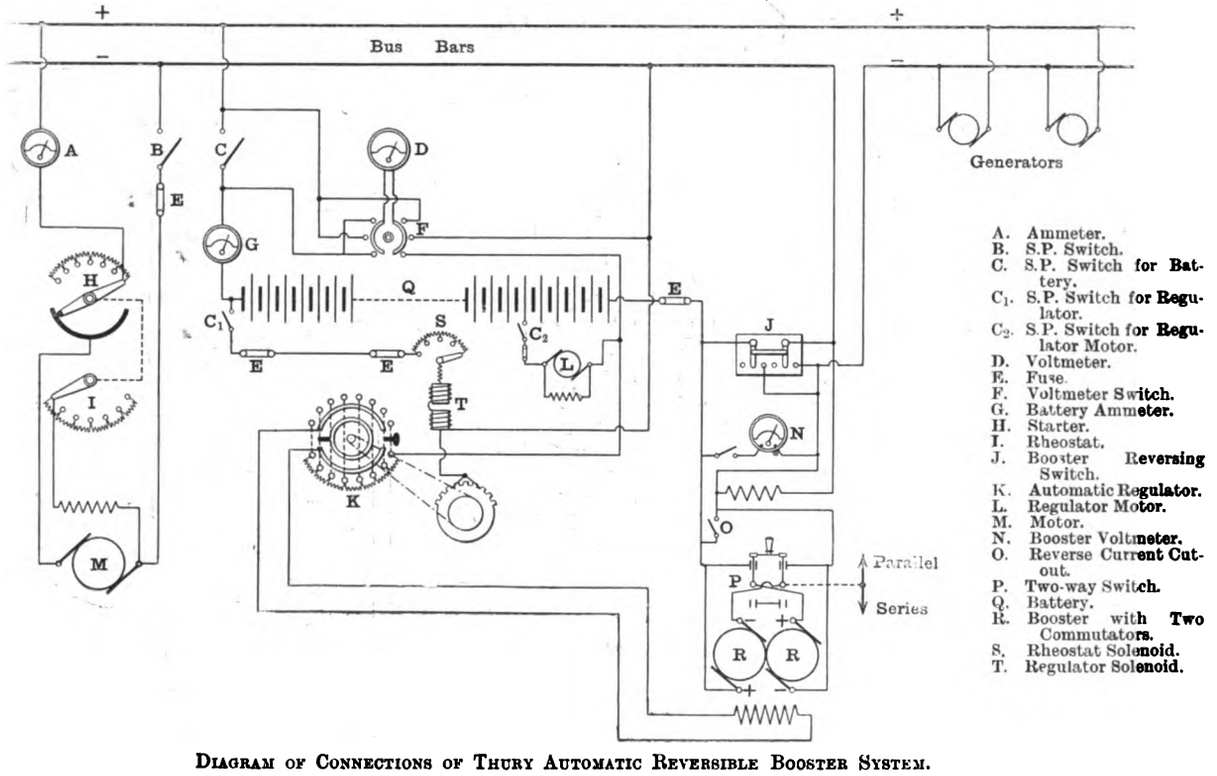

Diagram of Connections of Thury Automatic Reversible Booster System.

Generators.—There are three continuous-current compound-wound generators directly coupled to the Yates and Thom vertical engines, the output of each generator being 500kw. at 500 to 550 volts when running at 95 revs. per min. They are in every respect in accordance with the standard practice of Messrs. Dick, Kerr & Co. the magnet frames being of cast iron, the pole-pieces being built of laminated steel and cast into the magnet frame. The armature is built up on a special form of spider, the section of the rim being broken in order to avoid shrinkage strains; it is provided with a long bearing surface, and is bored accurately to the engine builders' gauge. The commutator is built up on its own spider, carried on the extension of the armature casting. The brush-holders are designed so that the current does not pass through any moving joints; these give adequate adjustment, and are mounted on a massive rocker ring attached to the generator frame. They can be rocked simultaneously by means of a hand-wheel and screw geared to the brush rocker ring.

Switchboard.—The switchboard supplied by Messrs. Dick, Kerr, & Co. is an extensive one, consisting of 25 panels of white marble, controlling, besides the three 500kw. generators, a negative feeder booster set of 20kw. capacity, a positive feeder booster set of 60kw. capacity, an automatic reversible battery booster set of 40kw. capacity, as well as station lighting and motors and the distribution. The motor starters are of Messrs. Dick, Kerr & Co.'s special slow-speed type, with automatic over-load and no-load release and generators running in parallel with the battery. The booster armatures are drum-wound with a slightly-channelled core, and the coils are held in by driving horns. A double-wound armature is employed, and each winding is connected to a commutator, one at each end of the machine. The two armature coils can be connected in series or parallel as required. We are informed that in the design of the reversible booster special attention has been paid to meeting rapid changes of load and voltage without sparking. With these armatures the winding on the smooth core is placed as near as possible to the periphery, and with the tangentially-arranged field coil the iron in the field magnets is reduced to a minimum. The combined efficiency of the reversible booster set is 81 per cent. After a six hours' run at full load, the temperature rise does not exceed 70°F.

We are indebted to Mr. George Mawbey, borough engineer to the Corporation of Leicester, for his courtesy in furnishing us with the above particulars and in lending us drawings from which to make the illustrations. Mr. W. Plant has acted as chief assistant for all the permanent way work, buildings, bridge work, &c. Mr. T. Robert Smith, who had been for some time previously in Mr. Mawbey's office, has been chief electrical and mechanical assistant, and he has now received the permanent appointment of resident electrical and mechanical engineer for running the system, Mr. Mawbey being the chief engineer for all constructional electric traction work to be carried out in future.

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POWER STATION DESIGN.

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers in connection with the Paper on "Power Station Design," by Messrs. C. H. Merz and Wm. McLellan. The Paper itself was published in *The Electrician* of April 29th, p. 49, of May 6th, p. 88, and of May 13th, p. 135.

Thursday, April 28th.

Mr. J. H. BARKER said that, having been in Newcastle for some years, he had followed the development of the Wallsend power station with some interest, as well as the Carville station. He must say, however, that with Mr. Merz's love of alternating current, he was surprised that he had not maintained it in his distribution system. Mr. Merz credited manufacturers with getting £10 per kilowatt for their engines and dynamos, but, alas! they were happy days which would never return. £6 was a lucky figure nowadays even for such small sizes as 500kw. and 600kw. A most important point in the Paper was the cost per kilowatt installed or maximum demand. He agreed with the authors in their partial condemnation of labour-saving apparatus. The supply of firemen was always adequate, and their capacity was certainly up to a ton or 1¼ tons per hour, and by this means much more steam would be got out of a boiler than by the best automatic stoker ever made. In Fig. 2 of the Paper was an item, "Calculated steam per kilowatt-hour." He was rather at a loss to understand what the "calculated" steam was. He had plotted these figures, and hardly thought the turbine had had full justice done to it. The turbine was nominally 1,500kw. It had since been raised to a capacity of 2,000, and a sister turbine from the same casting had been put in at Neptune Bank to do 2,500kw. Therefore, that turbine was not having fair play, as it was only running at about two-fifths of its full power. The leakage loss on that turbine was equal to the leakage loss on the 2,500kw. machine. He had continued the curve to 2,000kw., and had come down to close upon 15lb. of steam per kilowatt hour. Perhaps, also, the authors could give some figures as to the power necessary to move the volume of circulating water from the river to the Carville supply station. This must be very great. He would also like to hear some results of tests upon the Curtis turbine.

Mr. J. H. ROSENTHAL said that Mr. Merz's design had found a good many imitations. Probably the most important plant of the kind being erected at present was that at the new station for supplying electrical energy to the Metropolitain Railway of Paris, which would have a capacity of 20,000kw. The arrangement there was practically identical with Carville, the only difference being that the economisers were arranged on a floor above instead of in a line with the boiler house. He regarded the steam pipe design at Carville as a very practical and satisfactory one, and he thought it would not be long before the importance was recognised of designing steam pipe plants so that there were very few parts in it and these all alike, so that, as the station was supposed to run for ever without stopping, it would be a comparatively easy matter, without affecting the output, to take down a portion, replace it, and afterwards to test the portion taken out.

Major-Gen. C. E. WEBBER reminded Mr. Merz that three or four years ago, when the stations at Newcastle were in course of erection, he had stated before a Parliamentary Committee that the cost would be about £20 per kilowatt output. It would be interesting if Mr. Merz could, without revealing unduly the financial position of the undertakings in which he was interested, give some idea as to what the cost per kilowatt of the largest of the stations was, say now, and what it would be when it was at its full capacity.

Mr. G. L. ADDENBROOKE said that with power work great attention must be paid to capital cost, and the turbine was coming in as a great help to those engaged in this class of work. Mr. Merz had not dealt with of condensation and condensing water. It was astonishing what a very serious matter it became when the question of providing condensing water for a large power station. For instance, a station of 10,000kw. capacity required 1,000,000 gallons per hour, and even if the station happened to be near a river, the arrangements that had to be made, especially if the river were a tidal one, often necessitated very great care and attention. Dealing with Mr. Merz's curve (Fig. 1), he thought a little more accuracy would have been obtained if the coal line had been a sloping curve, for with coal more expensive than had been taken in the Paper the curve would be a little higher at the low power-factors. Then, again, in applying this curve to actual cost, so far as he could see, Mr. Merz had not included administration. Of course, administration in all these matters was a delicate point, but it would be well that members who took their costs from this curve should remember that, as far as he could see, the item for administration was not included, and in power schemes, where people could not work for nothing and where there had to be directors' fees and so on, this amounted to an appreciable sum. He would also like to know whether the table of costs was intended to cover units generated or units sold. This was a very important matter when the calculation of costs was taken in hand, and in a great many cases the difference was not always given. He had something to do with a power station in the South of England where coal was so much more expensive than in the North, and where, therefore, the value of gas engines would have been greater, and he had therefore to go very carefully into the relative costs. The only saving made by using gas engines was in the coal bill. As regards capital cost, as things stood at present this would be rather greater than for a steam station. Labour, administration and all other things were practically the same, and therefore it came down to the point of the saving on coal. Supposing that the saving on coal was really as much as the gas engine builders said it was, the result on a power scheme such as Mr. Merz had put before them would be something like this: It would make about 6 per cent. difference in the price at which consumers could be supplied, or, if the price to the consumer was kept at the same figure, it would add about 1 per cent. on the dividend to be paid to the ordinary shareholders. This was not very good, and when we came to places where coal could be got for 6s. a ton and less, it was pretty clear that there was not a very great opening for gas engines at present.

Mr. A. LUPTON asked the author of the Paper if he would kindly fill up the balance-sheet on p. 52 with regard to the gas engine and the turbine. Of course, the cost of fuel, which was shown on the diagram as 0·15d., was not a very large item. If it could be reduced to nothing, of course it would be of very great importance. The author, no doubt, was well aware of the claim made by certain gas-engine builders—viz., that they could reduce the fuel charge to nothing. The sale of by-products equalled the cost of the fuel. No doubt the author had investigated that claim, and he hoped they would have the benefit of that investigation. The author had dismissed the gas engine, however, entirely as being unworthy of standing in competition with the steam engine because it will not do the required work. If this were so, of course it settled the matter; but he was aware of great firms in the North of England whose names appeared to be very eminent, who were prepared to guarantee that the gas engine would do any work that any steam engine had ever done or could do. The speaker who had just finished had stated that the use of gas engines would increase the dividend 1 per cent. Whether an undertaking paid 4 or 5 per cent. made all the difference between success and failure.

Thursday, May 5th.

Mr. B. M. JENKIN was sceptical as to the possibility of moving the generating station as the system grew, as the long high-tension feeders would make the expense almost prohibitive. It was interesting to note that the results arrived at by the authors were very similar to the result arrived at quite independently and with different generating plant. He quite agreed with the authors as to the desirability of dividing up the station into units, but he should hardly like to go as far as they did, and give each generator its own group of boilers, so that if it became necessary to change from one generator to another it was necessary to change from one boiler to another also. Mr. Merz even suggested that all the auxiliary motors driven from any generator should be coupled to that generator alone and not to the switchboard. This would mean that the whole of the stoker motors would be stopped if the generator were shut down. It would be better to keep the boiler house complete in itself and independent of the generators. It seemed to him quite right to arrange the boilers at right angles to the engine room, as it was then possible to keep the boilers close to the generators and so make a simple arrangement. This was an arrangement which Dr. Kennedy had adopted some time ago in designing the Edinburgh station. Diagram A showed the Donald-road station, Edinburgh, which was designed in 1898. The centre part of the building consisted of two engine rooms, one of which was at present full. The same arrangement was repeated on the other side. The same plan was adopted with the boiler house. Consequently the two switchboards were end on and the control of the generating plant was all centralised, the boilers being on each side. The arrangement of the chimney was different to that described in the Paper. In considering a station in a town, exhaust steam had to be dealt with if it were running non-condensing, and that rendered it desirable to put the chimney near the engine room. When the station was running condensing or was exhausting direct into the atmosphere it did not matter. Repeating the boiler house and possibly the engine room had great advantages. It prevented the spread of fire and made the control of the station easy. Diagram B showed the station designed by Dr. Kennedy and Mr. Dobson for the Central Electric Supply Co., where there were Climax boilers. It showed how they could be arranged in groups. The site was a long narrow one. The bunkers were at the bottom beside the sidings, and the steam pipes went straight to the engine room. The leads went straight from the engine room to the switchboard, so that it was not possible to cross any leads with the steam pipes, and the arrangement described by Mr. Merz was obtained. The alternators were close to each other and all the leads went up the centre aisle. The switchboard was also a long narrow one running parallel to the boiler house just as Mr. Merz had described. The design was very similar, therefore, in all respects, although reciprocating engines were used and not turbines. In diagram C was shown a station with a condensing plant and with a very similar design to diagram B. The engines, however, were placed back to back, and the condensing plant between the engines with the circulating water pipe going up the cooling tower. The alternator leads were run up the outside of the building to the switchboard, which was parallel to the boiler house. That station could be repeated again and again, and it could also be duplicated in both directions. The provision of spare plant was a most important matter, and he did not think the Paper had fully emphasised the importance of it. It was necessary not only to have a spare to take the place of any generator that might fail, but to have a spare set which could be overhauled and entirely taken to pieces at the same time that the station was running at its full load. This meant two spare sets. Mr. Merz dealt with this by giving the plant a very large overload capacity, but where the units were rather large and there were not sufficient of them, it might be a dangerous practice to have only one set. Mr. Merz deserved thanks for having shown clearly how a switchboard should be designed, and that it really should have space. It was pleasing to see that he had had the courage to give his switchboard sufficient room. Many of them had been misled by the practice in connection with low-tension switchboards where a narrow gallery was sufficient, to try and put high-tension boards on similar galleries. But there must be sufficient room to separate the leads and get them properly

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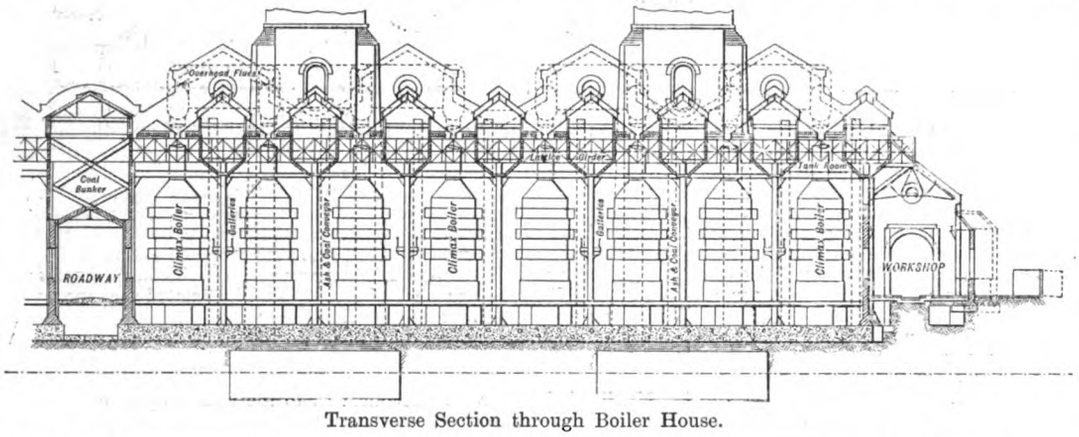
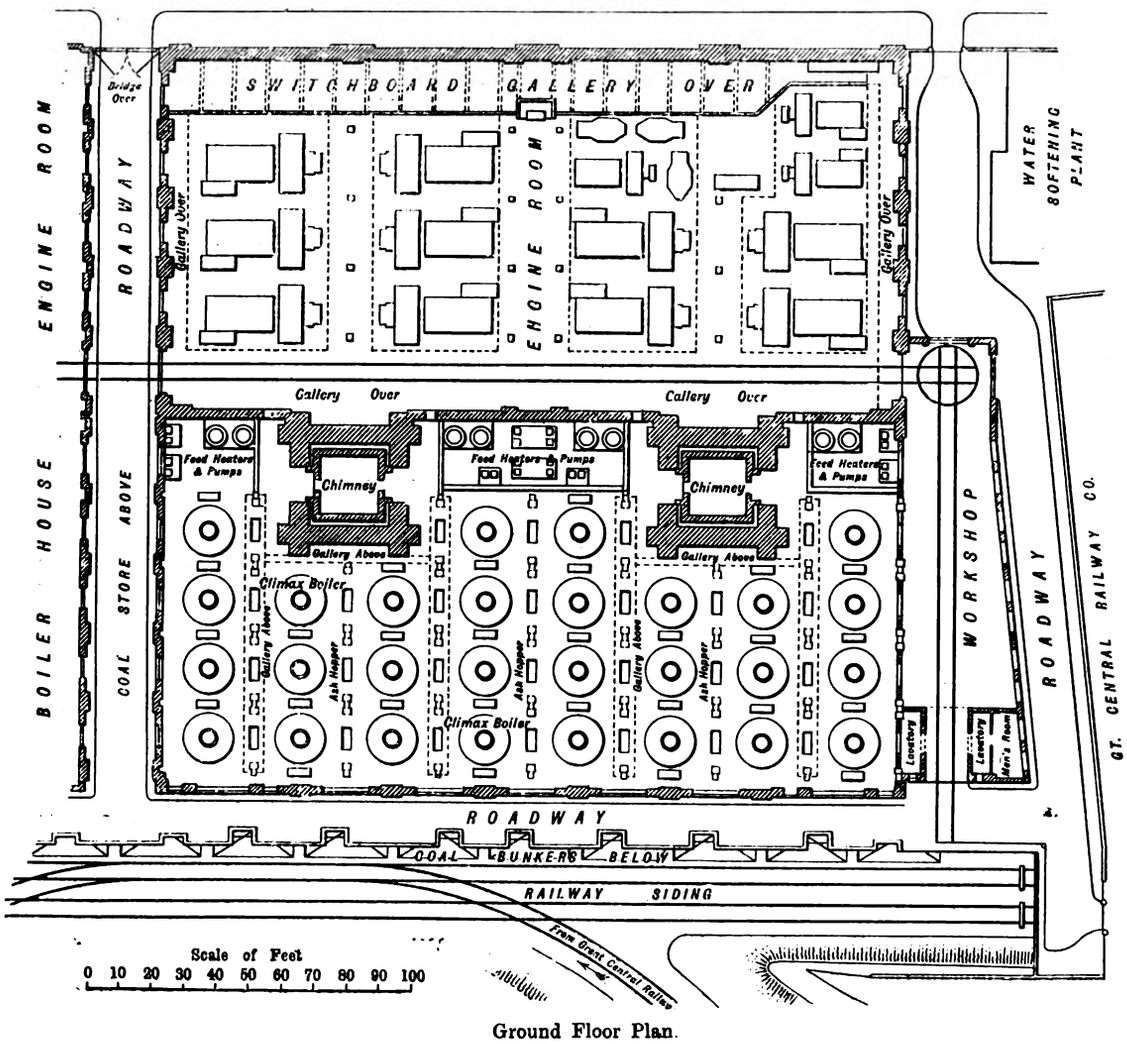
arranged and so on. The only point in which he did not agree was the arrangement of selector or 'bus bar-change over switches. There were two sets of 'bus bars, and at the back of the board there was a switch by which any feeder or any generator could be coupled to one or other of the 'bus bars. But from the controlling board on the gallery there was no means of telling how these change-over switches were set; whether any generator was connected to the top or bottom bars. By the arrangement shown it would be necessary to go round to the back of the board and actually look at the switches. This could be got over by an arrangement of signalling, but however it was done it was important that the switchboard attendant should be able to tell exactly what his switches were doing. The electrical controlling of the main switches seemed to have been very carefully worked out and made a capital arrangement. Mr. Merz had shown him over the station and he had been very much impressed with the way in which it had been done, but he did feel that if a mechanical control of these switches could be obtained by levers it would be a simplification. The switches would then be kept entirely separate, whereas with electrical control they were rather at the mercy of the electrical supply. For instance, if they were controlled from a battery some one might go in and throw a spanner on the battery or do something which might for the time being result in the control of the main switchboard being lost. As to automatics for high-tension work, he sympathised with the Paper entirely. It was impossible to get an automatic that really had sense, and this was what was wanted. But he was glad to say that he had seen tests of a low-tension reverse-current automatic which seemed to fulfil all the requirements wished. It would open with a small reverse current so long as the current was kept up. As the voltage was dropped it would still open the circuit and even with no voltage for the shunt coil the switch would still open under a reverse current equal to the full-load current of the machine. Again, it would not open even with no voltage in the shunt coil and the full load of 2,000 amperes in the working direction. This piece of apparatus seemed to have been designed to meet exactly what was wanted. If there were a similar cut-out for high-tension work it would solve the difficulty.



Transverse Section through Boiler House.



Ground Floor Plan.

DIAGRAM B.—GENERAL ARRANGEMENT OF THE CENTRAL ELECTRIC SUPPLY CO.'S POWER STATION, GROVE ROAD, MARYLEBONE, N.W.

Mr. E. W. COWAN said that, while he agreed with the authors as to oil break switches being essential, he regretted that this should be the case, because the oil break was not the most ideal form of break in all circumstances. Oil, being of a highly inflammable nature, might, in the case of a bad contact, bring about a rise of temperature to the point, and if the flash switch failed to open the circuit, the fact that the arc formed would be fed by the oil vapour rendered it of a very much more destructive nature. It had been found by experiment that an arc between metal electrodes, under certain conditions, would not re start unless the current was switched on again within a space of time amounting to $\frac{1}{27\frac{1}{500}}$th of a second; but, in the case of cored carbons, an arc formed under similar conditions could be re-established after a lapse of time of as much as $\frac{1}{4}$ of a second. He considered that an oil vapour fed arc was somewhat similar to the arc between cored carbons, and that under those conditions the arc was not likely to extinguish itself, but to spread and to cause disastrous destruction. On the other hand, an oil switch was compact, and it was on the whole a reliable way of breaking circuits of high pressure and heavy load. It also undoubtedly tended to open circuits at zero current, but though it had this tendency he doubted whether it could always be relied upon to do so. If it was so, and it could be relied upon, there would be every reason for its being permanently established as an ideal switch. He always regarded the breaking of a switch under oil as being due to the heat-absorbing power of the oil robbing the arc of its temperature and therefore extinguishing it, as the chief agent in extinguishing the arc. In fact, the operation was very similar to the wire cage in a Davy safety lamp. There was also, of course, the interposition of a non-conducting layer or partition in the arc tending to sever it, but the temperature effect was the chief one. Undoubtedly the temperature of the arc was lowest at zero current, and therefore it might be expected that the arc would be extinguished at zero current. Ninety times out of one hundred an oil-break switch would break the circuit in a satisfactory way, sometimes quietly, sometimes with a report more or less explosive, but sometimes it failed to open the circuit. This seemed to indicate that they did no always break at zero current.

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If the arc was broken at mean current the mischievous effect of breaking a current on inductive circuit would be just the same with an alternating current as with a continuous, and if it broke at maximum current the effect would be very much more mischievous. The ideal switch would be one that gradually reduced the current to zero before opening, and to do it without the intervention of a drawn out arc, as the varying arc was intermittent and oscillatory in its nature and caused a rise of pressure due to resonance and so on in the circuits. A method of opening the circuit without the formation of that long arc was the magnetic blow-out, and the horn break switches which were used very much on the Continent. These latter were single turn magnetic blow-out switches, the arc tending to be repelled by the field excited by the current. With that form of switch the tendency was to break the arc when both the field and the current were at a maximum, to which there was the same objection as to the ordinary magnetic blow-out switch. Another form of switch which had been used in this country and which had a great deal to recommend it was one which quenched the arc under water, but there were difficulties in adapting it to high pressures and high load owing to the conducting nature of water, and also to the fact that the water needed replenishing. He had not noticed anything in the Paper with reference to the charging of mains. His experience was that the automatic apparatus of the switchboard was very often neglected. Mr. Andrews was the first to use reverse current apparatus for alternating-current generators and transformers in parallel. The speaker approved of the remote control principle referred to in the Paper. He was sorry to see that some engineers were specifying and purchasing high-tension gear in which the breakdown of one part would spread and interfere with the neighbouring apparatus. He noticed that the designs of both switchboards given in the Paper were American in their essential parts. He had not any fault to find with them on this account, but he did venture to ask that engineers in this country who had to do with specifying for high-tension switchgear should give encouragement to British manufacturers to this extent: they should give consideration to their designs. He quite understood that the clause in specifications that no switch-gear or controlling gear could be considered from any maker who has not carried out similar work was a business-like clause from the business man's point of view, but in the case of the expert buyer something more might be expected of him, and he might give consideration to the designs of the British manufacturers.

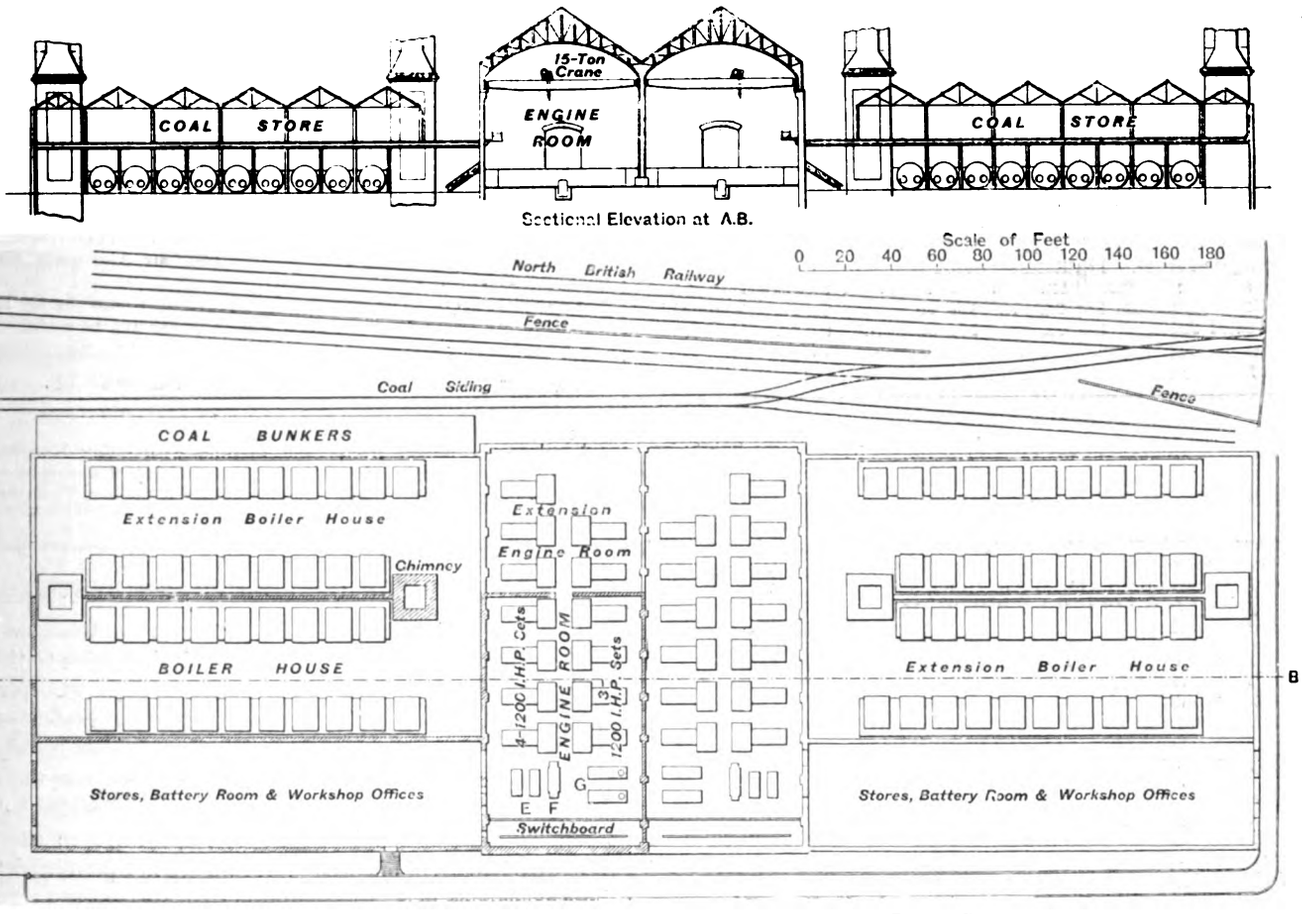

Diagram A.—General Arrangement of McDonald Road, Edinburgh, Power Station.

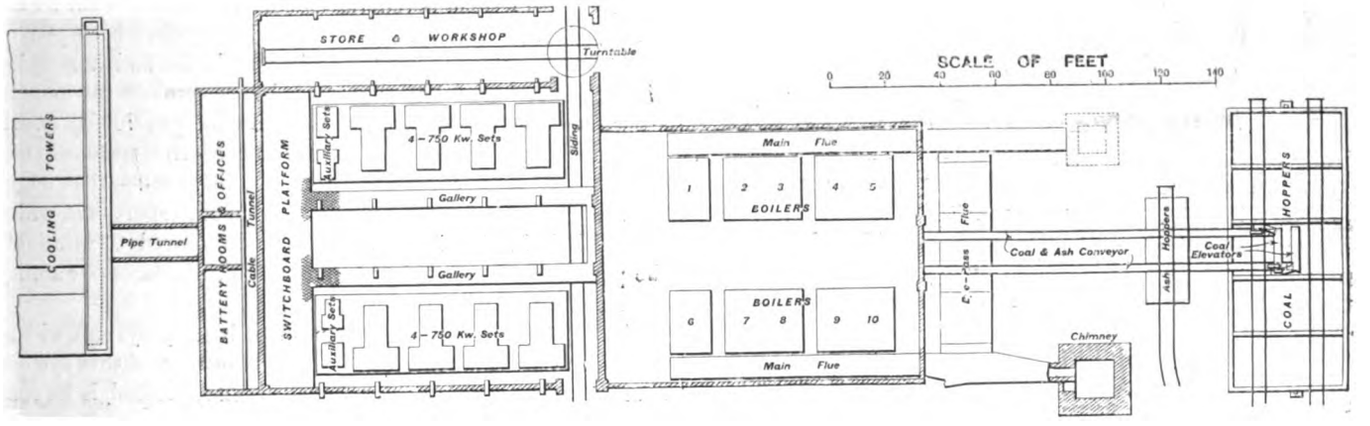

Diagram C.

(*To be continued*).

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A COMPARISON OF TELEPHONE SYSTEMS.

Two long sittings have been devoted by the Glasgow Local Section of the Institution of Electrical Engineers to the discussion of a Paper by Mr. A. R. Bennett on "Corporation Telephones." The Paper was an interesting sketch of Mr. Bennett's work in this direction, but unfortunately the author had put it together hurriedly, and we are, therefore, still without detailed descriptions of the modified "ring through" systems employed by Mr. Bennett in the more recent exchanges of his design. As we are not permitted to see these exchanges, it is to be regretted that Mr. Bennett has not described the apparatus in detail himself. His Paper contained no drawings or diagrams, and thus his defence of the obsolete call-wire and of the "ring-through" systems is not extremely convincing. Valuable time was wasted in the discussion on the Paper and on Mr. Bennett's reply by an unnecessary indulgence in personalities on the part of a number of speakers. It should have been possible to criticise designs and estimates without making the insinuation that the engineer responsible for them is ignorant of the subject in which he has specialised, and that the figures, even if they have been proved erroneous, had been put forward in bad faith; and a meeting of an engineering society should not be the occasion for making accusations against members of obtaining information by underhand means. While the tone of some of the speakers was deplorable, however, the discussion contained much that ought to be useful to telephone engineers, and in our report of it, which we conclude in this issue, we have endeavoured to eliminate the personal element and to bring out to the best of our ability the technical points that were raised.

Mr. Gill's remarks as to the central battery system will be read with particular interest. The one feature of this system, about which considerable doubts have been expressed, is its complexity. Numbers of relays have to be employed and the efficiency of the service depends to a large extent on the proper working of a chain of automatic devices. Mr. Gill gave the results of observations extending over a number of years, however, and it is safe to say that, if the same state of efficiency is continued, the trouble arising from rela y faults is not serious. There is much to say in favour of the simple magneto system, with branching multiple switchboards, for

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exchanges of small and moderate size. Automatic calling and clearing introduces a considerable complication; but for some reason it has come to be regarded as an essential to modern exchange systems, and even Mr. BENNETT has considered it of such importance that he has marred the sweet simplicity of his ring-through system by introducing this automatic feature with the aid of a "passing contact" in the subscriber's instrument—a thing abhorred by the majority of telephone engineers. Then comes the substitution of an incandescent lamp and a relay for the drop indicator, which is justified by the saving of space on the switchboard, and still more by the increased facility for supervision. If a telephone operator is not attending to her duties properly, the lamps in front of her immediately indicate the fact to the monitor; there is no need to employ a shorthand clerk to report on the conversations between the operator and her subscribers as it appears is done on the call wire in Glasgow, and even a most expert shorthand writer could not do justice to the call-wire babel at the busiest hours of the day. Now, when the telephone engineer has gone so far as to make provision for automatic calling and clearing and for lamp signals, very little more is required to make the system a complete central battery system, with central battery speaking, as well as central battery signalling. For small exchanges these refinements are certainly not necessary, but there is much to say in favour of having a uniform system throughout, both from the subscriber's point of view and that of the telephone administration to whom standardisation of parts and methods is of great importance.

The old principle that an endeavour should be made to lessen the operator's work by making the subscriber do part of the operating, as on the call-wire and ring-through system, has not been found to work out well in practice. An experienced servant of the telephone administration must necessarily be a more expert operator than the subscriber himself or his office-boy, and, as a matter of fact, the central battery system does simplify the operating, and a single operator is able to attend to far more subscribers on this system than on the old one. The greatest drawback to the ring-through system, however, is with junction working. Directly it is necessary to speak through two exchanges complications are introduced in the connections, and, moreover, the total exclusion of the operator from the circuit becomes a disadvantage instead of an advantage. If two subscribers to the same "ring-through" exchange neglect to ring-off, so as to be in constant communication with one another for long periods at a time, and therefore able to ring one another up whenever they please without the intervention of the exchange, no great harm is done. But if they belong to different exchanges, and thus monopolise a junction wire, the inconvenience to the exchange is considerable. In the call-wire system a failure to ring-off is more troublesome still, for the operator has then to disconnect herself from the call-wire in order to speak on the subscriber's line and ascertain if he has finished. On the other hand, the application of the central battery system is troublesome with the "extension" instruments so much employed in this country, but we believe that this difficulty is chiefly in the case of systems which have been converted and that it has been overcome when the central battery system is adopted from the outset. It is to be regretted that Mr. BENNETT did not raise this point in his Paper, so as to elicit some statement with regard to it from Mr. GILL and Mr. KINGSBURY, for it is a matter which is troubling London telephone users considerably just now—especially the subscribers to the Holborn exchange, which has just been changed over from the magneto to the central battery system—and probably Glasgow National Telephone Co. subscribers have had a similar experience. Although not coming directly within the title "Corporation Telephones," it is a point that might have been included in a Paper, the discussion upon which was sure to revert to a comparison between Mr. BENNETT'S systems and those of the Post Office and the National Telephone Co.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E FOURNIER D'ALBE.]

Secondary Röntgen Rays.—C. G. Barkla proves that the energy of the secondary Röntgen rays is by no means the insignificant portion of their primary energy that it is usually supposed to be. It is about $\frac{1}{1000}$th part, and thus makes up 25 per cent. of the total absorption, the remainder being spent in the ionisation of the gas and the production of heat. The character of the secondary radiation differs slightly from that of the primary rays. Thus, in air the secondary rays have the greater ionising power. The penetrating rays are transformed to a greater extent than the more absorbable rays. The energy of secondary radiation from a given gas through which a primary beam of given intensity is passing is independent of the character of the primary radiation. Applying the experimental results to the expression given by J. J. Thomson for the loss of energy per centimetre, due to radiation, in passing through a medium containing ions, and taking the negative electrons having $e/m = 7 \times 10^6$ and $e = 10^{-20}$ as the sources of the radiation, the number of electrons per cubic centimetre for air under normal conditions is of the order 10^{22}. Quantitative results show that the secondary radiation from metals, though of different penetrative power, is of the same nature as the primary X radiation.

[C. G. BARKLA, *Philosophical Magazine*, May, 1904.

Nerve Impulses and N-rays.—A. Charpentier has proved the existence of a wave propagation of nerve impulses, and determined their wave-length by means of N-rays. He found that if instead of using a single wire for the conduction of N-rays two wires were used, their combined effect upon the screen is sometimes weaker and at other times stronger than the effect of a single wire. This at once suggested to him the existence of interference, and since the intensity of the N-rays emitted by a nerve is proportional to the activity of the nerve, it was reasonable to suppose that the nerve impulses have a definite frequency and wave-length. The author therefore examined a nerve at two points by means of two wires of equal length, and found that there was no effect upon the screen when the points were 16mm. apart. This therefore, is half the wave-length of the nerve impulses, and their frequency is about 800 per second.

[A. CHARPENTIER, *Comptes Rendus*, May 2, 1904.]

Chemical Application of N-rays.—A. Colson has stated that N-rays are given off during certain chemical reactions, and that they can be utilised as a physical criterion for such actions. He has now obtained further results, and has found that the chemical reactions which give rise to N-rays are invariably accompanied by some physical action such as contraction or cooling. Some very vivid chemical reactions, such as the precipitation of salts, are not accompanied by any evolution of N-rays, so that there is evidently no proportionality between the chemical action and the evolution of N-rays. It is just this lack of proportionality which makes the N-rays valuable to the chemist, since he is thus enabled to discover actions which may be masked by the more evident chemical reactions. A solution of aluminium sulphate mixed with a saturated solution of potassium at the ordinary temperature gives out neither N-rays nor N′-rays. But if the supersaturation of the alum whose elements are found in the solution is made to cease, N′-rays appear. Similarly, sodium sulphate in a supersaturated solution gives off N′-rays when the supersaturation is stopped by the addition of a crystal, and the radiation ceases when the crystals are all deposited. Powdered chrome alum, thrown into cold water,

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increases the brightness of the calcium sulphide screen while the violet solution is being formed. But if boiling water is used, and the solution is rapid, the emission of N′-rays is such that the luminosity of the sulphide disappears almost completely. Thus the solution of chrome alum leads to the emission of N-rays, while its decomposition by hot water leads to the emission of N′-rays.

[A. COLSON, *Comptes Rendus*, May 2, 1904.]

Geodetic Pendulum of Invar Steel.—G. Lippmann has examined pendulums of Guillaume's nickel steel known under the name of invar steel owing to its small temperature coefficient of expansion, which is 20 times smaller than that of brass, and finds that they may be safely and advantageously employed as gravity pendulums. He examined a pendulum made of the substance, and found that it possessed a magnetic moment of 1,050 C.G.S. units. The effect of the earth's magnetic field upon the period of oscillation of such a pendulum would be $\frac{1}{5000000}$th of that of gravity, and would be equivalent to a change of length of 2 microns. Considering that the variation of 1deg. in the temperature of a brass rod means a change of length of 18 microns, and that it is very difficult to determine the temperature of a brass rod to within 1deg., the advantage of using invar steel is obvious. Moreover, if a reversible pendulum is used, the small error due to the earth's magnetism is eliminated.

[G. LIPPMANN, *Comptes Rendus*, Nay 2, 1904.]

Thomson Effect in Bismuth Alloys.—The peculiar interest attached to the electric properties of the bismuth-tin alloys has led S. C. Laws to investigate the Thomson effect, or the amount of heat evolved or absorbed by a current in passing along a conductor in which a temperature gradient is maintained. With the same current and the same difference of temperature, the amount of heat evolved or absorbed is proportional to the "specific heat of electricity" in the metal or alloy. The author employed two rods of the alloy mounted side by side, with their ends kept in boiling water and in ice respectively. A current of 3 to 4 amperes was sent through the rods in series, and reversed several times. The difference of temperature due to the Thomson effect was observed by means of a cross connection. The results show the striking effect of the addition of a very small quantity of tin to bismuth, the Thomson effect in an alloy containing 1 per cent. of tin being more than 12 times as large as in pure bismuth. With the addition of more tin, the value the Thomson effect continues to increase until the alloy contains about 3 per cent. of tin, when the effect is about 15 times as large as for bismuth. When the percentage of tin is increased beyond this amount, the value of the specific heat of electricity begins to decrease. This diminution goes on as the amount of tin becomes greater, until finally the Thomson effect in the case of pure tin has fallen to a value which is only about $\frac{1}{300}$th part of that which holds in the case of bismuth.

[S. C. LAWS, *Philosophical Magazine*, May, 1904.]

PHYSICAL SOCIETY.

At a meeting of the Physical Society held on May 6th, Mr. J. Swinburne, vice-president, in the chair, a Paper, entitled

"Some Instruments for the Measurement of Large and Small Alternating Currents,"

was read by Mr. W. DUDDELL. The author, after some preliminary remarks on the available means for measuring alternating currents, proceeded to describe three thermal instruments which he has constructed for this purpose. The first instrument is essentially a sensitive Ayrton-Perry twisted strip ammeter which is very quick in action for a thermal instrument, and has been used for observing and recording P.D.s and currents which varied as rapidly as 1 per second. It is compensated for change in the surrounding temperature by forming the sides of the frame which holds the twisted strip with the same wire that the strip itself is made from. With the instrument exhibited a current of 22 milliamperes gave a deflection of one-quarter the scale-distance—*i.e.*, 250mm. at 1 metre scale-distance. The mechanical periodic time is only about $\frac{1}{15}$ second. Using this instrument in series with a high resistance, the author has made observations on the variations in the voltages of alternators caused by cyclic irregularity of the engine. By working to a false zero it is easy to obtain 10mm. change in deflection for 1 per cent. change in the P.D. The second instrument exhibited was a very sensitive thermal galvanometer called in the Paper a "Thermogalvanometer." It consists of the combination of a radio-micrometer of the "Boys" type with a very small resistance which is heated by the current to be measured, and which in turn heats the thermojunction of the radio-micrometer by radiation and convection. The principle of its action is as follows:—A loop of wire has its two ends fixed to the two bars of a single thermojunction, a mirror is fixed to the loop, and the whole is suspended in a magnetic field by means of a quartz fibre. The heat from the resistance raises the temperature of the thermojunction and causes the current to flow round the loop which is deflected by the magnetic field. The sensibility of the instrument depends on the resistance of the heater. Using a heater having a resistance of 13,910 ohms, a deflection of 250mm. at a scale-distance of 1 metre is obtained with a current of 31 microamperes; a heater having 18 ohms resistance required 800 microamperes to give the same deflection. To illustrate the high sensibility of this instrument the author showed the large deflections produced by the currents through a telephone receiver even when the source of sound was many feet distant from the microphone; he also showed that if the thermogalvanometer was placed in series with the vertical receiving wire in spark telegraphy over a short distance, large deflections were produced. The third instrument described was a switchboard instrument which works on the same principle as the last, only that the moving part is pivoted in the usual way. The author exhibited one of these instruments, arranged to give the whole scale deflection for only 0·15 volt, which can be used in connection with shunts to measure large currents; for instance, to measure 1,000 amperes the power lost in the shunt would only be 150 watts. Transformers can also be used, as the power to produce the whole scale-deflection is only 0·3 watt. A similar instrument with a high-resistance heater was also exhibited giving the whole scale-deflection for 0·1 ampere, which can be used as a voltmeter by putting resistance in series with it.

Prof. R. THRELFALL, in a letter to the secretary, congratulated the author on his instruments, and stated that we were not told the effect of change of relative position in the heater and thermojunction during the operation of the thermogalvanometer. This effect might make it possible to construct an instrument having either a scale of equal parts or of any desired form.

Dr. P. E. SHAW, in a letter to the secretary, said it was possible to measure the amplitude of vibration in the diaphragm of a telephone receiver, and Mr. Duddell's instruments would enable us to determine the currents producing these vibrations.

Dr. D. K. MORRIS pointed out that in the earlier part of his Paper Mr. Duddell had discarded the electromagnetic and electrostatic instruments as not capable of further substantial improvement in the matter of working force, but he thought that the working forces in an electrostatic instrument could be increased by limiting the angular range without increasing the moment of inertia of the moving system. For instance, this could be effected in a quadrant electrometer with a wide needle by subdividing the needle into narrow fingers and subdividing the quadrants in a similar manner. The needle would then have the same total moment of inertia as before. If the fixed quadrants were similarly divided into sectors, then the working forces were increased. The force available for use depended on the *angular rate of change of capacity* of the needle; and though by the change described, the actual capacity (and therefore the capacity current) had not been increased, yet a very small angular movement was required for the needle to pass from the position of maximum capacity to that of least capacity. Dr. Morris showed an instrument constructed on this principle in 1899, by Mr. D. H. Bishop, capable of measuring 0·1 volt when used idiostatically, and to get large deflections with telephone voltages. The limit to this process of subdivision in the case of zero or small deflection instruments was decided by the practical working clearance; the clearance being determined by the tilting of the needle due to unbalanced electrostatic forces. Small charges on the parts due to contact P.D.s also rendered low-voltage electrostatic working very troublesome. Both these troubles, were however, simultaneously avoided by using a second needle attached to, and in the same plane as the other, but insulated from it, and connected electrically with the other set of sectors. On this principle a second instrument was constructed (in 1900) of a cylindrical type. (This was in Birmingham, and not very portable, but he had there the outer set of 20 fixed sectors.) In order to measure small alternating-current voltages on an ordinary potentiometer, the needle was brought back to zero by a small continuous current flowing in a little dynamometer coil attached to the mirror. These principles had been adopted at his suggestion in some of Mr. Addenbrooke's excellent electrostatic instruments of the sensitive type. Such an instrument might be called a *multipolar electrostatic instrument*, and Dr. Morris had used the same idea in the construction of a *multipolar electrodynamic instrument*. Air was, after all, but a poor conductor for magnetic lines, and he could not understand why it was necessary to provide coils enough to send a reasonable flux into spaces such as the centre of a dynamometer or wattmeter of any common type, where the flux was not wanted. This only caused inductive error. He supposed that the inductive errors depended very nearly upon the *volume* of the space

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which one filled with alternating flux. The sides of the moving coil of an ordinary dynamometer, or even of a modern high-class wattmeter, occupied but a small part of the space so magnetised. If, however, both the fixed and moving coils were wound *multipolar*, then, though the angular range was, of course, restricted, the sensitiveness might be increased and the inductive error clearly very much reduced. He had long intended to bring forward these instruments, but had not found time to write a Paper. The opportunity afforded him that evening by Mr. Duddell's most interesting Paper was therefore gladly accepted. A discussion on the best position of the sectors in the electrostatic instrument, or of the wires in the electrodynamic type, would be very interesting; so also would be one on the conditions for stabiliy of zero. But this would take too long. Dr. Morris said he was glad of the opportunity of Mr. Duddell's Paper for bringing them forward, and although they were well suited for use as zero instruments as detectors, they were not nearly so sensitive as the instruments designed by the author of the Paper, although well suited for pivoted zero instruments as detectors.

Prof. W. E. AYRTON said we had another example of the ingenuity of Mr. Duddell, and drew attention to the fact that he had not only designed the instruments but had also constructed them himself. He was pleased to see that good results had been obtained by using an Ayrton-Perry twisted strip. The use of such strips had hitherto been limited by the absence of contrivances for compensating temperature change effects. With such compensation it is possible, by using a twisted strip, to combine simplicity of construction with constancy of zero. In expressing especial interest in the experiment on spark telegraphy, Prof. Ayrton referred to the fact that Mr. Duddell had designed his thermogalvanometer for use in an important investigation, being unable to purchase a suitable instrument. The author had spoken about an alternator with a frequency of 120,000, and he hoped we would soon have some account of it. Referring to the remarks of Dr. Morris, he said it was often difficult to calculate the sensibility of a quadrant electrometer with a divided needle. In order to do so it was essential that the edges of the needles should never be near to the edges of the inductors. Any arrangement to increase the sensitiveness of an electrostatic instrument was desirable, and if Dr. Morris had obtained large deflecting forces without bringing the needles and inductors very near together, he was to be congratulated. He asked the author if it would not be better in his thermogalvanometer to double the heater on itself, and thus obtain a greater heating effect with diminished self-induction.

Mr. A. CAMPBELL expressed his interest in the instruments shown. Some years ago, in connection with the measurement of small alternating magnetic fluxes, he used a hot wire near a minute thermopile connected with an ordinary moving-coil galvanometer. One of the main difficulties with such arrangements was the slowness in reaching a steady deflection and in settling back to zero. For some relative positions of the thermopile and heater the deflection passes through its steady value and creeps back to it; for other positions the steady value is reached asymptotically. Even in Mr. Duddell's instruments the effect is quite noticeable, and it appears to want further elucidation. In order to render more uniform the calibration of the scale (which normally follows the square law), Mr. Campbell had sometimes mounted the heater so that by its expansion (or that of another hot wire) a spring drew it further from the thermopile as the temperature of the heater rose.

Mr. K. EDGCUMBE congratulated the author and said that as far as small alternating currents were concerned the instruments shown would be very useful. He could not, however, follow the author when he said that his pivoted form of thermogalvanometer would make a good switchboard instrument because it was never necessary to measure small currents. In using Mr. Duddell's instruments it was necessary to have very good contacts. Mr. Duddell had spoken of the advantage of being able to remove one heater and put in another, but the speaker pointed out that it would be necessary to adjust the second heater with accuracy or errors would be introduced. He was not a believer in hot-wire instruments, which were unsuitable for central-station work and gradually dying out in this country.

Mr. W. A. PRICE said he had recently been thinking of the possibilities of the instrument described by Dr. Watson in the discussion on Prof. Fleming's recent Paper on a "Hot-wire Ammeter." He thought that in many respects this instrument would be more practical than those brought forward, although it would probably not be so sensitive.

Mr. W. BENNETT asked how far the temperature correction in the twisted strip was perfect. It might be slightly affected by the fact that the twisted strip, though of the same material as the side wires, had been treated rather roughly in the process of flattening and twisting, the coefficient of expansion being possibly lessened. The fact that the strip and wires were at different temperatures might also affect the correction adversely on account of the temperature variation of elasticity. The sensitiveness of the radio-micrometer form of instrument would be increased if the efficiency of heat-transference between the heater and the thermojunction could be improved. If it were possible to make a heater that would nearly surround the junction this might be affected, and the variation of sensitiveness due to inaccurate replacement of the heater after removal would be lessened. He suggested using as a heater a thin film of platinum deposited on the inside of a small thin tube of glass or quartz.

Mr. R. S. WHIPPLE said he would like to testify to the great patience of Mr. Duddell in overcoming the difficulties met with in the construction of his instruments. He was of the opinion that a good deal of the bad name of hot-wire instruments could be attributed to their inability to stand overload.

Mr. H. TINSLEY, referring to Prof. Ayrton's remarks about the position of the needle in an electrostatic instrument, said he had recently tested the matter accurately. So long as the edges of the needle were well within the inductors it was easily possible to calculate the deflection which would be produced by any voltage to about one part in 500. Under such conditions the instrument accurately followed a square law, and its working-constant could be obtained from one observation.

The CHAIRMAN said that a thermopile had been used many years ago in a similar way to that in which the thermojunction had been used by Mr. Duddell, but the sensitiveness obtained was not nearly so great as that of the instruments exhibited. With regard to electrostatic instruments he did not see any advantage in being able to predict the deflection produced by any voltage, according to a definite law, as it was always easy to calibrate such instruments. The shape of an instrument with an Ayrton-Perry twisted strip often rendered it unsuitable for many purposes.

Mr. W. DUDDELL, in reply, said that it was necessary that the heater and the thermojunction should be very small, and this made it difficult to diminish the self-induction of the heater by doubling it on itself. It was also essential that the bars of the thermojunction should be narrow, otherwise creeping effects were introduced. The deflection might also be too small, due to the increase in resistance of the whole circuit brought about by the heating effect of the current. Referring to Mr. Edgcumbe's remarks, he pointed out that his pivoted instrument used less watts than any instrument on the market, and could be used if necessary in connection with transformer instruments.

Mr. F. E. SMITH exhibited and described the following instruments from the National Physical Laboratory:—(1) A mercury-resistance standard; (2) a 10-ohm built-up resistance-box; (3) an astatic galvanometer.

THE LONDON TELEPHONE SERVICE.

A conference of the Local Authorities within the London telephone area was held on Wednesday, under the auspices of the City Corporation, in the Council Chamber of the Guildhall. There was a large gathering, several representatives being present from each of 76 local authorities. The following is the agenda paper:—

A. That this conference is of opinion that it would be inexpedient for the Government to acquire the undertaking of the National Telephone Co. on any other terms than those set out in the agreement between the Postmaster-General and the company, dated November 18, 1901, and strongly deprecates the increased cost that would be entailed by the proposed acquisition of the undertaking before the expiration of the existing licence in 1911.

B. That this conference is of opinion that before any agreement is entered into with the National Telephone Co. for the purchase of their system, the terms of the proposed arrangement should be submitted for the consideration of the local authorities within the London telephone area.

C. That this conference again protests against the Post Office telephone tariff, being of opinion that the charge for the use of a telephone in the London area should not exceed the sum of £10 per annum for an "unlimited service," and that the other charges for the use of telephones should be proportionately reduced.

D. That in the opinion of this conference the trunk-line service is inadequate and unsatisfactory, and requires considerable improvement.

E. That the secretary of the Post Office be at once communicated with in the name of this conference, and asked that before any new agreement or contract is entered into with the National Telephone Co., an opportunity be afforded to the local authorities within the London telephone area of stating their views to the Postmaster-General.

F. That in the event of Parliament appointing a Committee to consider purchase negotiations between the Postmaster-General and the National Telephone Co., that the local authorities within the London telephone area should be enabled to submit their views before such Committee, and steps be taken to secure accordingly.

G. That copies of the minutes of proceedings be forwarded to the metropolitan members of Parliament, the various authorities in the London telephone area, and to each of the delegates.

The Right Hon. the LORD MAYOR OF LONDON (Sir J. T. Ritchie, Bart.) welcomed the delegates, and expressed a hope that their deliberations would be productive of good results. He asked them, when they had arrived at a conclusion, to bring all their influence to bear upon the Government in order that the public might derive some advantage from its telephone system.

The Lord Mayor then vacated the chair, and on the motion of Mr. (Deputy) TURNER, seconded by Mr. HUDSON, both of the City Corporation, Mr. A. C. Morton was unanimously elected chairman, and Mr. A. H. Montague Bates (principal clerk in the Corporation Public Health Department) clerk to the conference.

The resolution of the City Corporation authorising the convening of the conference having been read,

The CHAIRMAN said that he was pleased to see such a large gathering of delegates representing the local authorities in the London telephone area. This showed in an unmistakable manner the interest taken in the telephone question and the determination of the local authorities, so far as possible, to protect the business interests of the great and growing metropolis. They all regretted that there should have been any necessity for this constant vigilance in the public interest, but the inhabitants of London especially were the prey of companies and trusts, and we must do the best we could to protect the business interests of London, and with it the best interests of the whole country. There were present delegates from 76 local authorites, including the London County Council and the City Corporation. The London telephone area covered 634 square miles, with a population of 6,556,074, and a rateable value of £53,155,917. That was a large population and very large rateable value, but the business interests concerned were very much larger, and if the metropolis was to keep its place in the country and the world it must have the fullest advantage

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that could be given by a cheap and efficient telephone service. They had met to consider what they learned from the papers was a proposal of the Government to purchase the interest of the National Telephone Co. at once, instead of waiting, as had been expected, till the expiration of the company's licence in 1911. It was curious that all through these telephone proceedings, while the Post Office people always seemed to be in the confidence of the National Telephone Co., the local authorities had always been ignored. The question of reduced charges had also to be considered, the object being to make the telephone more popular and more useful. In 1899 the late Mr. Hanbury told the House of Commons, "We mean to popularise the system and throw it open to the whole country, to rich and poor alike." They were still waiting for that promise to be fulfilled, and one of the reasons for that meeting was to press upon the Government the necessity of reducing the charges for the use of telephones in accordance with what they justly thought was promised. The representatives of the Corporation were responsible for the notices A, B, C, D and G on the agenda. Notice E seemed to be the same as B. Notice F might be usefully added to B. This telephone question was not a party one. He hoped there would be unity in doing the best that was possible to get for the use of London a cheap and efficient telephone service, second to none in the world; if the National Telephone Co.'s system was purchased now at an inflated and unfair price, we might never secure the one or the other. Practically, all the local authorties in the London telephone area were represented at the conference, each having three delegates. They were all, therefore, on an equal footing as representing the whole of the London telephone area, and he hoped they would speak with one voice in demanding to be heard before these matters were settled, and that the result of their labours might be to get an efficient telephone service at a reasonable and just charge for "rich and poor alike."

Mr. Deputy TURNER (City Corporation) then moved resolution A, and said that he could not understand why the Government had not taken action with regard to this matter at the time when the legal decision was given that a telephone was a telegraph. Had they done so there was no doubt that the public and the users of the telephone would have had by this time what they ought to have—viz., a cheap service. It had been reported in the papers that the Postmaster-General had stated that any provisional agreement adopted by the Government would be put before a Select Committee. But that was not enough, because of the very large majority which the Government had, for if they wished to carry any such agreement there was no doubt that such persuasion could be used as to make the thing go through. If the matter of the purchase of the telephone company's undertaking could be sent to arbitration at once no doubt they would all be satisfied, but in view of the past history in connection with telephones, they could not help feeling that the purchase should wait until the expiry of the company's licence. The company always seemed to get the better of the Government at the expense of the public, and for this reason he urged that the resolution he had proposed should be adopted.

Mr. HUDSON (City Corporation) seconded the resolution.

Mr. PRESCOTT (town clerk, Fulham) in supporting the resolution referred to the inflated capital of the Telephone Company, the effect of which was not unforeseen as far back as 1898, when the London County Council passed a resolution to the effect that the existing high charges were due to the inflated capital. He had perused the agreement of November, 1901, and under clause 6 there was provision for a revision of rates after January 1, 1905. With respect to purchase, clause 9* provided for the purchase of the undertaking at the expiry of the lease upon terms which made no allowance for compulsory purchase or goodwill, and yet there was now a determination on the part of the Government to get behind the express terms of that agreement—a proceeding which was absolutely wrong and absolutely unnecessary, because if this were done it would mean an additional burden upon the London taxpayer.

Mr. HUGH TRENCHARD (Enfield) said that all the speeches so far had been of an *ex parte* character, and they appeared to have been made by gentlemen who were in the enjoyment of the promised land. For instance, he happened to know that Fulham was admirably served, and therefore it was all very well for the Fulham representatives to say, wait for another seven years. But what were they going to get at the end of the seven years? He was not proposing that an unlimited amount of money should be given for the undertaking at once, but, in view of the poor service which many of the more distant parts of London received, he contended that a simple actuarial calculation would show what was the present value of the undertaking upon the basis of the expiry of the licence in 1911, and therefore he would move that all words after "November 18, 1901" in resolution A be omitted, and that an addition be made to the effect that equitable compensation be paid to the company for the acquisition of their undertaking before 1911.

Mr. G. S. ENGEL (Enfield) seconded the amendment.

Mr. WHITE (Lewisham) supported the amendment, and said that in the licence of the company there was no clause as to purchase, and, unless there was to be an interruption in the service, the National Company could dictate what terms it liked to the Government.

Mr. BAIN (Westminster) thought that there was a misconception in both the resolution and the amendment. The licence of 1884 provided that it should exist for 31 years—*i.e.*, it would expire in 1911, and, under clause 17, the Postmaster-General had the power to buy up the whole undertaking of the company at septennial periods—viz., in 1890, 1897 and 1904. The agreement of November, 1901, only related to the London service. Therefore, what the resolution and the amendment were saying was that the whole system should be purchased in 1911 upon the terms which related only to London under the agreement of 1901, and this might not be to the advantage of the country. He was inclined to think that at the present moment they should not deter the Postmaster-General from considering the matter of coming to an equitable bargain beneficial to London alone.

The CHAIRMAN pointed out that it was quite understood that the Government had the power to purchase the London service in 1911, upon agreed terms, and the object of the conference was not against buying up now, but to see that the terms of purchase should not be different to those in the agreement. With the view of being united he would put resolution A without the amendment, but modified to the extent that all words after "November, 1901" be omitted:—

"That this conference is of opinion that it would be inexpedient for the Government to acquire the undertaking of the National Telephone Co. on any other terms than those set out in the agreement between the Postmaster-General and the company, dated November. 18, 1901."

On a show of hands this was carried unanimously.

Mr. PRESCOTT (Fulham) moved resolution B and E in the form of one motion, and pointed out that it would be necessary to press upon the Government that the Post Office should extend their system as rapidly as possible, because the National Company, being in the position of a dying concern, now refused to spend any more capital upon their undertaking. If the Post Office extended their system rapidly now it would save a great deal of delay when the whole telephone system of the country came into its hands.

Several objections having been made to the form of the resolution,

The CHAIRMAN said that they were only asking that the public should know the terms of any bargain before it was actually made.

Mr. LEE (Wandsworth) pointed out that the provincial authorities were not mentioned in the resolution.

The CHAIRMAN said that the provincial authorities had already held a conference, and were quite able to look after themselves. In fact, they had done a little better than London in this respect up to now.

Mr. WILLIAMS (Hanwell) asked what would happen if there were no agreement between the company and the Post Office as to terms. Could the matter be sent to arbitration?

The CHAIRMAN said he could not answer that. What they did know was that apparently there was a bargain being made, and they wanted to know all about it before it was completed.

Several other suggestions having been made, the resolution, in the following form, was passed unanimously:—

"That this conference is of opinion that before any agreement was entered into with the National Telephone Co. for the purchase of their system within the London telephone area, the terms of the proposed agreement should be submitted for the consideration of the local authorities within that area."

Mr. IVEY (West Ham), in submitting resolution C, thought it was only fair that the Government should be asked to revise its rates, in view of the persistence with which such obligations were placed upon electric lighting and tramway undertakings by Parliamentary Committees.

In the discussion which followed there was a general feeling that £10 was too low a figure, and that no specific subscription should be mentioned. One speaker referred to the telephone as a necessary luxury, and thought it would be unfair to have a low rate if it meant that any loss should come out of the pockets of numerous ratepayers who never used the telephone at all.

Mr. ANDERSON (Chiswick) suggested as an amendment that the charge should be graduated according to the use of the line. He had been a member of the States telephone service of Guernsey, and by adopting such a tariff the business had increased 15 per cent. in four months.

* Clause 9 of the agreement is as follows:

9.—(1) On or so soon as may be after the day of the determination of the company's licence in respect of the London area (unless the company's licence shall have been previously revoked and determined in accordance with the provisions therein contained), the Postmaster-General shall buy and the company shall sell and convey all such plant as is at the date last aforesaid in use by the company for the purposes of the company's London system and as is suitable for the actual requirements at the date last aforesaid of the telephonic service of the Post Office within the London area.

(2) No plant shall in any case be considered suitable for the requirements of the telephonic system of the Post Office which has been brought into use without the sanction in writing of the Postmaster-General, but subject, as aforesaid, if any question arises as to the suitability of any of the plant of the company for the requirements of the telephonic service of the Post Office within the London area, such question shall, in case of difference, be determined by arbitration. Provided always, and it is hereby agreed and declared that all plant of the company in use for the purposes of the company's London system at the date of this indenture shall be deemed to have been brought into use with the sanction in writing of the Postmaster-General, and all plant which the company may hereafter erect or put down for the purposes of the company's London system shall be deemed to have been brought into use with the like sanction if erected and put down in accordance with the specification and rules set out in the third schedule hereto.

(3) The value of all plant purchased by the Postmaster-General in pursuance of the provisions hereof, shall be deemed to be its fair market value at the time of the purchase, due regard being had to the nature and then condition of such plant and to the state of repair thereof, and to the circumstance that it is in such a position as to be ready for immediate working, and to its suitability to the purposes of a telephonic service, and no addition shall be made to such value in respect of compulsory purchase, or of goodwill, or of any profits which might have been or be made by the company by the use of such plant, and in determining the value of any plant, no advantage arising from the construction of such plant by leave of the Postmaster-General upon any railway or canal over which the Postmaster-General possesses exclusive rights of way for telegraphic lines shall be taken into account. In case of difference such value as aforesaid shall be determined by arbitration.

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Mr. SOMERFIELD (Wandsworth) and other speakers argued that it was no use having a cheap service without any regard to efficiency. There were absolutely no statistics to show that an unlimited service could be given for £10.

The CHAIRMAN said this figure had been fixed upon an estimate made by the London County Council.

During further discussion a suggestion was made that a request should be embodied in the resolution that zone tariffs should be adopted, whilst one speaker thought that both the resolution and amendments should be withdrawn pending a reply from the Government to the first two resolutions, which were the most important ones. This latter proposal, however, was shouted down.

Finally, the resolution was unanimously passed in the following form:—

"That this conference again protests against the telephone tariff, being of opinion that the charges for the use of a telephone in the London area should be materially reduced."

Resolution D was then proposed, seconded and carried unanimously without discussion, as was also G in the following form:—

"That copies of the minutes of proceedings be forwarded to the Prime Minister, the Leader of the Opposition, the Secretary of State for Foreign Affairs, the Right Hon. Earl Spencer, the Postmaster-General, metropolitan members of Parliament, the various authorities in the London telephone area, and to each of the delegates."

On the motion of the CHAIRMAN, it was agreed that the conference should be adjourned until a reply had been received from the Government.

A vote of thanks to the chairman closed the proceedings.

ROYAL COMMISSION ON LONDON TRAFFIC.

Thursday, May 12.

Mr. CHARLES CARPENTER, chief engineer to the South Metropolitan Gas Co., said that nowadays the obstruction caused to traffic by the opening up of the roads by his company was comparatively small. The introduction of the supply of gas by automatic meters had had a good deal to do with this, for it was now the practice to lay a service main under each pavement, and to reserve the roadway for the trunk mains. In connection with the traffic problem, he desired to point out the advantages of incandescent gas lamps placed along the line of kerb, as compared with the patchy effect given by high-power electric arcs. He agreed with the previous evidence of the gas companies that, neither on the score of expenditure nor of convenience, had subways for taking gas pipes proved satisfactory, and also blamed the electric lighting companies and the telephone department for the obstruction to traffic through breaking up the streets during the past few years.

In answer to the Chairman, Witness stated that he preferred incandescent gas lighting to arc lighting for this reason: One arc lamp giving, say, 600 c.p. cost £30 to £40 per year. But for this candle-power and for the same price there would be eight or 10 incandescent gas lamps, so that the light was distributed over a much larger area, and more evenly than with arc lighting.

Continuing, he said that the South Metropoltan Gas Co. had to obtain the consent of the local authority, except in case of emergency. This system had worked very well for the last 50 years in connection with the supply of gas, and he thought that it should be extended to every body which had the power to supply a public necessity.

Mr. C. A. BRERETON, a partner with Sir John Wolfe Barry, engineer to the Whitechapel and Bow Railway and for a portion of the Great Northern, Piccadilly and Brompton Railway, said that, in his opinion, the best way of dealing with the ever-growing congestion of traffic in London would be to construct a broad road running from east to west, with provision for a railway and tramway beneath. A similar road running north and south would also be advisable, but it was not considered of such importance as the east and west route. He suggested that the road should be double storeyed, with a width 140ft. on the upper storey, and allowing a carriage-way for vehicular traffic of 104ft. in width. There would then be two footpaths 18ft. wide. Underneath should be constructed two double lines of tramways and a double line of electric railway, as well as provision for main and smaller sewers, and cellars for the houses. Continuous footpaths would also be provided alongside the tramways to which there would be access from the upper storey. The lower storey would, besides affording facilities for the tramways, allow of underground crossings at various points for pedestrians. The tramways and railway would be worked electrically. With regard to the cost of this route, approximately it would amount to £1,250,000 per mile, without land, or a total of £6,250,000 for the 5 miles. But the details of the scheme as regards cost had not been entered into. The traffic on the north and south route would be proportionately considerably less than upon the east and west route, and it would not be necessary to construct any tramways or railways upon it. The cost of it in these circumstances, exclusive of land, could be approximately placed at £2,550,000.

Mr. A. R. STENNING, surveyor, said he had gone over the ground of the proposals of Mr. Brereton with a view to estimating the cost of land. On the east and west route this would amount to £11,293,550, to be deducted from which was £2,000,000 for recoupment. For the north and south route, he estimated the cost of the necessary properties at £7,000,000, less £1,000,000 for recoupment.

Sir J. WHITTAKER ELLIS detailed a huge scheme of street widening in London. He said he was against underground locomotion, but approved of subways for crossing the roads at dangerous places. He objected most strongly to the construction of tramways, not only because they were largely constructed by interested speculators, but also because they were on the eve of being superseded by the motor car for all purposes of urban traffic. Tramways in the suburbs were not so objectionable, and this was a question for the residents to decide. In any case he thought there was something in favour of the railless trolley lines. He favoured the establishment of a central tribunal, to which all schemes of locomotion should be referred.

Friday, May 13.

Mr. E. HARPER, the statistical officer of the London County Council, gave evidence with regard to tramways statistics. He said the total length of tramway lines opened for traffic in London, which was 62·16 miles in 1879, rose to 126·87 miles in 1889. It then remained practically stationary until 1901, since when it has been somewhat increased by the extensions of the London United Tramways system. On the average there was almost exactly 1 mile of tramway to every square mile of the area of London. North of the river the average worked out at 1·16 miles per square mile, and on the south it was 0·88 of a mile per square mile. Whilst, however, there were 29,628 persons to every mile of tramway south of the river, there were 48,589 to every mile on the north. In the west of London there was only a few miles of tramway, and these worked out at 1 mile for every 123,986 of the population. In the south-eastern section of London the population per mile of tramway was 34,636, which was below the average, but this section of London was the least thickly inhabited part. The 116 miles of tramways in the County of London were worked in 63 routes, varying in length from 0·50 to 11·50 miles, the aggregate track mileage being 274. With regard to the increased carrying capacity of electric cars, he said that the carrying capacity of the 956 electric cars which ran into Westminster Bridge was 56,056 passengers, whilst the capacity of the 1,101 horse cars which ran to Moorgate-street was only 47,802. If all the cars were increased to the average of the Westminster Bridge cars, the total capacity of the daily cars running towards the centre of London from all parts of the county would be increased from 447,920 to about 535,000. Witness also went at great length into the question of fares and also the remunerativeness of workmen's trains.

Col. R. E. B. CROMPTON, C.B., gave evidence as chairman of the Kensington and Knightsbridge Electric Lighting Co., and said that he agreed with Dr. Kennedy's evidence given last week so closely that it was unnecessary to repeat it in detail. With regard to the question of subways, he agreed with Dr. Kennedy as to the present use of them. He hardly thought, however, that the Commission would propose the construction of subways other than in great and important lines of thoroughfare, but they must with some certainty contemplate the fact that distributing systems carrying energy not only in the form of electricity, but possibly for water and compressed air, were not only likely but were certain to increase. There was some degree of certainty that a house-to-house distribution of considerable bulk would eventually take place through tubes possibly 12in. diameter. He had given evidence as to the desirability of encouraging such distribution as decreasing the number of vehicles which at present used the surface of the streets (see *The Electrician*, Vol. LII., p. 787). The Kensington Company had constructed subways under the footpaths for the purpose of its own mains, and access could be given to their customers by boring a hole from the openings in the streets into the tops of cellars situated under the same footways. He thought more night work could be carried on than was the case at present.

The Commission adjourned until June 2.

CORRESPONDENCE.

COMPLETION OF THE PRACTICAL SYSTEM OF UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest Prof. David Robertson's letter on "The Completion of the Practical System of Units" appearing on pp. 24 and 25 of your serial No. 1,353 of April 22, 1904.

Prof. Robertson recognises the misfortune which attaches to our electromagnetic system of units by having two sets of units for the same quantities—namely, the fundamental C.G.S. system and the "practical" system. He proposes an ingenious solution of the difficulty by taking a third system adapted to be fundamental, and at the same time to conform in the magnitudes of its units to those of the existing practical system. If such a plan could be universally adopted, whereby the practical system would become merged with the fundamental system, the anomalous duality that we now labour under would cease.

It is, perhaps, open to question whether the C.G.S. electromagnetic system is really based, as assumed by Prof. Robertson, upon four fundamental quantities—length, mass, time and magnetic permeability. Is it not generally admitted that the C.G.S. system is based only upon length, mass and time, and that permeability is thrown in at present because its "dimen-

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sions" in terms of those three quantities are not yet determined? As soon as the "dimensions" of permeability are realised, the term will disappear in a modification of the dimensions of the units where now it comes in evidence. Under such an interpretation would not a system based upon the metre, kilogramme, second *and ohm* be disrupted?

However, aside from the question of ultimate dimensions, is it not now too late to uproot the C.G.S. system from the scientific ground of the civilised world, and replace it with a M.K.S. system? The C.G.S. system has not only been legally adopted by a number of Governments in relation to electromagnetic units, but it also largely enters into international non-electrical science. Does it not seem that the C.G.S. system has taken up permanent international abode? Is it likely that any plan for substituting a M.K.S. system for the C.G.S. system would succeed all over the world? Any step of this kind must surely be international to be successful.—Yours, &c.,

Cambridge, Mass., U.S.A., May 5. A. E. KENNELLY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to various letters regarding units which have appeared in your journal recently, I would say that I am strongly in favour of rationalising the units by taking the ampere current as the unit difference of magnetic potential and the magnetic line as the unit of magnetic quantity. As I have pointed out in previous Papers, this will give us a rational system, and will entirely eliminate irrational quantities from our present calculations.

One advantage of this method of rationalising the units is that it does not change any of the legal or standard units, all of which will remain exactly as they were before. I enclose a table giving the new units and the new formulæ, which will show how advantageous they will be in practical work.

The necessity for the rationalisation of units will be more obvious as time goes on. Just as practical electricians generally did not appreciate the value of the calculus until alternating currents were introduced, so practical electricians are not apt to appreciate the value of rational units until they begin to deal with problems connected with the transmission of power over long distances and with electromagnetic wave phenomena. As this latter subject becomes more important, electricians will begin to realise the inconvenience of working with irrational units.

I believe that every effort should be made at the present time to rationalise the units. If, however, it should be impossible to accomplish this, no effort must be spared to prevent the establishment of legal units of magnetic potential and of magnetic quantity. If the present theoretical units—*i.e.*, 4π magnetic lines—be made the unit of quantity, and $1/4\pi$ ampere turns be made the unit difference of magnetic potential, we will cut ourselves off absolutely for several hundred years from having a set of rational units. Whatever happens, everybody interested in having a rational system of units must take every means possible to oppose the misguided, short-sighted and fatal step of making 4π lines the legal unit of quantity of magnetism and $1/4\pi$ ampere turns the legal unit of difference of magnetic potential.

I would call your attention to the curious fact that there is no necessity of manufacturing names for the physical quantities, because if we write these physical quantities in terms of their dimensions, with a suitable prefix to denote whether the quantity is an electric, magnetic or a gravitational one, we get names which have the advantage that they not only uniquely describe the quantity, but also give its dimensions.—Yours, &c,

Washington, D.C., May 11. REGINALD A. FESSENDEN.

[The tables referred to by Prof. Fessenden were published by him in the *Physical Review*., Vol. X., No. 2, to which those of our readers who are interested in the subject will be able to refer.—ED. *E.*]

ELECTRICITY IN SMALL TOWNS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The writer has read with interest your leading article under the heading "Overhead Mains" in *The Electrician* for May 13th, and would like to say a few words on the subject of electricity supply to small towns. In this country there is an abundance of small waterfalls, and those producing, say, from 15 H.P. upwards, in cases where the energy can be readily used, are employed to furnish light and power to the surrounding villages. The writer knows of one case where no less than 23 small villages are supplied from one power station of 90kw. capacity! The majority of these small installations would have been nipped in the bud had they been forced to lay their mains underground, whereas, instead of that, they are flourishing little concerns, paying in some cases a dividend of 10 per cent. the year after opening.

The writer finds it hard to believe that there are not some small waterfalls in the British Isles that could be turned to account in this way if aerial lines were permissible, though the scheme might be unprofitable if underground mains were employed. With steam stations (leaving gas engines out of the question, as the interest on the capital cost is too great for the remunerative working of such small concerns) the case is, of course, different; but one concludes that the writer of the article under "Electricity in Small Towns" that appeared in your journal a short time ago would not have fixed the size of the town at such a figure as was specified if the question of aerial mains had been considered.

In the case of steam stations, the power-factor is of first importance, and in this connection might be mentioned a plan adopted by many companies owning small concerns in this country—namely, that of installing and working a flour mill deriving its power from the network. A power-factor of 60 per cent. or better is thus obtained, in addition to the advantages of a lucrative business.—Yours, &c. R. GULEY-LEWIS.

Madrid, May 16.

SOME PROPERTIES OF ALTERNATORS UNDER VARIOUS CONDITIONS OF LOAD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the Paper read before the Institution, at Birmingham, on the above subject, a vector diagram is given representing the conditions obtaining in Baum's method of determining the synchronous impedance. It is Fig. 11 on p. 105 of your issue of the 6th inst. This diagram contains an error which, although not materially affecting the result of the test, should be rectified. The leading current vector OI requires an E.M.F., OR, in phase with it to overcome ohmic resistance, and an E.M.F., OM, 90deg. ahead of it to overcome the induced E.M.F. OL. The resultant E.M.F. required to overcome the impedance is hence OY and not OZ as given in the Paper. OM is equal and opposite to OL, and OY is the resultant of OR and OM. The effect of this is to make the opposition in phase of the applied pressure V and the back pressure E not so exact as that shown.—Yours, &c.,

Municipal Technical School, Hull, May 19. G. W. O. HOWE.

ELECTRICAL APPOINTMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the current issue of your paper "Modulus" draws attention to a grievance in connection with municipal appointments. I trust you will grant me space to point out what I consider an even more serious matter.

I worked for some years with a London firm of electrical contractors, during which time I gave them every satisfaction, and was in every way on the best of terms with them. Strange to say, however, on my notifying them I was leaving to take up another appointment, and asking for a written testimonial, they refused this unless "I would give them a written guarantee not to work with any other opposition contracting firm." This I naturally refused to do, and, of course, have never received any testimonials from them covering that period. On inquiry amongst my friends, I have been informed that this sort of thing is by no means uncommon in England.

The want of testimonials did not prevent me getting along, but it might have been serious. The letter I received from the firm asking for a guarantee, &c., has generally been hailed with shrieks of laughter, and the remark, "Just like him" by the "other" firm.

However, I consider that junior engineers should compile privately some "useful data" regarding this class of firms which, unfortunately, does exist, so that good men will not waste their time working for them. In this way the "quality" of contracting firms generally will be raised. Further, it is high time contractors' assistants formed a union of some sort.—Yours, &c. ELECTRON, B.Sc.

May 14.

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PARLIAMENTARY INTELLIGENCE.

ST. MARYLEBONE ELECTRIC LIGHTING BILL.

This bill came before a Committee of the House of Lords, of which Lord Brougham of Vaux is Chairman, on Friday last week.

Mr. FITZGERALD, K.C., who appeared for the promoters, with Mr. H. Lloyd, K.C., and Mr. Vesey Knox, said that the bill proposed to borrow money for the purposes of electric supply in Marylebone. It had already been passed by the House of Commons (see *The Electrician*, March 24, 1904, p. 914), and the only opponent was the Gas Light and Coke Co., to whose locus he raised an objection. The petition of the Gas Light and Co. appeared to be based upon a misconception. It raised the question of competition, but the Marylebone Borough Council were authorised to supply electricity, and by the terms of the arbitration of 1901 were bound to acquire the undertaking of the Metropolitan Electric Supply Co. within its area. Clause 34 of the bill, which was a modification of the "Bermondsey" clause, was as follows:—"The Council shall, once in every year in which they shall themselves work the undertaking after the expiration of three years from the commencement of the order of 1901, cause to be laid before them a statement and balance-sheet of the accounts of the electric lighting undertaking drawn up in accordance with the form of accounts presented by the Board of Trade for a local authority under the Electric Lighting Acts, 1882 and 1888. And the Council shall thereupon fix annually the charges to be made for the supply of electrical energy for the then ensuing year (not exceeding the maximum rates specified in the order of 1901), so that, so far as is reasonably practicable, the revenue for that year shall not be less than the estimated amount of the expenditure and of the charges for interest and sinking fund for that year." This clause had been agreed with the Great Central Railway Co., and precluded any possibility of damage to the gas company as ratepayers. The Gas Light and Coke Co. asked for exemption from extra taxation in order to make good any deficiency upon the electrical undertaking; but this was practically making an alteration in the Electric Lighting Acts. He asked the Committee to refuse the gas company a *locus*.

Mr. POLLOCK, K.C., for the Gas Light and Coke Co., said that the company paid £8,600 per annum in rates to the Marylebone Borough Council, and the total amount paid to the whole of the London boroughs in whose districts they supplied amounted to £250,000, and this made a difference in the price of gas to the extent of 3d. per thousand cubic feet, With regard to the argument that the Gas company were really seeking an alteration of the Electric Lighting Acts, he could only point out that nothing was being done under the Electric Lighting Acts, inasmuch as it was this particular bill which would authorise the borrowing of the necessary money. There was a clause relating to free wiring to which he objected to, and the clause referred to by Mr. Fitzgerald did not go far enough. There was no provision in it for depreciation. It would be possible for the Council to charge a high rate on the street lighting and a low rate for private lighting and so kill the company and yet make it pay a portion of the loss on the private lighting. The only chance that a company like his had of opposing the proposals of a local authority was in Parliament, as under the Borough Funds Act he had no vote. He therefore asked to be allowed to oppose the bill.

Mr. FITZGERALD, with regard to the free-wiring clause, said that it expressly stated that the Council should not do the work itself, but should give it to contractors. This was an ordinary clause and was in many bills.

On Monday it was announced that an agreement had been come to with the Gas company that the following addition should be made to clause 34:—"There shall not be charged against the general rate in respect of street lighting or other municipal purposes for which such energy shall be employed, any larger amount than is charged to the ordinary consumer using energy during the like hours of supply."

Mr. E. DEBENHAM, chairman of the Electric Lighting committee, then gave formal evidence in proof of the preamble, and the bill was ordered for third reading.

MIDDLESBROUGH, STOCKTON AND THORNABY TRAMWAYS.

The Committee of the House of Commons, of which Mr. Henry Hobhouse is chairman, continued the consideration of this bill on Friday last week. After the remaining speeches for the opposing landowners had been disposed of,

The CHAIRMAN stated that the Committee found the preamble of the bill proved, with the condition that compensation should be paid to the owners of the tolls to an extent to be settled by an arbitrator.

On Monday clauses were considered.

Mr. CHARTERIS, for the promoters, submitted a clause in respect of the compensation for tolls. This provided that an annual sum should be paid so long as tolls were levied upon other vehicles using the roads. It would be manifestly unfair to the company, he said, to have to pay a lump sum based upon a large number of years, and perhaps in a year or two the roads would be freed.

In opposition to this, for the toll owners, it was argued that there ought to be two arbitrations—one to determine the amount to be paid in respect of the easement over the road, and another with regard to the sum to be paid in lieu of the tolls. In both cases it was asked that a lump sum should be decided upon by an arbitration under the Land Clauses Act.

Mr. CHARTERIS, for the promoters, objected to this, as the payment of the tolls was for the right to use the road, and to have to pay for an easement in addition would be paying twice over.

The CHAIRMAN said the Committee would pass the clause proposed by the promoters.

The remaining clauses having been adjusted, the bill was reported for third reading.

SUPPLY OF ELECTRICITY BILL.

In the House of Lords on Friday last week,

Lord WOLVERTON moved the second reading of this bill. He said its objects were to carry into effect the recommendations of Lord Cross' Select Committee of 1898.

(The text of the bill was given in *The Electrician* for May 6, p. 102.)

The bill was read a second time.

OTHER ELECTRICAL BILLS.

The *Chesterfield Corporation Tramways and Improvements Bill* has been passed by the Unopposed Committee of the House of Commons. It has already been passed by the House of Lords (see *The Electrician*, March 18, p. 871).

A Committee of the House of Commons, composed of Sir E. Strachey (Chairman), Mr. David Morgan, Mr. Barry and Mr. Melville, has been formed to consider the following bills:—*Tyneside Tramways and Tramroads, Preston, Chorley and Horwich Tramways* and *Preston and Blackburn Tramways*. The first sitting will take place on Tuesday, June 7. All the above bills have passed through the House of Commons.

The *University of Leeds Bill* was before the Unopposed Committee of the House of Commons last week. It proposes to merge the Yorkshire College in the University of Leeds. The bill, which has already been passed by the House of Lords, was ordered for third reading.

The Longwood Gas Co. has deposited a petition in the House of Lords against the Huddersfield Electric Lighting Provisional Order, which seeks authority to supply in Longwood. The object of the opposition is to prevent any deficit from this undertaking being made good by means of the rates.

In the House of Lords on Friday last week the *Harrow Road and Paddington Tramways Bill* was read the second time. On Monday the *Shipley Urban District Council Bill* was read a second time. The *Portmadoc, Beddgelert and South Snowdon Railway, Bournemouth Corporation Tramways* and the *Newcastle-upon-Tyne Corporation Bills* were read a third time. On Tuesday the *North Wales Electric Power Bill* and the *Holywood Tramways Bill* were read a third time and passed.

In the House of Commons on Monday, the *Metropolitan District Railway Bill* was read a second time. On Tuesday the *Clyde Valley Electric Power Bill* was read a second time.

The *Govan Burgh (Electricity) Bill* was sent forward for third reading by the Unopposed Committee of the House of Commons on Tuesday. The bill has already passed the House of Lords (*The Electrician*, Vol. LII., p. 833).

The *Lothians Electric Power Bill*, which, as announced in our last issue, was put back last week by the Unopposed Committee of the House of Lords for further consideration, was duly passed on Tuesday.

BIDEFORD, WESTWARD HO! AND APPLEDORE LIGHT RAILWAY ORDER.

In the House of Commons on Friday last week, Mr. SOARES asked the President of the Board of Trade whether he was aware that by the Bideford, Westward Ho! and Appledore Railway Act, 1896, the promoters of the railway were empowered to lay a single line of rails along the Quay-road, Bideford, but were forbidden to make a loop or passing-place on the Quay-road without the consent of the Corporation; that on the faith of this and other sections being inserted for their protection the Corporation and the inhabitants generally did not oppose the bill; that, notwithstanding a subsequent refusal of their consent by the Corporation, the company laid the loop; that an action in the High Court was successfully brought by the Corporation; that the railway company then applied to the Light Railway Commissioners for power to lay the loop, who decided to grant the application, and that the Board of Trade have notified their intention of confirming the sanction; and, if so, whether, in view of the circumstances of the case, he would take steps to revoke the confirmation by the Board of Trade of this order.

Mr. GERALD BALFOUR, in a printed reply, said that the matters referred to were argued before the Light Railway Commissioners, who held a local inquiry, and again at the Board of Trade on appeal from the Commissioners. The Board were advised by their inspecting officers that the loops ought to be authorised for the safety and convenience of the road and rail traffic, and the Department decided accordingly to uphold the decision of the Light Railway Commissioners.

WEIGHTS AND MEASURES (METRIC SYSTEM) BILL.

The House of Lords went into Committee on this bill on Friday last week, and, after amendment, it was reported to the House for third reading.

PRIVATE TELEPHONE LINES.

In a printed reply to Mr. Rigg in the House of Commons on Wednesday,

The POSTMASTER-GENERAL stated that it had been necessary to refuse to provide long telephone lines between London and such places as Manchester, Liverpool and Glasgow for private use owing to the difficulty of finding space on existing routes even for the new wires required for the public service. Estimates of the cost of constructing new routes for additional wires had been prepared, and he was considering whether it would be possible to supply long private telephone lines to all applicants fo them.

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THE TRUNK TELEPHONE SERVICE.

In a printed reply to a question by Mr. LODER in the House of Commons on Monday, respecting the delays which take place upon the telephone lines between London and Brighton,

The POSTMASTER-GENERAL stated that the telephone traffic between London and Brighton is subject occasionally to delay owing to some exceptional difficulties in the maintenance of the lines as well as to the amount of the traffic. Steps were being taken, however, to provide additional lines which he hoped would prevent these delays.

ELECTRIC FOG SIGNALS.

In a printed reply to Mr. Sloan, in the House of Commons, last Thursday,

Mr. GERALD BALFOUR stated that the inspecting officers of the Board of Trade would be glad to have an opportunity of considering detailed information in reference to an electric bell substitute for the old style of railway fog signal. The attention of the railway companies had been called to the question of some mechanical system of fog signalling, and certain companies were making experiments, but until a thoroughly reliable apparatus was produced a grave danger might arise from its use.

LEGAL INTELLIGENCE.

Macartney, McElroy & Co. v. Brighton Corporation.

This case, reported in our issues of April 29 and May 6, came before Mr. Justice Grantham for further consideration on Monday.

Mr. CAUTLEY, M.P. (for plaintiffs), asked his lordship on the findings of the jury to dispose of the action so far as it had been gone into, and pointed out that only part of the action—that relating to (B)—had been heard. He asked his lordship to find in his clients' favour on (B), and to say what he would do as regards the other part of the action. The claim under (A) was for £2,035. 15s. 5d., for the difference between the price named in the tender and the amount certified for, and also for extra work which plaintiffs carried out, less what the Corporation engineers had certified for. Defendants admitted items of £113. 19s. 4d., £8. 14s. 2d., and £472. 5s. 1d., total, £594. 18s. 7d. They had counterclaimed for damages under the maintenance clause, by which plaintiffs agreed to keep the wood paving in order for 12 months, and also for some goods supplied to the value of £246 odd. Plaintiffs had admitted on that item £237. 10s. 5d., and, taking that from the £594. 18s. 7d., there was an admission of £357. 8s. 2d. due to plaintiffs from defendants. The balance of account for extras not certified remained for disposal. Plaintiffs claimed about £1,316 for work done under (A) which had been omitted in the certificates. That was over and above what they had admitted in their pleadings. What was left in dispute was plaintiffs' claim for £1,316 and defendants' counterclaim for £586 odd, and if his lordship could see his way some time early next term to deal with it they would be glad.

After a brief discusion, his lordship thought the part of the action relating to (A) would have to be deferred.

Mr. FLETCHER MOULTON proceeded to deal with the legal construction to be placed upon the contract, and submitted that there was no ground for variation of the contract. The work to be done came under sec. 174 of the Public Health Act, 1875, which provided that every contract exceeding £50 in value entered into by an urban authority must be in writing and sealed with the common seal of the authority. The case of "Young *v.* the Mayor of Leamington" decided that sealing was obligatory. That swept away the idea of an agreement between the surveyor, Mr. May, and plaintiffs, and declared that no agreement between Mr. May and plaintiffs, no matter what the delegation, could have any effect at all. Either the work was done under the sealed contract, or its value could not be recovered. He contended that the suggestion that plaintiffs could have, by reason of prior negotiations, a rectification of a contract with an urban authority coming under sec. 174 of the Public Health Act was impossible. Either plaintiffs must produce a contract under seal or they must be nonsuited. He further submitted that plaintiffs unquestionably knew the point as to what the specification and contract meant, and from that moment till the trial they insisted that they meant the contract they signed and that there had been no mistake. They took the contract under seal from defendants, and knew the contents of it. That being so, they sued on that contract, which was the one they meant to take, and they could not say they wanted that altered. He did not think anybody could alter it. Plaintiffs could not, because they did not pretend not to have known the terms used, and they thought still that the interpretation of that contract was in their favour. A mistake in the interpretation of the contract was no ground for rectification, even between ordinary persons. He cited the case of the "Midland-Great Western Railway Co. of Ireland *v.* Johnson and Kimber" in support of his contention that any correction must be under seal. Plaintiffs misunderstanding the meaning of what they signed did not give the right to alteration; but they did not even say that. They said their construction was right and there was no allegation that they thought the contents of the contract were different from what they were. He submitted that plaintiffs' pleadings were bad in law because there was no contract between Mr. May and plaintiffs, and even if there were it would not be valid. He argued that the excavating, concreting and floating under the wood-paving formed part of the contract works and that the sum to be paid included payment for all works that had to be done under the contract.

His LORDSHIP pointed out that contracts were often divided.

Mr. MOULTON said the question was whether the work under the wood blocks had to be done. Either it was to be done or plaintiffs could not recover. If it was to be done it was for the price named. If it was not to be done plaintiffs had no contract. He submitted that the word "works" meant the whole, including excavating, concreting and floating. Everything turned on a certain figure being in a certain place. The contract required the whole of the work in the specification to be done, that work included excavating, concreting and floating, and if it was to be done what contract was there for paying for it except the contract in question and the sum named?

Mr. LUSH, for plaintiffs, said it was important to bear in mind the jury's finding that it was impossible and impracticable to estimate for the cost of making the concrete bed in (B), and he submitted that when they came to look at all the documents and made them fit, there was only one conclusion possible, and that was that plaintiffs were to be paid for making the concrete bed in accordance with the prices in the schedule of prices, and he further submitted that the fallacy in the Corporation's argument was that they persisted in calling the tender a lump sum tender for (B). The lump sum price in the tender was only for providing the wood and laying it. Tenders were invited for the work in the original specification and the bills of quantities, which meant the bills of quantities for both sections, and it was important to observe that wood paving was defined as meaning only the supplying and laying of the wood. The works included in the specification under (B) included laying the electric light ducts, and, if the Corparation's contention was right, that meant that plaintiffs were to do that work in the lump sum of £101,000. It was clear, from the Corporation's own description, that what the excavation was to be was left at large because it was stated that the depth was to be "not less" than 15in. It might be they would have to go 50in. deep.

Mr. Justice GRANTHAM: I must say that it seems to me the natural meaning is that as far as the contract says he is to bind himself to excavate to 15in. deep and anything beyond that depth he would be paid for.

Mr. LUSH said that it was very important to observe that wood paving was used in another place in contradistinction to making the concrete bed, and another clause that described what was to be done in wood paving did not say anything about the concrete bed. The crux of the case was clause 103, which provided that "the whole of the work will be measured up while in progress or on its completion, and the amount of work actually executed will be paid for according to the prices affixed to each description of work in the schedule of quantities in the form of tender, and the difference between the amount actually executed and the amount given in the schedule of quantities will be added to or deducted from the lump sum item." According to that, the deductions to be made if plaintiffs did not do the work must correspond with what they were to have if they did the work; yet defendants would deduct 18s. for work plaintiffs did not perform, although they only paid 12s. 7d. for what plaintiffs did perform. Why tell the engineer to measure up the excavation for 2 or 3 miles if plaintiffs were not to be paid for it? Unless plaintiffs were to be paid for all the excavation work, it was a useless function measuring up all the work. Plaintiffs were asked to name a price for laying the wood, and were told that all the work they did should be measured up, and they would be paid according to the schedule of prices. There was nothing in the contract from which defendants could extract even the notion that plaintiffs were to lay the concrete bed for nothing. The plaintiffs were entitled to be paid on the measurements. As to the rectification of the contract, he urged that in the form of tender originally before the Works committee, it was first intended that there should be two prices, wood plus concrete bed, but it was ultimately decided to have wood alone, and that last form of tender was the one sent in by plaintiffs, and the price quoted was only for wood. Assuming that it was found that the contract did not mean what he said, it meant, he submitted, that by a mutual misunderstanding the words used did not record the real agreement, and that the parties meant one thing and another thing was inadvertently put into the contract. That, he submitted, formed the grounds for rectification of the contract, and the argument about the seal of the Corporation had absolutely nothing to do with what he urged in favour of rectification. As to the way he would rectify the contract, Mr. Lush said he would add words to the effect that the excavating, concreting and floating were to be taken separately and to be paid for according to the schedule of prices. If the Court was against him on his first two points, he would subsequently raise a third point—viz., that as the Corporation had paid £9,000 odd for the work, they could not get that back.

Counsel for the Corporation having replied,

Mr. Justice GRANTHAM intimated that he would take time to go through the arguments, and would give his judgment to-day (Friday).

Grenfell and Others v. Willox and Others.

At Liverpool Assizes last week, before Mr. Justice Jelf and a special jury, Messrs. A. G. Grenfell, C. W. Pulling, C. Greenhouse, W. Y. Fausset and N. A. Earle sued Sir J. A. Willox, M.P., the Hon. Arthur Stanley, M.P., and Messrs. E. K. Muspratt, James B. Atherton and Jacob Atherton for damages for alleged misrepresentation in the prospectus of the South Lancashire Electric Traction and Power Co. (Ltd.). Plaintiffs alleged that they were induced to subscribe for certain debentures in the company on the faith of a prospectus issued by defendants, which contained a statement untrue to their knowledge, or, if not untrue to the knowledge of defendants, was, in fact, untrue. Plaintiffs alleged considerable loss, and claimed that this loss should be made good by defendants. Defendants denied that they issued the prospectus to the plaintiffs, that the statement in the prospectus was untrue, that if untrue, it was not untrue to their knowledge; that they had reasonable ground for thinking it was true, and that they did, in fact, think it was true at the time of the issue of the prospectus and up to the date when the debentures were allotted to plaintiffs.

Mr. SUTTON, for plaintiffs, said that when the action was commenced there were allegations made which would seem to imply that there had

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been moral deceit on the part of defendants, but since then they had had opportunities of inquiring into the matter, and into the proceedings which led to the promulgation of the prospectus, and these allegations would not be made. Plaintiffs, however, alleged that the gentlemen who issued the prospectus did undoubtedly make a statement in it which was not true in fact, and they asked the jury to say that defendants had no reasonable grounds to believe that it was true. About three years before 1899 Messrs. Jacob Atherton and James B. Atherton formed a scheme for the supply of electricity in South Lancashire for power and traction, and introduced into Parliament in 1900 a bill called the South Lancashire Tramways Bill, but in that bill there was nothing about power, the sole scheme then in contemplation of the parties was to obtain powers to make tramways. Sec. 85 of the bill provided that the company should not supply electrical energy in the district of any local authority, for any purposes other than the purposes of the act, without the consent of the local authorities. In June, 1900, Messrs. Atherton registered a company called the South Lancashire Electric Supply Co. (Ltd.) for supplying electricity for other purposes than traction, and a draft prospectus was prepared but was not issued. It was suggested by defendants that sec. 85 of the Tramways Act was an enabling section giving that company power to supply electricity for all purposes. Counsel's opinion was somewhat in favour of this claim, and the directors and all the defendants (except Mr. Muspratt) had made up their minds to claim this power under the Tramways Act. Another prospectus, which was the same as the previous one, excepting for some minor alterations, was subsequently approved, and the directors endeavoured to raise £400,000 cumulative preference shares and £750,000 4½ per cent. first mortgage debenture stock. The whole of the ordinary capital was to go to Mr. J. B. Atherton to compensate him for his work. Counsel for plaintiffs now urged that defendants were all and severally responsible for certain statements made in the prospectus issued in connection with this flotation, the charges against defendants really centreing round the question whether the statements in the prospectus claimed larger powers for the company than the Act of Parliament under which it worked had, obviously, conferred.

The case was argued at great length, his Lordship on several occasions rebuking one of the plaintiffs (a solicitor) on the question of the charge of fraud which was originally made. At the conclusion of the evidence, and after hearing counsel at length,

His LORDSHIP, in summing up, severely commented upon the action of plaintiffs in alleging fraud and then abandoning it at the last moment. If it were not that some of the defendants might have felt that their integrity was so well known that they could afford to treat the charge with contempt, it might have been a matter of very great anxiety and trouble. The charge was only withdrawn at the last moment in court without one word of apology or regret that any such view was taken, and never withdrawn until the moment of the opening of the trial. He had great doubt—the point had not been decided—if the Directors' Liability Act was intended to apply to statements of opinion. The statement in the prospectus was one the truth or falsehood of which could only be determined as a matter of law by a tribunal. What was alleged against the defendants was that they had made a statement untrue in fact as to the interpretation of an Act of Parliament. To apply the Directors' Liability Act to such a case would lead to extraordinary results. One of these results was that, this being the interpretation of a statute, the jury were supposed not to be competent to decide what was a question for himself as judge. His view at the moment, subject to reconsideration, was that the opinion which had been given by Mr. Balfour Browne as to the construction of the company's Act of Parliament was right, yet, because defendants put forth the same opinion, they were sought to be made liable in damages. But plaintiffs had not only to show that defendants had no reasonable ground for their belief in the truth of the statement made in the prospectus, but that the statement was made and intended to be acted upon, and that plaintiffs did act upon it as a material inducement to subscribe to the issue of debenture stock, &c. It was pertinent to bear in mind that not until the debentures held by plaintiffs had been postponed new debentures was a conclave held at Mr. Earle's (the solicitor's) office, and the alleged false statement discovered It was only then that the decision was taken to sue first of all for fraud, and, if that failed, then under the Directors' Liability Act. Even if the jury found for plaintiffs on all those points, they must find that plaintiffs had suffered loss, but if plaintiffs held securities of par value, then there was no loss. The jury might, of course, take the view that those debentures were worthless or depreciated. He advised them to deal with the matter by a percentage applicable pro rata. To say that defendants did not believe the statement was true was bringing forward in another shape the charge which had been withdrawn. The crux of the case was whether or not defendants had reasonable ground for their belief in the truth of the statements. Turning to the company's Act of Parliament, it seemed extraordinary that Parliament should have put in a clause prohibiting the company from doing without the consent of local authorities something which the company had no power to do. Such a clause had no meaning. The Directors' Liability Act was not intended to lay traps, but to deal with careless statements made without due inquiry. His Lordship then put to the jury the following questions:—(1) Had defendants, or some, and which of them, reasonable ground for believing, and did they believe, that the statement in the prospectus complained of by plaintiffs was true? If they answered that question in the affirmative, there was an end of the case; if in the negative, then he asked them to decide (2) were plaintiffs, or some, and which of them, induced by the statement to take the debentures? (3) Did the plaintiffs, or some, and which of them, suffer damages by taking the debentures and, if so, how much?

Eventually the jury returned a verdict that defendants took reasonable precautions to ascertain that the statements in the prospectus were true.

Upon this finding his Lordship gave judgment for defendants, with costs.

Illuminated Advertisements.

In the Divisional Court on Friday (before the Lord Chief Justice and Justices Wills and Kennedy) the London County Council appealed from a decision of Mr. Plowden (Magistrate at Marylebone Police Court) dismissing a summons by the Council against the Illuminated Advertisements Co., charging them with unlawfully erecting certain structures in contravention of Part III. of the London Building Act, 1894, beyond the general line of buildings without the consent in writing of appellants. Respondents had erected on the front wall of 48, Cranbourn-street, 12 advertisement cases, constructed of sheet-iron, supported by strong wrought-iron supports securely cut and pinned through the front walls of the building. The outer side of each of the cases was covered with a wooden frame carrying canvas or linen with advertisements, and provision was made for illuminating the interiors of the cases by electric light. Each of the cases stood out 10in. in front of the front wall, but each projection was less by 14in. than the projection of the existing cornice over the shop. Appellants contended that the cases were structures within secs. 22 and 200 (3) of the 1894 Act, but the magistrate thought the cases were not structures within the act, and that they were mere excrescenses which could be removed at will without injury to the building.

After hearing the arguments, Mr. Justice KENNEDY, in giving judgment, said he was unable to decide that the magistrate had gone wrong in law. It was a question of fact and of degree in each case, and it was for the magistrate to decide, and he had so decided.

Mr. Justice WILLS differed. Questions of that kind were (he held) questions of mixed law and fact. He could not help feeling that as long as the advertisement cases remain annexed to the building they were part of it, although they could be removed.

The LORD CHIEF JUSTICE was unable to say that the magistrate had gone wrong as a matter of law. The question was whether the magistrate on the facts was bound to hold that a thing so erected came within sec. 22 and sec. 200 (3).

The appeal was, therefore, dismissed.

Llanelly Tramways Co. v. Llanelly and District Electric Lighting, &c., Co. and Others.

In the Chancery Division on Wednesday, Mr. Justice Joyce delivered his reserved judgment in this action. The proceedings at the trial were reported in our issues of March 18 and 25.

His LORDSHIP said in 1900 the British Insulated Wire Co. was desirous of acquiring the tramway undertaking of plaintiffs, and by an agreement of Dec. 4, 1899, between the local authority and the company, the latter agreed to apply for a light railway order to construct a system of electric tramways in Llanelly and to acquire plaintiff's existing tramway. It was agreed that the company should find all capital required for carrying out the objects of the local authority, subject to the approval of the Board of Trade to a subsidiary company (to be formed) which should acquire plaintiff company's undertaking, and, provided the B.I.W. Co. guaranteed the capital of the subsidiary company to the satisfaction of the local authority. A clear and definite bargain was concluded between the Tramway Company and the B.I.W. Co. for the sale by the former and the purchase by the latter of the tramway undertaking for £5,000. It was suggested by the B.I.W. Co. that the letters and telegrams which passed did not constitute a valid agreement, but he could not agree with that contention, nor with the plea that the Traction Co. had been substituted for the B.I.W. Co., as he held that there had not been novation. For all practical purposes the Llanelly and District Electric Lighting and Traction Co. was nothing more than a name; in a commercial sense it had never had any real existence. He held that the plaintiffs had always looked to the B.I.W. Co. to find the money and complete the purchase, either in the name of the Traction Company or otherwise. The consent of the Board of Trade had not and could not be obtained unless the company had sufficient means to carry out the undertaking. Taking into consideration all the circumstances disclosed by the correspondence, &c., there must be judgment for plaintiffs declaring that the B.I.W. Co. had not been discharged or released from its liability under its agreement, and he, therefore, granted a decree of specific performance of the agreement, an inquiry as to damages, and the B.I.W. Co. must pay the costs.

Electrolytic Plating Apparatus Co. v. Morrison.

Before Mr. Justice Darling, on Thursday last, Mr. MCcARDIE moved, on behalf of defendant, to set aside a judgment. Plaintiffs are proprietors of apparatus for electro-plating and burnishing in one operation, and defendant also has a similar patent of a later date. He had made arrangements to work his patent in Walsall with plaintiffs, and they on one occasion handed him (said counsel) a piece of paper, which he had since learnt was a writ for infringement of their patent. In February, 1903, he received a letter stating than an order had been made against him by Mr. Justice Darling restraining him from infringing plaintiffs' patent. He now said he had a good defence to the action, but wish to plead as a pauper.

In answer to the Judge, Mr. COLEFAX (for the company) said the question of infringement had not been tried. But in many cases of prosecution for infringement defendants did not appear, and judgment went by default, as in the present case. His clients did not wish to cause Mr. Morrison any loss, and would undertake to grant him a personal licence for himself and family to work the patent, but he must not seek to assign it to anyone else.

Mr. McCARDIE said that it was hard that an injunction should be granted against defendant when there had been no inquiry as to infringement.

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Mr. COLEFAX offered to withdraw the record and to stay proceedings. So long as the patent was kept to defendant's family, no action would be taken, but if an attempt was made to assign it, proceedings would be taken.

The JUDGE said one of the offers made by plaintiffs ought to be accepted. He should not make the order asked for by defendant, but would adjourn the case to permit of a settlement.

Manchester Carriage and Tramway Co. (Ltd.) and Swinton and Pendlebury Urban District Council.

This special case, stated by the late Sir Frederick Bramwell (as arbitrator in the matter) as to whether the District Council were to purchase any of the company's depots outside the district of the Council, came before Mr. Justice Channell on Friday last. The question arose under sec. 43 of the Tramways Act, 1870, the appeal being upon the question whether the words "within such district" qualified the word "undertaking" so that a depot situated outside the Council's district, but suitable to and used for such part of the undertaking as was within the district, was to be paid for by the Council as part of their undertaking. There are two depots, both outside Council's district. The special case found that one depot was suitable and that the other was not.

After hearing arguments of counsel,

His LORDSHIP said that, if the arbitrator had been still alive, he would have sent the case back to him, but in his opinion there was some evidence upon which the arbitrator could find that the second depot was suitable. He therefore upheld the special case, and granted leave to appeal.

Wooller v. Yorkshire (Woollen District) Electric Tramways (Ltd.)

At Dewsbury County Court last week plaintiff sued for £50 damages for an assault by the company's servants and for false imprisonment.

For the plaintiff it was stated that some time ago the company issued tokens, which they disposed of at a fraction under 1d. each to intending travellers. Plaintiff, who used the cars three or four times a day, bought 20s. worth of these tokens. Before that supply was exhausted the company issued a notice saying that after a certain date the tokens would not be received in payment of fares. Plaintiff, however, tendered a token at each subsequent journey. It was not accepted as payment, and, while he was on a journey in March, he was told to leave the car as he would not pay his fare. On the occasion complained of, the conductor unsuccessfully tried to put him out. Eventually a constable was called, but plaintiff rode to the end of the street where he lived, and was followed to his house by the officer, plaintiff refusing to give his name and address. The charge of false imprisonment was now withdrawn.

After hearing evidence, the jury returned a verdict for plaintiff for £10. The question of costs was reserved.

Tramcar Licences.

At Dewsbury Police Court, on Tuesday, the Yorkshire (Woollen District) Electric Tramways (Ltd.) were summoned for not taking out licences for their cars which run from Dewsbury to the Spen Valley district.

Mr. ELLIS (town clerk), for the prosecution, said that the company running steam trams to Batley paid for licences, and he contended that the Yorkshire company were equally liable. If they were entitled to exemption they should have had a special provision in their tramway order to that effect.

Mr. JONES, for the company, submitted that they were under no obligation to take out licences.

The Bench decided that licences should be taken out, and imposed a fine of 2s. 6d. and costs.

The Bench agreed to state a case.

Elmore's Trust (Ltd.)

The petition of a judgment creditor for winding-up this company has been directed to stand over till July 12.

National Electric Traction Co. (Ltd.)

On Tuesday Mr. Justice Buckley dismissed a petition for the winding-up of this company, petitioners' claims having been settled.

Electric Tramways Construction and Maintenance Co. (Ltd.)

The petition of Mr. A. J. Paine for winding-up this company, and certain summonses relating to the same company, were ordered by Mr. Justice Buckley on Tuesday to stand over to July 12.

Duties on Catalogues.—We have previously recorded the decision of the Australasian authorities to impose a duty upon trade catalogues imported into the Commonwealth. It having been intimated that Canada and India are likely to impose such a duty, a meeting of the Manufacturers' Section of the London Chamber of Commerce was held on the 9th inst. to discuss the subject. It was decided to impress upon the Agents-General for the Commonwealth States, and upon the representatives in this country of Canada and India, that the free admission of trade catalogues and circulars into those countries was likely to be of mutual benefit to trade within the Empire, and to assist in its development. The remission of any such duty was, therefore, advised.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Weymouth and Melcombe Regis Corporation require an electrical engineer to take entire charge of their electricity supply department. Commencing salary £250, increasing by annual increments of £25 to £300 per annum. Applications to the town clerk (Sir R. N. Howard) by June 8. See also advertisement.

The Gas and Electric committee of Belfast Corporation require an electrical distributing assistant. Salary £200 per annum. Applications by May 31 to city electrical engineer, Mr. Victor A. H. McCowen. See advertisement.

Middlesex Education committee require an electrician to be responsible for the gas engines and dynamos at polytechnics in the county and for the care of electrical plant, also to assist in taking some of the electric light wiring classes. Salary £150 per annum. Applications to Mr. B. S. Gott, Guildhall, Westminster, by June 1.

Southampton Corporation require a superintendent of works for reconstruction of tramways for electric traction. Applications by 9 a.m. 24th inst.

The Governors of the Northern Polytechnic Institute, Holloway, London, N., invite applications by June 8 for the position of head of the engineering department. Commencing salary £275 per annum.

Birmingham Public Works committee require a track engineer (£5 to £6 weekly) and an inspector (£4) for their tramways. Applications by 31st inst.

The Senate of the University of London invite applications for the professorship of civil and mechanical engineering, vacant by the retirement of Prof. W. C. Unwin. Salary £1,000 per annum. Applications by June 7.

A demonstrator and assistant lecturer in physics is required for University College of South Wales and Monmouthshire (Cardiff). Applications by June 20.

An assistant lecturer in mathematics and physics is required for the Birkbeck College, London. Applications by June 8.

Mr. A. J. Margetson, A.M.I.Mech.E., has been selected from a large number of applicants for the post of additional lecturer in the engineering departments of the Merchant Venturers' Technical School, Bristol:—

Mr. Margetson received his preliminary education in the secondary school of the college, proceeding to the adult day classes by means of a Bristol City Scholarship. He passed through his college career with success and gained the associateship of the college in electrical engineering in 1894; he then entered the Bristol Wagon Works, where he remained for six years, returning to the college as a junior teacher in 1900. Mr. Margetson is a silver medallist of the City and Guilds of London Institute.

Mr. J. Fereday Glenn has been appointed manager of the Horndean Light Railway.

Mr. H. M. Sillar, of Belfast, has been appointed mains engineer to the Yorkshire Electric Power Co.

Mr. F. H. Eberl, of the Windsor Electrical Installation Co., has been appointed assistant electrical engineer at Aldershot.

Mr. C. H. Allin, of the supplementary establishment, secretary's office, G.P.O., London, has been appointed Director of Posts and Telegraphs in the Federated Malay States.

EDUCATIONAL NOTICE.

East London Technical College.—A course of five lectures on "Polyphase Work," with special reference to three-phase power transmission, will be given by Mr. J. T. Morris, A.M.I.E.E., Assoc.Inst.C.E., at this college, on Monday evenings (8 to 9:30 p.m.), commencing May 30. A course of lectures on "Electric Traction Principles" will also be given on Fridays (8 to 9:30 p.m.) See also advertisement.

Accrington.—The accounts of the electricity department for the year ended March 31 have been issued, and show total capital expenditure £44,527. 18s. 3d., increase £2,011. 15s. during the year. Loans outstanding were £40,323. 18s. 3d., and the equated period for the repayment of the whole amount is 23·9 years. 243,309 units were sold during the year at an average price of 3·3d. per unit, an increase of 78,425 units on the previous year, when the average price was 3·58d. Gross revenue showed a surplus of £1,919. 9s. 8d., but interest and sinking fund instalment required £2,795. 13s. 6d., leaving a deficit of £876. 3s. 10d., compared with a deficit of £1,323. 11s. 2d. the previous year. The income included £92. 2s. 10d. for hiring electric motors separately purchased last year out of the rates. The total maximum supply demanded was 194kw.

Arc Works Engineering Society.—The first annual meeting was held last week, Mr. S. L. Brunton presiding. It was reported that The membership is now 122, and that there is a balance in hand of about £18. The average attendance at the lectures and visits to engineer-

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ing and electrical works had been 42. Col. Crompton, C.B., was re-elected president, and Mr. Brunton was appointed chairman of committee. Mr. T. M. Mundle was elected hon. sec. in place of Mr. C. Crompton, resigned, and Mr. L. O. Ilbert assistant secretary.

Barrow-in-Furness.—The Council have fixed the charge for current for motive power at 2½d. per unit for the first 2,000 units per quarter, 1¾d. for the next 2,000 and 1½d. per unit for all current in excess of 4,000.

Benwell.—The District Council have applied for sanction to a loan of £5,000 for laying electric lighting cables.

Berlin Tramway Strike.—It is stated that about 1,200 employés of the Berlin Tramways Co. are out on strike.

Bermondsey (London).—On Tuesday the accounts of the electricity undertaking for the year ended March and the estimates for the present year, were submitted to the Council.

During the past year the capital expenditure was £25,014, making the total £69,266. Receipts were £7,974, including sale of current to private consumers, £3,964, public lighting £3,149, wiring consumers' premises £755. The annual expenditure was £5,820, including fuel £2,088, management expenses £1,111, wages at generating station £639, repair and maintenance of public lamps £569, rent, rates and taxes and insurance £459. After payment of £1,588 for interest and £56 for instalments of principal the balance was £509. 199,515 units were supplied for public lighting and 330,225 were sold to private consumers, against 100,165 and 183,993 units in 1903.

For the 12 months to March 31, 1905, it was estimated that the expenditure would be £10,239, income £12,091. The estimates were approved. The present scale of charges is to be continued. £500 of the £509 surplus on the year's trading has been transferred to reserve.

The salaries of Mr. Vincent, the electrical engineer, Mr. Young, the chief clerk, and others have been increased.

Upon the recommendation of the Housing committee it was decided to have the electric light installed at an estimated cost of £260 in the staircases and courts of the dwellings now being erected.

Bournemouth.—The price to be paid by the Corporation for the undertaking of the Poole and District Electric Traction Co. will shortly form the subject of arbitration proceedings. The company claim £200,000.

Bredbury and Romiley.—The Board of Trade are urging the Council to carry out the provisions of their electric lighting order, 1900. A committee has therefore been appointed to approach Stockport Council with a view to obtaining a supply of current for the district.

Brighouse.—There was a deficit of £572. 6s. on the past year's working of the electricity department, including £200 allowed for assisting to wipe out a bank overdraft of £2,581. 11s. 3d. A scheme for extending and improving the station plant is under consideration.

Burslem.—The Council will apply for powers to supply electricity in bulk in Tunstall if the Tunstall Council support their application.

Bury (Lancs.)—The revenue of the Electricity department was £8,010 for the past against £6,170 in the previous year, the output being 672,911 units, compared with 424,993.

The tramway manager is seeking from the Postmaster-General permission to attach letter boxes on the Corporation tramcars.

Burton-on-Trent.—The accounts of the electricity supply and tramways departments for the year ended March 31 have been issued.

Capital expended on electricity supply is £6,200. Revenue from sale of current was £8,594, meter rentals and miscellaneous receipts £368—total £8,962. 8s. 10d., increase £3,442. 1s. 1d. Gross profit amounted to £4,650, or 7·02 per cent. on the capital. Interest absorbed £1,869 and sinking fund £1,583, leaving the net profit £1,197. 11s. 1d., which has been added to reserve, now amounting to £1,385. 14s. 678,020 units were sold, the total costs per unit being 1·52d. The average price obtained was 4·86d. per unit for private supply, 1·45d. for traction (362,827 units were supplied for this purpose during eight months of the year under review) and 3d. for public lighting, a mean of 3·02d. The equivalent of 26,390 8 c.p. lamps was connected at the end of the year. The maximum load was 370kw. and the load-factor 12·5. Plant capacity at the end of the year was 1,110kw. The increase in demand is sufficient to require an additional 500kw. set before next winter. The number of consumers is 339, an increase of 21·1 per cent., and the increase in units sold for light and power is 21·7 per cent. Motors have increased from 64·5 H.P. to 115·5 H.P.

The total receipts of the tramways (eight months' working) were £11,943. 16s. 8d., parcel traffic bringing in £43. 4s. 9d. Operating costs were £9,335. 5s., or 78·16 per cent. of revenue, interest on stock was £1,117. 6s. 5d., and sinking fund £772. 16s. 2d., leaving net profit £718. 9s. 1d. 282,378 car-miles were run and 2,566,134 passengers carried, the number of passengers per car-mile being 9·08. Traffic revenue per car-mile was 9·84d., or 1·84d. per passenger, total revenue per car-mile 10·15d. Power cost per unit was 1·45d., and the total costs per car-mile 7·57d., but this figure includes considerable initial expenses, tools, sundry stores, &c.

Canterbury.—The accounts of the electricity department for the past year show capital expenditure £54,028. 9s. 4d., increase of £1,780 for the year.

Receipts from sale of current for private lighting (including wiring) were £4,939. 7s. 4d. Public lighting receipts were £1,858. 9s. 2d. Meter rentals, &c., brought the total to £7,135. 15s. 2d. Generation expenses were £1,813. 9s. 9d., cost of distribution £121. 14s. 9d., maintenance of public lamps £207. 19s. 6d., rents, rates and taxes £249. 7s. 10d., management expenses £639. 14s. 5d, making, with incidental charges, a total expenditure of £3,086. 3s., leaving gross profit £4,049. 12s. 2d. to meet interest (£1,484. 2s. 11d.), sinking fund instalment (£1,753. 0s. 6d.), leaving (after taking credit for £99. 7s. 10d. from previous year) a balance of £911. 16s. 7d. to be carried forward, compared with £99. 7s. 10d. in the previous year. 489,659 units of current were generated, 238,445 were supplied to private consumers and 163,133 to public lamps. The total maximum supply demanded was 339kw.

Cardiff.—The borough electrical engineer and tramways manager (Mr. Arthur Ellis) reported to the Lighting committee on Monday that the negotiations with Sir W. T. Lewis were proceeding satisfactorily, and he hoped to be able to announce next month that the offer of the Corporation had been accepted to supply electrical current to the Cardiff Railway Co.'s premises at Bute Docks. The consumption would be equal to 5,000 H.P., and the extra revenue to the Corporation would be between £25,000 and £30,000 per annum. There are now 1,012 consumers connected to the mains, with the equivalent of 110,341 8 c.p. lamps.

Chesterfield.—In his report on the second year's working of the electricity department the borough electrical engineer (Mr. R. L. Acland) states that large extensions have been carried out during the year.

The capacity of the station was increased by one-third, the increase in capital expenditure on account of extensions being £10,051. Further extensions had been put in hand, and these would probably provide for their requirements for two years. Consumers increased from 221 to 318. The demand for power was increasing rapidly, 43 motors of a total of 223 H.P. being connected; 17 motors of 73 H.P. were on hire from the department. The maximum demand system of charging is not in much favour with the majority of consumers, and Mr. Acland advises that the charges for private lighting for the 12 months ending March 31, 1905, be for all classes of premises under two rates, a maximum demand of 6d. and 3d. per unit (as at present), with a rebate of 10 per cent, and a flat rate of 4d. The net balance to be carried to reserve was £1,080, which, with the sum brought forward, now amounts to £2,054 for the first 2½ years' working.

Colwyn Bay.—The estimates of the electric lighting department were presented to the Council on Tuesday, the estimated profit for the current year being £385. The charge for current for public lighting has been reduced from 4½d. to 4d. per unit.

Crediton.—The Council have sanctioned the use of overhead wires for the supply of electric current in the district.

Dalkeith.—As the Council refuse to guarantee a minimum number of hours during which they will take current for public lighting from Crompton & Co., the lessees of the Council's electric lighting powers, Messrs. Crompton, who propose 3,000 hours per annum as a minimum, remind the Council that under an agreement of February, 1902, they are bound to enter into a contract for 10 years' lighting upon terms to be agreed or settled by arbitration.

Darlington.—The official inspection of the electric tramways will take place after Whitsuntide.

Denmark.—It is announced that the first electric railway in Denmark is to be constructed on the island of Zealand. The line will be 56·51 miles in length, and will extend right across the island.

Devonport.—The income of the electricity undertaking for the past year was £12,412, against £9,441 in the previous year. The actual profit on the year's trading was £1,915, but the deficits from previous years (£2,478. 14s. 9d.) and £556 disallowed by the Local Government Board, turned this into a deficit of £1,119.

Durban (Natal).—The Council recently decided to supply private consumers with electric current for power at £5 per horse-power and 2d. per unit, or at a uniform charge of 4d. per unit. Consumers under the former system are to receive 15 per cent. discount on all current consumed beyond 3,000 up to 10,000 units per month, and 35 per cent. on current consumed beyond this quantity.

Durham.—The Board of Trade have struck out the clause agreed upon by the promoters of the Bishop Auckland, Shildon and Spennymoor tramways and the Durham County Council for the payment by the former of an annual way-leave of £50 on the ground that the proposal is contrary to practice.. The promoters being willing to pay the amount, it was decided to draw up a formal agreement.

On the motion of Councillor Hopper the Council have protested against the granting by the Board of Trade of a provisional order for electricity supply to a company in the eastern part of the county for 42 years, and have requested local Members of Parliament to resist the confirmation of the order, as the Council have under consideration a scheme of electricity supply for the county.

East Barnet.—The Council have sealed a 14 years' agreement with the North Metropolitan Electric Power Supply Co. for electricity supply.

Edinburgh.—The Electric Lighting committee recommend the Council to reduce the charge for electric current for private lighting from 3¾d. to 3½d. per unit.

Electric Driving of Works.—Messrs. John Rogerson & Co. of Stanner's Close Steel Works, Wolsingham, have placed a contract

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with Bruce Peebles & Co. for the supply and erection of generating plant and electric motors for the electric lighting and driving of their works. There will be three Lancashire boilers, two 150kw. high speed engines direct-coupled to polyphase generators, 13 motors, 60 arc lamps, &c.

Electric Power in Dockyards.—A site has been acquired near Priddy's Hard for the Admiralty generating station for the supply of electric power and light for all the workshops and dockyard at Portsmouth, Priddy's Hard, the Royal Clarence Victualling Yard, Forton Barracks and the Government buildings at Gosport.

Electricity in Gold Mining.—At the recent meeting of the Um Rus Gold Mines of Egypt (Ltd.), the chairman (Mr. J. Harvey) said the milling, &c., plant, which had been ordered, would be driven electrically, this being found to be more economical than other systems. The winding and compressing plants would also be operated by electric power.

Exhibition at Wimbledon.—There was opened on Wednesday, at the Worpole Hall, Worpole-road, Wimbledon, Surrey, by Mr. G. L. Apperson, J.P., I.S.O., chairman of the District Council, an interesting and instructive exhibition of electrical apparatus, fittings, accessories, &c., which have been brought together under the supervision of Mr. H. Tomlinson-Lee, the energetic chief electrical engineer to the District Council. The object of the promoters of the exhibition is, of course, to demonstrate the many domestic uses to which electricity can now be applied, and the efficiency and beauty of the fittings and fixtures which can be supplied to meet public requirements. Support has been accorded to the project by many local firms of electrical engineers and contractors, as well as by prominent manufacturing and supply houses. In the former category may be mentioned Messrs. P. J. Buddery & Co, Spearing and Stark, Whitehead Bros., Oates & Co., A. How & Co., and the makers of the Foster patent hot-wire arc lamp (Messrs. Foster & Co.). Messrs. Whitehead & Co. have a fine exhibit, embracing a large variety of plain and ornamental electric light fittings, electric heating, cooking and ventilating apparatus, and useful domestic sundries such as radiators, cigar lighters, &c. At Messrs. Buddery's stand are shown electric lighting and heating fittings and apparatus and some small motors driving domestic and workshop machinery. Motors, too, form the principal attraction at Messrs. Spearing and Stark's stand, and motor-car appliances at that of Messrs. Oates & Co. Electric novelties and lighting fittings are well displayed by Messrs. How & Co. Messrs. Foster & Co.'s display of arc lamps, &c., merits more detailed notice, but it will suffice to say here that the Foster lamp has an interest for supply station engineers beyond, perhaps, any other exhibit at Wimbledon. These lamps are shown running on both continuous and alternating-current circuits, and the method of changing over from one to the other circuit is shown. Amongst the manufacturing and supply houses represented are the Langdon-Davies Electric Motor Co. (a good show of motors, some employed driving boot-making and finishing machinery, band and circular saws, &c.); the Simplex Steel Conduit Co. ("Simplex" fittings of all kinds); the Dowsing Radiant Heat Co. (luminous radiators, electro-medical appliances, and a separate room equipped with appliances for demonstrating the Dowsing radiant heat and light treatment. A very interesting exhibit); the Conduit and Insulation Co. (conduits, switches, &c.); the General Electric Co. (the actual manufacture of "Robertson" lamps is shown, and a large exhibit of telephones, electric light fittings, apparatus, &c.); the Linolite Co. (a specially constructed stand designed to demonstrate the special adaptability of Linolite strip and apparatus to shop window illumination, &c. This also is a very attractive exhibit). At the stand of the Sir Hiram Maxim Electrical and Engineering Co., besides show cases of Maxim lamps and fittings, arc lamps, &c., there is given a practical demonstration of Hunter's patent electric candle lamp. The inventor is well known in electrical circles, and his system is the nearest approach to real candle lighting in appearance ever yet placed upon the market. We have previously mentioned this system in describing a list sent out by Messrs. Bonnella & Co., of Mortimer-street, London, W. At Wimbledon the demonstration is very effective and is calculated to bring this system of table decoration prominently to the front. We understand that large orders are being filled for the wire-woven felt and accessories which are alone required in connection with the system where electric current is available. Messrs. Dick, Kerr & Co. have sent an exhibit in the form of a model electric tramcar, which naturally attracts attention in a district so far unprovided with this popular means of transit. The exhibition will remain open, we understand, until May 28.

Fatality.—The inquest into the circumstances attending the death of a child named Irving, who, as stated in *The Electrician* last week, was killed on the North-Eastern Railway, was held on Thursday last:—

The father of the child said that his son's left leg was burnt to the bone and his cheek singed, but as there was a smile on the child's face witness thought he must have been killed instantly. The line was not, he considered, adequately protected, being only separated from the road by an open horizontal fence, which afforded no more protection than under the old system.

The train driver, who found the boy, said he had undoubtedly been killed by electric shock. He (witness) had never seen anyone on the line there previously.

A verdict of accidental death was returned, the jury recommending that more protection should be afforded by the company, on whose behalf it was stated a military fence had been erected in some places on the line.

Faversham.—The Municipal electricity works are approaching completion, and a formal inauguration ceremony is being arranged.

Finchley.—For the half-year ended March 31 there was a deficit of £300. 18s. 4d. on electric lighting account.

The electrical engineer (Mr. E. Calvert) having reported to the Council that the continued drought of the past few weeks was causing inconvenience in connection with the water supply at the generating station, the Electricity committee recommended that Mr. Calvert be authorised to expend £25 in making trial borings for water. This recommendation was approved, as also was one in favour of wiring the new workmen's dwellings at a cost of £245 and to purchase prepayment meters for these buildings for £250.

Fremantle (W. Australia).—The ratepayers of Fremantle and East Fremantle have authorised the local authorities to raise £100,000 for electricity supply works and electric tramways. The consulting engineers (Messrs. Shaw and Diamond) estimate the annual receipts from the tramways at £19,850 and from electricity supply at £11,293. 15s., the net profit being £3,132. 15s. 4d.

Fulham (London).—The accounts of the electric lighting undertaking are reported to show that the previous transfer from the general rate account was not expended by an amount of £1,176 owing to the unexpectedly heavy consumption of electric current during the March quarter. This sum, together with the saving on the previous rate provision (£1,665), gave a surplus of £2,841. The Borough Council have applied £2,800 of this sum to forming a machinery, maintenance and reserve account.

The electrical engineer (Mr. Arthur J. Fuller) has been authorised to have the Western Hospital connected to the mains.

German Electrical Enterprise.—In a recent report upon German trade and industry it is stated that recent amalgamations in the incandescent lamp branch has led to an improvement in the industrial position, the demand for lamps having increased and prices gradually improved. Amalgamations in other branches, it is claimed, have been similarly successful. Some anxiety is, however, expressed as to how the enlarged works resulting from these combinations are to be kept in full and lucrative employment. It is urged that there is little prospect of the installation of new central supply stations, and that the demand for electric tramways is on the wane, from the fact that it has been found that towns with less than 40,000 inhabitants do not provide remunerative traffic for the tramways. There are at present only nine towns in Germany, with 40,000 inhabitants and over, which remain unprovided with electric tramways. The hopes of the industry are stated to be in the direction of the supply of plant and apparatus for the mining industry and in the conversion of existing short steam railway lines to electric traction.

German Exports—The exports of German machinery for 1903 were of higher value than for any year since 1900, and exceeded in number any previous return. 13,575 machines were exported, valued at £1,086,000. The export of turbines was on a largely extended scale, the total being 1,985 machines. There was a small decrease in boiler exports and also in machine tools compared with 1902.

Golborne.—Lancashire Electric Power Co. have informed the District Council that they will be able to supply electric current in January, and have asked the Council to take a supply in bulk or to consent to direct supply to private consumers by the company.

Gravesend.—The Council have fixed the charge for electric current for power at 5d. per unit for the first hour's maximum demand and 1d. after. Inquires are being made by the Council on the subject of "free" wiring and prepayment meters.

Halifax.—The Tramways committee recommend the Council to construct in the near future a tramway from Brighouse to Bailiff Bridge, and to again apply for powers for a line down Salterhebble Hill, with a view to constructing a line to Elland, via West Vale.

Hampstead.—The Lighting committee are reporting upon systems of charging for electric current. The income of the electricity department for the quarter ended Lady-day was £57,710. 12s. 6d., compared with £47,332. 13s. 5d. for the corresponding period of 1903.

Hanley.—Plans for extending the Potteries Electric Traction Co.'s lines have been approved by the Council.

Harrogate.—The following reductions in price of electric current are recommended by the Lighting committee:—Flat rate, from 6d. to 5d. per unit for lighting; demand indicator system, 6d. and 2d. (instead of 6d. and 3d.) for lighting and 1½d. (instead of 2d.) for power.

Hornsey.—The Electricity supply committee have addressed a communication to builders and property owners in the borough on

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the question of wiring new buildings and premises. Arrangements have already been made for wiring 300 houses in course of erection.

Mr. G. H. Baker, has been promoted to the rank of station superintendent, and Mr. S. M. Teal, wiring inspector, has been appointed distributing assistant.

Hotel Lighting.—In the published particulars relating to the new block of buildings occupied by the Savoy Hotel, London, prominence is given to the extensive and complete system of electric lighting which has been adopted. The wiring work for electric light, electric bells and telephones, has been carried out by Messrs. Strode & Co., the wiring throughout being on the conduit system, solid-drawn steel tubes screwed together being employed. There are over 100 main distributing switchboards of the latest design, the switches being marble mounted and enclosed in cast-iron cases. The system throughout is fireproof and watertight. There are over 150 miles of cables and wires drawn into the conduits for lighting over 6,000 lamps. The electric bell system, which is most elaborate, comprises over 2,000 pushes. The electricity generating station has been equipped by the British Westinghouse Co., the plant, &c., put in by this company including 21 electric passenger, luggage and service lifts and a complete system of artificial ventilation electrically operated. The generating plant consists of five turbo-generators of a total capacity of 900kw. The boilers are by Messrs. Babcock and Wilcox, who have also supplied boilers for heating the water for baths and other purposes, heating the hotel and for cooking. The boilers are fitted with Babcock and Wilcox chain-grate stokers, and the furnaces are fed by means of coal-conveying apparatus.

Hove.—The Council have referred back the recommendation of the Electric Lighting committee to take electricity in bulk from the Hove Electric Lighting Co.

Huddersfield.—The Council decided on Wednesday to reduce the charge for electrical energy for power to 2d. per unit for the first two hours and 1d. afterwards. If a consumer guarantees to use a motor at half its full load for eight hours per day (300 days per annum) the charge for current will be 1d. per unit.

International Electric Power.—It is stated that official permission has been granted to an Italian firm to import into Italy, free of duty, electric energy generated at a station on Swiss territory and transmitted over cables into Italy. In granting this permission the Italian Minister of Finance is stated to have intimated that no provision has been made in the Italian tariffs for the taxing of imported electric energy.

Islington (London).—In August last the Council made an order reducing the permanent staff of the electricity department to 86 men, at a total weekly wage of £154. This was found insufficient and temporary hands had to be engaged. At present (including temporary hands) 107 employés are engaged and the weekly wages bill is £195. The Lighting committee have increased the permanent staff to 108 and the wages to £199 a week; and the consideration of the suggestion of the electrical engineer (Mr. Gay) that a graduated scale of pay be adopted for the staff generally has been adjourned for the present, except in the case of the technical officers, who are already placed upon a scale, and whose maximum salaries the committee consider should be increased.

Keighley.—The Council have decided to use 21 250 c.p. Nernst lamps for the lighting of Cavendish-street, estimated to cost £96 per annum.

Kings Norton and Northfield.—An inquiry was held on Tuesday into the application of the Council for sanction to borrow £9,000 for refuse destructor works.

Kingston-on-Thames.—There is a net profit of £60 on the past year's working of the electricity undertaking

Leeds-Guiseley Tramways.—A proposal made by the Leeds Tramways committee for the extension of the Leeds municipal electric tramways to Guiseley is under consideration.

Leeds.—The accounts of the electric lighting department for the year to March 25 have been submitted to the Lighting committee, and show income (after providing for bad and doubtful debts, &c.), of £75,671. 10s. 6d. (against £56,013. 15s. 11d. in previous year) from sale of electricity, including £65,656. 15s. 2d. from private lighting, £1,107. 6s. 3d. from street lighting, and £8,907. 9s. 1d. from power and heating. Generation expenses were £14,067. 8s. 7d., cost of distribution £2,965. 8s. 6d., rents and rates £1,951. 6s. 7d.; and management expenses came to £5,091. 3s. 4d., insurance £308. 6s. 2d., expenses incidental to raising and administration of loans £1,028. 19s. 6d., sundry charges incidental to change of voltage and of system of supply £770. 16s. 3d. The gross profit was £49,537. 7s. 1d. (against £36,659. 9s. 4d.), and, after paying interest (£26,087. 5s 4d.) and putting aside £20,019. 11s. 8d. for redemption of debt, the surplus profit was £3,430. 10s. 1d., against £1,383. 11s. The total capital expenditure is £752,508. 16s. 3d., an increase of £80,097. 11s. 8d. for the year. 6,271,186 units of electric current were sold at an average price of 2·90d. per unit, compared with 4,448,650 units at an average price of 3·02d. in 1902-3. The expenses per unit, including interest and sinking fund were 2·77d., compared with 2·95d. in the previous year, the surplus per unit being 0·13d. and 0·07d. respectively.

The receipts of the municipal electric tramways were £280,562. 16s. 9d., against £265,010 16s. 7d. in 1902-3. After deducting expenses there was a gross profit of £131,667. 18s. 2d., compared with £119.885. 18s. The net profit was £85,312. 14s. 4d.

Leyland.—The Council have applied for an extension of time for carrying out their provisional electric lighting order, which expires in June.

Lichfield.—The Board of Trade have deferred until March 31 of next year consideration of the Council's application for a supplementary provisional order to enable them to supply electricity outside the city boundaries.

Light Railways.—The report of the Light Railway Commissioners on their proceedings for the year 1903 and the report of the proceedings of the Board of Trade under the Light Railways Act, 1896, have been issued.

On Dec. 31, 1902, 16 orders were before the Board for confirmation; 12 of these were confirmed during the year, one was withdrawn and three are held over. Thirty-nine fresh orders were submitted by the Commissioners for confirmation, and objections were lodged to most of them. Twenty-six of these orders were confirmed, making 38 orders in all during 1903. Confirmation was refused in one case and the remainder (12) were under consideration on Dec. 31, but two have since been confirmed. Since the last report the Treasury have conditionally agreed to make advances of £945 for the Dornoch scheme, in addition to £14,000 previously promised, and of £2.000 for the Elsenham, Thaxton and Bardfield light railway, in addition to £19,250 previously promised. Since the passing of the Light Railways Act, 459 applications (including amending orders) have been lodged with the Commissioners; 255 orders were submitted to the Board for confirmation, 11 applications have been approved and are under settlement and 169 applications have been rejected or withdrawn. Six applications have been deferred and 16 (out of 17) new applications made in November last remained to be considered at Dec. 31.

The Light Railway Commissioners further considered on Tuesday the scheme for the construction of the proposed Hayling Island light railway and conveyor bridge.

Blackpool and Garstang Light Railway Co. give notice of intention to apply for an order to extend the time limited by their 1901 order for the completion of the railways, &c., and to change the name of the company. Objections to the secretary, Light Railway Commission, 54, Parliament-street, London, S.W.

Liverpool.—The resident electrical engineer (Mr. Alfred Clough) reports that the supply of electrical energy for lighting, power and tramways during March amounted to 2,664,467 units, compared with 2,178,473 in the corresponding period of last year. The units supplied from Jan. 1 to March 31 were 7,646,089, against 6,332,658. The Electric Power and Lighting committee recommend that application be made for sanction to the borrowing of £400,000 further for extensions.

London County Council.—At Tuesday's meeting the Finance committee reported having received an application for a loan of £5,000 from Woolwich Council for assisted wiring of consumers' premises for electric lighting, and the letting electric motors and other appliances on hire. Woolwich is the only metropolitan council empowered to supply and let on hire these fittings. The Borough Council had not supplied information as to how the £5,000 would be applied, and therefore the committee only recommended that £1,000 be lent pending further particulars, the period of repayment to be spread over eight years.

Tramway Works.—It was agreed to expend £22,190 on capital account in the erection of tramway car sheds at Camberwell. A supplemental estimate of £4,500 in connection with roadwork for plate-laying for the Tooting to Westminster section of the Council's tramways was approved; and it was resolved to expend £1,500 in connection with the erection of car sheds, &c., for the proposed electrification of the northern tramways.

It was reported that Mr. A. P. Trotter (Board of Trade) had inspected the Council's sub-stations at Camberwell and New Cross to which current at high pressure is supplied for working portions of the tramways, and a report had since been received containing certain recommendations as to the means to be taken for insuring the safety of persons using the buildings and also the prevention of fire.

Electrification of the Northern System of Tramways.—The Board of Trade has expressed approval in principle of the proposed underground conduit system of electric traction for St. John-street, St. John Street-road and Rosebery-avenue, and for the reconstruction of the first sections (about 22¼ miles of single line) of the Council's northern tramways. The Board's final approval is withheld until certain outstanding questions of detail are settled.

Local Authorities and the Supply of Electric Fittings.—The Highways committee reported on the question of London local authorities being empowered to supply fittings, &c., for electric lighting and to borrow money for that purpose, and recommended that application be made to Parliament next session to enable this to be done.

Lowestoft.—The Council have adopted a flat rate of 5½d. per unit for electric current for private lighting.

Lynn.—Sanction has been received to the borrowing of £7,979. out of £11,500 applied for, for electric lighting extensions. There

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are at present about 470 private consumers connected, representing the equivalent of about 19,000 8 c.p. lamps.

Maidstone.—The net profit on the electricity undertaking for the March quarter was £317. 14s. 7d., after providing for all charges.

Middlesbrough.—An inquiry was held on Tuesday into the application of the Corporation to borrow £20,000 for electric lighting extensions.

National Electrical Contractors' Association.—The annual general meeting of the Northern Section was held at Leeds on Saturday. The president (Mr. E. C. Wallis, of Leeds) was in the chair and representatives were present from Newcastle, Leeds, Huddersfield, Manchester, Blackburn, Liverpool. In moving the adoption of the report and balance-sheet,

Mr. Wallis said there were at present 64 members. The main work done had been the perfecting of the scheme for the reconstitution of the Association as an incorporated body, and the final settlement of the terms of the agreement with the National Electrical Manufacturers' Association, which had been in operation since Jan. 1, and which had already been of very material benefit to the members. Several bills, involving encroachments on private electrical enterprise had been successfully opposed. The question of the education of workmen was discussed, and schemes for the provision of correspondence classes and co-operation with local education authorities were referred to the Council for consideration. A survey of the work done in opposing the abuse of municipal trading was presented. Special reference was made to the powers asked for by many Corporations to supply, fix, let on hire, &c., electrical apparatus, wires, and fittings on the premises of consumers, and it was pointed out that it was not to the best interests of the trade in general to oppose these, but to ensure the insertion of the "Ealing" clause, which provided that the Corporation might adopt such schemes, provided the actual work was carried out through a bona fide electrical contractor. The question of a standard specification for wiring of buildings was brought forward and Mr. Rawlings (London) reported that the specification was in the press, and would soon be available for the use of members.

The new chairman is Mr. J. McDermott (Manchester).

At the dinner given on Friday by the Leeds Branch of the Northern Section of the Association Mr. E. C. Wallis presided, and was supported by Mr. P. N. Hirst, chairman-elect of Leeds branch, and representatives from Leeds, Bradford, Huddersfield, Sheffield, Nuneaton, Newcastle, Liverpool and London.

Newcastle-on-Tyne.—The annual report of the general manager of the Corporation tramways (Mr. Le Rossignol) states that the total receipts for the year ended March were £185,027, total expenditure £121,545.

The car mileage was 4,059,907. Interest and sinking fund absorbed £51,534, and the balance was £8,991, compared with £18,000 last year. The estimated income for next year is £209,700, expenditure £139,125, and, after payment of interest and redemption, the estimated balance is £5,841. Mr. Le Rossignol recommends the abolition of ½d. workmen's fares, as otherwise it will be impossible to realise the income per car-mile assumed in making up the estimates, and the balance of receipts over expenses and capital charges will be reduced, if not extinguished. Mr. Le Rossignol states that it costs about 1d. to carry a passenger 1½ miles, and every passenger carried that distance for ½d. results in a dead loss to the tramways. 39,715,120 passengers were carried last year.

The Welbeck-road tramway extension was opened for traffic yesterday.

Newton Abbot.—The Board of Trade have refused to insert in the Urban Electric Supply Co.'s provisional electric lighting (extension) order a clause embodying the agreement between the company and the Council fixing the price of current at 7d. instead of 8d. per unit for a certain number of hours per quarter and 3d. instead of 4d. per unit when the maximum number of hours is reached.

Northampton.—The directors of the Northampton Electric Light and Power Co. have refused the offer of the Council to purchase the company's undertaking for £100,000 on condition that payment was deferred for four years, interest being payable meanwhile at 3½ per cent.

North-Eastern Railway.—A 15-minute service of electric trains is now in operation on this company's line between Newcastle and Tynemouth.

Norwich.—The receipts of the electricity department for the year ended March amounted to £26,972, against £28,732 in 1903 and £23,192 in 1902. 1,819,708 units of electric current were sold, against 1,481,179 in the previous year. The year's working left a trading balance of £15,147. 10s., out of which interest (£8,030) and sinking fund instalment (£3,527) have been paid.

Mr. E. Wild, chairman of the Electricity committee, on Tuesday, said the balance to credit of the committee at the end of their first year's operations as a municipal undertaking was £4,432, and this, with £5,365 from the previous year, they proposed to form a suspense account for the payment of special charges, including cost of obtaining their electric lighting act, of changing the pressure from 220 to 440 volts, &c. The net result was a balance of £4,432 to the good, and he knew of no corporation or company that had shown a better result in the first year of trading.

Obituary.—The death has occurred of Mr. Wm. Hy. Robson, of the firm of Maund and Robson, electrical engineers, of Corporation-street, Southport. Mr. Robson was only 41 years of age.

Overhead Telephone Wires.—Harpenden Council have reiterated their objection to the erection of overhead telephone wires by the Postmaster-General.

Paisley.—The first section of the electric tramway system was officially inspected on Friday last.

Penge (London).—At the last Council meeting a suggestion was made that public electric lighting should be adopted. The clerk to the Council said the provisional order for the district owned by a company had expired, and the Council were now entitled to ask for its revocation.

Plymouth.—The annual returns and estimates of the tramways and electricity undertakings have been issued.

On the tramways the total expenditure for last year was £27,960, total income £31,993. The estimates for the current year are: Expenditure £32,644, income £33,808. The electricity accounts show an expenditure of £18,246, income £19,165, leaving a profit of £919, which has been added to reserve. For the current year expenditure is estimated of £19,487, and income at £20,700, an anticipated profit of £1,213. Last year £2,276 was also applied to wiping off arrears of or suspended sinking fund, in addition to the annual sinking fund charge of £1,680.

Poplar (London).—The Electricity committee have decided to adopt raising and lowering gear for trimming arc lamps in substitution of tower ladders at a cost of 60s. per lamp (total £960). The net saving (after meeting interest and repayments of capital) will be £364 per annum.

Portsmouth.—The salary of the tramway manager (Mr. W. R. Spaven) has been increased from £350 to £400, with an ultimate increase to £500 a year by annual increments of £50.

Radcliffe.—The charge for electric current has been fixed at 5d. per unit for lighting and 2d. for power.

Rosario (Argentina).—Amongst the recent public works executed in this city is the placing underground of all the electric lighting and power supply cables.

Salford.—The municipal electric tramways are being extended to the Eccles boundary at Alderforest, making a junction with the South Lancashire system.

Sheerness.—The Sheerness and District Electric Power and Traction Co. have declined to water their tramway track. The Council have offered to provide a tank and water free of charge if the company will affix a sprinkler to the trams.

Shoreditch (London).—On Tuesday the Lighting committee reported having acquired certain property at £2,700 in order to avoid an action for alleged blocking of ancient lights and obstructing right of way and an injunction to restrain an alleged nuisance from vibration and noise caused by machinery and coal bunkers in the erection of the new generating station.

The Highways and Lighting joint committee reported having ascertained that the most effective way of determining the value of the steam supplied by the destructor to the electricity department is to take a special test of about 8 hours' duration of the generating plant when coal only was being used. At the end of the test the amount of electricity generated is noted, also the exact quantity of coal used, and the result was to fix the cost of generating electricity at per unit with coal as fuel, taking the average contract price of coal for the time being. This will provide the basis on which to calculate the sum due to the destructor for any particular period, as by deducting the units of electricity generated by coal from the total units generated in the period, the number of units which have been generated by refuse will remain, and these will be paid for at the rate determined by the special tests. At recent tests this worked out at 0·9d. per unit.

The report was adopted.

It has been decided to hold in the autumn an exhibition showing the application of electric power to the staple trades of the borough.

South London Tramways.—The arbitrator (Mr. H. Graham Harris) has issued his award in the arbitration as to the value to be placed upon the undertaking of the London, Deptford and Greenwich Tramways Co., acquired by London County Council. The amount is £91,363. The company's valuation was £105,000, and the Council offered £53,000.

Spain.—It has been estimated that there are at the present time in Spain over 1,000 works generating electric current for lighting and power, and that in these works over 2,000 generating sets are installed. A large proportion of the capital for this enterprise has been obtained from Bilbao. Many of the companies working these electricity undertakings are using water power. Two of the companies established in Bilbao are now engaged endeavouring to utilise 20,000 H P. from neighbouring waterfalls for the town supply. This is in addition to the steam plant used by five companies already engaged in supplying electric current in Bilbao. Besides

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these sources of supply, there has been a co-operative movement amongst certain consumers, and a generating station is actually being built for supplying members of these co-operators with electric energy.

In 1903 Bilbao imported 58,336 incandescent electric lamps, compared with 224,806 in 1902. Of the first-mentioned number, less than 400 came from the United Kingdom, the bulk being imported from the Netherlands.

The electric tramways at Hernani (6¼ miles in length) have been running since last summer with very satisfactory results. A double line of tramways is being constructed between San Sebastian and Irun.

Stafford.—The electric lighting accounts were passed by the Council on Tuesday. The income was £2,879, expenditure £1,332, gross profit £1,547 to meet interest and sinking fund (£1,852). The Gas and Electricity committee have placed £400 to depreciation fund for renewal of cables and £211 for renewal of battery. The total deficit is £963.

Standish (Lancs.)—The Council are in favour of the introduction of electricity supply, and negotiations are to be opened with the Lancashire Electric Power Co.

Stirling.—The Council have applied for sanction to a loan of £4,300 for electric lighting extensions.

Telephone across Lake Baikal (Siberia).—To facilitate traffic across Lake Baikal, which at this time of the year is always considerable, and owing to the war between Russia and Japan is now heavy, a telephone service is provided from shore to shore. The length of line is about 25 miles.

Telephone in Germany.—It is stated that the total capital cost of the German Federal telephone system to March last is £12,000,000. Wurtemberg and Bavaria are not included in this system, these kingdoms having their own independent telephone service. Of the telephone trunk lines the longest is between Berlin and Paris, 742 miles, Berlin to Budapest coming next with 612 miles, Berlin and Memel 593 miles, Berlin and Basle 577 miles. In addition to these there are the following connections all exceeding 300 miles in length: Hamburg to Copenhagen, Frankfort to Paris, Frankfort to Hamburg, and Berlin to Dortmund, Düsseldorf, Essen, Frankfort, Cologne, Munich, Gleiwitz and Konigsberg. The line between Berlin and Frankfort is the one most used, the number of communications averaging nearly 500 per day. Between Berlin and Cologne the number is 243, Berlin and Vienna 118, Berlin and Düsseldorf 116. Between Berlin and Paris the average is 65 communications daily.

Tynemouth.—An inquiry was held on Wednesday into the application of the Corporation to borrow £15,000 for electric lighting extensions.

The borough electrical engineer (Mr. C. Turnbull) explained the necessity for extensions of plant and mains. In the first year they had sold 482,000 units of electric current, in the second 820,000 and in the last year 1,103,000 units. In addition, they had motors equivalent to 525 H.P. connected, and applications for lighting and power were coming in rapidly. For Cullercoats they would take current in bulk from a local company, but they would lay down their own distribution system.

U.S. Exports.—In a recent return of the principal articles of export from New York during 1903, electrical instruments represent a value of £767,000, compared with £637,000 in 1902. Electrical machinery stands for £566,000, compared with £808,000 in 1902.

Water Power in France.—Application has been made to the French Legislature for sanction to employ the water power of a lake, 1½ miles wide, situated on a high point in the department of the Ardèche, for the purpose of generating electric power for lighting, not only St. Etienne, but all the principal towns in the department of the Loire. This scheme is in addition to the electricity supply project belonging to the municipal authorities of St. Etienne, and is promoted by M. Mallet, of St. Etienne. It is anticipated that 20,000 H.P. will be available from the Ardèche waters.

West Bromwich.—For the year ended March 31 the total revenue of the electricity department was £9,318. 5s. 11d., and the expenses (including interest and sinking fund) were £7,772. 8s. 8d., leaving a profit of £1,545. 17s. 3d. 1,253,188 units were generated, compared with 366,263 in previous year; 791,353 units were supplied to the tramways department, against 105,947; 271,096 to private consumers, compared with 178,308. The total maximum supply demanded was 788kw.; the capacity of the plant installed is 1,150kw. The total works costs were 1d. per unit, compared with 1·81d. in the previous year, and the average price obtained per unit sold was 2·02d., against 2·31d. No account is given of £423. 16s. 1d. received from free wiring installations and motors, as this is devoted to the reduction of capital expended on these items. The net profit will be carried forward as a reserve or depreciation fund.

West Ham.—The Education committee are obtaining tenders for wiring and fitting up the West Ham Park Schools for the electric light.

Wrexham.—An inquiry has been held into the application of the Council to borrow, among other sums, £5,600 for extensions of electric lighting cables.

Yarmouth.—For the year ended March the total receipts of the tramways were £7,876. 4s. 6d. and the expenses £5,988. 14s. 8d., balance £1,937. 9s. 10d. Adding balance due for previous year (less sinking fund arrears) and after paying £1,569. 19s. 9d. for interest and £582. 6s. 2d. for sinking fund, the balance was £191. 3s. 4d.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Exeter Corporation invite tenders for the construction of permanent way and paving (including copper bonding) of about 4 miles of tramway, single line, with passing places; overhead electrical equipment of lines and car-shed; supplying and laying insulated cables and stoneware conductors; and for supply and delivery of 12 double-deck single-truck motor cars. Specifications, &c., may be inspected but not obtained at the offices of the consulting engineer (Mr. J. Edward Waller, M.Inst.C.E.), 29, Great George-street, Westminster, S.W. Specifications, &c., can be obtained and plans inspected at the office of the city engineer and surveyor (Mr. Thomas Moulding), Municipal Offices, Southernhay West, and at the offices of the city electrical engineer (Mr. H. D. Munro), New North-road. An advertisement contains further particulars. Tenders to the town clerk (Mr. George R. Shorto), Southernhay West, Exeter, by noon June 9.

The directors of the *North-Eastern Railway Co.* invite tenders for telegraph apparatus and telegraph wire and line stores for six months ending Dec. 31, 1904. Further particulars are given in an advertisement. Forms of tender from the company's telegraph superintendent (Mr. C. H. Ellison), and tenders to the secretary (Mr. R. L. Wedgwood), York, by 9 a.m. June 4.

Tottenham Education committee invite tenders for providing and fixing fire alarm apparatus in each department of each of the provided schools in the parish of Tottenham. Plans, &c., may be obtained from the surveyor (Mr. W. H. Prescott), Coombes Croft House, 712, High-road, Tottenham. Tenders by noon May 30 to the clerk to the committee (Mr. W. Mallinson, Education Offices, Philip-lane, Tottenham. See also advertisement.

Callender's Cable and Construction Co., Hamilton House, Victoria Embankment, London, E.C., require 20,000 to 50,000 blue tiles delivered at Kilmarnock. See also advertisement.

The Scottish office of the *May-Oatway Fire Appliances (Ltd.)*, 49, Queen-street, Glasgow, invite tenders for wiring the installations set out in an advertisement. Plans and specifications can be inspected from 26th to 28th inst. at the Scottish office, and also at the London offices, 92-94, Paul-street, Finsbury, E.C. Tenders for the Coats' installation by noon 31st inst., and for the two Edinburgh establishments by 25th inst.

Handsworth Urban District Council invite tenders for the erection of a generating station. Bills of quantities and conditions of contract (after 27th inst.) from the clerk (Mr. H. Ward), Council House, Handsworth, near Birmingham. Drawings, specifications and conditions of contract can be seen at (but not obtained from) the offices of the architects, Messrs. Henman and Cooper, 19, Temple-street, Birmingham. Tenders to the Council House by noon June 8. See also advertisement.

Johannesburg Council invite tenders for insulated cables and bare overhead conductors and certain accessories. Specifications, &c., after May 30, from the consulting engineers (Messrs. Mordey and Dawbarn), 82, Victoria-street, London, S.W. Tenders must reach Messrs. Mordey and Dawbarn by noon July 4. An advertisement contains additional information.

Shanghai Municipal Council invite tenders for a concession for constructing and working about 24 miles of electric tramways on the trolley system in the streets of Shanghai. Particulars from the Council's London agents, Messrs. John Pook & Co., 63, Leadenhall-street, E.C., where also plans of Shanghai may be inspected. Tenders to the secretary of the Municipal Council, Mr. J. O. P. Bland, Shanghai, China, not later than noon July 30. An advertisement contains further particulars.

The Lords Commissioners of the *Admiralty* are prepared to receive proposals from persons willing to submit for competitive trial range-finders, both large and small, for naval use. Conditions, &c., will be furnished to bona fide inventors or manufacturers of such instruments on application to the Director of Navy Contracts, Admiralty, London, S.W. Full descriptions of the range-finders proposed must be sent in by June 30.

Kilmarnock Corporation invite tenders for overhead equipment, trolley wires, poles and brackets, &c., rolling stock, wiring of generating station and car shed. Tenders to the town clerk (Mr. W. Middlemas) before noon May 28.

Warrington Electricity committee invite tenders for four mechanical stokers, water softener and purifier at their electric light station. Tenders to chairman, Town Hall, Warrington, by noon May 30.

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Sunderland Corporation require one 500kw. three-phase induction motor-generator for traction purposes. Tenders (addressed chairman of Electricity and Lighting committee) to the town clerk (Mr. Fras. M. Bowey) by noon May 27.

London County Council invite tenders for two continuous coal and ash conveyors (gravity bucket type) at Greenwich electricity generating station and for maintenance of same for 12 months. Tenders to the clerk of the Council (Mr. G. L. Gomme) by 10 a.m. June 14.

Canterbury Lighting committee invite tenders for one Lancashire or dry-back marine boiler, superheater and steam pipes, one 300kw. steam dynamo, switchboard and connections, and extensions to economiser. Tenders to town clerk (Mr. Henry Fielding) by June 1.

Hornsey Town Council invite tenders for condensing plant, water cooling apparatus, pipe work and valves, water softener and purifier, switchboard and connections. Tenders to the town clerk (Mr. F. D. Askey), 99, Southwood-lane, London, N., by 10:30 a.m. May 30.

Erith District Council require tenders by noon June 13 for additions to and alterations at electric lighting station, and for steel bridge building and road diversion work in connection with the construction of electric tramways.

Pontypridd District Council invite tenders for motors. Tenders to chairman of Electric Lighting and Tramways committee by noon June 4.

Royton and Crompton District Council invite tenders for overhead equipment and cables. Tenders to chairman of the Tramways committee, Town Hall, Royton, by noon May 28.

Fulham (London) Guardians require tenders by 30th inst. for work (wiring, bells, &c.) in connection with fire-alarm systems at the workhouse and infirmary.

Wandsworth (London) Guardians want tenders by 26th inst. for overhauling fire alarms, electric bells, re-wiring, &c., at their infirmary.

Birmingham Electric Supply committee invite tenders (until 25th inst.) for excavation, concrete and brickwork for the foundations of the Summer-lane generating station.

Kirkcaldy Lighting committee require tenders by noon 23rd inst. for extension switchboard panel and cable connections for 430kw. generator.

Atherton District Council invite tenders by 25th inst. for wiring the free library.

Maidstone Corporation Light Railways committee invite tenders for the privilege of advertising on tramcars and tickets.

Coventry Corporation require tenders by 25th inst. for a 15-ton electric crane and for pipework.

Southampton Corporation require 150 tons of steel rails, fish-plates, &c. Tenders by 2 p.m. June 6.

Walthamstow District Council invite tenders by June 3 for stores for the electricity department.

Batley Corporation require tenders for a superheater, steam pipes, &c., by June 2.

St. Anne's-on-the-Sea Council require leadless cables for laying solid. Tenders by May 30.

TENDERS RECEIVED AND ACCEPTED.

At a special meeting of the Dublin Lighting committee on Friday tenders submitted for the new set of electrical plant for the Pigeon House station were considered. Although a considerable number of tenders were received, only four were in accordance with the specification of the plant (polyphase generator and exciter, condensing plant, pipe work and valves, switchgear, cables and connections, foundations and builders' work). The following were the inclusive figures of the four complete tenders :—

Lahmeyer Electrical Co.	£21,348	General Electric Co.	£19,227
Dick, Kerr & Co.	19,417	Electric Construction Co.	18,955

A lengthy report from the consulting engineer (Mr. R. Hammond) was before the committee, in which it was pointed out that the equalising of certain requirements in connection with the pipe work, &c., would place the General Electric Co. lowest on the list, and Mr. Hammond recommended the acceptance of the tender of that company. The following alternative tenders were received on the basis of deferred payment, as set out in the report of the committee recently adopted by the Corporation :—

General Electric Co. (*accepted*)	£19,227	Lahmeyer Electrical Co.	£22,250
		Electric Construction Co.	21,789

Steps are being taken to obtain the necessary sanction for borrowing.

Poplar (London) Council have received the following tenders for (A) 8 miles of high-tension cable and (B) 4 miles telephone cable :—

	A.	B.
Western Electric Co. (*recommended*)	£2,496	£256
Johnson and Phillips	3,289	304
W. T. Glover & Co.	3,280	320
Callender's Co.	3,232	300
St. Helens Cable Co.	3,116	293
Siemens Brothers & Co.	2,930	280
W. T. Henley's Co.	2,800	288
British Insulated and Helsby Cables	2,760	288

For supply, erection and maintenance of storage battery Poplar Council have received the following tenders :—

*Elec. Power Storage Co. (*accepted*)	£1,860 0	D. P. Battery Co.	£2,275 14
		A.B.P. Accumulator Co.	2,081 13
Chloride Electrical Storage Co.	2,771 0	Tudor Accumulator Co.	1,972 0
		Hart Accumulator Co.	1,937 12
‡Northampton Batt. Co.	2,528 14	†British Battery Co.	1,790 0

* £114 per annum for maintenance. The charge for annual maintenance in the remaining tenders varied from £88. 18s. to £180. † This tender provided for annual maintenance from £90 for first to £105 for fourth year, and ‡ tender from £50 for first to £90 for fourth year.

The Great Western Railway Co. have placed an order with Bruce Peebles & Co. for 5,000kw. in motor-generators, including 10 400kw. sets and four 200kw. sets, spares and switch gear, all to the specification of the company's consulting engineers, Messrs. Kennedy and Jenkin.

Colchester Corporation have accepted the offer of a firm to pay £20 per car per annum for five years for the privilege of affixing advertisements to the Corporation tramcars, the cars to run on an average 50 hours per week each, the rent to be increased or decreased in the same proportion as the number of hours varied.

Stockport Town Council have accepted the tender of S. Fiddes & Co. for Nernst lamps, that of the St. Helens Cable Co. for house cables, and that of Dick, Kerr & Co. for Belliss engine and tr action generator and steam separator at £2,971.

It is announced that Gainsborough Corporation have recently accepted the Post Office tender for electric fire alarms at £46. 5s. per annum. Other tenders sent in ranged from £90 to £230 for the work required.

The British Electric Plant Co. have received an order (through Messrs. D. Selby Bigge & Co.) for 25 electric motors, aggregating over 800 H.P., for the works of the Central Marine Engineering Co., West Hartlepool.

Walsall Corporation have accepted the tender of Milnes, Voss & Co. to fit an electric tramcar as an experiment with their patent roof-cover at £80.

Epsom Council have accepted the tender of the Western Electric Co. for feeder cable at £667. 19s. 6d., distributors at £608. 0s. 4d., pilot wire at £77. 6s. 10d., and other cables at £102. 10s.

Birtley Iron Co. have placed an order with the Brush Co. for a 400kw. generating set for supplying current for lighting and power at their collieries.

Messrs. W. A. Baker & Co. have placed an order with Messrs. Walker and Hodgetts for a 3-ton electric motor-driven capstan.

Liverpool Corporation have accepted the tender of Morrison & Son for sub-station at Walton at £3,000.

Wolverhampton Corporation have accepted the tender of Thomas Parker (Ltd.) for a 120kw. steam generating set at £1,910.

The Admiralty have placed a further large order with Crompton & Co. (Ltd.) for electrical plant required for the Devonport Dockyard.

Ayr Town Council have accepted the tender of Siemens Brothers & Co. for a steam balancer and booster at £1,700.

BUSINESS NOTICES.

Messrs. Willans and Robinson have been placed on the British Admiralty list as manufacturers of seamless steel tubes. The company have recently equipped their tube works with powerful presses in connection with the manufacture of large solid-drawn Niclausse headers, and they are now able to supply seamless steel tubes up to 18in. diameter or 14in. square.

Owing to expansion of their business, Messrs. Siemens Brothers & Co. have removed their cable, railway signalling and patents departments' offices into larger premises at Queen Anne's-chambers, Broadway, Westminster, S.W., where all future communications for these departments should be addressed.

Messrs. Cecil Hodges & Co. announce that increased business necessitates their removal from 52, Queen Victoria-street to Balfour House, Finsbury-pavement, London, E.C. An extension to the works at Millwall has, it is stated, also been necessitated by the demand for the company's goods.

LIQUIDATIONS, BANKRUPTCIES, &c.

Meetings of the contributories and shareholders of the Automatic Telephone Co. (1903), Ltd., took place on Tuesday.

The chairman (Mr. Winearls) said it was what might be called a shareholders' liquidation, as the accounts showed assets more than sufficient to pay creditors in full. It was decided to leave the liquidation in the hands of the official receiver. A statement of affairs was submitted by Mr. Max Margowski, managing director, but the secretary has declined to concur in it on the ground that no books of account were kept by the company. The unsecured debts were returned at £275. 5s., but proofs amounting to £1,100 had been lodged, while the assets consisted of cash 5s., shares and patents valued at £4,100 and unpaid calls £85. 7s. 6d., a deficiency of £10,051 as regards shareholders. The company was registered on Jan. 10, 1903, and was a reconstruction of the Automatic Telephone Co. (Ltd.) formed in July, 1897, with a nominal capital of £100,000 in 5s. shares, to take over the assets of the Apostoloff Synd.,

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registered in 1895. The nominal capital of the present company was £100,000 in 47,940 preference and 752,060 ordinary shares of 2s. 6d. each. The chairman said that there were matters in connection with the affairs of the company and of its predecessors which would require investigation, and it would probably be necessary to apply to the Court for the public examination of the officials. The official receiver is liquidator, with a committee.

The Electric Light Insurance and Maintenance Co. (Ltd.) is to be wound up voluntarily. Mr. E. Hill, 79, Mark-lane, London, E.C., is liquidator, with power to consent to the registration of a new company.

The Electrical Inkless Printing Synd. (Ltd.) is to be wound up voluntarily. Mr. A. J. H. Robertson, 20, Bucklersbury, London, E.C., is liquidator.

W. Wenham, electrical engineer, 5, Century-buildings, London-road, Croydon, has been adjudicated bankrupt.

A receiving order has been made against J. J. and H. K. De Lacy (trading as De Lacy Bros.), electrical engineers, 58, Old Hall-street, Liverpool. The first meeting of creditors will take place on 25th inst. at 35, Victoria-street, and the public examination on June 2 at the Court House, Liverpool.

Sale by Auction.—Mr. Henry Sherley-Price (of Wheatley Kirk, Price & Co.) has been appointed by the Court to sell by public auction in one lot as a going concern, at the Mart, Tokenhouse-yard, London, E.C., on Tuesday, May 31, at one o'clock prompt, the extensive freehold and well-equipped car-building works known as the Castle Car Works, Hadley, near Wellington, Salop, together with the whole of the fixed plant and machinery and trade connection. An advertisement contains further information. Particulars and further information from the receiver and liquidator (Mr. H. D. Eshelby, F.C.A., of Messrs. Harmood Banner & Son), 24, North John-street, Liverpool; of Messrs. Gribble, Oddie, Sinclair and Johnson, solicitors, 38, Bedford-row, London, W.C., or of the auctioneers, 46, Watling-street, London, E.C., and Albert-chambers, Albert-square, Manchester.

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 30, Birley-street, Blackpool.

A 9in. horizontal Waverley turbine, a 4 B.H.P. shunt-wound motor coupled direct to 2in. centrifugal pump, with starting switch and resistance, are advertised for sale in another column. Applications to Mr. John MacEwan, contractor, Wishaw.

A battery of 52 21-plate Chloride storage cells is advertised for sale by Mr. E. C. Theedam, Dudley.

Register of Superintending Electricians, &c.—The Simplex Steel Conduit Co. (Ltd.), Westinghouse-buildings, Strand, London, W.C., announce that they have on their register the names of superintending electricians and foremen, &c., whom they can recommend as having considerable experience in "Simplex" conduit insulations. Particulars on application.

Easton & Co.—For some time past the closing of this company's works at Erith has been regarded as inevitable, and the announcement is now made that the end of May, 1904, will witness the termination of the company's association with Erith, which was commenced just 40 years ago. The business was started by James Easton in 1822, at 281, Strand, London, recently demolished for the new Kingsway and Aldwych. In recent years the firm has passed through many vicissitudes and changes of name. At one time about 700 hands were employed, and up to quite recently work was found for about 300, who will now be thrown out of employment.

Fire-alarm Contracts.—The Scottish office of the May-Oatway Fire Appliances (Ltd.) have secured an important order for wiring the extensive works and premises of Messrs. J. and P. Coats at Paisley. The installation comprises some 60 buildings (most of which are already "sprinklered"), and it is claimed to be the largest automatic fire-alarm installation yet contracted for in the United Kingdom. 18 automatic telegraphs will be required to complete the contract. The central fire-station equipment will be as extensive as any in Scotland with the single exception of Glasgow.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from May 11 to 17, with the ports of destination:—

Aden, £150 (telegraph material). *Africa*—Cape Town, £136; Durban, £271; East London, £350; Port Elizabeth, £1,575. *Argentina*—Buenos Ayres, £457 (including £190 telegraph cable). *Australasia*—Adelaide, £55; Auckland, £379 (including £272 telegraph material); Invercargill, £150; Melbourne, £360; Perth, £238; Sydney, £108; Wellington, £37. *Belgium*—Ostend, £25. *Brazil*—Rio Janeiro, £12. *British Guiana*—Demerara, £11. *Canada*—Quebec, £54. *Ceylon*—Colombo, £25. *China*—Shanghai, £29,060 (including £28,600 telegraph material). *Colombo*—Santos, £23. *France*—Dunkirk, £9; Le Treport, £46; Paris, £48. *Gibraltar*, £2,664. *Holland*—Amsterdam, £171. *Hong Kong*, £12. *India*—Bombay, £824; Calcutta, £803 (including £155 telegraph cable); Madras, £7,205. *Japan*—Tokyo, £78; Yokohama, £24. *Russia*—St. Petersburg, £820 (telegraph cable). *Straits Settlements*—Singapore, £28. *Sweden*—Gothenburg, £95. *Turkey*—Constantinople, £361. Total £46,664, against £57,981 in the corresponding week last year (May 13 to 19).

Catalogues.—Section S of the General Electric Co.'s catalogue is now ready, and comprises branch switches, fuses, cutout boards, ceiling roses, lamp-holders, Robertson lamps and Nernst lamps. Several of the well-known G.E.C. types of switches, fuse boards, &c., with all latest improvements, are listed. For the type of fuse board shown the spring-clip type of fuse is used in most cases, which, it is claimed, permits of safe and easy replacement. For circuits up to 250 volts the patent hollow china fuse is mounted on the best-quality boards, while for a cheaper pattern board a new type Channel fuse is used. These boards can, if necessary, be fitted in cast-iron cases for protection against mechanical injury and climatic changes. Special attention is given to the "Quadrant" switch, for which a ready sale has arisen. It is pointed out that the porcelain used throughout these fittings is of British manufacture. The illustration, Fig. A, shows a double-pole fuse board fitted with patent hollow china fuse holder in cast-iron case, in which the proper holes are tapped to permit of the inlet and outlet of the cables and wires. The case is rendered waterproof by indiarubber rings or packing, on which the cover rests, which in turn is secured in position by butterfly nuts, providing an easy means of unscrewing for inspection. The hollow china fuse holder mounted on porcelain base is shown in Fig. B. The General Electric Co. have also ready a new list (No. 1049) of "Witton" small motors, in which class of goods there has been a great reduction in price. The 15th edition of the L section catalogue of the General Electric Co. is also available. This deals with electric bells, batteries, pushes, indicators, lightning conductors, speaking tubes and telegraph instruments and supplies. An immense variety of these instruments apparatus and accessories are listed and illustrated. As usual, a full set of diagrams of connections for bell and indicator circuits accompanies this list.

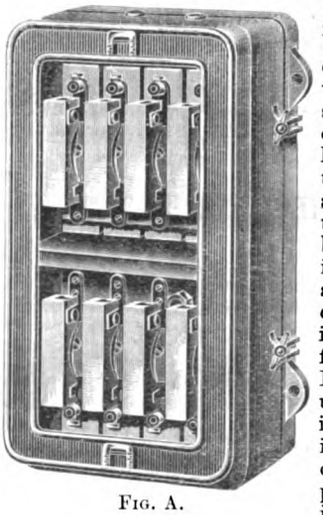


FIG. A.

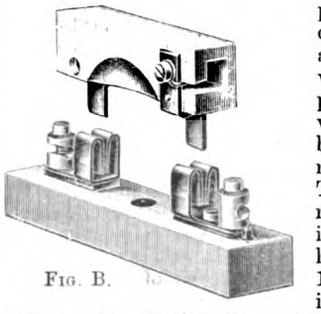
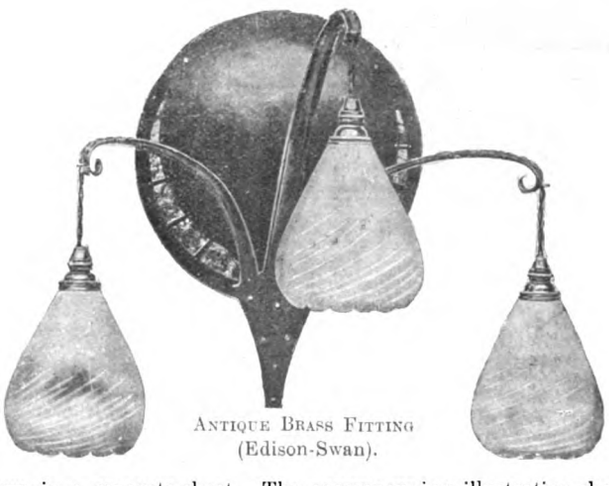


FIG. B.

The Edison and Swan Co. have ready section IX. of their main catalogue (electric bells, &c.), including indicators, pushes, pulls, bell switches and burglar alarms. Some quaint electric light brackets constructed of hand-made fret metal, inlaid mother-of-pearl, are shown in a separate sheet. The accompanying illustration shows (one-sixth size) a neat three-light antique brass fitting, the back plate 13½in. by 10in., with a 10¾in. projection.



ANTIQUE BRASS FITTING (Edison-Swan).

Messrs. Falk, Stadelmann & Co., of Farringdon-road, London, E.C., have ready a complete bound catalogue of electrical supplies, including bells, telephones, lighting accessories and lighting fixtures.

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A copy of the complete book can be obtained by members of the trade post free on application, or separate sections will be sent.

Messrs. Gent & Co., of Leicester, have ready a new descriptive sheet of water-level alarm apparatus, with special contact arrangement for signalling high and low water in deep wells.

Catalogue No. 68 of the Berliner Telephone Mfg. Co., 200, Upper Thames-street, London, E.C., announces a reduction in the price of a number of the instruments manufactured by the company, due to the increasing demand for these instruments. The list illustrates telephones, switchboards, junction boxes, &c.

Reuter's Directory of Telegraphic Addresses.—Reuter's Telegram Co. announces the preparation of a series of directories of telegraphic addresses registered in the British colonies, compiled from official records. The first of these, containing a list of addresses registered in Australia and New Zealand, is just published, price 7s. 6d. net, and can be obtained from the company's offices, 24, Old Jewry, London, E.C.

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

February 17, 1904.

3,995 B.T.-H. Co. and A. S. Cubitt. Electric couplers.
3,996 H. C. Levis (G.E. Co., U.S.) Electrical conductors and making same.
3,998 H. C. Levis (G.E. Co., U.S.) Producing metals from a compound containing silicon.
3,999 and 4,004 H. C. Levis (G.E. Co., U.S.) Arc light electrodes, making same.
4,005 H. C. Levis (G.E. Co., U.S.) Arc lamps.
4,016 F. Protz. Galvanic battery with regenerative apparatus.
4,020 A. C. Reyrolle. Switches.*
4,024 A. Collis. Apparatus for cleaning electrotypes and the like.*

February 18, 1904.

4,034 A. S. Bright. Terminal coupling for batteries or wires.
4,057 A. Louis (known as Guy) de Sainville. Manchester. Appliances for charging and "cutting out" accumulators.
4,059 W. Simm, H. Simm, R. Storey and J. H. Sellers. Liverpool. Electric furnaces.
4,062 G. Scialpi. Italy. New type of arc lamp.
4,075 H. L. Doulton and C. E. Morris. Supports for conductor rails of electric railways.*
4,104 W. Deckert. Damper for use in preventing concurrent vibrations in microphones and like instruments.*
4,110 W. C. Martin and J. Lowson. Electrical connectors.
4,116 E. Chaudoir. Electrically-controlled lifts and hoists.
4,133 H. C. Levis (G.E. Co., U.S.) Arc lamps and electrodes therefor.
4,138 Siemens Brothers & Co. (United Telephone Co., U.S.) Telphers.*

February 19, 1904.

4,145 J. S. Highfield. Methods of fixing switchboard panels.
4,146 R. W. Paul. Centreing devices and arc lamps for optical lantern illuminants.
4,147 T. L. Kolkin. Obtaining even operation of electric generators with interrupted driving.
4,167 R. Sanderson and J. Sanderson. Newcastle-on-Tyne. Cooling sparking arrangements in internal combustion engines.
4,168 W. Whitewell & Co. and C. Demain. Stockton-on-Tees. Driving mechanism for electric cranes, &c.
4,176 S. D. Field. Manchester. Multiplex telegraphy.*
4,188 A. Blackman. Hampton Wick. Accumulators or storage batteries.
4,191 E. F. Moy and P. H. Bastie. Electric traction systems.
4,219 H. J. Ridley. Pneumatic sound disc or diaphragm.
4,233 G. K. B. Elphinstone. Switchboard appliances.
4,234 G. K. B. Elphinstone. Electrical measuring and indicating instruments.

February 20, 1904.

4,252 N. S. Bertram. Manchester. Overhead wires or equipment of electric railways.
4,291 L. A. Carré. Automatic and electric fire alarm on the principle of the dilatation and contraction of air or other gases.
4,308 W. A. Wilson. Electrical ignition gear for explosion engines.
4,309 General Contracts Co., E. S. Cook and W. H. Chippenfield. Switches.*

February 22, 1904.

4,335 J. Walton and A. E. Mitton. Birmingham. Electrolytic plating apparatus.
4,353 P. Hoffmann. Electric vibrating apparatus for massage.*
4,357 J. S. Peck. Transformers. (Date applied for, Feb. 28, 1903, date of application in U.S.)*
4,359 Ekardos. Leytonstone. Arrangement for insulating separately vessels containing acids or liquids electrically excited and in circulation.
4,372 P. Corbin. Electrolytic manufacture of chlorates and perchlorates. (Date applied for, Dec. 31, 1903, date of application in France.)*
4,373 W. S. Rawson. Manufacture of carbon articles.
4,376 J. M. Tourtel and Tourtel Mfg. Co. Electricity meters.
4,378 W. S. Mappin and G. S. Mappin. Richmond. Switches.
4,395 R. F. Ferguson. Gripping appliances for lamp shade clamp rings.
4,396 R. F. Ferguson. Controlling incandescence lamps.

February 23, 1904.

4,422 V. W. Delves-Broughton. Sparking plugs for internal combustion engines.
4,443 H. Peace. Birmingham. Trolley heads for electric traction systems.
4,448, 4449 and 4,450 W. Fairweather (American Electric Telephone Co., U.S.) Thermal cutout.*
4,451 G. Sperryn and W. H. Wood. Birmingham. Switches.*
4,461 E. F. Moy and P. H. Bastie. Electric traction systems.
4,472 and 4,473 H. G. Pape and E. J. Higgins. Audiphones, telephones and like instruments for transmission of sound.*
4,487 H. M. Granier. Manufacture of sulphate of copper and caustic alkalies by electrolysis of alkaline chlorides. (Date applied for, April 6, 1903, date of application of France.)*
4,502 C. P. Grew. Ploughs for collecting current from conduit conductors.
4,506 L. Leiness. Preparation of calcium carbide.
4,507 A. C. Eastwood. Electric controllers.*
4,512 H. Nehmer. Generating electricity by moist chemicals pressed upon zinc.
4,519 G. Bamberg. Electric mercury vapour lamps.

February 24, 1904.

4,579 S. B. Griffith and F. Biliotti. Arc lamps.
4,587 G. Smith. Construction of switch.
4,590 A. Eckstein and F. G. Bell. Manchester. Telephone annunciator or indicator switchboard.*
4,592 E. Shones and S. Bridgwater. Electro or other magnets.
4,594 F. Seary and J. Lenderyon. Make and break devices.
4,600 W. R. Macdonald. Electric fuses.
4,609 B. Becker. Indicators operated electrically from a distance.

February 25, 1904.

4,629 G. C. Shanester. Hull. Arc lamp.
4,646 M. W. F. Petmeky. Manchester. Metallic circuit intercommunication telephones.*
4,647 W. Campbell. Trolley for electric tramcars.
4,660 S. R. Cohen and B. R. Cohen. Contact breakers or tremblers for ignition coils.
4,663 P. H. Thomas. Rupturing electric circuits.*
4,676 T. D. Ward and H. C. Furniss. Insulators for electric railways.
4,704 M. D. Spicknall. Current collecting skates.

February 26, 1904.

4,721 E. Brown. Glasgow. Auto-condensation plate for use with currents of high potential and frequency for therapeutic purposes.
4,731 G. H. Scholes. Manchester. Pendant incandescent lamps.
4,748 W. T. Oades and E. V. Gratze. Epping. Combination speed indicator and speed limit alarm.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

4,389 Chauvin and Arnoux. System of contact breaker for the primary circuit of induction coils.
6,829 Brown. Relay working of submarine cables.
7,022 Johnson (E.A.G. vorm. W. Lahmeyer & Co.). Varying the self-induction of induction coils and application thereof to measurement of velocity of bodies in motion.
7,064 Lanchester. Electrical connections.
7,139 Carolan (G.E. Co., U.S.). Alternating-current motors.
7,292 Poulsen, Pedersen and Schon. Apparatus for receiving and storing up messages, signals and the like.
7,293 Winter and Eichberg. Method of regulation for alternate-current machines.
7,377 Davies. Switches.
7,462 Carolan (G.E. Co., U.S.). Electric motor control systems.
7,585 Turchi and Brunè. Apparatus for enabling telephonic and telegraphic messages to be transmitted over the same line.
7,587 Carolan (G.E. Co., U.S.). Electrolytic meters.
7,829 Sayer. Electric railways.
8,112 Lionel Edward Harvey, Ernest Paul Bruno Estler, Paul Traugott Julius Estler and Hans Paul Charles Estler. Automatic electric signalling apparatus for tramways.
8,812 Leitner. Automatically regulating electric circuits.
10,723 Raworth. Control of electric vehicles.
10,728 Heym. Secondary battery for use as a pocket battery.
11,242 Fielding. Trolleys of electric vehicles.
11,509 Evershed and Vignoles and Evershed. Electrical measuring instruments.
11,554 Callender's Cable and Construction Co. and Ward. Switches and fuses and boxes for same.
11,726 Carolan (G.E. Co., U.S.). Electrical power-factor indicators.
11,728 Carolan (G.E. Co., U.S.). Switches.
11,894 Best. Electrically igniting miners' safety lamps.
12,283 Callender's Cable and Construction Co. and Callender. Cables.
12,409 Lake (Soc. Anon. le Carbone). Brushes for dynamo-electric machines.
14,995 Bock and Waser. Burglar alarms.
21,305 Siemens Brothers & Co. (Siemens and Halske A.G.). Method of and apparatus for maintaining two electric motors in synchronism.

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1904.

658 FAIRWEATHER (Cutler-Hammer Mfg. Co.). Rheostats.
3,730 KELLER. Electric furnaces.
4,104 DECKERT. Damper for use in preventing concurrent vibrations in microphones and like instruments.
4,448, 4,449 and 4,450 FAIRWEATHER (American Electric Telephone Co.). Thermal cutout for electric circuits.
4,783 PADRIS. Electric heating device.

COMPANIES' MEETINGS AND REPORTS.

Western Telegraph Co. (Ltd.)

The sixty-first ordinary general meeting was held on Tuesday under the presidency of Sir JOHN WOLFE BARRY, K.C.B.

The SECRETARY (Mr. E. Steer Hodson) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: I do not think the present report calls for any lengthened treatment. The message receipts for the half-year under review amounted to £202,062, and for the corresponding period of 1902 to £212,683, or a decrease of £10,621. A large part of this decrease is due to the fact that in the corresponding half-year of 1902 we carried the whole of the traffic with Brazil and an increased proportion of traffic with West Africa, in consequence of an interruption to the competitive route. The traffic with the Plate and the West Coast of South America shows substantial increase. Our other sources of revenue —viz., interest, rents, transfer fees and dividends on investments in other telegraph companies, are about the same in the two periods. Interest on investments on account of reserves is now carried to revenue account, instead of, as heretofore, to the general reserve fund. For the current half-year the March quarter showed a decrease of traffic compared with that of last year, but that decrease is being rapidly reduced by the improved returns of the last six weeks, and I hope it may perhaps have disappeared before June 30 next. On the other side of the account there is a small decrease in the general expenses in London, but an increase of nearly £6,400 in the expenditure abroad, distributed over eleven items, of which the following is the most important: Salaries and wages, £635, due to the rising scale of pay and an increase of 11 in number of the staff, who were required to temporarily replace members incapacitated by a very severe epidemic of fever at one of our large stations and a less severe one at another. This also accounts for an increase of £678 in travelling expenses incurred in bringing men home or transferring them to other stations. Rent, house allowances and light show an increase of £814, principally caused at Rio de Janiero pending the completion of the new staff quarters and the increased cost of lighting our principal stations since the installation of electric light. Maintenance of land lines, electrical instruments and stores £1,959, expended in store tanks and their erection and renewals to underground and aerial lines. Repairs and renewals of furniture £2,300, new furniture for the Rio, St. Vincent and Santos quarters. Medical expenses increased by £262, due to the sickness already referred to. The bulk of this extra expenditure is of a non-recurrent nature. Six of the accounts show small decreases. Comparing the other expenses, including cables, we find a net increase of £7,944. Repairs of cables and expenses of ships accounted for £9,351. The "Norseman" cost £2,031 more in stores, coal and repairs, as she was at sea for a longer period. The "Cormorant" cost £2,709 and did not appear in the accounts for 1902; she was almost continuously engaged during the six months and has fully justified her acquisition. Cable use and depreciation of that in stock accounts for £5,517. Against these, and sundry other extra expenses amounting to a total of £294, there was a saving of £1,200 through not having had to charter any steamers this half year, making a net increase on account of repairs of cables and expenses of ships as before mentioned of £9,351. The various electric light installations having been completed, no expenditure was incurred on this account, and this relief, with the balance of other small items of increase and decrease, make a net increase of £7,944 in expenses (not coming under abstracts A and B) referred to on p. 4 of the directors' report. The net result of the half-year's working is a decrease in revenue, excluding interest on investments on account of reserves, of £10,600 and an increase of close on £14,300 in expenses. After providing £13,578 for debenture stock and debenture interest and sinking fund, and £2,622 for income tax, there remains a balance of £112,678; to this is added the sum of £2,639, brought forward from June 30 last, making a total of £115,318. First and second interim dividends, amounting to £62,379, have been paid, and after transferring £30,000 to the general reserve fund, and £18,000 to the maintenance ships' reserve fund, there remains a balance of £4,939, which is carried forward to the next account. The shareholders are aware that nearly 4,000 miles of our new cables are laid in deep water and the risks of interruption are consequently far less than those in shallow water. Unfortunately a fault appeared in the Para-Pernambuco direct cable, due, it is believed, to a seismic disturbance, which was experienced at Ceara on the day the fault in the cable appeared. The "Norseman" was unable to work in the depth of water (1,600 fathoms) where the fault is situated owing to insufficient power and the exceptionally strong currents prevalent for the greater part of the year in the locality. She is an excellent vessel for shallow water work for which she was originally constructed. Her unsuitability for all the requirements of our system has given the board much anxiety and we have decided to replace her by a somewhat larger and more powerful steamer, and as time is of importance have agreed to purchase, at what is considered a reasonable price, the Eastern Company's cable ship "Mirror" which has proved herself capable of effecting repairs in any depth. We shall therefore probably have to face a serious loss in disposing of the "Norseman" and to meet such a contingency and also to provide against ordinary depreciation of the "Cormorant" and store-ship "Norna," we have transferred £18,000 to the maintenance ships' reserve fund, bringing it up to £30,000. I now move the adoption of the report and accounts.

Sir JOHN DENISON-PENDER seconded the motion, which was carried unanimously.

A cordial vote of thanks to the chairman, directors and staff (proposed by Major Cotton and seconded by Mr. W. S. Partridge) was carried unanimously, and after a brief reply by the chairman, the proceedings terminated.

An interim dividend has been declared, payable June 24, of 3s. per share, or at the rate of 6 per cent. per annum (tax free) for the quarter ended March 31. The transfer books will be closed from June 17 to 23 inclusive.

West India and Panama Telegraph Co. (Ltd.)

The fifty-fourth ordinary general meeting was held on Wednesday, Mr. WALTER B. KINGSFORD presiding.

The MANAGER and SECRETARY (Mr. R. T. Brown) read the notice calling the meeting, and also the Auditors' report.

The CHAIRMAN said: The total amount to credit of revenue is £32,399, as compared with £31,062 in the corresponding half-year of 1902, being an increase of £1,337, but, as the account shows, this increase is entirely due to our having included two items of an abnormal nature—namely, an amount of £1,500 transferred from income tax account, and £1,485 balance to the good after the final settlement of the "Grappler" account. The £1,500 referred to have been gradually accumulating for a number of years, owing to the varying amounts of income tax assessment. This sum being no longer required, the Directors thought that the time had arrived to transfer it to revenue. As to the £1,485, this is a small surplus after adjusting the "Grappler's" account consequent upon her loss. Without making these transfers, the dividend of 6s. now recommended could not be paid, and as the dividends on our preference shares are cumulative, the Directors feel that every effort should be made to prevent the arrears from increasing. The expenses amount to £25,243, against £20,679 for the corresponding period. This increase of £4,564 is wholly accounted for by the increased cost of repairs to cables, the renewal of the land lines in Jamaica, which were partially destroyed last August by the hurricane, and the sum of £1,676 reserved for depreciation on our new ship the "Henry Holmes." These items involved an increased expenditure of £4,697. The general expenses, therefore, other than repairs to cables and land lines, are £133 less than those for the corresponding period. I am sorry to say that no less than 44 nauts of new cable were used in ordinary repairs, as compared with 19 nauts only in the corresponding period. In addition to this, 11 nauts, valued at £934, have been charged to reserve. These 11 nauts were chiefly expended in the partial renewal of the St. Lucia-St. Vincent section, which was interrupted by volcanic disturbances at St. Vincent. This is the first complete half-year during which our new repairing steamship, the "Henry Holmes," has been actively at work. I am glad to say that her expenses have been found thus far to compare not unfavourably with those of the "Grappler." Wages and victualling will probably settle down to just about the same figures. Of the other expenses, a few will, of necessity, be somewhat heavier owing to the structural and mechanical differences between the two vessels. The captain has, however, been strictly enjoined to keep down the expenses to the very lowest point consistent with full efficiency. You will have seen by the report that, after much difficulty, we have successfully completed the repair of the St. Lucia-St. Vincent cable, which was twice interrupted by eruptions of the volcano at St. Vincent. The final cost of this repair will appear in the accounts for the next half-year. After completing this work the "Henry Holmes" spent some weeks in examining the condition of the Dominica-Martinique and the Martinique-St. Lucia sections. The first-named cable was broken close to St. Pierre, at Martinique, on May 3, 1902, and, as you will remember, it was whilst the "Grappler" was repairing that cable on May 8 that she was destroyed by the eruption of Mont Pelée. The Martinique-St. Lucia section was also interrupted in May, 1902, close to St. Pierre, two days only before the great catastrophe, and our recent operations, to which I have just referred, were undertaken with the view of taking the cables away from Martinique and joining them up into one section from Dominica direct to St. Lucia. These operations show that there are several breaks in these two cables at various distances from St. Pierre, and some of the cable when picked up was found to be all in shreds, with the gutta-percha core cut and broken. Whilst the ship was at work it was noticed by the officers on board, that Mont Pelée was continually smoking and steaming. In that state of things, with the loss of one ship at Martinique, and the narrow escape of another off St. Vincent, still fresh in our memories, we felt that it would be a very risky thing indeed to allow the "Henry Holmes" to continue at work under such threatening and dangerous conditions. We have, therefore, decided to suspend operations in that quarter until safer and more peaceful times. I ought to tell you, gentlemen, that when we do take this work in hand we fear that it will involve a deviation of route and probably an expenditure of at least 50 or 60 nauts of cable. Such are the continual difficulties, dangers and heavy outlays which have to be encountered in maintaining telegraphic communication in these highly-volcanic regions. As already stated, the dividend which is now being paid to you is partly derived from previous accumulations, a state of things which, I am sure, none of us can possibly regard as being altogether satisfactory. I hope and trust, however, that some development may shortly take place favourable to the Company, and that the valuable services which it so long has rendered to the Imperial Government, a

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well as to the Governments and commercial interests of the West Indies, may be rewarded, not only by increased traffic, but by assistance from the Imperial Government and the colonies. Our difficulties, gentlemen, as you know, have always been great owing to poorness of traffic, the volcanic nature of the sea bed on which, unfortunately, our cables have to be laid, and the consequent heavy cost of keeping them in good working order. For some years past these difficulties have been very much increased by competition at three points of the Company's system—namely, at Martinique and Guadeloupe, at Panama and Colon, and at Jamaica. I may remind you that the competition at Jamaica was established and is maintained by an Imperial subsidy. We are now threatened with further competition from this source, the object of it being to push a cable into the very heart of our system and to obtain the subsidies at present paid to our Company. I very much doubt, however, whether any competitor would be willing, or, indeed, able, to keep up a system such as ours, with its 4,600 miles of cable, and 21 stations, several of which are quite unremunerative, to maintain a well-equipped repairing steamer, and, in spite of a poor and non-expansive traffic and most unfavourable physical conditions, to give the colonies that efficient service which we have given them for more than 30 years. I trust, therefore, that the Colonial Governments will recognise that their interests will be better served by maintaining and strengthening the present telegraphic system than by promoting fresh competition in a field so poor and unremunerative that even one company finds it hardly possible to live. I also trust that the Imperial Government will not be unmindful of the important services which our Company for many years has rendered them, and that, so far from encouraging any further competition, they will rather be inclined to give all the assistance in their power to the Company which so greatly needs it, and which, on the ground of long and meritorious service, may fairly claim to be entitled to receive from the Government the most favourable consideration and the heartiest support. The capital of our Company is no less than £1,275,000, and it is held by over 1,800 shareholders. I am very strongly of opinion that, to say nothing of the question of fairness and common justice to ourselves, it would be altogether contrary to public policy that the Imperial Government should do anything, directly or indirectly, which would seriously endanger this large and important undertaking. I now move the adoption of the report and accounts and the payment of the preference dividend of 6s. per share.

Mr. HOLMES seconded the resolution, which was carried without discussion.

The retiring director, Mr. H. Holmes, and the retiring auditors, Messrs. Deloitte, Dever, Griffiths & Co., were re-elected, and a vote of thanks was then passed to the chairman, directors, and the staff at home and abroad.

Globe Telegraph and Trust Co. (Ltd.)

The thirty-first ordinary general meeting was held on Tuesday under the presidency of the Marquess of TWEEDDALE, K.T.

The SECRETARY (Mr. Sidney Collett) read the notice convening the meeting.

The CHAIRMAN then said: The report and accounts, which you will doubtless take as read, deal with the first complete year since the change was made in the date of the holding of our annual meetings, and consequently we cannot compare the figures with those of a similar period. I may say, however, that the company has never been in a better financial position than now, and the dividend on the ordinary shares is the largest paid since the establishment of the company. Our receipts, after deduction of expenses, and including £3,072 brought forward, were £206,082. Interim ordinary and preference dividends have been paid, and the balance dividend of 5s. per share now recommended will make 5½ per cent. for the year on the ordinary shares. The chairman proceeded to review the holdings of the Globe Company in various telegraph companies, and said that the capital of the Globe Company was well invested. The companies in which they had the largest interest were paying good dividends, and the market value of their shares had risen substantially during the past year. Last year the depreciation was £273,381, while this year there was an appreciation of £43,259, representing an increase in the value of their securities of £316,640 compared with the previous year. He concluded by moving the adoption of the report and accounts and the payment of the dividends as recommended.

Sir JAMES PENDER, Bart., seconded the motion.

Mr. CRICKMAY: Can you explain why our stock stands below par although we are paying 5½ per cent. dividend?

The CHAIRMAN: I cannot, but I referred to the depreciation that had occurred as being probably due to the scare in connection with wireless telegraphy. The shares have been considerably lower, and have now risen, and the inference I have drawn from that fact is that the feeling of distrust of submarine cable shares, owing to wireless telegraphy, is passing away.

The motion was then carried unanimously.

The retiring director, Sir John Denison-Pender, and the retiring auditors, Messrs. Deloitte, Dever, Griffiths & Co. and Mr. John Newton, were re-elected, and a vote of thanks to the chairman and directors terminated the proceedings.

BARCELONA TRAMWAYS CO. (LTD.)—The report for 1903 states that the total receipts were £120,140, working expenses £83,047, gross profit £37,093. Loss on exchange and other items made the available balance £31,750. After paying interest and preference dividend and placing £2,000 further to renewal fund, the directors recommend a dividend on the ordinary shares at the rate of 3 per cent. per annum, tax free.

BULAWAYO WATERWORKS CO. (LTD.)—At the meeting on Wednesday, the chairman (Col. A. R. M. Lockwood, M.P.) said that their electric lighting department had 493 consumers in 1903 and in January this year 542.

CASTNER-KELLNER ALKALI CO. (LTD.)—At the meeting on Monday the chairman (Sir W. Mather) said that the company's scheme for converting their fuel from coal to power-gas had taken longer to develop than had been anticipated, and the contractors had only recently delivered the plant. Arrangements had been made for proving the scheme for using alkali products to greater advantage than at present possible, but the new development would not involve any capital outlay.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—An extraordinary meeting was held on Monday, when the resolution passed at the general meeting on the 27th ult., altering the articles of association (as noted in *The Electrician* for April 29 last) was submitted for confirmation. The chairman (Mr. Chas. Holland) proposed the confirmation of the resolution, which was seconded by Sir W. R. Brooke and unanimously adopted.

RAND CENTRAL ELECTRIC WORKS (LTD.)—The report of the directors for the year ended Dec. 31 last states that a decided improvement in the company's affairs has taken place. The revenue from supply of power has been augmented by £18,043 above that of 1902, and the result of the year's operations shows a working profit of £28,500 before deduction of a sum for depreciation. For the first four months of 1904 there was an increase of revenue of about £8,200 over the same period of last year. The receipts from supply of power and rent of plant were £70,513. 9s. 4d., compared with £52,469. 19s. 7d. during 1902. The gross profit was £28,547. 0s. 2d., and, after deducting £17,962. 13s. 7d. for depreciation, the net profit was £10,584. 6s. 7d., which, with balance of reserve now transferred, reduces the deficit from last year to £11,947. 16s. 4d. The general manager reported that the total power generated during 1903 was 8,192,680 units, and that the demand had been of a more uniform character. The directors have been unsuccessful in their efforts to obtain from the Imperial Government a refund of £2,729. 19s., and this sum has therefore been written off against reserve. The question of the extension of the works has engaged serious attention, and it has been decided to increase the capacity of the plant by 1,000kw. As a first instalment, an order has been placed for a steam turbine of 400kw., and if, as anticipated, this type of machinery proves successful, the full extension will then be proceeded with on similar lines.

TRACTION AND POWER SECURITIES (LTD.)—Mr. A. E. Scanes, at the meeting on Tuesday, said that one of the factors that had militated against the company was the rejection of the City and South-East Suburban Electric Railway Bill owing to the Parliamentary Committee requiring a guarantee for the whole cost of the line. Among their securities, the traffic on the Mersey railway was steadily increasing, as was also the traffic on the Paris tramways.

WILLANS AND ROBINSON (LTD.)—The result of the poll taken at an extraordinary meeting of shareholders on May 11, on the resolution set out in our last issue, was as follows: For the resolution votes, representing 61,501 shares, against 100. There were in addition in the secretary's hands proxies carrying 10,240 votes which were not used. The total number of shares issued is 133,332.

STATUTORY RETURNS, LIENS REGISTERED, &c.

STATUTORY RETURNS.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—In return to Feb. 26 the capital is £7,000,000, consisting of £718,580 consolidated ordinary stock, £3,140,710 preferred ordinary stock and £3,140,710 ordinary stock, all of which has been taken up and paid for in full. Mortgages and charges, nil.

BRITISH WESTINGHOUSE ELECTRIC AND MFG. CO. (LTD.)—According to return to Feb. 19 the capital is £3,250,000 in 500,000 preference shares of £5 each and 75,000 ordinary shares of £10 each, of which 400,000 preference and 75,000 ordinary shares have been taken up. £5 per share has been called up on the preference shares, and £2,000,000 has been received. £750,000 is considered as paid on the ordinary. Mort. and charges, £616,353.

ELECTRIC WIRING AND FITTINGS CO. (LTD.)—The return to Jan. 28, gives the capital as £5,000 in £1 shares, of which 1,382 have been taken up. £1 per share has been called up and £1,375 has been received, leaving £7 in arrears. Mortgages and charges, nil.

ELECTRICAL TRADES SUPPLY (LTD.)—According to return to April 1 the capital is £5,000 in £1 shares, of which 2,507 have been taken up. £2,507 has been paid. No mortgages or charges.

ERNEST F. MOY (LTD.)—The return to April 8 gives the capital as £10,000 in 8,500 ordinary and 1,500 preference shares of £1 each, of which 7,873 ordinary and 1,420 preference shares have been taken up. £9,193 has been paid, leaving £100 in arrears. Mort. and charges, £1,300.

FLADBURY ELECTRIC LIGHT AND POWER CO. (LTD.)—In the return to Dec. 31, the capital is put at £2,000 in £1 shares, of which 857 shares have been taken up. £855 has been received, leaving £2 in arrears. Mortgages and charges, nil.

W. T. HENLEY'S TELEGRAPH WORKS (LTD.)—According to return to March 25 the capital is £400,000 in 40,000 ordinary and 40,000 preference shares of £5 each, of which 34,000 ordinary and 40,000 preference shares have been taken up. £5 per share has been called up on 29,000 ordinary and 35,000 preference, and £3 per share on 5,000 ordinary and 5,000 preference. £30,000 is considered as paid on 6,000 ordinary shares. Mortgages and charges, £45,900.

HOWARD CONDUIT CO. (LTD.)—The return to April 13 gives the capital as £20,000 in 19,000 ordinary and 1,000 deferred shares of £1 each, of which 1,007 ordinary and 1,000 deferred have been taken up. £7 has been paid and £2,000 is considered as paid. No mortgages or charges.

HOVE ELECTRIC LIGHTING CO. (LTD.)—In return to March 31 the capital is given as £100,000 in 20,000 shares of £5 each, of which 15,000 have been taken up. £5 per share has been called up on 13,000 and £2

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per share on 2,000, and £70,247 has been received, including £1,263 paid in advance of calls. £16 remains in arrears. Mortgages and charges, £44,600.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The return to March 29 gives the capital as £1,500,000 in 100,000 ordinary shares of £10 each and 100,000 preference shares of £5 each, of which 100,000 ordinary and 75,250 preference shares have been taken up. £10 per share has been called up on 97,968 ordinary and £5 per share on 75,250 preference. £1,355,930 has been paid. £20,320 is considered as paid on 2,032 ordinary shares. Mortgages and charges, £470,000.

NATIONAL TELEPHONE CO. (LTD.)—The return to March 3, gives the capital as £6,000,000 in 15,000 first and 15,000 second preference shares of £10 each, 250,000 third preference and 100,000 ordinary shares of £5 each, £1,983,333. 6s. 8d. preferred stock and £1,966,666. 13s. 4d. deferred stock, of which all the first, second and third preference shares and preferred and deferred stock have been taken up. £10 per share has been called up on 12,220 first preference and 15,000 second preference and £5 per share on 221,716 third preference shares, and the full amount on £1,264,660 preferred and £529,320 deferred stock. £3,174,760 has been received. £2,325,240 is considered as paid on 2,780 first and 28,284 third preference shares and £718,673. 6s. 8d. preferred and £1,437,346. 13s. 4d. deferred stock. Mortgages and charges, £2,689,593.

NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—In the return to April 11 the capital is given as £200,000 in 16,452 ordinary, 2,998 ordinary preferred and 550 founders' shares, all of £10 each, of which 10,852 ordinary, 2,998 ordinary preferred and 550 founders' shares have been taken up. £10 per share has been called up and £144,000 has been received. Mortgages and charges, £55,000. Ditto issued jointly by company and Kensington and Knightsbridge Electric Lighting Co., £148,000.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)—The return to Feb. 23 gives the capital as £300,000 in 40,000 ordinary and 20,000 pref. shares of £5 each, all of which have been taken up. £5 per share has been called up on 39,650 ordinary and 20,000 preference shares, and £298,250 has been received. £1,750 is considered as paid on 350 ordinary. Mortgages and charges, £150,000 3½ per cent. debenture stock and £145,691 4 per cent. guaranteed debenture stock of Central Electric Supply Co. (Ltd.), being half total loan capital.

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LTD.)—The return to March 15 gives the capital as £448,200, in 37,350 shares of £12 each, all of which have been taken up and paid for in full. No mortgages or charges.

WESTMINSTER ELECTRIC SUPPLY CORP. (LTD.)—In the return to March 15 the capital is given as £800,000, in 110,000 ordinary and 50,000 preference shares of £5 each, of which 110,000 ordinary and 28,151 preference shares have been taken up. £5 per share has been called up, and £690,755 has been received. Mortgages and charges, £250,000.

MORTGAGES AND CHARGES.

ELECTRIC LIGHT INSURANCE AND MAINTENANCE CO. (1904), LTD.—A debenture for £2,000, dated May 4, 1904, charged on company's real and personal property, present and future, except uncalled capital, has been registered. Holder, E. Hill.

IMPROVED ELECTRIC GLOW LAMP CO. (LTD.)—An indenture dated April 21, 1904 (supplemental to trust deed dated July 18, 1901, securing £4,000), charged on company's undertaking and property, present and future, including uncalled capital, has been registered. Trustees, H. Muff and F. L. Gardner.

INDIA RUBBER, GUTTA-PERCHA AND TELEGRAPH WORKS CO. (LTD.)—Issue on May 3 of £99,000 4½ per cent. second debentures, part of series created April 12, 1904, to secure £100,000. Property charged, company's undertaking and property, present and future, including uncalled capital, subject to £300,000 prior debentures. No trustees. No previous issue of same series.

NEWCASTLE-ON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The fresh issue of ordinary shares was over-applied for to the extent of 65 per cent.

SUNBEAM LAMP CO. (LTD.)—Issue on April 28 of £200 debentures, part of series created Jan. 28, 1904, to secure £10,000, charged on company's undertaking and property present and future, except uncalled and unpaid capital. No trustees. Previously issued of same series, £8,200.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (April 21, 1904). Price of silver 25 1/16d. per oz. (May 12). Consols 90⅜—90½ for money, 90 7/16—90 9/16 for account; 2½ per cent. annuities 89¾—90¼ (May 19). Consols Pay Day, June 1; Stocks and Shares Continuation Days, May 25 and June 8; Ticket Days, May 26 and June 9; Pay Days, May 27 and June 10; Mining Share Carry-over Days, May 24 and June 7.

BRUNNER, MOND & CO. (LTD.)—The directors recommend payment of a final dividend of 15 per cent. on the ordinary shares, making 30 per cent. for year ended March 31, £150,000 has been added to reserve, bringing it up to £1,000,000.

JAPAN.—Tokyo Electric Light Co. recently decided to increase their capital of 3,500,000 yen (=£320,834) to double that sum and also to borrow one million yen.

LONDON, CHATHAM AND DOVER RAILWAY.—The Rt. Hon. Sir William Hart-Dyke, Bart., M.P., has been elected chairman of this railway, in succession to the late Mr. J. Staats Forbes.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—Mr. Henry Ruffer (of Messrs. A. Ruffer and Sons, bankers) has joined the board of this company.

PROVINCIAL TRAMWAYS CO.—Mr. A. W. White, J.P., has been appointed a director.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to grant quotations to a further issue of £116,363 4 per cent. redeemable mortgage debenture stock of the *British Westinghouse Electric and Mfg. Co. (Ltd.)*, and a further issue of 6 per cent. cumulative preference £5 fully-paid shares of *Edmundson's Electricity Corp. (Ltd.)*

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 14	1,177	+ 229	50	60,100	+ 12,818
Airdrie	,, 6	191	...	12	2,423	...
Ayr Corporation	,, 7	205	- 28	51	13,698	+ 82
Barnsley	,, 6	176	+ 11	18	2,869	- 155
Barrow	,, 6	153	+ 92	12	1,971	+ 1,198
Bexley District Council	,, 12	144	...	31	5,081	...
Birkenhead	,, 15	1,036	+ 74	...	...	...
Birmingham Corporation	,, 14	257	...	17	5,899	...
*Birmingham Tramways Co.	,, 14	5,344	+ 446	19	98,805	+ 5,581
*Blackburn Corporation	,, 18	782	+ 53	7	6,314	+ 394
Blackpool Corporation	,, 12	502	+ 96	6	4,096	+ 392
Blackpool and Fleetwood	,, 14	299	- 2	20	4,924	- 256
Blackp'l, St. Anne's & Lytham	,, 12	271	+ 271	28	5,196	+ 4,617
Bolton Corporation	,, 15	1,788	+ 154	7	11,865	+ 118
Bournemouth Corporation	,, 11	977	+ 29	6	6,665	+ 897
*Bradford Corporation	,, 14	4,055	+ 784	6	27,424	+ 4,911
Brighton Corporation	,, 15	866	+ 87	6	5,656	+ 88
Brisbane Tramways	...	...	...	...	...	...
*Bristol Trams & Carriage	,, 18	4,788	+ 84	25	116,895	+ 4,506
*Buenos Ayres & Belgrano	April 17	3,230	+ 114	26	83,759	+ 4,482
Burnley Corporation	May 15	978	+ 267	7	7,138	+ 1,689
Burton Corporation	,, 15	321	...	41	13,579	...
Calcutta Tramways Co.	,, 14	₹32,888	+ ₹2,881	20	₹688,848	+ ₹98,031
Camborne-Redruth	,, 16	98	- 1	2	196	- 12
Cardiff Corporation	,, 14	1,872	+ 168	6	12,341	+ 599
Carlisle Tramways Co.	,, 14	176	- 2	19	8,418	+ 262
Central London Railway	,, 14	6,708	- 435	20	188,488	- 1,475
Chatham & Dist. Lt. Rys.	,, 12	587	+ 34	19	10,057	+ 1,700
City & South London Rly.	,, 15	2,882	- 252	20	60,781	- 2,092
Cork Electric Trams Co.	,, 12	452	- 11	19	7,716	- 296
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 6	516	+ 66	18	8,499	+ 1,181
Dover Corporation	,, 14	194	+ 2	7	1,812	- 93
Dublin & Lucan Railway	,, 15	126	+ 16	20	1,978	+ 126
Dublin Southern District	,, 18	842	+ 109	¶20	85,669	+ 2,102
Dublin United	,, 13	3,950	+ 296			
Dudley—Stourbridge	,, 6	814	+ 71	18	13,885	+ 609
Dundee Corporation	,, 11	789	+ 4	...	...	...
East Ham Council	,, 14	694	+ 57	6	4,728	+ 601
Gateshead & Dist. Trams	,, 6	907	+ 86	18	15,661	+ 848
Glasgow Corporation	,, 14	14,113	- 1,678	50	681,897	+ 59,252
Glossop	,, 14	108	...	19	1,896	...
Gravesend—Northfleet	,, 6	244	+ 22	18	4,010	+ 617
Gt. Northern & City Rly.	,, 14	927	+ 4	13	12,115	...
Greenock & Port Glasgow	,, 6	541	+ 42	13	8,683	+ 660
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 6	282	+ 55	18	4,568	+ 481
Huddersfield	,, 14	1,188	+ 82	6	7,992	- 588
Hull Corporation	,, 14	1,992	- 218	6	13,034	+ 847
Ilford District Council	,, 14	432	+ 65	6	2,959	+ 460
Ilkeston Corporation	,, 11	126	...	...	...	...
Ipswich Corporation	,, 14	401	...	7	2,780	...
Isle of Thanet Co.	,, 14	432	+ 24	...	...	...
Kidderminster & District	,, 6	115	+ 10	18	1,847	- 74
Kirkcaldy Corporation	,, 11	211	- 89	19	3,998	...
Lanarkshire Trams Co.	,, 13	615	...	19	11,226	...
Leeds Corporation	,, 14	5,741	+ 397	7	39,385	+ 3,215
Liverpool Corporation	,, 7	10,067	+ 421	19	183,378	+ 4,875
*Liverpool Overhead Rly.	,, 15	1,656	+ 58	20	31,163	+ 144
*London County Council	,, 7	10,728	+ 2,245	§5	58,168	+ 12,035
Lowestoft	,, 14	145	...	¶42	8,247	...
Manchester Corporation	,, 14	11,855	+ 996	6	70,069	+ 1,587
Mersey Railway	,, 14	1,491	+ 117	19	27,996	+ 6,449
Merthyr	,, 6	209	+ 14	18	3,585	+ 208
Middleton	,, 6	309	+ 14	18	4,823	+ 85
Nelson Corporation	,, 14	108	+ 46	7	787	+ 369
Newcastle-on-Tyne Corp.	,, 14	3,528	+ 474	19	66,468	+ 8,661
Newport (Mon.)	,, 14	475	+ 190	6	3,077	+ 1 966
Oldham, Ashton & Hyde	,, 6	562	+ 15	18	9,389	- 489
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams.	,, 13	1,342	+ 292	19	26,060	+ 3,596
Peterborough	,, 6	150	+ 16	18	2,206	- 216
Poole and District	,, 6	292	+ 22	18	4,613	+ 48
Portsmouth Corporation	,, 14	1,714	+ 250	†7	11,695	+ 1,280
*Potteries	,, 6	1,677	+ 111	18	29,991	+ 2,499
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	,, 16	126	+ 9	7	819	- 76
Rotherham	,, 6	98	+ 28	18	1,149	+ 57
Salford Corporation	,, 16	3,974	+ 923	7	25,962	+ 3,582
Sheerness	,, 4	52	- 26	18	858	- 251
Sheffield Corporation	,, 15	4,574	+ 446	§7	32,944	+ 985
*Southampton Corporat'n	,, 12	903	- 86	...	...	...
Southend Corporation	,, 11	253	- 20	6	1,667	+ 127
Southport Tramways	,, 6	885	+ 79	18	4,770	+ 332
S. Staffordshire Trams.	,, 6	798	- 57	18	13,720	+ 80
Stockport Corporation	,, 13	445	+ 181	6	3,164	+ 1,226
Sunderland Corporation	,, 15	1,185	+ 112	6	7,500	+ 219
*Swansea Trams	,, 6	494	+ 24	18	8,550	+ 813
Taunton Trams	,, 6	60	+ 3	18	896	- 63
Tynemouth and District	,, 6	266	+ 50	18	4,004	- 180
Tyneside Trams Co.	...	...	...	...	...	...
Wallasey District Council	,, 14	619	+ 68	§6	4,314	+ 194
Walsall	,, 14	435	...	19	8,959	...
Warrington Corporation	,, 5	293	+ 6	6	1,823	+ 26
	,, 12	281	...			
West Ham Corporation	,, 12	688	...	11	5,706	...
Weston-super-Mare	,, 4	63	- 3	18	686	- 42
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 6	399	+ 12	18	6,298	- 263
Worcester	,, 6	308	+ 147	12	3,419	+ 1,411
Wrexham	,, 6	103	- 55	18	1,912	- 134
Yorkshire Woollen District	,, 6	654	+ 354	18	9,845	+ 4,326

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 8 days. ¶ Plus 8 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., May 18.	Rate per Cent. Yielded.	Dividend Due	Business, Week to May 18	
				£ s. d.		Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	5 —5⅛	4 15 3	April, Oct	5⅛	5
St.	6%	Do. Permanent 6% Deb. Stock	129 —134	4 9 6	..	..	..
t.	34/2	Auckland Elec. Trams 5% Deb. (red.)	98 —100	..	..	99½	99
10	10/0	Barcelona Tramways Ord.	6 —8	6 5 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 6	..	..	..
100	5%	Do. 5 per Cent. Debs.	96 —99	5 1 9	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	⅞—1	..	..	..	..
1	..	Do. 5% Cum. Pref.	1—1	..	..	⅞	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	100½	99
10	8%	Bristol Tramways and Carriage Ord.	18 —19	4 4 2	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10½—10⅝	3 17 8	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100 —103	5 16 6	..	101½	101
St.	5%	Do. Pref. Ord. Stock	99 —102	5 0 0	..	100¾	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10⅝	5 11 7	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102¾—104¾	4 6 7	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	9 —9½	8 8 5	..	9½	9⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	10 —10½	5 14 4	Feb, Aug	10⅜	10⅛
St.	5/0	Do. 5 per Cent. Perpetual Debs	116 —119	4 4 9	..	118⅜	116½
5	3/0	Buenos Ayres and Belgrano Ord.	2⅜—2⅞	5 3 9	..	2⅜	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5½—5¾	5 4 4	..	5⅛	5⅜
5	3/0	Do. "B"	5 —5½	5 9 1	..	..	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	100 —103	4 19 0	..	102	101
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	96 —101	5 0 0	..	..	..
5	3/6	Calcutta Tramways	7 —7½	4 0 0	..	7⅛	7⅛
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —109	4 3 7	..	108½	..
1	1/0	Cape Electric Tramways Shares	2 —2⅛	7 11 1	..	2⅛	2⅛
St.	4%	Central London Ordinary Stock	91 —94	4 5 1	June, Dec	93½	93½
St.	4%	Do. 4 per Cent. Pref. Stock	98 —101	3 19 9	..	..	..
St.	4%	Do. Deferred Stock	85 —88	4 11 3	..	..	..
100	4%	Do. 4 per Cent. Debs.	110 —113	3 10 9	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2%	City and South London Rly. Con. Ord.	50 —52	4 11 4	Feb, Aug	51	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 8	Feb, Aug	124½	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 —109	3 18 5	May, Nov	109½	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(red.)	99 —102	4 18 3	..	101½	101
10	6 0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8½	Gt. Northern & City Rly. Prf. Ord. (4%)	5 —6	5 0 0	..	5½	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	† Imperial Tramways Ord	18 —19	5 5 3	Mar, Sept	..	..
10	6%	† Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	† Do. 4½ per Cent. Debs.	103 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	1½	Liverpool Overhead Railway Ord	4½ —4½	3 1 1	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	4 0 0	Jan, July	..	..
1t	5/0	London United Trams. 5% Cum. Pref..	11 —11¼	4 7 0	..	11⅜	11⅜
St.	4%	Do. 4% 1st Mort. Deb. Stock	102 —104	3 18 9	..	103⅜	101⅜
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅞—1	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1	5 0 0	..	..	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 —105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs.(1922)	105 —107	4 5 0	..	..	..
5	..	New Gen. Tract. 6 per Cent.Cum. Pref.	1 —2	..	May	..	..
St.	5%	Perth (W.A.)Elec. Trams. 1st Mt. Db. Stk.	100—103	4 19 0	..	101	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	90 —93	3 7 7	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 6	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	12/6	Anglo-American	49 —52	5 12 4	F,My,Ag,N	50	49½
St.	25/0	Do. Preferred	94 —96	6 0 0	F,My,Ag,N	95⅜	94⅜
St.	2/0	Do. Deferred	7½—7¾	1 5 10	F,My Ag,N	7¾	..
100	£2	Commercial Cable Capital Stock	175 —185	4 6 6	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 —96	4 3 9	Jn Ap Jy,O	96	94½
10	5/0	†Cuba Submarine Ord.	7 —8	7 10 0	Feb, Aug	..	..
10	10/0	† Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	99⅞—102⅞	4 9 3	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10½	6 3 10	Ja,Ap,Jy,O	10½	10½
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	99 —102	4 9 6	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	127 —132	5 6 0	Ja,Ap,Jy,O	130½	128
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 —89	3 18 8	Ja Ap Jy,O	88½	86
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104 —107	3 14 9	May, Nov	105½	104½
10	6/6	Eastern Extension xd & bonus	11⅜—12⅜	5 14 0	Ja,Ap,Jy,O	12⅜	11⅞
St.	4%	Do. 4 per Cent. Deb. Stock	104 —107	3 15 6	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb.1909	99 —102	3 19 0	Feb, Aug	100½	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99% —101%	3 19 3	May, Nov	..	..
10	20 0	Great Northern (of Copenhagen)	25 —26	5 15 6	Jan, July	..	..
100	4½%	Halifax & Bermuda4½% 1st Mt. Db. (red.)	99 —102	4 9 6	June, Dec	..	..
25	37/6	Indo-European	43 —45	5 11 2	May, Nov	44½	44½
100	4%	Pacific&Europe'n Tel.4% Guar. Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	2/0	West African Telegraph Shares	5 —6	1 18 4	..	..	..
2½	..	West Coast of America	1/16—3/16	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 10	Jan, July	..	..
10	..	West India and Panama	⅝—¾	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 7	May, Nov	6⅝	6½
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	5	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 18 4	Jan, July	..	..
10	8/0	Western Telegraph	12½—13	5 7 8	Mr,Jn,O,D	12⅞	12⅝
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 17 9	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	100 —103	3 17 8	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5⅛	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	9 —9½	5 15 8	Ja Ap Jy O	9⅜	9⅛
10	3/0	Do. 6 per Cent. Pref.	13 —13½	4 8 11	Ja Ap Jy,O	13⅜	13⅛
8	4/0	Reuter's	6¾—7⅛	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	117 —122	4 18 4	April, Oct	120½	..

Share	Last Dividend	Name.	Price Wed., May 18.	Rate per Cent. Yielded.	Dividend Due	Business, Week to May 18	
				£ s. d.		Highest.	Lowest.
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid,	4½—5½	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	104 —106	5 13 3	..	..	105
St.	5%	Do. Def. Stock	87 —90	5 11 2	..	..	89
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 —13	4 12 4	Feb, Aug	11¾	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5½	4 15 3	Feb, Aug	5⅜	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —100	3 11 0	June, Dec	98½	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 —105	3 17 0	..	104	1
..	..	Dc. Do. Prov.Certs,70%tobepd.	29 —31	..	..	30½	..
1	0/8½	Oriental	⅛—1⅛	6 6 3	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	6 4 6	..	..	..
5	3/0	United River Plate	5½—6	5 16 8	July ..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅝—5⅛	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 —106	4 15 10	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Greenwich. Dist. Ord.(f.p.)	⅜—½	..	..	..	..
1	0/8½	Do. 7% Cum. Pref.	1 —1½	5 12 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. &con.)	120 —125	3 12 0	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11⅛—12⅛	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9⅛—10⅛	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord	10⅜—11⅛	4 5 1	..	..	10⅛
5	3/6	Do. 7 per Cent. Pref.	10½—10⅜	3 5 1	Mar, Sept	..	..
5	3/0	†Calcutta Electric Supply Ord.	6⅜—7⅛	4 9 8	..	7⅛	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	107 —110	3 14 1	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7⅛—7⅜	5 8 3	Feb, Aug	7⅜	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 5 9	Feb, Aug	5⅜	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅜—5	4 10 0	..	..	..
5	1/7	Do. Do. (1903)	4⅜—5	..	..	4⅛	4
St.	4%	Do. 4% Deb. Stock (red.)	103 —105	3 17 6	..	..	..
5	3/6	Chelsea Electric Supply Ord.	6½—6⅝	4 1 5	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —110	4 3 0	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10⅜—11⅛	4 9 0	Feb, Aug	11	10
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13¼	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	102⅜	..
10	4/0	County of London Elec Supply Ord.	7⅛—8⅛	4 14 3	..	8⅛	7
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106 —109	4 2 11	..	107½	107
St.	4½%	Do. Second Deb. Stock Prov. Certs.	99 —102	4 8 3	..	100⅜	100
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	90 —95	..	..	..	..
5	3 6	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 8	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 8 0	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
5	5 0	Hove Electric Lighting Ord.	7⅛—8⅛	5 0 0	..	..	..
St.	4½%	†I.of W.Elec Lt.& Power 4½% Db St (red.)	101 —103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	⅜—⅝	..	..	..	..
5	7/0	Kensingtn & Knghtsbdge Ord	11⅛—12⅛	4 16 0	..	12⅛	..
5	6%	Do. 6 per Cent. 1st Pref.	6⅝—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Knghtsbdge Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	..	..
3	..	London Electric Supply Ord.	1½—1⅝	..	..	..	..
5	3/0	Do. 6 per Cent Pref.	4½—5	6 0 0	..	4⅝	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 —98	4 2 11	Mr,Jn,S,D	96⅛	..
10	9 6	Metropolitan Electric Sup. Ord.	19½—20½	4 5 6	April, Oct	20⅛	19⅞
5	1/4½	Do. 4½ per Cent. Cum. Pref.	5⅝—5⅞	4 1 0	..	5⅞	5⅞
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 —100	3 11 0	..	97½	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
10	6 0	Notting Hill Electric Ord.	12½—13½	4 8 11	March ..	13⅛	..
5	4 0	Oxford Electric Ord.	5½—5⅞	5 13 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 3	..	..	..
1	..	Rand Electric	⅞—1	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	98 —101	4 9 1	April, Oct	..	..
5	9 6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	15	14⅛
5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	8⅞	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3 —3½	5 14 3	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	3/0	South London Electric Supply Ord.	3⅜—4⅛	3 10 7	..	..	..
5	2/6	Urban Electric Supply Ord.	4⅛ 4⅜	5 2 6	..	..	..
5	2/6	Do. 5% Cum. Pref.	4⅜—4⅝	5 2 6	..	..	..
5	7/0	Westminster Electric Supply Ord.	12½—13½	5 0 0	Mar, Sept	13⅛	12½
5	2/6	Do. 5 per Cent. Cum. Pref.	6⅛—6⅝	3 14 0	..	6⅜	..
		ELECTRIC MANUFACTURING &c.					
1	..	Aron Elec. Meter 6% Cum. Pref.	½—⅝	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5½—5⅝	6 19 2	July, Feb	..	..
5	3.0	Do. 6 per Cent. Pref.	5½—5⅝	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —105	4 7 0	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	8⅛—4	7 10 0	..	3⅜	3⅛
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	89 —92	4 8 6	..	90½	89
2	..	Bruah Electrical Engineering	½—1	..	March ..	..	..
2	2/4½	† Do. 6 per Cent. Pref. Non-Cum.	1—1½	..	Mar, Sept	1½	1½
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	78 —73	5 17 8	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	10½—11½	6 10 5	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5⅝	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 3	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅜—2⅛	6 13 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96 —99	5 2 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7⅜—8⅛	..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5 —5⅜	5 9 1	..	..	..
St.	4½%	Do. 4½% Deb. Stock	102—104	4 7 2	..	..	..
5	..	Edison & Swan United("A" Sh.)(£8 pd.)	⅜—⅝	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	⅜—1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 8 11	June, Dec	72⅛	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	74 —79	6 6 7	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5⅜—6⅛	5 12 0	H'lf-yearly	5⅜	5⅛
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅜—6	5 0 0	..	5⅛	5⅜
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.	105 —108	4 4 6	..	..	..
2	1/2½	Electric Construction Co.	1⅜—1⅝	7 2 10	Jan, July	1⅜	..
2	2/0½	Do. 7 per Cent. Cum. Pref.	2⅛—2⅜	5 2 0	July	2⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9⅛—9⅜	5 2 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	11⅛ —12⅛	6 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5¼	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	12⅛—12⅜	5 2 7	Feb, Aug	12⅜	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	36/0	Telegraph Construction & Mainten'ce.	35 —38	6 2 0	Mar, July	37	36⅛
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
5	..	Willans and Robinson Ord.	2⅛—3⅛	..	Apr, Oct	2⅜	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅜—4⅛	..	Apr, Oct	4⅛	4
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	90 —95	4 5 9	May Nov	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

THE Board of Trade has recently addressed to tramway and light railway undertakers a further letter on the reporting of accidents, somewhat modifying its previous requirements in this respect. We have noticed the earlier circulars on this subject as they appeared. The general effect of the last letter (published in full in another column) is to reduce the number of occasions which have to be reported. Only three classes of accidents have now to be reported in all cases—viz., trolley boom pulled out, trolley wire breaking and falling, car running away. Accidents of other classes need only be reported if causing injury to any person (or, in some cases, if likely to have caused personal injury), serious damage to cars or other vehicles, or "alarming results." This reduction will be an appreciable relief to the more conscientious tramway managers, who have often felt that they were reporting trivialities, although it will be rather a tax upon the tramway manager's ingenuousness to determine nicely whether a particular accident had or had not an "alarming result." So much depends upon the coefficient of alarm-susceptibility of the particular spectators or auditors. The returns have doubtless been useful in proving to the Board's officers how comparatively rare serious accidents are and how trifling the majority of such incidents. We venture to think that a summary of them, with remarks by the Board's officers, might be published with some advantage.

A FURTHER memorandum on details of tramway construction just issued by the Board somewhat modifies and enlarges the scope of the last edition. The most important alteration is the additional width of rail groove permitted—viz., 1⅛in. generally and 1¼in. on curves of less than 1 chain radius, instead of the 1in. which has stood as the maximum for many years. The apparently small addition is of great value, as it has been impossible to make a flange of adequate strength for the heavy electric car of to-day to run reasonably well in a 1in. groove, even on the straight. It is no secret that the inch maximum has been very generally exceeded during the last five or six years, but it is all to the good to get official sanction. The adoption of the 1⅛in. groove by the Standardisation Sub-Committee on Tramway Rails has undoubtedly helped the Board's officers to make the concession. As regards clearance, the minimum of 15in. between the sides of passing cars, between cars and the kerb or any standing work, is made applicable to curved roads as well as straight, whereas 18in. on curves figured in former memoranda. There is an additional warning that any stone kerbing fitted round central poles should not be wide enough on the sides next the rails for any person to stand on. There have been several nasty accidents to persons who have mistaken kerbs for refuges, and we think the safer plan is to use a cast-iron guard-ring with a curved surface, which no one can stand on. It might have been well on this point to call attention to the way in which a long bogie car overhangs the rails on sharp curves. We have known of cases in which the introduction of bogie cars in place of four-wheel ones has necessitated the reconstruction of loops and curves, and with the extension of running power arrangements that is certain to come about trouble may easily arise by the running of a "foreign" bogie car on to lines that have not known anything longer than the four-wheeler.

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A PRACTICALLY new note, at least as forming part of the official memorandum, refers to the construction of cars. The "reversed" staircase is to be avoided, especially on narrow-gauge lines. We have before pointed out that this seems to be a rather one-sided view. The "reversed" staircase has some very great advantages, and we think it can be arranged to allow the motorman free movement and vision. However, there are already some alternative designs on the market which seem to have good points. It is not generally recognised in this country that the staircase and the top seats of the tramcar are objectionable excrescences from an engineering point of view.

HANGING-GATE or "trigger" life-guards are preferred, and whilst this type has certainly been fairly successful, it is not the ideal, and we hope the official preference will not check invention and progress. Folding steps are also considered desirable, in order not to interfere with the efficiency of the life-guards. This note appears to us an unusually premature pronouncement for a Government department to make, and to arise from a serious want of sense of proportion. Folding steps are on their trial; one hardly likes to say that the patterns now offered are reliable, they have not been in use long enough. But they do present another opportunity for human error, and more accidents may occur from a rush off a single holiday-crowded car when the step has been imperfectly unfolded than bring the life-guard into use for months or even years. It does seem a mistake to put a possible trap into the path of every passenger for the sake of avoiding a chance of further injury to an occasional unfortunate person who has been knocked down by a car. The safety of the car users would seem to stand first.

THE greater part of Prof. RUTHERFORD'S discourse at the Royal Institution last Friday evening was merely a resumé of our present knowledge and of the more widely accepted hypotheses with regard to radio-activity, and the experiments were not of as brilliant a nature as some which had previously been shown in connection with the same subject in the same lecture theatre. Yet the large audience was well repaid by hearing from Prof. RUTHERFORD towards the close of the lecture an interesting suggestion for the explanation of one of the most troublesome points of difference between scientific men at the present day. Physicists and geologists have decidedly different opinions as to the age of the earth, and both sides have excellent evidence to support their own computation. Lord KELVIN, on behalf of the physicists, had qualified his estimate by saying that it was correct "provided some new source of heat is not discovered," and the discovery of radium emanation in the earth may therefore point to the new source of heat which would help to explain the discrepancy between the two estimates. The temperature gradient of the earth might also be explained by the assumption that a considerable amount of radium is contained in the earth and that its energy is being transferred from the centre outwards in the form of heat. Prof. RUTHERFORD was rather vague—probably purposely so—in his manner of putting forward these suggestions; doubtless the matter will be considered further by himself and others, and, as our knowledge of the properties of radio-active bodies accumulates, fresh light will be thrown upon these questions. It must not be forgotten that it is only during the last year that the disintegration theory to explain the phenomena of radio-activity has been accepted by the majority of physicists, and that there is still a large school of scientific men who are not prepared to accept it. It is necessary, therefore, to move cautiously before we elaborate upon it.

AN interesting case was heard at the Newcastle County Court last Friday, when the Newcastle Electric Supply Co. claimed £44. 5s. 7d. from a contractor for wrongfully disturbing and damaging an electric cable. It was stated that the cable in question was disconnected by the defendant on two separate occasions and the lighting and power supply to an entire district seriously endangered. For the defence, the damage was not denied, but it was held that the plans deposited with the Corporation by the Company were at fault. At the point where the cable was damaged, these plans showed that the cable was not less than 4ft. 6in. from the building, but, actually, it was found to be within 9in. at certain points, and the Company's engineer admitted 12in. The defendant, therefore, argued that if the cable had been laid in accordance with the plans it would never have been damaged. In giving judgment for the plaintiffs, however, his Honour Judge GREENWELL said there was no ground, either in law or common sense, for the defence set up. The disturbance of electric mains by road labourers is by no means an infrequent occurrence, and it is interesting to have a legal decision on the point. Probably, no action would have been taken if the incident had not been repeated within a very short time of the first occasion, when the Company naturally thought it was time to take steps towards prevention. The arguments for the defence were certainly weak. On the other hand, it is doubtful whether the Company was not, to a certain extent, guilty of contributory negligence if, as was stated, there was an error of nearly 4ft. in the official data as to the position of the mains in question.

A LARGE debt of gratitude is owing to the old City companies for their interest and work in the deserving cause of technical education, and no inconsiderable share of this debt must be placed to the account of the electrical industry. Indeed, much of the progress of the industry is due solely to the munificence of the City and Guilds of London Institute, who, last year, spent no less than £37,000 on the institutions under their control. It would indeed be regretable if their efforts were marred by any fresh policy in connection with the University of London. The fact that students of the Central Technical College may be registered as internal students of the University, and at the end of the three years' course, take the B.Sc. by examination, is at first sight an admirable arrangement calculated to raise the status of both the engineering profession and the Central Technical College. But too much importance must not be attached to the degree itself, for it must not be forgotten that the main function of the college is to train students for the engineering profession—one for which the mere teaching for examinations is by no means sufficient. Up to the present, employers have placed a higher estimate upon the value of the Central Technical College diploma than

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upon the B.Sc. degree, and although the institution of an engineering B.Sc. degree will gradually improve its value in the engineering market, it will not do for the impression to get about that the Central Technical College is to do no more than prepare students for a university degree, a distinction that must always have a certain academic sound about it.

WE learn that some local authorities are intending to oppose the Supply of Electricity Bill, which is now on its way through Parliament, particular exception being taken to the clauses which will extend the powers of private companies. We have already expressed the opinion that the measure is conceived on a fair and broad-minded basis, and we trust that no effort will be spared by those who have the interests of the electrical industry at heart to frustrate any attempt to defeat or postpone this needful revision of the electric lighting law of the country.

The Rede Lecture.—Prof. J. A. Ewing will deliver the Rede lecture at Cambridge on June 11th, the subject selected being "The Structure of Metals."

London University Engineering Degree.—On Wednesday, among the degrees bestowed by Lord Rosebery, as Chancellor of the Universlty of London, were 10 in engineering.

King's College Annual Dinner.—The 44th annual dinner of King's College, London, will be held at the Hotel Cecil on Monday, June 20th, with the Marquess of Salisbury in the chair.

Ferranti Alternating-current Meter.—In the *London Gazette* of May 13 it is announced that the Ferranti alternating-current meter has received the official approval of the Board of Trade. A full description of this meter appeared in *The Electrician*, Vol. LII., p. 422.

The "Haimun."—Two hundred miles seems to be about the limit of distance over which the wireless telegragh apparatus on board *The Times* despatch steamer "Haimun" can transmit messages. In Saturday's *Times* the following statement occurs:—"As part of last Sunday's wireless message had to be transmitted a distance of over 200 miles, some sentences were garbled."

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 18, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Dakar—Konakry	May 13, 1904
Gibraltar—Tangiers	May 17, 1904

Steam Turbines.—In view of the Paper on steam turbines recently read before the Institution, the following description, from an American local newspaper, of a Westinghouse-Parsons turbine is particularly interesting:—

An interesting feature of the equipment is a steel turbine equipment of 3,000 H.P. The turbine is a reciprocating engine with a piston rod that extends back and forth instead of in a circle, and is the most modern. It is compact and takes up less room than other styles, and is now in use in many of the first-class manufacturing establishments.

The "Canadian Scholarship" at Cambridge.—The McGill University of Montreal have offered to endow a Canadian scholarship of £80 a year for three years at Christ's College, Cambridge. The scholar is to be chosen from students of McGill University, Montreal, by the principal and professors of that university, but not by competitive examination. The scholarship will be available for any subject taught at Cambridge University. It is probable that the first Canadian scholar will come into residence next year. McGill University of Montreal is affiliated to the University of Cambridge.

Personal.—Mr. F. G. Donnan, Ph.D., M.A., has been appointed to the chair of physical chemistry recently founded at the University of Liverpool by Sir John Brunner, M.P. After graduating at the Royal University of Ireland, Dr. Donnan went abroad and worked in the laboratories of Prof. Ostwald, of Leipzig, and Prof. Van't Hoff, of Berlin. On his return to England he was associated with Sir William Ramsay, of University College, London, for about three years, first as his assistant in the Department of Chemistry, and then as assistant professor. Dr. Donnan was subsequently elected to a Junior Fellowship in the Royal University of Ireland. He is now lecturer at the Royal College of Science, Dublin.

Association of Academies.—The delegates to the general assembly of the International Association of Academies were received by the King at Windsor on Wednesday. This (Friday) evening they are invited to a reception by the University of London. To-morrow they are invited to visit the Universities of Oxford and Cambridge, and degrees will be conferred in the afternoon, while on Monday, the Lord Mayor of London will entertain them at a banquet at the Mansion House. The following are among the delegates:—

London.—Royal Society.—Sir William Huggins, Mr. A. B. Kempe, Prof. Larmor, Mr. Francis Darwin, Prof. H. E. Armstrong, Mr. W. Bateson, Prof. George Darwin, Prof. A. R. Forsyth, Sir Michael Foster, Sir David Gill, Lord Kelvin, Prof. A. Liversidge, Sir Norman Lockyer, Prof. J. Milne, Sir William Ramsay, Sir Arthur Rücker, Prof. A. Schuster and Dr. A. D. Waller.

Paris.—Académie des Sciences.—M. Mascart, M. Gaston Darboux, M. Henri Poincaré, M. H. Moissan, M. A. de Lapparent, M. A. Giard and M. Darboux. Académie des Sciences Morales et Politiques.—M. Georges Picot, M. Paul Leroy-Beaulieu, M. Glasson, M. le Comte de Franqueville, M. Boutroux, M. le Baron de Courcel, M. Henri Joly and M. Paul Meyer.

Washington.—National Academy of Sciences.—Sir Archibald Geikie and Prof. E. Ray Lankester, foreign associate members.

Light Railways Act, 1896.—The Board of Trade have made an additional rule under the Light Railways Act, 1896, with respect to the notices to be given and deposits made in cases where alterations of works are proposed during the progress of an application for an order. The additional rule, which will be placed on sale as a Government publication, reads as follows:

Where an application for an order authorising a light railway has been made to the Light Railway Commissioners, and the promoters communicate to the said Commissioners their desire to make any additions to or alterations in the line of the railway or the works thereof or the lands to be taken as respectively proposed under such application, and such desired additions or alterations are not of such extent or character as to make it inconvenient or inadvisable in the opinion of the Commissioners that the same should be dealt with under the said application, the promoters shall, with the consent of the Commissioners, given at any time before the said application has been decided on by them, publish such advertisements and give such notices and make such deposits (including any lists and statements required under rules 32 and 33 of the Board of Trade Rules, 1898), as would have been requisite under the said rules if such additions or alterations had formed the subject of a separate application for an amending order in accordance with rule 38 of the said rules, except that, notwithstanding anything contained in the said rules, such advertisements shall be published, such notices given and such deposits made at such times as shall be directed by the Commissioners.

Details of Tramway Construction.—The Board of Trade has issued the following memorandum relating to details of construction of tramways:—

1. *Clearance.*—The space between the inner rails of a double line must depend upon the overhang of the cars. It is, however, necessary that there should be at least 15in. between the sides of the passing cars, and also a similar space between the side of a car and any standing work such as lamp posts, telegraph posts and trolley wire standards in a street. As a rule there should be at least 15in. between the side of the car and the kerb, whether on straight or curved roads. Where central poles are used for electric traction any stone kerbing should not be left wide enough at the sides facing the rails to enable any person to stand upon it as a refuge.

2. *Rails.*—For mechanical traction it is generally considered that the weight of rails should not be less than 90lb. per yard, 100lb. being preferred. The groove of the rail should not exceed *one and an eighth inch* in width, but the Board of Trade are prepared to accept a groove not exceeding *one and a quarter inch* on curves of less than 1 chain radius.

3. *Cars.*—Staircases of the "reversed" type should be avoided, more especially on narrow gauge lines. Of existing types the "trigger" life-guard is the pattern which is preferred. The hanging gate should be as close to the ground as possible, and there should be at least 3ft. between it and the front of the guard. Both the guard and the gate should be at least as wide as the outside of the frame of the truck. In order not to interfere with the efficiency of the life-guard it is desirable that folding steps should be adopted on all new cars. Where trolley ropes cannot be dispensed with or tied up, precautions must be taken to prevent the "slack" causing accidents. To prevent trolley booms being pulled out, or trolley standards broken, "traps" should be minimised and detachable trolley heads provided.

The Conversion of the Hanover Tramways from the Accumulator to the Overhead System.—Amongst the large Continental tramway systems Hanover was one of the few upon which accumulator traction had been adopted. The usual troubles were experienced, notably the expensive and trouble-

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some upkeep of the car batteries, and the tramway company decided long ago to convert the tramways to the overhead system. A strong opposition arose, however, and it was only after tedious negotiations and after legal proceedings had been taken, that the company was able to carry out its plan and convert its whole system (equivalent to 30 miles of single track). According to an article on the subject by Herr L. Liebenberg in the *Elektrotechnische Zeitschrift*, the conversion was carried out by the Union Elektricitäts Gesellschaft, the bonding of the rails being done by the tramway company themselves. The bonds consist of 8mm. copper wire with conical lugs at the ends. These lugs were driven into holes carefully machined into the web of the rails, the holes being coated with a thin deposit of copper by means of copper sulphate. The drilling device was electrically operated with the aid of a small portable battery. An iron armoured cable serves as a return path for the current, and the dynamo is not earthed at the station. The overhead wire is used in two sizes with cross-sections of 0·0775 and 0·0975 sq. in. respectively, and has lateral grooves in both cases, so that a section through the wire takes approximately the form of an **8**. Section insulators are inserted into the overhead line about every $\frac{1}{3}$ mile. The current collectors are of the "bow" type. Herr Liebenberg states that the total cost of conversion amounted to £39,800, and that the total time taken for it was $4\frac{1}{2}$ months.

A Switching Tower for Tramways.—The *Street Railway Journal*, in a recent issue, describes a switching tower used at a busy crossing point of the Los Angeles, Cal., tramways. The apparatus is operated by means of oil pressure. To each of the four switches is run a pressure pipe, $\frac{3}{4}$in. in diameter, and the oil cylinders of the switches are connected by one common return pipe to the oil tank in the tower. Two double-acting plunger pumps in the tower are driven by $\frac{1}{2}$ H.P. slow-speed series-wound motors from the 500-volt line. At each end of the pump base is an air chamber, from which pipes are brought around to four three-way valves on a switchboard. All the switches are held in the position for straight track by means of springs. When the operator pulls down one of the valve handles to a horizontal position, this opens the three-way valve and allows oil under 60lb. pressure to move the switch tongue over against the force of the springs. The switch cylinder, which is located in an iron box just outside the track, is $3\frac{1}{2}$in. in diameter, and, as it works constantly in oil, its wearing qualities are very good. It is not even necessary to use rings in the piston head. In order to signal the motorman to proceed after a switch is set, small semaphore blades are arranged, which, when thrown to a vertical position uncover electric lamps that serve as signals at night. Each semaphore is operated by an electric solenoid switch controlled by a push button located beside the valve handle. The tower is hexagonal in shape, the operating room being $8\frac{1}{2}$ft. across and 6ft. high. It is supported 8ft. above the edge of the sidewalk by means of a hollow steel post, the bottom of which is stayed to an iron plate embedded in concrete. The four pressure pipes and the return pipe are carried down within this post.

Electric Tramways and Magnetic Observatories.—The United States Treasury Department, controlling the United States coast and geodetic survey, has recently issued a buff book marked "Appendix No. 5 of the Report for 1902," setting forth the conditions of the United States magnetic observatories in operation on July 1, 1902. In commenting on this volume, the *Electrical World* of New York recalls the removal of magnetic observatories in various countries necessitated by the introduction of electric traction, and continues that the United States observatories have now joined in the exodus. There are now four United States magnetic observatories considered safe for the time being from the trolley cars. One is in Sitka, Alaska, "near the new Russian cemetery," a quiet, remote place. The second is "on an immense coral plain," 20km. west of Honolulu, in the island of Hawaii. The third is in Baldwin, Kan., 21km., in an air line, south of Lawrence, Kan. This, however, is but a temporary site, and, if trolleys should come, the equipment can be removed quickly. The fourth is at Cheltenham, Md., which is visited by two local passenger steam trains daily. The report states that the land in this region, while in a flourishing condition before the civil war, when slaves were available for tilling the soil, is now so undesirable that so far as can be seen at present, there will be little inducement to run electric car lines into this region. The civil war was thus evidently not in vain from one special viewpoint. Great pains have evidently been taken with the construction of the buildings for these observatories, so as to maintain a nearly uniform internal temperature at the magnetographs. This thermal insulation has been provided by using multiple walls and large thicknesses of dry sawdust. It is stated that 3,000 sacks of sawdust were used in the Sitka Observatory alone. The thermograph records for Cheltenham Observatory inside and outside the building during a week show that while the external range of temperature during that time was about 50deg., the internal range was about 1deg. It is interesting to observe that the apparatus employed for making and recording the observations differs but little from that employed 30 years ago.

The Faraday Society.—At an ordinary meeting of the Faraday Society on May 9th, Dr. F. M. Perkin read a Paper, by A. Fontana and himself, on "The Electrolytic Oxidation of Anthracine." The authors had taken up the study of the oxidation of anthracine primarily to ascertain whether it was possible to obtain a good laboratory method for the preparation of anthraquinone. The first attempts were made with solutions in acetone, platinum electrodes being employed. Although oxidation took place in solutions of anthracine in acetone, it was not found possible to oxidise more than about 55 per cent. of the anthracine. Attempts were then made to electrolyse anthracine suspended in 20 per cent. sulphuric acid or in caustic alkali to which an oxygen carrier had been added. Various carriers were employed, the most satisfactory being chromium, cerium or manganese salts. The anode consisted of a lead vessel, and the cathodes, four in number, were also of lead and were placed in four small porous cells. There was also a lead paddle which was connected with the positive pole, the total anode surface being about 6 sq. dcms., current density 1 ampere per sq. dcm., temperature 70°C. to 80°C., and E.M.F. from 2·5 to 3·5 volts. The yield of anthraquinone was about 80 per cent. and it was not found possible to increase the yield more than 1 or 2 per cent. above this. It was afterwards found that almost equally good results were obtained without a diaphragm. In this case the stirrer, $\frac{1}{2}$ sq. dcm. in area, was made the cathode. In discussing the results of their experiments the authors considered that, owing to its volatility and the comparatively poor yield, a solution in acetone could not be recommended. On a large scale no method in which a diaphragm is employed would be satisfactory, owing to the migration of the SO_4 ions from the cathode to the anode side. In the discussion, Mr. Blount (the chairman) suggested the use of thallium salts. He thought the energy bill in this instance might not necessarily be an all-important item. Dr. Steinhart thought better results would be obtained if the anode solution were removed from the cathode. Mr. Inglis discussed the effect of the P.D. between the anode and solution. Mr. Gaster thought the cost of energy was of prime importance.

Electric Traction for Goods Traffic in the Chicago Telephone Tunnels.—The network of tunnels which has been built under the streets of Chicago by the Illinois Tunnel Co. (formerly the Illinois Telegraph and Telephone Co.) for the purpose of carrying the wires and cables of the company's automatic telephone system is to be utilised for a system of electric traction for the carriage of goods. The franchise does not permit of passenger traffic. The idea is to carry freight and coal between warehouses, wholesale houses and railway freight stations; to carry mail and express matter between the railway stations, post offices and express offices; and to carry newspapers between the newspaper offices and the railway stations. Sidings and spur tracks will be built as required. A franchise covering this privilege was granted to the company in July, 1903. An experimental section of line has been laid and locomotives and cars put in service. It is expected that contracts for 150 locomotives and 2,000 cars will be placed in the course of a few weeks. It is also stated by the company that regular traffic service will be started in September, and that about 200

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locomotives and 3,000 cars will be in operation by 1905. At the present time there are 99,000ft. of tunnels 6ft. by 7½ft., and 140 four-way intersections, while about 1 mile of the first large tunnel, 12⅔ft. by 14ft., has been completed. The steepest grade in the tunnels is 1·75 per cent., and the grades at railway terminals are not to exceed 12 per cent. These latter steep grades will form the approaches to the tunnels, which are built with the rails some 30ft. below the street level. The four-way intersections have curves of 20ft. radius, and the sharpest curves on the main line are 16ft. radius. The track is of 2ft. gauge, laid with 56lb. T-rails fastened by bolted clamps to cast-iron chairs embedded in the concrete floor of the tunnel. The Morgan third-rail traction system is used, consisting of a perforated metal plate (½in. thick and 4in. wide) forming a rack, which is bolted between two lines of timber stringers. These serve to protect and support the rail. The locomotive is of the class used in mine haulage work, but is peculiar in the method of taking current. The rack rail serves both for traction and as a third-rail conductor, the current being taken up by the teeth of the driving gears and led to motors geared to the axles, with suitable controlling devices. The running wheels are of the adhesion type, and the track rails are used for the return current. The locomotive weighs about 3 tons with one motor or 5 tons with two motors. Of the first 150 locomotives, 75 will have two 80 H.P. motors and 75 will have one 75 H.P. motor. The drawbar pull is about 6,000lb. In some cases the third-rail may be placed at the side of the tunnel wall.

Electric Transmission Line 110 Miles in Length.—According to the San Francisco *Journal of Electricity*, the Washington Water Power Co. of Spokane is about to begin the commercial operation of its 110 mile transmission line. In the generating station two 2,250kw., 4,000-volt revolving field generators, each directly connected to a Victor turbine, operating under a head of 70ft. have been installed. The electrical machinery, including generators, transformers, switches, lightning arresters, &c., was built by the General Electric Co. Two sets of 'bus bars allow the city service and the transmission system to be separated when necessary. All generator switches are of the motor-operated, remote-control type, and operate so promptly upon closing the relay switch on the switchboard that no difficulty is encountered in synchronising machines. Three water-cooled transformers (with one spare for emergencies) step the voltage up from 4,000 to either 45,000 or 60,000 volts depending upon connection, for the long distance transmission. There are no high-tension switches other than disconnecting switches installed between the line and the transformer primaries. Lightning arresters are installed, each single-pole arrester being in a separate brick compartment extending from the lower floor of the building to the high-tension wires, which are near the roof. The line is approximately 110 miles long to the furthest power user. A portion of it runs through marshy or boggy country where considerable trouble was experienced last winter from ice forming around the pole butt and finally lifting the pole out of the hole. This difficulty was overcome by putting horizontal cross-pieces on the butts underground. The line consists of three No. 2 solid copper wires, with 60,000-volt Locke insulators and iron pins. These pins are made of about 3in. wrought-iron with cast-iron shanks, for insertion in cross-arm and lead threads. There are six sub stations, each equipped with three-phase, step-down, water-cooled transformers, varying in size from 100kw. to 750kw., with primary taps for 60,000 or 40,000 volts, according to line pressure. Each sub-station is equipped with an automatic high-tension oil switch mounted in a separate brick compartment above the panel and connected between the transformer primary and line. The power will be used almost exclusively for mining purposes, the most notable installation being at the Standard and Hecla mines, where four General Electric 300 H.P. induction motors will be used to drive compressors, hoists, &c. One of these motors will be geared directly to a hoist. There is an aggregate of about 800 H.P. in synchronous motors and the rest in induction motors. The synchronous motors will be started directly from the line through low voltage taps on the transformers. The plant has already been operated for some time at 60,000 volts, but with no load at the end of the line, and no defects have been encountered.

Explanation of a Phenomenon in Three-phase Working.—In a short Paper read before the Dublin Local Section of the Institution of Electrical Engineers on April 14th, Mr. W. Tatlow suggested an explanation for the fact that comparatively large currents, which cannot be attributed to faulty insulation, have been observed in the wire earthing the star connection of the three-phase alternators working at the Pigeon House Fort station in Dublin. By a simple application of Fourier's theorem he shows that the harmonic pressures of three times (or multiples of three times) the main frequency are the same in magnitude and direction in all the three phases at any moment, whereas the fundamental and remaining harmonics differ by 120deg. in phase in each of the three phases. It follows at once that in a mesh-connected winding harmonic pressures of three times or three n times the fundamental frequency will, if present, add together and drive idle currents round the mesh, while the fundamental and remaining harmonics form, on the other hand, balanced sets, the sum of the three pressures due to any of them taken round the mesh being zero at any moment. In the case of a star-connected winding these harmonics of the third order will tend to drive current into or out of the star point equally in all the three windings at any moment, and therefore they will be balanced, and, as far as pressures between any pair of the three wires coming from the machine are concerned, harmonics of the third order are eliminated by the star connection, and should not appear in the pressure wave. They would, however, appear in the pressure wave taken between any of the three leads and the neutral point if they happen to be set up in the windings, and the waves of pressure between lead and lead and between any lead and the neutral point would differ in form. Now, if the star point of the three-phase generator is earthed, and the three leads bringing current from the machine are in the form of a three-core lead-sheathed cable, these harmonics of the third order will give rise to a capacity current flowing to earth from the neutral point and charging the sheath of the cable; for Mr. Tatlow shows that the mean potential of the three cores is not zero, but a fluctuating quantity, which will give rise to a capacity current depending on the capacity between the three cores taken together and the sheath. In the Dublin cables the capacity of the two cables in parallel amounts to approximately 1·5mfd., and Mr. Tatlow says that currents in the earth-wire of the star of the order of 1 ampere or more might be expected. The truth of this deduction relative to the capacity current in the earth-wire of star, Mr. Tatlow concludes, could easily be tested by bringing a coil connected to a telephone near to the earth-wire and observing the pitch of the note in the telephone, and he hopes to make this test shortly.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, May 27th.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "The Law of Action between Magnets and its bearing on the Determination of the Horizontal Component of the Earth's Magnetic Field with Unifilar Magnetometers," by Dr. C. Chree, F.R.S.; (2) "On the Ascertained Absence of Effects of Motion through the Ether in relation to the Constitution of Matter on the FitzGerald-Lorentz Hypothesis," by Prof. J. Larmor, Sec. R.S.; (3) "On Coherence and Recoherence," by Dr. P. E. Shaw and C. A. B. Garrett.

ROYAL INSTITUTION.

9 p.m. Evening discourse: "The Progress of Oceanography," by His Serene Highness Albert Prince of Monaco.

THURSDAY, June 2nd.

RÖNTGEN SOCIETY.

8:30 p.m. Meeting at 20, Hanover-square, W. Paper to be read: "Experiments to Determine the Effects of Form and Winding upon Resonance Phenomena," by Dr. C. A. Wright.

FRIDAY, June 3rd.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Development of the Theory of Electrolytic Dissociation," by Prof. Svante Arrhenius.

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REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Radio-Activity. By E. RUTHERFORD, D.Sc., F.R.S., F.R.S.C., Macdonald Professor of Physics, McGill University, Montreal. (Cambridge: The University Press.) 1904. 10s. 6d.

The rapidity of progress in the new chapter of Physics opened by Becquerel, through his discovery of spontaneous radio-activity, is well illustrated by the size of this compendium of the subject, as now known, by one of its most prominent and successful investigators. Scarcely anything to be found in this book was known 10 years ago, and the greater part of it has been discovered within the last five years, and some very important portions during the year just gone by.

The book epitomises the work that has been done by many investigators, and is by no means limited to the author's own researches. It is dedicated to Prof. J. J. Thomson, and it proceeds on the working hypothesis of corpuscular disintegration and intrinsic energy of atoms. After referring rapidly to the introductory work of Lenard, Röntgen, Niewenglowski, Troost, Arnold, and Le Bon, it begins with Becquerel's discovery, in February, 1896, and rapidly arrives at the quantitative measurements of Mme. Curie, and at the discoveries of Schmidt and Giesel. Since then the field has been open to the world, and there are few who have not contributed some trifle to it.

The book does not aim at anything ambitious or at any new departure, but is a straightforward and very convenient summary of the work that has been done, with only such an amount of theory as is necessary to weld the whole together and to make it more readable and assimilable than a mere catalogue of laboratory facts could be. Few things can be more dreary than a Paper or a book which relates a series of laboratory experiments without any clue or working hypothesis on which to string them together. Some hypothesis must necessarily occur to the worker, one would imagine; and he ought not to expect anybody else to be willing to wade through his experiments without such a clue as they have suggested to him. There is no need to accept the hypothesis as true, nor to give it any particular weight, but it furnishes a point of view from which to regard the whole, and the point of view may with advantage be changed from time to time. There are, no doubt, industrious workers who, on principle, would dissent from this view of the matter, and prefer the relation of crude facts undigested and unmixed with theory. They have, no doubt, something to say in support of their contention that bare facts alone are always preferable, and they may have the authority of a great name in support of it, but, save in exceptional cases when this mode of treatment is obviously called for, they must hardly expect their Papers to be read except by the few who have already taken up the same line of research. Fortunately the Cambridge school, of which Prof. Rutherford is a distinguished disciple, has never erred in this manner, and accordingly the experimental work of that school can for the most part be read with ease and pleasure.

In so well known a subject as Radio-activity, it would be absurd here to reproduce the main familiar features; but there are a number of side gleanings in a book like this, some of which it may be convenient to quote in a review in order to indicate the kind of facts which one may find lying by the roadside ready for utilisation. First it is interesting to notice on p. 23 that actinium is regarded by the author as probably a real and distinct element; also that a convenient test of the purity of a radium salt is the carmine colour which it imparts to a flame, for if it contain much barium it will only colour the flame green. The spectrum of radium seems also fairly easily visible, since its principal line can be observed in radium so impure that it is only 50 times as active as uranium. The phenomenon which was called "induced-activity," supposed at first to be due to the excitation of radio-activity in neutral substances by the inductive presence of a radio-active compound, is, of course, attributed to a solid deposit of one of the products of disintegration—a view for which the evidence is exceedingly strong. The question whether thorium is really radio-active itself, or whether it simulates the power because it contains a trace of impurity, is discussed on p. 25, with a decided inclination to the view that it is itself radio-active.

The Ionisation Theory of Gases forms the subject of the second chapter, including all the good work that has been done at Cambridge in connection with measurements on the saturation-current principle; and the interesting influence of dust or smoke, which should be known to every experimenter, is mentioned on p. 39. The notable rapidity with which dissociated ions re-combine in dust-free air is also quantitatively stated. It is to be noted that the ionic charge in gases considered as electrolytes appears to be always that of a monad atom, whether the gas be oxygen or any other—in this respect differing from liquid electrolytes. The remarkable measurements by C. T. R. Wilson on the different cloud condensations caused by positive and negative ions, and other experiments in the same direction, are described, together with those which indicate that an aggregate or cluster of molecules is often the real traveller, except at very low pressures. The remarkably sensitive character of the condensation test for the presence of ions is emphasised on p. 45, and the rate of travel of ions through gases is given on p. 42.

The third chapter has to do with Methods of Measurement, and gives interesting practical details about different forms of electrometers, and the way to make them work in a simple satisfactory and delicate manner. The modes of insulation described are admirable, and Prof. Curie's beautiful quartz-plate measuring instrument or high-resistance gravitation metrical crystal battery is briefly described.

Chapter IV. begins the treatment of the Nature of the Radiations, and is subdivided into four parts, three of them dealing with the beta, alpha and gamma-rays separately, while the introductory part deals with the three together. I have observed in popular writings a tendency to assume that because the alpha-rays are easily stopped by obstacles, therefore they are slow-moving things; whereas, as a matter of fact, they are projected with about a tenth of the velocity of light—certainly a very remarkable speed for atoms of helium or hydrogen, and quite sufficient to account for their energetic qualities. Singularly uniform in speed the alpha-rays appear to be; there is much greater variety about the speed of the beta particles. Another mistake which is sometimes made is to ignore the material quality of the alpha particles, and to consider that helium is the last product or residue of the emanation. There is no evidence that that is so, and it is unknown what substance or substances the emanation ultimately becomes. Helium apparently is shot off from it, whatever may be left behind.

Not all substances, however, appear to send off the same alpha particles. The alpha-rays from uranium and polonium seem to be less penetrating than those from thorium. It is, I suppose, well known that polonium gives out alpha-rays alone; hence it does not much affect ordinary X-ray screens (which are much more strongly stimulated by beta and gamma-rays), but it causes strong luminosity on a screen of zinc sulphide, which is a specially sensitive detector of alpha-rays.

The most sensitive detector of any rays, however, is their electroscopic action due to ionisation. An alpha particle produces an enormous number of ions in its passage through air before its speed is reduced; for, whereas a beta particle produces about 21 ions in its course, an alpha particle can produce more than 70,000. The most sensitive test for ionisation is the condensation of mist—an incredibly small amount of ionisation being thus rendered visible by the cloud of globules which gather round it. Photography is by no means the most sensitive test for rays. Alpha-rays indeed seem to have very small photographic effect. "The rays which are most active electrically are the least active photographically."

The ingenious method by which Becquerel observed the magnetic curvature of beta-rays, by means of a photographic plate with the film on the back on to which shadows were cast by the circularly moving particles, and likewise the kind of magnetic spectrum observed with the different speeds of beta-rays, are given on pp. 97 to 99. The automatic charging of a radium preparation when enclosed so that the negative particles only escape, can be illustrated in many ways, but perhaps most strikingly by Strutt's experiment, p. 105, where also are described important quantitative experiments by Wien.

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The reason why the alpha-rays from polonium are more easily stopped or absorbed than those from radium is not at all clear. It appears from experiments of Becquerel that the magnetic curvature of such rays, though of course extremely minute, is nevertheless the same for both kinds. Nevertheless the polonium rays are even more easily stopped than the alpha-rays from radium; and therefore presumably are moving slower. If so, it appears to indicate that the massiveness of the polonium projectiles is greater than that of the radium projectiles; in which case it is probable that polonium is not shooting off helium but something heavier. This, however, is at present quite uncertain, and the whole thing requires further investigation.

It is remarkable how sensitive a zinc-sulphide screen is to mechanical disturbance of any kind. It is plain that the flashes in a spinthariscope are due to crystal cleavage under the blows. "Tommasina found that a zinc-sulphide screen removed from the action of the radium rays for several days showed the scintillations again when an electrified rod was brought near it."

There is a good deal of interesting discussion as to the mode by which alpha-rays are absorbed by matter. It seems to be a question whether they are slowed down in speed, so that they become gradually less and less prominent, or whether their charge is gradually removed from them, that is to say, whether the charge is removed from one after another of them. For it must be remembered that their detection is due to their ionising power: if they have too slow a speed they will not be able to ionise and render the air a conductor; if they lose their charge they will likewise not be able to do much in that *direction*. Accordingly, "it is possible that, in addition to the alpha and beta charged particles, there may be a stream of uncharged particles moving through the gas with great velocity, the existence of which has not yet been detected."

Such uncharged particles would be fairly penetrating, and one view of the gamma-rays is that they consist of uncharged particles; and this was at one time Strutt's view; but it has always appeared to me much more likely that they are Röntgen pulses or shells of exceptional thinness—Röntgen rays of extra "hard" quality; and it now appears in a note added February 18, 1904, that the most recent evidence lies in this direction (see p. 145). The peculiarity which led Strutt legitimately to liken gamma-rays to particles rather than to pulses was their greater similarity to cathode rays as regards their effects on different gases, in which respect they differ considerably from the X-rays produced by an ordinary Röntgen bulb.

The fifth part of this chapter deals briefly with Secondary rays excited by the impact of the others, owing to which, radiographs are apt to show considerable diffuseness of outline, since the secondary rays excited by the impact of the beta particles have a decided photographic effect.

Chapters V. and VI. deal with the Rate of Emission of Energy and with Properties of the Radiations. The result of Wien's experiments is to show that the number of alpha particles projected by a gramme of radium in a second is the tenth part of a billion. The striking effect of radium in precipitating a spark across a spark-gap, and likewise its effect on selenium, are mentioned on p. 171; also its influence in making solids and liquids conduct, on p. 173. Some chemical actions are dealt with briefly, but they will probably have been more amply treated by Mr. Soddy, in his forthcoming work.

The next few chapters give an account of the fundamental experiments of the author with respect to the continuous production of radio-active matter and the decay of the emanation—the foundation, in fact, of the disintegration theory. It is interesting to note that the discovery of the emanation itself was first made in the case of thorium by Mr. Owens, a student of promise. (*Phil. Mag.*, October, 1899.)

Chapter X., on Radio-active Processes, involves at first a good deal of repetition, but ultimately leads to important considerations respecting the lifetime of radium, the amount of gas emitted by it per annum, its possible loss of weight, causes of its disintegration, the effect of its energy on solar and terrestrial history, and other matters of great interest.

The author appears to think that the alpha radiation is not only the chief, but is the first in point of time, from any atom; and that the beta and gamma-rays, which always seem to occur together, are a sort of residual phenomenon. As has been said before, it appears likely that a gramme of radium expels about 10^{11} alpha particles per second, and of these it seems likely that four are emitted during the disintegration of a single atom. On this estimate it appears likely that only about 1 per cent. of a piece of radium will remain after the lapse of 10,000 years.

The amount of radio-activity required in the crust of the earth to account for its present temperature seems to be not very different from what, by the direct experiments of Elster and Geitel, can be found there (see p. 346). A measurement of vital importance to Darwinian biologists.

The question whether radium disintegrates more rapidly when pure than it does when extremely diluted with other substances has been attacked as described on p. 339, with the result that its own bombardment seems to exert but little influence on its own rate of disintegration, so that however diluted and scattered the radium atoms may be, it seems likely that they will have almost the same chances of occasionally breaking up as if they were tightly packed; but it is quite clear that the chances of a single atom of radium breaking up in any reasonable time are very small. I estimated some time ago that if one out of every 10,000 atoms of radium explodes once a year, that would be sufficient to account for all the observed phenomena.

Rutherford's measure of the atomic weight of the alpha particles by their slight magnetic deflection, which he was the first to detect, indicates that they consist either of hydrogen or helium. Ramsay and Soddy showed that helium was one of the disintegration products, but there may be hydrogen too. One reason why the helium spectrum easily makes its appearance is because it is so good a conductor of electricity and because its spectrum lines are exceptionally bright. Concerning the volume of the alpha-particles (considered as a gas) which are emitted by a gramme of radium per annum, two different estimates appear to be given on p. 331—1 cubic mm. and 90 cubic. mm. respectively—but the larger quantity is from the radium itself, while the smaller quantity is from the emanation released from a gramme of radium, and from that alone. The amount of helium actually observed seems to have been about ½ cubic mm., but it is assumed that some is absorbed by the glass.

One of the most striking speculations contained in the book is the hypothesis that the known life history of radium involves its birth as well as its death, and that it is continually being produced as a disintegration product of uranium, which, being a radio-active substance, must be very slowly decaying. If the source is not uranium then it must be something else: the question is what. It appears quite probable that there may be a whole series of disintegration products of every grade of stability. Those which are very stable we consider permanent elements, and they are only slightly radio-active, if at all. Those which are very unstable have but a short existence of a few months, days, or hours, and while they last are violently active, out of all proportion to their infinitesimal weight. Of such a character are the emanations and the excited activities or deposits. But there is probably an intermediate class of moderately stable atoms, which behave as elements with a life of a few thousand years, and with an intermediate amount of radio-activity; and to this class it may be conjectured that radium belongs.

The whole doctrine of the evolution of matter—the building up of complex atoms from simpler ones on the one side, and the falling down of complex atoms into simpler ones on the other—is now a working hypothesis of the utmost interest, which must guide the researches of physicists and chemists for some time to come; with a result which it would be unwise to try to anticipate.

The amount of energy involved in the aggregation of the constituent corpuscles into an atom is something enormous—far greater than any other store of energy known. It is calculated that 1 gramme of the radium emanation, for instance, can give out during its life a thousand million C.G.S. units of heat—*i.e.*, the heat required to boil and convert

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into steam 1600kg., or about 1½ tons, of ice-cold water. But on the electrical theory of matter there is no difficulty in attributing this energy to the ingredients of which atoms are composed, even though the substance itself may be at a temperature of frozen air, and therefore nearly deprived of ordinary molecular or heat energy. Whether a practical way will ever be found to control at will the disintegration of atoms, and thus to render their store of energy available, is another matter altogether, and one to which no glimmering of an answer appears likely immediately to be forthcoming.

The concluding chapter deals with the important subject of the Radio-activity of the Atmosphere and of Ordinary Materials. The radio-activity of the atmosphere has been chiefly investigated by those admirable experimenters Elster and Geitel. They found that a negatively-charged surface gradually acquired radio-activity by attracting to itself positive emanations; and that the air in a cave, which had been undisturbed for some time, had more emanation in it than the open air. The surface of the earth being negatively electrified, it must tend to cover itself with positive radio-active carriers. Rain water brings them down; but the greatest effect is found in air which has been sucked up from the pores of the earth, showing that the crust of the earth contains more than traces of radio-active matter. It is well known that deep springs of water show the same property.

The amount of radio-activity obtainable from the atmosphere is affected by meteorological conditions. It is probable that it is less over the sea than over land. It is also observed that the air in rooms is full of a slight trace of very penetrating radiation, causing enclosed electroscopes to leak slightly, a leakage which is probably due to the few gamma-rays associated with and emitted by the general radio-activity.

Whether ordinary substances are really radio-active or not must still be regarded as an open question. They undoubtedly emit rays, but that may be due to a very slight trace of radium or other impurity. The only way to discriminate is to measure the rate of decay of the emanations and excited activity which ordinary substances originate, for in that way the identity of almost imperceptible quantities of radio-active substances can be ascertained. It furnishes an extraordinarily sensitive instrument of qualitative analysis.

The slight amount of radio-activity which has thus—by Strutt, Cooke, McLennan and Burton, and other observers—been measured is something extraordinarily small. Ionisation at the rate of 10 ions per cubic centimetre per second has been observed, and this would be accounted for by the expulsion of one alpha particle per hour from each square centimetre of surface. Such a rate of disintegration, if it is due to the disintegration of ordinary matter at the rate of one atom per second per gramme, would give it a great length of life—roughly, about three million million centuries; but that after all may be regarded as an inadequate lifetime for ordinary forms of matter, and the hypothesis may be preferred that the observed radio-activity is due to impurity. It may be left an open question at present, but it must be admitted that theory points in the direction of a finite life-history for every kind of atom.

OLIVER LODGE.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

"Elements of General Radio-Therapy for Practitioners." By Dr. Leopold Freund; translated by G. H. Lancashire. (New York: Rebman Co.) £1.

"Annual Catalogue of Massachusetts Institute of Technology." 1903-4. (Boston: G. H. Ellis & Co.)

"A Text Book on Static Electricity." By H. Mason. (New York: McGraw Publishing Co.) $2.

"Electric Lighting Accounts." By G. Johnson. (London: Gee & Co.) 5s.

"Transactions of the American Institute of Electrical Engineers," March and April, 1904. Nos. 3 and 4, Vol. XXI. (New York: The Institute.) 50 cents.

"Leerlauf und Kurzschluss-Versuch in Theorie und Praxis." By J. L. La Cour. (Brunswick: Friedrich Vieweg & Son.) 3.50m.

CAPE TOWN CORPORATION ELECTRICITY WORKS.

The new electricity works of the Cape Town Corporation were formally opened by the Mayor of Cape Town (Mr. Councillor W. Thorne) on April 14th.

In 1895, the original undertaking was started, Messrs. Siemens and Halske having installed the whole system. No statutory authority was obtained, but in 1902 the Council succeeded in passing a bill which empowered them, with the consent of the local authority, to supply electricity. It also provided, subject to certain exceptions, that no person might supply, within the municipal limits, for sale or otherwise, electric energy or power without the permission of the Council given in writing under the Corporate seal.

The Graaff electric lighting station, which derived its name from the mayor who initiated the original scheme, is situated in close proximity to the Molteno reservoir. The low-tension five-wire distribution system was first adopted, lighting current being supplied at 110 volts between any two adjacent wires, and 440 volts between the two outside wires being used for motors. This was changed to a three-wire system during 1897, current for lighting being then supplied at 220 volts, the supply for motors remaining 440 as before. The original plant comprised two multitubular boilers, manufactured by Messrs. Simonis and Lanz, of Frankfurt-on-Main; two continuous-current shunt-wound dynamos, with external armatures of 150kw. capacity each, by Messrs. Siemens and Halske; two 200 H.P. vertical cross-compound engines by Messrs. Kuhn, of Stuttgart, and two 200 H.P. Pelton wheels by J. M. Voitch, of Wurtemburg. By means of special clutches these dynamos were driven either by the Pelton wheels or steam engines, water for the former being supplied from the reservoir on Table Mountain. In the early stages of the undertaking the steam plant only was used, water being unavailable, but, owing to this water power only being sufficient at any time to drive one dynamo, it soon became necessary to use both steam and water together. Current generated at this station is conveyed by means of trunk mains to the Dorp-street distributing station, from whence feeders are run to different parts of the city. A battery of 1,400 ampere-hours capacity is also installed at Dorp-street, and was provided by Messrs. Siemens and Halske in their original contract. The whole of this plant is still in existence, although the only portions now in operation are the turbine-driven plant at Molteno and the battery at Dorp-street, the steam plant at Molteno having been shut down some four months ago.

In the early part of 1898 it was found necessary to extend the plant, and in consequence the site in Dorp-street was converted into a generating as well as a distributing station. There were installed two locomotive-type boilers by Messrs. Clayton and Shuttleworth; one 200 H.P. Bumsted and Chandler-Crompton high-speed directly coupled continuous-current set and two 50 H.P. steam balancers of similar design. Of this plant the 200 H.P. set is now running in the new power house at Dock-road, the remainder being shut down entirely. At the same time, two separate machines were installed at the Molteno generating station, being driven by means of ropes from the existing engines in order that the whole steam plant might be utilised in conjunction with the available water power. These 150kw. machines were supplied by the General Electric Co. of America.

Towards the end of 1900, still further extensions were carried out, four Davey-Paxman boilers, which are described later on, being installed in a temporary wood and iron shed near the site of the new power house. The generating plant in this shed, which was put up temporarily owing to the phenomenal increase in consumption, comprised two 500 H.P. high-speed tandem compound engines, manufactured by Messrs. Sisson & Co., directly coupled to continuous-current machines by Messrs. Johnson and Phillips. Owing to the great and growing demand, a Belliss and Morcom engine, directly coupled to a Mather and Platt generator, described later, was also installed in the temporary shed in the early part of last year; this has, of course, been removed, and is now running in the new power house.

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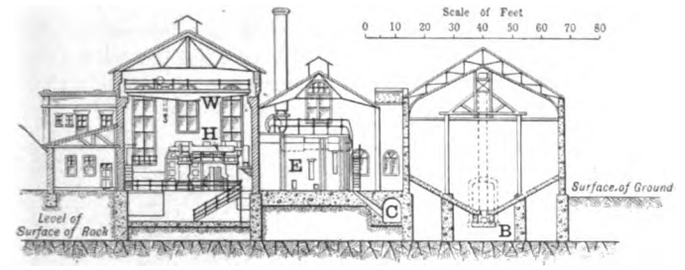
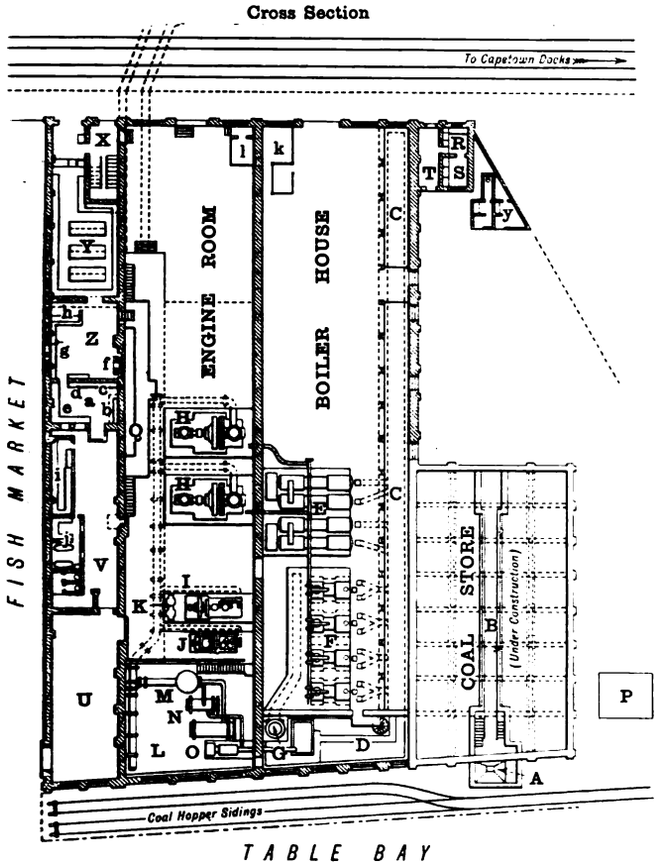
The site of the new works originally formed part of a plantation, being bounded to the north by Table Bay, to the south by Dock-road, to the east by the fish market and to the west by municipal land. It covers 42,790 sq. ft., and being formerly a portion of the foreshore, and therefore entirely reclaimed land, the foundations had to be carried through very uncertain ground to an average depth of 18ft. before a good and sound rock bottom was obtained. The main walls and engine foundations are founded on rock, the foundations being cement concrete 8 to 1, 3ft. 6in. wide under walls. Owing to the great depth, the foundations had to be carried



Cross Section



Plan and Cross-section of Power Station.

A. Hopper to Coal Store.
B. Coal Conveyor.
C. Ash Subway with Coal Bunkers over.
D. Feed Pump House.
E. Babcock and Wilcox Boilers.
F. Davey-Paxman Boilers.
G. Chimney Shaft.
H. Ferranti 1,000 H.P. Engines. English Electrical Mfg. Co. Dynamo.
I. Belliss and Morcom 450 H.P. Engine. Mather and Platt Dynamo.
J. Bumsted and Chandler 200 H.P. Engine. Crompton Dynamo.
K. Electric Construction Co. Balancer.
L. Condenser House.
M. Grease Separator.
N. Worthington Condenser.
O. Cole, Marchent and Morley Condenser.
P. Site for Proposed Water Cooler.
Q. Switchboard and Gallery.
R. Time and Pay Office.
S. Mains Foreman.
T. Workmen's Entrance.
U. Machine Workshops.
V. Yard.
W. Craven Bros. 20-ton Overhead Traveller.
X. Entrance Lobby to Offices.
Y. Stores.
Z. Meter Stores, &c.
a. Testing Department.
b. Photometer.
c. Bridge.
d. Potentiometer.
e. Switchboard.
f. Motor-generator.
g. Workbench Arc Lamps.
h. Meter Inspectors.
i. Battery for Testing Current.
j. Workmen's Lockers and Bath.
k. Mains' Breakdown Gang.
l. Shift Engineer.
y. Workmen's Conveniences.

below high-water mark in Table Bay, and pumping had to be resorted to both day and night to prevent the trenches being submerged with sea water. The heavy rains, too, which were experienced in the winter of 1902 gave considerable trouble on account of the flow of water into the excavations, increasing the work of the pumps. To deal with this difficulty, two 3in. centrifugal pumps were used, the motive power being electricity generated at the temporary power station. No less than 5,782 casks of cement, forming, approximately, 7,000 cubic yds. of concrete, were used, both in the foundations for walls and engines—the large Ferranti engines alone requiring 1,150 cubic yds. each. The whole of this work was carried out departmentally. During this period the erection of engines and boilers was proceeded with.

The main elevation fronts the Dock-road, and is carried out in brickwork in a combination of Old Dutch and classic design, with granite base and sills and facework of plaster, the whole of the timber work being of teak. A fresh-water tank, 5ft. high, weighing 71 tons, and having a capacity of 55,000 gallons, runs the whole length of the building. Between the stanchions and west wall of boiler house the coal bunkers are placed. The front is of framed stinkwood, 4ft. high, and placed 12in. above floor level to allow the coal to escape to the firing floor. Running the entire length of the boiler house, and situated under the coal bunkers, an ash subway, 6ft. 6in. wide and 9ft. high, has been constructed, and is provided with tramlines, hoppers and ash shoots slanting upwards to the boiler fronts. A wrought-iron main chimney stack is situated on the side of the boiler house next to the engine room, and is 5ft. in diameter, 45ft. high, on a brick base 8ft. square, roof high. The coal store (still under construction) will, when completed, be capable of storing 3,500 tons of coal.

Arrangements have been made by which coal will be brought by railway trucks to the sea end of the coal store and discharged into a crushing hopper. After being crushed it will be elevated by an endless chain of buckets and conveyed along the centre of the coal store, being discharged either into the coal store itself, at any point, or through chutes leading directly into the coal bunkers. The floor of the coal store is arranged in the form of a hopper sloping from both ends and sides towards the centre, and from end to end below the centre of the store is a culvert in which the conveyor runs, with chutes leading to it from the store. These chutes can be opened from inside the culvert, the coal then drops into the bucket conveyor, and is elevated and discharged to the bunkers through the chutes at the top of the conveyor mentioned above; the same conveyor thus accomplishes both the storing of the coal and at the same time supplies it to the bunkers from the store. The capacity of this store will be 3,500 tons; the plant is electrically driven, and was manufactured by the Jeffreys Mfg. Co., Columbus, Ohio, U.S.A., and supplied through Messrs. Arthur Koppel (Ltd.), Cape Town. Opposite each ash pit door a chute is placed, communicating with the subway, the lower end of which is at such a height as will allow of the ashes being discharged directly into a truck. This truck is then run by hand on rails along the subway to the opening near the end of the boiler room, where the body of the truck is lifted (leaving the carriage on the rails), and conveyed along a telpherage into the yard. The ashes may then be either tipped directly into a cart, or on to the ash heap for subsequent removal. The electrically-driven telpherage for this purpose will be supplied by Messrs. Siemens Limited, Cape Town.

Six boilers form the present equipment in the boiler room, four being Davey-Paxman "Economic" boilers, recently removed from the temporary shed, and the remaining two water-tube boilers being supplied by Messrs. Babcock and Wilcox. Each of the latter has 5,730 sq. ft. of heating surface, and is constructed for a working pressure of 150lb. per square inch, at which pressure it is capable readily of evaporating, with inferior fuel, 18,000lb. to 20,000lb. of water per hour. The boilers are each constructed of 20 sections of tubes, there being 13 tubes in each section, and the tubes are 18ft. long. The headers are of wrought mild steel. There are two steam and water drums, 54in. in diameter, in each boiler, as well as a Babcock and Wilcox patent steam superheater, capable of imparting from 100°F. to 120°F. of superheat to the steam, each superheater containing about 863 sq. ft. of heating surface. The arrangement of superheaters in this installation is somewhat different from the Babcock and Wilcox

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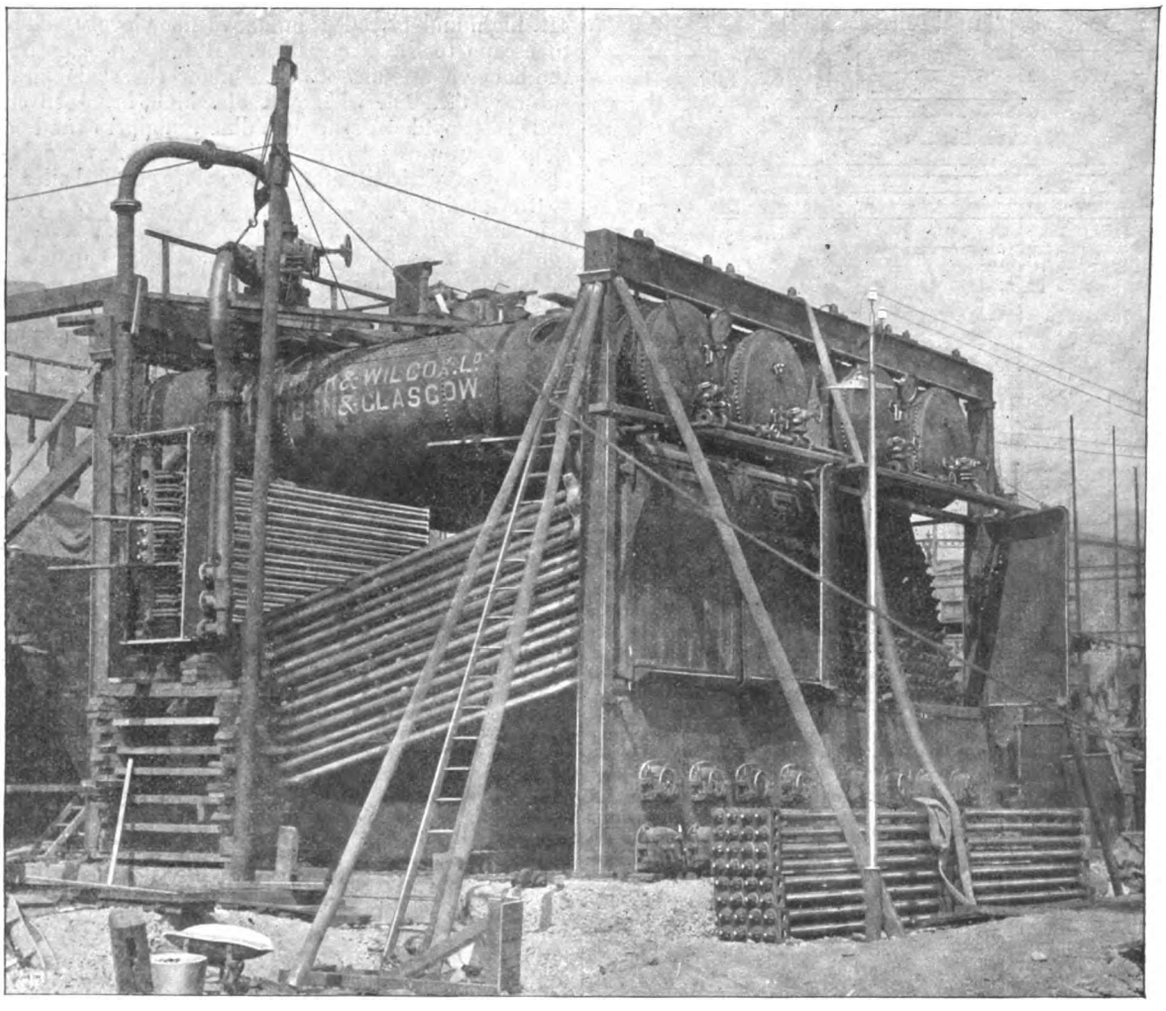
ordinary standard, in that the tubes run at right angles to the steam and water drums instead of parallel with them, in this respect following the arrangement adopted for blast-furnace-fired boilers. The gases leaving each boiler pass through an economiser of the Babcock and Wilcox circulating type, having 960 sq. ft. of heating surface, comprised in 96 cast-iron pipes. These pipes are arranged horizontally, and are connected at the ends by special boxes. The illustration shows the two boilers before the brickwork was started and before the economisers were placed in position, these being shown in the foreground. The Davey-Paxman boilers, which were supplied three years ago, since when they have been used in the temporary shed, have each an evaporative capacity of 7,000lb. of steam per hour at a working pressure of 150lb. per square inch, and are fitted with Meldrum steam blasts. The gases discharge into a common flue leading to a wrought-iron chimney, 60ft. high, stationed at the sea end of the boiler house. The main steam range, which runs the whole length of the six boilers, is arranged in two sizes, that of the Babcock and Wilcox boilers being 12in. in diameter, and that connecting the Paxman boilers 7in. in diameter. The two ranges are connected together by means of an 8in. expansion bend and valve, and each boiler is connected to this main through a valve and expansion bend. The branch to each engine is controlled by means of a valve at its junction with the main range, as well as by the stop valve on the engine. Ample space has been left in the boiler room for extensions when required.

The boiler feed pumps are situated at the end of the boiler room, the level of the feed-pump house being 12ft. below that of the boiler room, to avoid any lift on the suction pipe. Feed water can be taken either from the hot well—2,400 gallons capacity—from the overhead storage tanks, or, in emergency, directly from the water main. The overhead storage tank is placed immediately over the coal bunkers running the whole length of the boiler room, and has a capacity of 55,000 gallons. There is a division plate half-way along the tank to enable either half to be cleaned while the other is in use. Two Weir feed pumps are in use at present. Either pump is capable of supplying the feed water for the two Babcock and Wilcox boilers. Four injectors are also installed for use in case of emergency. The feed water is passed though filters placed on the delivery side of pumps for extracting any oil that may be carried over from the hot well.

Of the four generating sets in the engine room, No. 1 is a 200 H.P. two-crank single-acting compound engine, by Messrs. Bumsted and Chandler, directly coupled to a two-pole 150kw. Crompton dynamo; this engine will give 220 I.H.P. with 140lb. of steam, at a speed of 350 revs. per min. No. 2 is a three-crank triple-expansion engine, by Messrs Belliss and Morcom, of 450 H.P., running at 400 revs. per min., and coupled directly to a six-pole 300kw. generator, by Messrs. Mather and Platt. The dynamo is of the firm's standard pattern, the circular yoke ring of the magnets being in two parts, the upper of which is easily removable, thus affording ready access to the armature. The poles project radially inwards, and are cast in one with the yoke ring from steel of high magnetic permeability. The pole-pieces are specially designed to provide for uniformity of magnetic flux, and to give fixity of lead under varying load. The core is built up of well-annealed soft-iron plates of high magnetic permeability, securely fixed to the shaft; ample spaces are left for efficient ventilation. The armature is drum wound; the conductors, of copper strip of high conductivity, insulated with special tape, are placed in slots cut in the core-plates, the slots being first lined with



Babcock and Wilcox Boilers in Course of Erection.

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troughs of special insulating material. The machine is wound for an output of 300kw. when running at 400 revs. per min., and under normal circumstances gives this output at a pressure of 500 volts; it is required, however, that the machine should be able to deliver 300kw. at pressures varying from 450 to 550 volts, and that there should be a sufficient margin to allow of an overload up to 330kw. for two hours consecutively. The current is collected by six brush spindles, each carrying nine carbon brushes. The half coupling is cast in one with the armature spider, thus affording very rigid connection to the engine. It was guaranteed that the rise of temperature should not exceed 70°F. after an eight hours' run, and on test it was found that the machine had reached a little more than 60°F. The commercial efficiency of the combined set was over 87 per cent., a considerable increase on the guarantee of 80 per cent. Under test the steam consumption was as follows:—Full load 24·6lb., three-quarter load 24·75lb., half load 25·4lb. per kilowatt hour.

Nos. 3 and 4 engines are both by Ferranti Limited, and are each capable of developing 750kw. when running at normal speed—viz., 160 revs. per min. They are of the vertical cross-compound type, having cylinders 25½in. and 49in. diameter respectively, with a 21in. stroke. Both cylinders are fitted with cast-iron liners. The engines are designed for a working pressure of 160lb. per square inch. The dynamos were manufactured by Messrs. Dick, Kerr & Co., and the armatures are mounted on the engine crankshaft alongside the flywheel.

The engines have several special features, particularly as regards valve gear. To obtain the economy of Corliss engines the system of four valves per cylinder has been adopted, and these valves are placed in the covers so as to minimise clearance surfaces and spaces. The valves are of the grid type, and have a very short movement, and as the valve gear is only worked at half the speed of the engine, the surface speed of the valve faces is very low indeed, and consequently the wear-and-tear is low. The valves are actuated directly from cams, the latter being so designed as to give a constant distance between the cam rollers, thus making it possible to work with fixed rollers and rendering the motion quite independent of springs and, therefore, quite positive. The cams are arranged on vertical shafts, working in a completely enclosed box, which stands midway between the cylinders. This box is filled with oil, and the whole of the valve gear, therefore, works immersed in oil. This has a very important bearing on the satisfactory working of the cam gears, and, further, it leaves no part of the valve gear to be oiled by the engine attendant. The connection between the cam and valve is a direct one, and the external valve gear is extremely simple. The cam shafts are driven by means of cut gearing from the crankshaft, and each wheel is arranged to run in an enclosed casing containing oil, thus eliminating any question of their lubrication. The governor is arranged to act on a throttle valve, in which case the cut-off is made adjustable by hand. On the whole, the main parts of the engine are of ordinary construction, similar to those usually adopted in marine practice, the main bearing steps resting in spherical seats. The reciprocating parts are very thoroughly enclosed, so as to prevent the slightest splash or leakage of oil, and Messrs. Ferranti inform us that in proof of the effectiveness of this design, they have had an engine running in their shops for over six weeks and not a pint of oil has been added, except for the cylinders. Forced lubrication is adopted on the Cape Town engines, and pumps of ample capacity are employed to give sufficient pressure after the engine has run a considerable time and, in consequence, has worn the bearings rather slack. This removes the necessity for frequent adjustments of bearings, which is experienced if the oil pump is small. The oil is forced from the pump through a filter, which is arranged in the engine bed-plate. From the filter the oil passes to the various bearings, and from thence it falls into the bed-plate, through a strainer at the bottom of the bed-plate into a tank below, from which it is again pumped through the filter to the bearings. To prevent the oil creeping along the crankshaft, oil throwers are arranged in series, on the principle that the only effective way to prevent creeping of oil is to allow the last thrower to deal only with such small quantities of oil as may have escaped the preceding thrower. The exhaust from the engines is taken below the floor, and the steam led into a 24in. main exhaust running along a trench 10ft. wide and 10ft. deep on one side of the engine room, and leading to the condenser room. At this point, one main branch leads to the condensers and another through an automatic valve to the atmospheric uptake.

(To be concluded.)

THE STEAM TURBINE AS APPLIED TO ELECTRICAL ENGINEERING.*

BY THE HON. CHARLES A. PARSONS, F.R.S., G. GERALD STONEY AND C. P. MARTIN.

In the early days of electric lighting the speed of dynamos was far above that of the engines which drove them, and therefore belts and other forms of gearing had to be resorted to. To make a high-speed engine, therefore, was of considerable importance, and this led to the possibilities of the steam turbine being considered. It was, however, at once seen that the speed of any single turbine wheel driven by steam would be excessive without gearing, and in order to obtain direct driving it was necessary to adopt the compound form, in which there were a number of turbines in series, and thus, the steam being expanded by small increments, the velocity of rotation was reduced down to moderate limits. Even then, for the small sizes of dynamos at that time in use, the speed of revolutions was high, and therefore a special dynamo had to be designed. Speaking generally, an increase of speed of a dynamo increases its output, and therefore it was obvious that such a high-speed dynamo would be very economical of material.

These considerations led, in 1884, to the first compound steam turbine being constructed. It was of about 10 H.P., and ran at 18,000 revs. per min., the diameter of the armature being about 3in. This machine, which worked quite satisfactorily for some years, is now in the South Kensington Museum. Before, however, this first turbo-dynamo was constructed, a set of preliminary experiments were commenced at Gateshead-on-Tyne, with the view of ascertaining, by actual trial, the conditions of working equilibrium and steady motion of shafts and bearings at the very high speeds of rotation that appeared to be essential to the construction of an economical steam turbine of moderate size. Trial shafts were run in bearings of different descriptions up to speeds of 40,000 revs. per min.; these shafts were 1½in. in diameter and 2ft. long, the bearings being about ⅜in. diameter. No difficulty was experienced in attaining this immense speed, provided that the bearings were designed to have a certain small amount of "give" or elasticity, and after the trial of many devices to secure these conditions, it was found that elasticity combined with frictional resistance to transverse motion of the bearing bush gave the best results, and tended to damp out vibrations in the revolving spindle. This result was achieved by a simple arrangement; the bearings in which the shaft revolved was a plain gunmetal bush with a collar at one end and a nut at the other; on this bush were threaded thin washers, each being alternately larger and smaller than its neighbour, the small series fitting the bush and the larger series fitting the hole in the bearing block, these washers occupying the greater part of the length of the bush. Lastly, a wide washer fitted both the bush and block, forming a fulcrum on which the bush rested, while a spiral spring between the washer and the nut on the bush pressed all the washers tightly against their neighbours. It will be seen now that, should the rotating shaft be slightly out of truth (which it is impossible to avoid in practice), the effect is to cause a slight lateral displacement of the bearing bush, which is resisted by the mutual sliding friction of each washer against its neighbour. The shaft itself being slightly elastic, tends to centre itself upon the fulcrum washer before mentioned, and under the gyrostatic forces brought into play by the rapid revolutions of the shaft and influenced by the frictional resistance of the washers, the shaft tends to assume a steady state of revolution about its principal axis, or the axis of the mass, without wobbling or vibration. This form of bearing was exclusively used for some years in turbine engines aggregating some thousands of horse-power, but it has since been replaced by a simpler form fulfilling the same functions. In this latter form the gunmetal bush is surrounded by several concentric tubes fitting easily within each other with a very slight lateral play; in the interstices between the tubes the oil enters, and its large viscosity when spread into thin films has the result of producing great frictional resistance to a rapid lateral displacement of the bearing bush; the oil film has also a centring action, and tends, under vibration, to assume a uniformity of thickness around the axis, thus centring the shaft, and, like a cushion, damping out

* Paper read before the Institution of Electrical Engineers, May 12th.

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vibrations arising from errors of balance. This form of bearing has been found to be very durable and quite satisfactory under all conditions.

These first turbine engines consisted of two groups of 15 successive turbine wheels, or rows of blades, on one drum or shaft within in a concentric case on the right and left of the steam inlet, the moving blades or vanes being in circumferential rows projecting outwardly from the shaft and nearly touching the case, and the fixed or guide blades being similarly formed and projecting inwardly from the case and nearly touching the shaft. A series of turbine wheels on one shaft were thus constituted, and each one complete in itself is like a parallel flow water turbine; the steam, after performing its work in each turbine, passing on to the next, and preserving its longitudinal velocity without shock, gradually falling in pressure as it passes through each row off blades, and gradually expanding. Each successive row of blades was slightly larger in passage way than the preceding to allow for the increasing bulk of the elastic steam, and thus its velocity of flow was regulated so as to operate with the greatest degree of efficiency on each turbine of the series. All end pressure from the steam was balanced by the two equal series on each side of the inlet, and the revolving shaft lay on its bearings revolving freely without any impressed force except a steady torque, the aggregate of the multitude of minute forces of the steam on each blade. It constituted an ideal rotary engine, but it had limitations. The comparatively high speed of rotation that was necessary for so small a size of engine as this first example made it difficult to prevent a certain spring or whipping of the shaft, so that considerable clearances were found necessary, and leakage and loss of efficiency resulted. It was, however, perceived that these defects would decrease as the size of the engine was increased, with a corresponding reduction of rotational velocity, and consequently efforts were made towards the construction of engines of larger size, which resulted in 1888 in several turbo-alternators of 120 H.P. being supplied for the generation of current in electric lighting stations, and at this period the total horse-power of turbines at work reached in the aggregate about 4,000, all of which were of the parallel flow type and non-condensing.

About 1890, however, on account of the temporary loss of control of the patents, the radial flow type of turbine was reluctantly adopted, and this was in 1892 arranged to work condensing, and a 100kw. plant driving a 2,000-volt single-phase alternator at 80 periods, which ran at 4,800 revs. per min. and therefore was two-pole, when tested by Prof. Ewing was found to take only 27lb. per kilowatt-hour with 100lb. steam pressure moderately superheated to about 70° F. and with 27in. vacuum, a result comparable with the best obtained by reciprocating engines at that time, and thus a wide field was opened up for the use of the steam turbine as a prime mover. Many of these plants, mostly of 150kw., were made for the electric lighting stations of Newcastle, Cambridge, Scarborough and elsewhere. In 1894, on the recovery of the original patents, the parallel flow type was reverted to, with considerable improvements in design calculated both to increase the economy and decrease the cost of manufacture. Instead of the steam entering at the centre and expanding both ways, one set of blades was replaced by a set of dummy pistons which were substituted for them, in which a grooved piston or dummy on the spindle ran close to but not in contact with corresponding grooves in the cylinder, thus making a practically steam-tight and yet frictionless joint. The bearings also were made of the later type, with several concentric tubes At the same time the system of blading was greatly improved, giving a more perfect form of blade, and one also with much greater mechanical strength than in the original formation. A section of this type of turbine is shown in Fig. 1 and a diagram of the blades in Fig. 2. The first large turbines of this improved type were of 350kw. output, and were placed in the Manchester-square station of the Metropolitan Electric Supply Co., this station being threatened at the time with an injunction for vibration caused by the reciprocating engines used there, and the substitution of the turbines proved entirely satisfactory to the company.

In 1900. two 1,000kw. turbo-alternators were supplied to the City of Elberfeld in Germany, and when tested by a committee of German experts on behalf of the city, the following results shown in Table I. were obtained:—

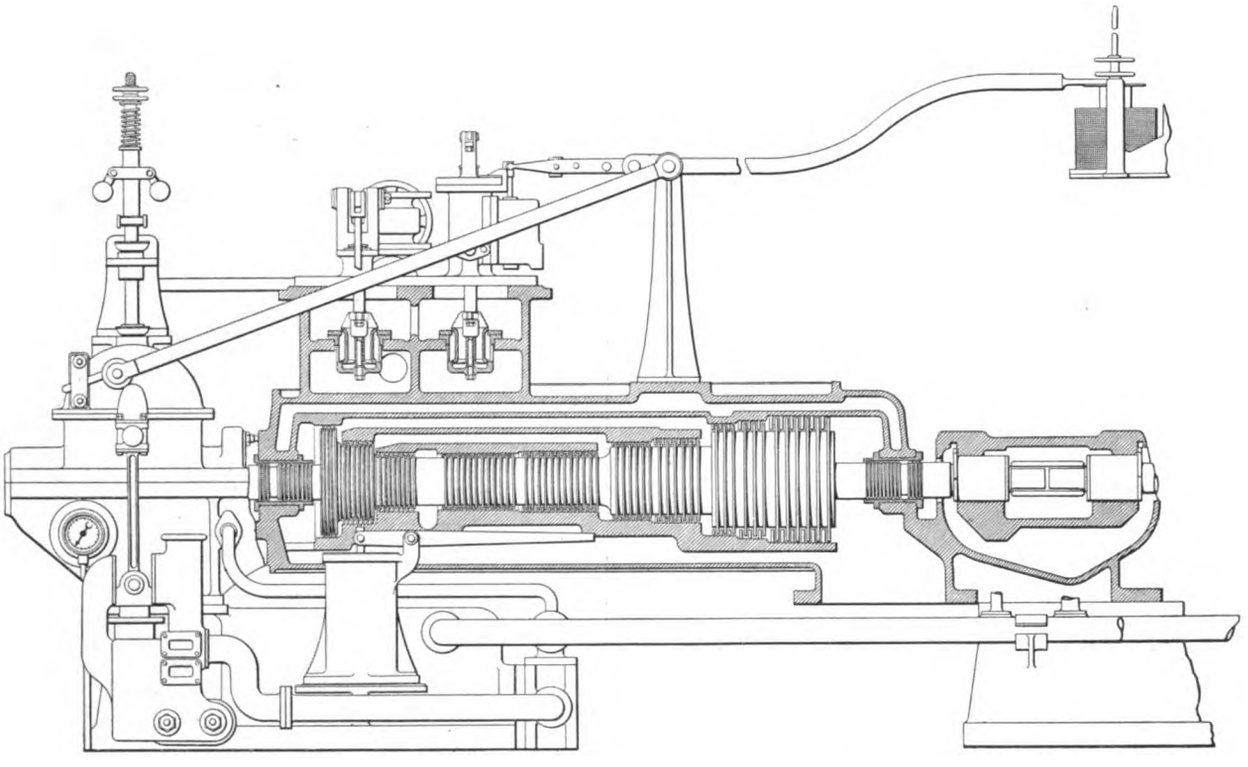

FIG. 1.—SECTIONAL ELEVATION OF STEAM TURBINE.

Table I.

Load.	Temp. of steam C°.	Abs. steam pressure. Before stop valve 2 Kg. per cm.	Abs. steam pressure. Outlet L.P. Cm. of Hg.	Average load. Kw.	Steam per kw-hour. Lb.	Steam per kw-hour. Kg.	Revs.
Preliminary test (overload) ..	230·0	10·10	4·13	1,172·7	18·22	8·26	1,493·0
Normal	192·0	10·47	3·9	994·8	20·15	9·14	1,461·0
Overload.....	189·5	10·11	4·65	1,190·1	19·43	8·81	1,486·6
¾ load	190·0	10·76	4·0	745·35	22·31	10·12	1,469·9
½ load	209·7	10·40	3·4	498·7	25·2	11·42	1,473·0
¼ load	196·4	10·14	3·7	246·5	33·76	15·31	1,485·0
No load with excitation ..	193·0	10·34	3·2	..	..	..	1,488·3
No load without excitation	194·5	10·49	2·68	..	..	..	1,504·5

These turbines were of the tandem type in which the expansion of the steam was first carried out in a high-pressure cylinder and completed in a low-pressure, but it was soon found that better economy, except possibly in very large sizes, could be obtained by having the whole turbine in one cylinder.

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Large numbers of tests have been made from time to time, chiefly by various consulting engineers and station engineers, out of which the following are selected, as shown in Table II.:—

Table II.—*75kw. Continuous-Current Turbo for Banbury.*

At stop valve. Pressure above atmosphere. Lbs. per sq. in.	Superheat. F°.	Vacuum. Inches.	Speed. Revs. per min.	Load in kw.	Steam used per hour. Lbs.	Lbs. per kw.
141·2	84·2	27·1	4,140	75·7	2,006	26·4
144·0	..	27·0	4,140	75·2	2,201	29·2
142·0	..	27·1	4,140	56·6	1,777	31·2
135kw. Turbo Alternator—Findlay, Durham and Brodie.						
150 8	99·0	27·15	3,600	138·3	3,152	22·8
151·0	81·0	27·3	3,600	66·9	1,845	27·6
200kw. Continuous Current Turbo for Shipley.						
150 0	57·0	27·0	3,000	204·2	4,538	22·23
151 0	55·0	27·9	3,000	101·2	2,698	26·67
156 0	181·0	27·3	3,000	202·5	4,130	20·39
151·0	166·0	28·0	3,000	100·27	2,446	24·41
375kw. Turbo Alternator for Dundee.						
152·9	..	27·4	3,000	376·9	8,143	21·6
149 4	148·9	27·5	3,000	374·06	7,202	19·25
350kw. Turbo Generator for Pennsylvania Salt Co.						
150·0	71·3	27·82	3,360	359·5	7,423	20·64
152·0	65·7	28·27	3,151	185·5	4,346	23·44
140·2	92·3	17·4	3,430	353·5	9,030	25·54
143·4	82·5	17·4	3,255	177·2	5,715	32·26
300kw. Turbo Alternator—Hulton Colliery.						
161·0	..	..	3,000	296·6	10,180	34·2
158·0	..	15·33	3,000	297·4	8,732	29·36
157·0	..	19·33	3,000	305·1	8,369	27·43
152·0	..	22·33	3,000	303·4	7,764	25·59
154·0	..	25·33	3,000	303·15	7,336	24·19
158·0	..	26·58	3,000	303·2	7,020	23·15
300kw. Turbo Alternator—De Beers Explosives Works.						
150·0	53·3	27·88	3,000	312·1	6,260	20·06
153·0	50·0	27·78	3,000	231·8	4,960	21·45
150·5	40·2	27·9	3,000	154·5	3,670	23·75
1,500kw. Turbo Alternator—Newcastle-on-Tyne Electric Supply Co.						
196·0	76·0	27·45	1,200	1,442·0	25,962	18·0
197·0	84·0	27·35	1,200	1,015·5	20,124	19·8
196·0	76·0	27·95	1,200	714·0	15,288	21·4
199·0	77·0	28·35	1,200	360·5	9,114	25·2
200·0	68·0	28·45	1,200	..	2,948	..
After 16 months' use the following figures were obtained :—						
203·0	92·0	26·11	1,210	1,823·0	32,431	17·7
207·0	66·0	26·46	1,208	1,513·0	27,582	18·23
1,500kw. Turbo Alternator for Sheffield Corporation.						
With vacuum augmentor and including 450lb. steam per hour used by it.						
113·6	108·3	26·69	1,455	1,316·5	24,732	18·76
111·6	156·4	27·12	1,500	1,061·6	19,830	18·66
141·0	113·0	27·72	1,500	512 7	11,425	22·3
154·0	47·5	27·72	1,500	..	3,128	..
Without vacuum augmentor.						
115·6	143·0	25·18	1,500	1,029·3	21 264	20·7
137·0	119·0	25·97	1,500	534·25	12,820	24·02
150·3	72·4	26·62	1,500	..	2,957·4	..
3,000kw. Parsons Turbo Alternator supplied to Frankfort by Messrs. Brown, Boveri & Co.						
138·5	235·0	27·0	1,350	2,993·0	44,200	14·74
170·5	187·0	27·5	1,350	2,518·0	38,300	15·59
142·0	120·0	27·2	1,350	2,600·0	41,200	15·8
139·0	114·0	27·2	1,350	2,600·0	41,400	15·9
168·5	184 0	27·9	1,350	1,945·0	30,800	15·84
146·0	120·0	27·6	1,350	2,000·0	32,600	16·3
137·0	101 0	27·4	1,350	1,442·0	25,400	17·6
142·0	30·0	29·3	1,350	..	4,700	excited
142·0	30·0	29·3	1,350	..	3,560	non-exctd.

In all the above tests the barometer is taken as 30in. Superheat in degrees Fahrenheit in all cases.

In non-condensing turbines the following may be selected :—

250kw. Continuous Current—Messrs. Guinness, Son & Co.

At stop valve. Pressure above atmosphere. Lbs. per sq. in.	Superheat. F°.	Back Pressure. Lbs. per sq. in.	Speed. Revs. per min.	Load in kw.	Steam used per hour. Lbs.	Lbs. per kw.
144·0	..	..	3,047	251·55	9,510	37·80
142 6	..	6·0	3,047	255·82	10,584	41·38
138·0	..	11·1	3,055	253·15	11,194	44·15
143·0	..	11·0	3,115	125·45	7,475	59·58

500kw. Turbo-Alternator—Metropolitan Electric Supply Co.

At stop valve. Pressure above atmosphere. Lbs. per sq. in.	Superheat. F°.	Vacuum. Inches. Hg.	Speed. Revs per min.	Load in kw.	Steam used per hour. Lbs.	Lbs. per kw.
142	..	..	1,800	506·2	16,903	33·39
147	..	15·67	1,800	509·06	14,800	29·07
144	..	18·57	1,800	514·9	14,591	28·33
145	..	20·67	1,800	512·2	13,945	27·22
146	..	22·57	1,800	509·85	13,714	26·89
154	..	..	1,800	..	3,552	..
151	..	26·1	1,800	..	1,560	..

The effect of varying vacua is shown in a condensing turbine in Figs. 3 and 4, which are the consumptions of the 300kw. for Hulton Colliery, and in a non-condensing one in Fig. 5, which are those of

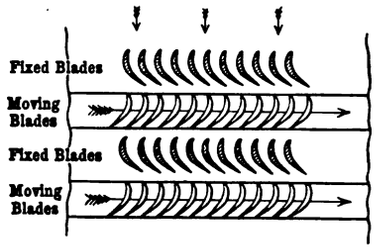

FIG. 2.—ARRANGEMENT OF BLADES.

one of the Metropolitan Company's 500kw. plants. The effect of varying load is shown in Figs. 6, 7 and 8 for the 1,500kw. plants for the Newcastle Electric Supply Co. and the Sheffield Corpora-

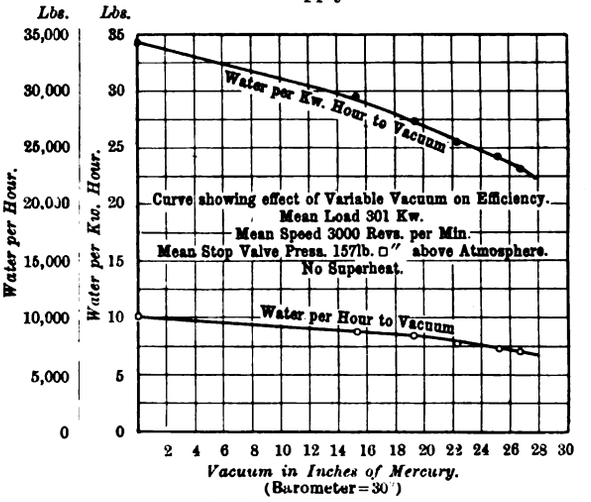

FIG 3.—HULTON COLLIERY.

300kw. 3-phase alternator; 420 volts; consumptions at varying vacua.

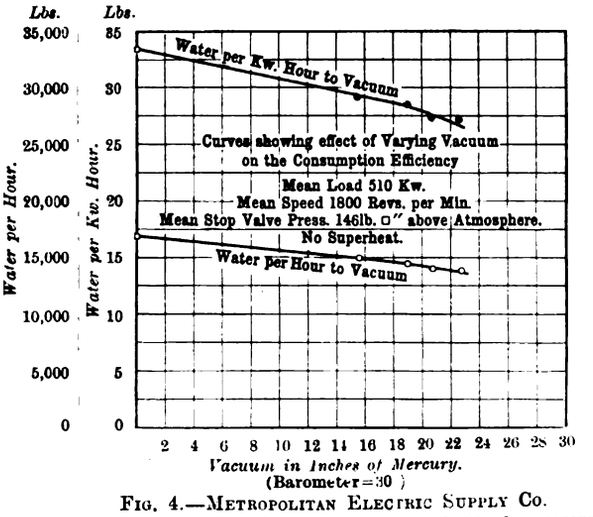

FIG. 4.—METROPOLITAN ELECTRIC SUPPLY CO.

500kw.; 2-phase non-condensing turbo-alternator; 1,000 volts; consumptions at varying vacua.

tion, which latter also shows the advantage gained by the use of the vacuum augmentor described on p. 225, and also for the Frankfort 3,000kw. turbine. In the case of the Newcastle Electric Supply

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Co.'s turbine, the consumptions in the latter half of the table were taken after 16 months' use. It will be seen that under the conditions of, say, 140lb. steam pressure and 100°F. superheat and a vacuum of 27in. (barometer 30in.) the consumptions are in round numbers as follows:—A 100kw. plant takes about 25lb. of steam per kilowatt-hour at full load, a 200kw. takes 22lb., a 500kw. 20lb., a 1,000kw. 19lb., a 1,500kw. 18lb. and a 3,000kw. 16lb. These figures are derived from averages of a large number of tests which have been made from time to time. Without superheat the consumptions are about 10 per cent. more, and every 10°F. of superheat up to about 150°F. affects the consumption by about 1 per cent.

A good vacuum is of great importance in a turbine, as the expansion can be carried in the turbine right down to the vacuum of the condenser, a function which is practically impossible in the case of a reciprocating engine, on account of the excessive size of the low-pressure cylinder and also of the ports, passages and valves, which would be required. Thus, in a turbine the benefit derived from a good vacuum is much more than in a reciprocating engine, every 1in. of vacuum between 23in. and 28in. affecting the consumption on an average about 3 per cent. in a 100kw., 4 per cent. in a 500kw., and 5 per cent. in a 1,500kw., the effect being more at high vacua and less at low. It is thus seen how a good vacuum is of importance in a turbine plant, and in this regard it may be well to look into the conditions necessary for obtaining the same. The first point is to avoid all air leaks, and this is easily accomplished in a turbine plant, as there are no packed glands and stuffing boxes to leak. The only places where leakage of air is possible are where the turbine spindle comes out of the cylinder, and here leakage of

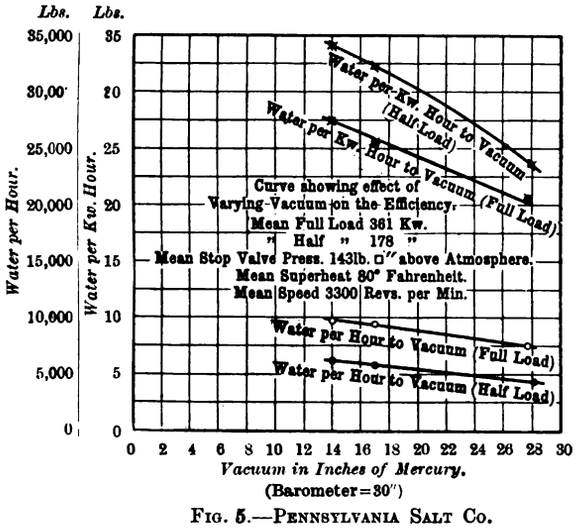
Lbs.
Lbs.
Water per Kw. Hour to Vacuum (Half Load)
Water per Kw. Hour to Vacuum (Full Load)
Curve showing effect of Varying Vacuum on the Efficiency.
Mean Full Load 361 Kw.
" Half " 178 "
Mean Stop Valve Press. 143lb. □" above Atmosphere.
Mean Superheat 80° Fahrenheit.
Mean Speed 3300 Revs. per Min.
Water per Hour to Vacuum (Full Load)
Water per Hour to Vacuum (Half Load)
Water per Hour.
Water per Kw. Hour.
Vacuum in Inches of Mercury.
(Barometer = 30")

FIG. 5.—PENNSYLVANIA SALT CO.
300kw. generator; 250 volts; consumptions at varying vacua at full and half load.

air is rendered very small by packing the glands with steam, so that any leakage which takes place is steam and not air. The next is to have a suitable condenser, and in this regard sufficient area must be allowed by suitable arrangements of the tubes, and also ample way for the steam between them, proper velocities of the water in the tubes, sufficient supply of cooling water and efficient means of cooling the condensed water so as to keep the air pump cool, and full provision for extracting by the air pump and other means the inevitable small quantity of air which must leak in. By attention to these requirements it is unnecessary to increase the size of the condenser beyond that used in ordinary practice, so that in the case of the most recent condensers for steam turbines from 10lb. to 12lb. steam is condensed per square foot per hour; and, at this rate of condensation, vacua of from 27½in. to 28in., with barometer 30in., can be obtained at full load. The amount of cooling water generally allowed is about 50 times the full-load steam consumption, which will increase the vacuum under normal conditions by about ¾in. or 1in. over that obtained by the usual 30 times the steam used. If we allow 14ft. total head on the circulating pump due to lift, and for friction in the pipes and condensers, &c., which in most cases is excessive, especially where the return pipe is sealed, with 50 times the steam consumption in a plant taking 18lb. steam per kilowatt-hour, and assuming 50 per cent. efficiency in the pump and motor, the power used by the circulating pump is only 1 per cent., and with circulating water 30 times the steam consumption it would be 0·6 per cent., a difference of only 0·4 per cent., such a small difference as not to be comparable with the gain of 4 to 5 per cent. in the turbine by the use of increased circulating water.

With regard to extracting the air, a great improvement has been effected by the use of a vacuum augmentor which has been recently introduced. In it the air pumps are placed about 3ft. below the bottom of the condenser (see Fig. 9). From any convenient part

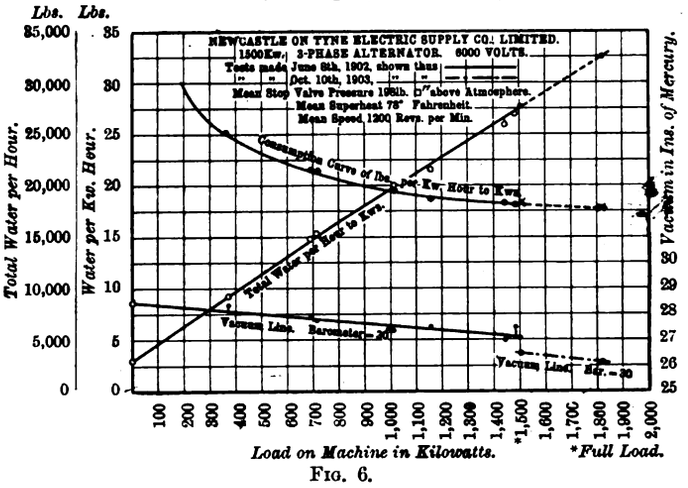
Lbs.
Lbs.
NEWCASTLE ON TYNE ELECTRIC SUPPLY CO.: LIMITED.
1500Kw. 3-PHASE ALTERNATOR. 6000 VOLTS.
Tests made June 8th, 1902, shown thus
" " Oct. 10th, 1903, " "
Mean Stop Valve Pressure 195lb. □" above Atmosphere.
Mean Superheat 75° Fahrenheit.
Mean Speed 1200 Revs. per Min.
Consumption Curve of lbs. per Kw. Hour to Kws.
Total Water per Hour to Kws.
Vacuum Line. Barometer = 30"
Vacuum Line. Bar. = 30
Total Water per Hour.
Water per Kw. Hour.
Vacuum in Ins. of Mercury.
Load on Machine in Kilowatts.
*Full Load.

FIG. 6.

of the condenser, preferably near the bottom, a pipe is led to an auxiliary condenser, generally about $\frac{1}{10}$th the cooling surface of the main condenser, and in a contracted portion of this pipe a small steam jet is placed which acts in the same way as a steam exhauster,

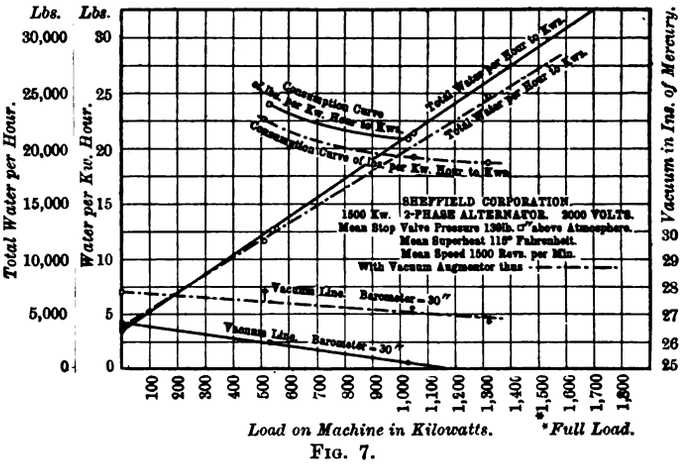
Lbs.
Lbs.
Consumption Curve of lbs. per Kw. Hour to Kws.
Total Water per Hour to Kws.
Consumption Curve of lbs. per Kw. Hour to Kws.
Total Water per Hour to Kws.
SHEFFIELD CORPORATION.
1500 Kw. 2-PHASE ALTERNATOR. 2000 VOLTS.
Mean Stop Valve Pressure 190lb. □" above Atmosphere.
Mean Superheat 115° Fahrenheit.
Mean Speed 1500 Revs. per Min.
With Vacuum Augmentor thus
Vacuum Line. Barometer = 30"
Vacuum Line. Barometer = 30"
Total Water per Hour.
Water per Kw. Hour.
Vacuum in Ins. of Mercury.
Load on Machine in Kilowatts.
*Full Load.

FIG. 7.

or the jet in the funnel of a locomotive, and sucks nearly all the residual air and vapour from the condenser and delivers it to the air pumps. A water seal is provided, as shown on Fig. 9, to prevent the air and vapour returning to the condenser. Thus, if there is a vacuum of 27½in. to 28in. in the condenser, there may be only about 26in. in the air pump, which therefore need only be of small

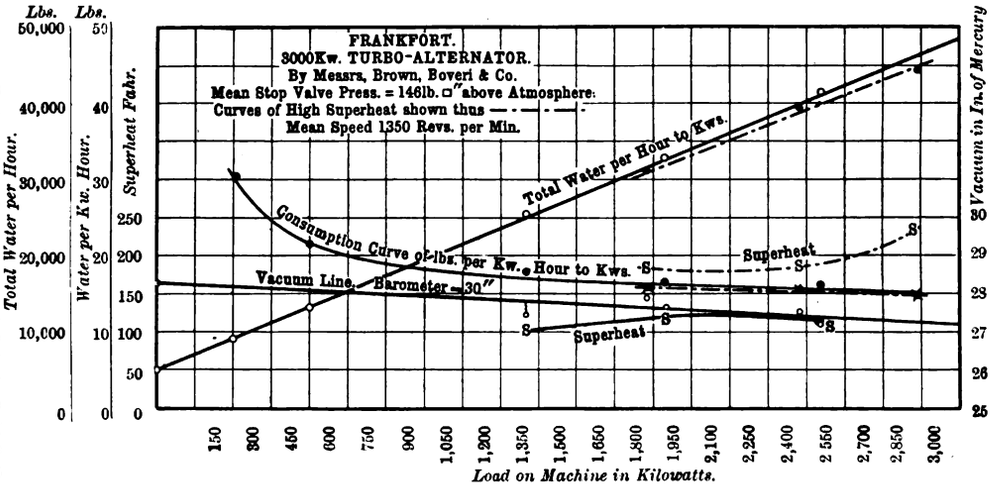
Lbs.
Lbs.
FRANKFORT.
3000Kw. TURBO-ALTERNATOR.
By Messrs. Brown, Boveri & Co.
Mean Stop Valve Press. = 146lb. □" above Atmosphere.
Curves of High Superheat shown thus
Mean Speed 1350 Revs. per Min.
Total Water per Hour to Kws.
Consumption Curve of lbs. per Kw. Hour to Kws.
Superheat
Vacuum Line. Barometer = 30"
Superheat
Total Water per Hour.
Water per Kw. Hour.
Superheat Fahr.
Vacuum in In. of Mercury
Load on Machine in Kilowatts.

FIG. 8.

size, the jet compressing the air and vapour from the condenser to about half or a little less of its original volume. The small quantity of steam from this steam jet, which is only about 1½ per cent. of that used by the turbine at full load, together with the air extracted, is cooled down and condensed by the auxiliary condenser, which

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is generally supplied with water in parallel with the main condenser. In this connection it should be observed that condensation in a condenser takes place much more rapidly and effectually if the air is thoroughly extracted than if there is much air present, as the air seems to form a blanket round the tubes and retards the steam getting to them. In Table II. and Fig. 7 are given two curves of a test on a 1,500kw. plant for Sheffield, showing the difference of consumption with and without this augmentor; in these figures are included the steam used by the augmentor, which amounts to 450lb. per hour. The difference

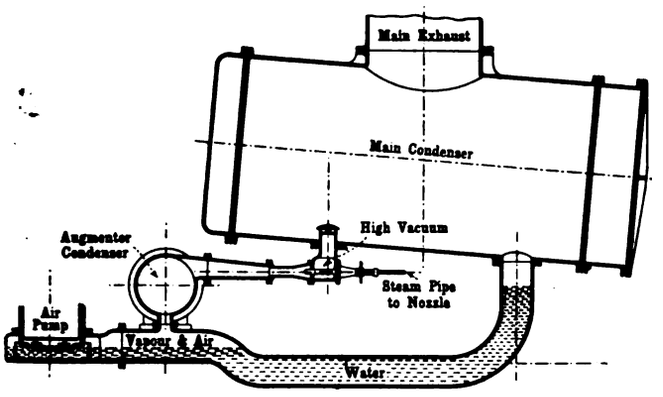

FIG 9.—ARRANGEMENT OF PARSONS' VACUUM AUGMENTOR.

of vacuum is also shown, and when it is remembered that the augmentor jet only took about 1½ per cent. of the full-load steam consumption, it is easily seen from the gain of vacuum where the total gain by the use of the augmentor comes in. In this case the vacuum was not as good as it should be, as the cooling water was 85°F., and was only about 30 times the steam consumption at full load.

(To be concluded.)

POWER STATION DESIGN.*

DISCUSSION.

Continued from p. 187.

Mr. A. H. DYKES thought that the authors had not done justice to the gas engine in their Paper. The engine itself must not only be compared with the steam engine or turbine, but the auxiliaries should also be taken into account; the gas-generating plant should be compared with the boiler plant. One should not overlook the very greatly diminished fuel costs, not only by reason of the amount of coal used, but also the saving which, under certain conditions, could be obtained by making use of the residuals. At the present time he was putting down a station of about 1,000 H.P. with a plant consisting of four 250 H.P. gas engines and producer-gas plant, and the guarantees under fairly heavy penalties came out to 1·63lb. per kilowatt-hour with the very cheapest form of fuel. Then Mr. Merz gave the labour costs with the gas engine as high. This was true in comparison with the steam engine or turbine, but on the other hand the labour costs in the producer plant were very considerably less, and this must be taken into account. The repair costs were high at present, but in a few years this item would be very considerably reduced. As regards high capital costs, in the plant he had referred to the gas engines and generators, including the whole of the pipes and accessories, water cooling, &c. (in fact, everything with the exception of foundations) worked out at £13 per kilowatt, and the total cost, including the producer, was £18. Therefore, for a small plant it compared very favourably with a steam plant. It should also be remembered that a saving was made as regards buildings. Not only did the use of gas engines do away with the chimneys, but also with the whole of the boiler house. The cost of buildings and foundations for a producer plant of the size referred to was £350, which was very small compared with the cost of boiler house, chimneys and sidings. In the plant in question, in addition to the gas plant, several large boilers had to be run, and the exhaust was carried out in a cement-lined trench over which the feed water for the boilers flowed. One point in which he could not agree with the Paper was in connection with overload. It was quite true that, in a gas engine, the economical load was up to the maximum load, but in the ordinary way a gas engine would not always be worked up to the maximum load day after day, and there would, therefore, be a certain overload capacity, the same as in a steam engine. The speaker also alluded to the advantages of starting up three-phase motors by letting them run up with the generators when this was feasible. He had a case of a 375kw. three-phase plant off which several 100 H.P. motors were being run. The normal current of the motor at full load was 130 amperes, and when starting this up with an ordinary auto-starter, the current taken from the generator by each motor was 400 amperes. By fully exciting the generator and starting it up slowly from rest, with the motor switched on, the current rose immediately to a little over 100 amperes, and then instantly dropped back to 65, and did not exceed that until the motor had got away. The motor at starting was running on some heavy shafting, but not on its full load.

Mr. W. GEIPEL said it was 10 years since Col. Crompton read his memorable Paper on the cost of electricity supply, in which he showed that the unit could be generated for the then astounding figure of 3d. In that Paper, also, the principal points were the effect of the capital charges and the coal bill. The authors stated in the present Paper that the operating and capital costs were minor considerations in the early days. He could not agree with that. In the Paper referred to, which was read by Col. Crompton, it was shown how to generate electricity at 3d. per unit, and the author took a rather forlorn hope of the possibility of ever reducing that figure on account of the capital charges. The speaker himself had contributed the following passage to the discussion:—"The reduction of the cost of electricity supply stations is very largely indeed the business of us engineers. In my opinion, the present high price of electric supply is due mostly to an insufficient consideration having been given to this question of first cost. It is certainly not always judicious to incur every possible expense in providing for saving in coal and labour and stores without regard to the consideration of outlay. For example, costly chimneys are frequently erected when a less outlay in this respect would suffice, or condensers and economisers are erected capable of dealing with the maximum load, the consequence being that a large portion is utilised but a mere fraction of the year. Is it not the function of an engineer to so lay out the capital that the cost of interest, depreciation and the working expenses together are a minimum?" With regard to the curve (Fig. 1) in the Paper, showing the cost of coal and the working expenses and the capital charges, in the discussion on Col. Crompton's Paper he himself had ventured to put in what he thought might be taken as ideal costs against Col. Crompton. These showed that although 3d. was a marvellously low charge in those days, it could quite well come down to 2d. with an ordinary lighting load-factor, and he made up his costs in this way: Fuel 0·15d., as compared with 0·15d. in this Paper; water 0·01, against 0·01; stores, 0·04, against oil 0·01; wages and repairs 0·2, against 0·076; maintenance and profit 0·98, against 1·1, the authors' 1·1 being the equivalent of a 15 per cent. load-factor, which was the basis upon which he himself had worked the costs out. In the end his costs came out at 2d. per unit for the whole of the expenses including distribution, whereas he took it that the charges in the Paper were exclusive of the distributing plant. He might also mention that perhaps a more interesting way of showing the effect of capital charges would be, instead of drawing curves for every load-factor and every price per kilowatt, to include the two together in one item and to call the capital costs so much per unit of output. He did not know whether this was clear, but, in the *Proceedings* containing Col. Crompton's Paper and the discussion he had published a curve which showed the effect of reducing the capital outlay per unit output, and this curve also showed the equivalent saving in coal. It worked out to this: that if the cost of coal were decreased by 80 per cent. a saving of only ¼d. was made upon Col. Crompton's then ideal cost, whereas if a saving of 80 per cent. were made upon the capital cost a saving of 2d. per unit was the result. In the fourth paragraph of p. 50 the authors had suggested that in considering this question of the capital outlay no plant should be put in without allowing 15 per cent. on the capital cost plus repairs, although in the last paragraph of p. 49 they put this figure at 10 per cent. He would suggest that 10 per cent. was very much nearer the right figure, although the money market was so bad at present. This percentage would be ample to cover standing charges and improvements. With regard to turbines, these did possess many advantages, but the authors of this Paper had omitted a very important one from the engineering point of view—viz., that the feed water had no oil in it. The authors stated that "in order to secure the shortest possible steam pipe it was imperative that the boilers should be located directly opposite the engines they normally supply." He agreed with this, but on looking at the plan of the Carville station he noticed that the boilers were so arranged that the steam pipes were as long as they possibly could be, and a much better arrangement could have arrived at if the method advocated on p. 52 had been carried out—viz., the division of the boilers and engines and auxiliaries into sections, so that each section was independent of the remainder. In the plan of the Carville station it would be noticed that the whole row of boilers were feeding into one common steam pipe. He did not see any difficulty—although the authors had mentioned it—of arranging turbines in such a way that the boilers could be more or less opposite to their respective turbines. Of course, if the turbines were arranged at right angles, so to speak, to the boilers, then, owing to the narrow width and great length of the turbines, one got an arrangement which did not enable each turbine to be opposite its sectional boiler. But arrange the turbines lengthwise instead of on the cross, and then each would be more or less opposite its own boilers. A very much cheaper engine room would result on account of the smaller span and less strength of building required for the smaller span and lightness of the travelling crane and scantlings of the building. By this arrangement, therefore, not only was a saving made in the steam pipes but also in the capital charges. The authors' recommendation that boilers should be forced at the peak of the curve, together with the plant generally, represented a practice that had been carried out in central stations for many years and was being adopted repeatedly and continually at present. The difficulties of time circuit-breakers were discussed. One way which he would suggest for overcoming them was to have a time fuse for breaking the smaller excess current due to local short circuits, and also a circuit breaker for extra

* Paper by Messrs. C. H. Merz and Wm. McLellan before the Institution of Electrical Engineers. See *The Electrician* of April 29th, p. 49, May 6th, p. 88, May 13th, p. 135 and May 20th, p. 185.

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excess, which would act instantaneously. One other point he would like to refer to and he hoped it would not be considered hypercritical. The authors continually spoke of units: units of plant, British thermal units, Board of Trade units and the price of units. Some years ago it was usual to call a plant a unit, a kilowatt a unit, and in fact everything a unit, and it was a retrograde step to go back to the word unit for describing sets of plant. The word unit in the electrical world should be confined, as far as possible, to the kilowatt-hour.

Mr. L. ANDREWS referred to the reverse current circuit breaker by Messrs. Brown, Boveri & Co., mentioned in the Paper, and said that he had shown that identical break in that very room seven years ago. It was gratifying to him that it had been adopted by such distinguished parents, and perhaps he ought to give some excuse for abandoning it. That particular type was particularly susceptible to a drop in pressure, and a number of other types experimented with were also seriously affected in this manner. There was another difficulty which had not been touched upon, however, and that was that in nearly all alternating-current cut-outs the series current acted inductively upon the shunt current and actually produced a drop in pressure. This had not been generally recognised. The only thing they could do was to design the cut-outs so that they would work with as big a drop of pressure as possible. He had succeeded in getting a cut-out that would operate reliably with 75 per cent. drop in pressure, and this was as low as they were likely to drop with alternating-current generators. With direct current it might be posssible to drop down to zero. If anything went wrong with a direct-current generator, it very often meant that the commutator was flashed round, and a bad short-circuit took place on the cross 'bus bars. With this it was obvious that any drop in pressure might be obtained. When he was at Bristol the other day he was interested to hear that during the fire on the switchboard there, although the station was being fed by generators which were 2 miles away, and the 'bus bars were to all intents and purposes short-circuited by this very heavy work, the pressure never fell below 60 per cent. in the Temple Back station, and never below 75 per cent. at the generating station. This showed that in this case there would have been plenty of pressure to operate reverse-current circuit breakers if they were set to operate with a drop of 75 per cent. There were conditions, however, under which a greater drop than 75 per cent. could be obtained, and these conditions arose if one attempted to use a reverse-current circuit breaker at the end of duplicate feeders. This latter had been a suggestion of his own originally, and he was sorry to have to admit that a serious objection to it was that it was necessary to maintain the pressure due to the C^2R losses in the feeder between the distributing centre and the fault. If the fault occurred near the generating station, the leads were then going right away to the distributing station and back again, and the distributing station was about half-way along the line, with the result that there would be an appreciable pressure at the distributing station, which would be quite sufficient to operate cut-outs, but if the fault occurred near the distributing centre then there was bound to be a drop of pressure to practically zero, and he thought under these conditions it was absolutely impossible to get a reverse-current circuit breaker that would operate reliably.

Col. R. E. CROMPTON said he would keep to the Paper and not deal with the minor details which so many speakers had attacked. Mr. Geipel had called attention to certain prophecies of his made when he was a comparatively young man and sanguine, saying that they had been more than fulfilled. But he did not think Mr. Geipel had been quite correct in what he had said concerning this matter. The costs that he himself had prophesied had included certain things which he knew existed and which still existed, and which were a great scandal and had to be included in costs. These were such things as municipal taxes and so on, which were quite as great as the coal bill, and the 3d. had to bear on its back something of that sort. These power gentlemen were in the fortunate position of starting on an entirely new thing. The load-factor assumed would have been a luxury to those who for 20 years had been designing central stations, and the fact of its existence enabled central station design to be carried out on entirely different lines. Once the coal bill and the labour bill for firing the boilers and working the plant in the station became the important factor instead of quite the minor factor, as it was in those days, then the whole question of generating in the best way entered on a new phase. The gentlemen who had now to design these stations had what appeared to the older members of the profession an easy task. There was a little tendency on the part of Mr. Merz to say very little—too little perhaps—of those who had gone before, and those who had really developed the present possibilities of design. The speaker then referred to the question of the steam versus the internal combustion engine. In Calcutta he had started a station with both classes of plant to obtain more light on the question. He had in his charge several internal combustion stations, and for a small scale they were a decided success. They were cheaper, but as they had not been running long he could not speak about repairs. But as regards small sets for power stations, there was no doubt that they could be done cheaper when the whole thing was put on to a balance-sheet, including interest and depreciation. But for all this he was not going to say that steam was going. He was wholly with Mr. Merz. His station was as near perfect as we knew at present, for he was certain that every advantage that could be obtained, and had been obtained, by substituting the turbine for the direct use of an expanding fluid, could be equally applied to the gases produced by explosions, and that great simplification would follow whilst we had the minds of men like Parsons at work upon the subject. It was perfectly certain that we should have turbines fed direct from the products of explosion, and then we should get very near perfection. He was disappointed in another direction from not getting the information on this subject he had hoped for. When it came to the question of producing steam on its way to the turbines, he thought the Paper told far too little. Any fool could work with Welsh coal, but it took a clever man to work economically with a fuel which had 30 per cent. of ashes. He was burning satisfactorily in Calcutta coal with 30 per cent. of ashes, and evaporating 9lb. of water per pound of this coal. There were some gigantic improvements in the last few years with regard to steam raising. The water-tube boiler had been sneezed at for a long time by the old-time people. But they did not know how to use a water-tube boiler, and it was only a few years since a water-tube had been set which had been worth looking at. There had never been sufficient space to get proper combustion chambers and proper combustion. Then came the universal introduction of superheat, and the investigations of what this did showed that it did ever so much more than the professors told us it could do. They had entirely ignored the enormous discovery made by Prof. Callendar that superheated steam behaved in an entirely different manner to ordinary steam. In fact, it was hardly believed in yet. Then came, last, thermal storage. It was only during the last year or two that it had been tried upon a commercial scale. Mr. Halpin had got results which were perfectly astonishing. By adding thermal storage a boiler which ordinarily evaporated 12,000lb. of water per hour would do 36,000lb.

Mr. W. H. BOOTH said that, the ordinary peak of a lighting station being triangular, the lower portion might be dealt with by means of a heavier class of boiler, but when the peak was reached, the lower half of it could be dealt with by means of such a boiler as the Solignac, with liquid fuel, and the top might be dealt with by means of accumulators. In a traction station the mean load was practically identical the whole day through, and the same class of boiler would be required throughout the day. If they considered a station running, say, 65 cars, a load-factor of 44 per cent. would be obtained. Ordinarily such a load would be run by means of a compound engine, the ordinary cut-off being at about one-third of the stroke and the latest at about three-quarters of the stroke, so that the minimum expansion would be 1¾ in the first cylinder or equal to four times on the two cylinders. If the load-factor was only 44 per cent., an expansion of about 67 times was obtained. Supposing the compound system was abolished and a simple engine installed it would be possible to carry the same load with a reduction of the mean expansion by about four times and yet the mean cut-off would be very early. Then there was the question of cylinder condensation, which was very much in excess of that of the compound engine, but this could be got over by means of superheating. It was that fear of breakdowns which had led to such an enormous duplication of plant, steam pipes and feed pipes, &c. It was far better to put in excellent material to begin with than to put in cheap trash and provide for breakdowns. Why should not strong riveted steel pipes be employed instead of the ring main, which ought to be avoided. If more care were taken in the manufacture and erection of steam pipes a far greater satisfaction would result. The authors seemed to doubt the value of stokers, but they had overlooked the fact that mechanical stokers enabled the boilers to be run at a more even temperature, especially if the boilers were of the Lancashire type, and this resulted in longer life. Another point was that where the doors were being opened for constant firing the flue-fired superheaters were being cooled down and uneven work on the engines was the result. A still further point was that, with the boilers set as they were in this country, mechanical stokers were essential for the prevention of smoke. There was, of course, the same amount of smoke, but it was emitted in small quantities at a time so that the smoke inspector did not notice it. The boiler setting of the Eastern States of America had been adopted in some cases in this country, but it was wholly bad for the conditions here, although it might be good for the hard coal burned in America. Gas engines would put steam engines out of court, if electrical engineers took whatever boilers might be offered them without considering the settings and other points. At the Carville power station the boilers were set at right angles to the engines, a design with which he was familiar more than 30 years ago. Such a design with water-tube boilers called for independently fired superheaters, and, if these were placed between the boilers and the engine room, many advantages could be obtained, notably a most direct form of steam main; and further with the Cruse controllable type of superheater, which adapted itself to high or low temperatures of superheat as might be required, the controller feed water could be reheated to the full temperature of the boiler, thus increasing the duty of the boilers and allowing of a considerable reduction in boiler plant and an all-round saving in coal.

Mr. E. K. SCOTT suggested that with vertical shaft turbines it would be possible to have the engine room on two floors. All the generators and the switchboard could be on the upper floor, and all the turbines with their condensers and auxiliary plant below. The advantage of the double floor arrangement was that in case of an accident it would only mean closing a hatchway to shut off the electrical plant altogether. Steam engines for dock pumping had also been built and were running very economically. The great thing that was going to settle all these matters was the great space for the boiler house. This was going to turn the whole question in favour of gas, and gas turbines had gone a little further than was generally imagined. At Leeds they had been experimented with for some time, and one had run—not for long, but it had run. Mr. Reavell was a great steam engine enthusiast, but he was now giving all his attention to the gas turbine, mainly on account of the fact that the boiler makers could not make big enough sets of plant. He had had this matter of capitalisation very prominently placed in front of him recently in connection with a water power station. There he was enabled to use Pelton wheels, and it was really remarkable at what a very cheap price a 6,000 H.P. plant could be put down. It only cost £11 per kilowatt.

Mr. J. J. STEINITZ said they had heard how 10 years ago, when Col. Crompton's Paper had been read, the necessity of keeping down the capital cost was thoroughly understood. That might have been so, but after the lapse of five years it was apparently entirely forgotten, and at the present time—in fact, since the discussion was opened, he had met several engineers who were responsible for some of the largest stations in this country who had told him that they had not, until after they had

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read the Paper, thoroughly appreciated the immense importance of capital cost, and the relation it bore to the selling price of the unit. It had been his duty, during the last year to read through a good many specifications of consulting engineers and others and in all those for engines and dynamos an overload had been called for. He thought that the authors' basis for rating a station, by taking account of the overload capacity in place of spare plant, was correct. Last winter he went through a good many stations where engineers wanted a certain amount of sympathy because they were running the station without any spare plant, but if they had only considered the overload that each individual plant could do they would have found that they had 25 per cent. of spare plant. Many engineers who had specified the overload did not take advantage of it. The authors mentioned £40 per kilowatt as being a charge for station plant and buildings, but there were very few cases in which that figure had been reached. If it had, then those gentlemen who had control of power companies had a very good time before them. With regard to the arrangement of the auxiliary plant the authors had laid down a hard and fast rule that there should be no basement. If they considered a place where it was possible to start building right on the ground the basement formed itself naturally. He had had this occur in one or two stations which he had designed and had found it exceedingly useful and not at all expensive in working.

Mr. W. L. MADGEN said that Mr. Geipel had drawn attention to the number of practical students in the domain of economics of electric supply who had drawn attention some years ago to the importance of capital charges as compared with the works costs in the total cost of the unit, but he did not think that Mr. Geipel had remembered what had happened in the meantime. A very large number of stations had been put up by municipalities, and the conditions under which they had been put up had not been conducive to economy in capital cost. But this was hardly to be expected with a surveyor who desired to put up a station which was a cross between a museum and cathedral. Many of them who were engaged in manufacturing and general engineering were aware that it was regarded as an axiom that the capital should be turned over once a year. In electrical supply works, and in some other public services of that character, the capital was not turned over in one year, in fact, in taking an average of the representative electrical supply stations, he thought that it would be found that the ratio of gross revenue to capital expenditure was something like 12½ per cent., that was to say, that the capital was turned over once in about eight years, and interest, sinking fund, charges, dividend and all other charges had to be met out of that 12½ per cent. Obviously it would be seen how important it was to decrease the amount of investments and increase the amount of the revenue. Mr. Merz's Paper showed, as also did the reference which had been made by other speakers, that upon the 30 per cent. load-factor, the works costs were 0·25d. per unit and the capital costs 0·275d. per unit, making together 0·525d. per unit, This figure, he thought, afforded some indication of the fate which was awaiting the small separate generating stations, which he was glad to see were not being now erected with the same freedom as they were before the era of the large power supply undertakings. The authors of the Paper had put before the meeting in a very clear light the importance of economy of capital, and he thought there was one very important aspect of it which should be borne in mind —namely, that it was not a question of what could be achieved in one generating station so much as what could be achieved by diminishing the number of generating stations—*e.g.*, that if in a given district the requirements could be dealt with by means of one, two or three generating stations, then every additional generating station which was put up by a local authority or a company was an additional capital charge upon the community of that district considered as a whole. It was much to be regretted that the industry was there in a very undecided frame of mind with regard to the point. In one district with which he had had to do—namely, the North Metropolitan area—the Willesden District Council, under the advice of Mr. Ruthven-Murray, had sold the generating station to the North Metropolitan Power Co., which now became one of the main power stations of that area, and the generating station in question had a much larger sphere of usefulness than it had before.

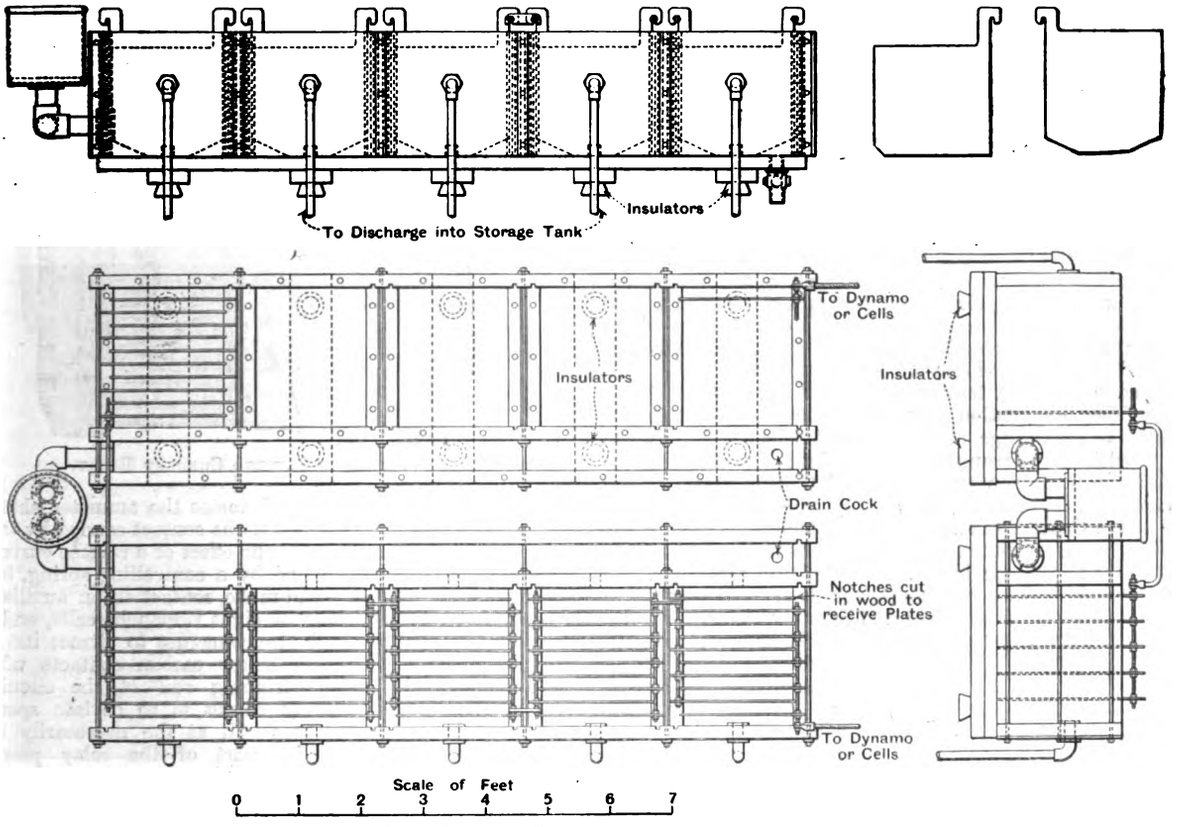
(*To be concluded*).

AN ELECTRICAL OIL SEPARATOR.

The problem of effectively removing oil from the air pump discharge is no new one, and has been attacked in a variety of different ways. The employment of an ordinary filter is insufficient to remove oil from the discharge, as it is largely in an emulsified condition, and the problem, therefore, resolves itself into causing the minute particles of oil to coalesce and so form bodies of appreciable dimensions which may be caught by filtering material. In previous oil separators this has been usually attained either by the use of chemical reagents, or by causing the exhaust steam, before being condensed, to impinge upon suitably-arranged baffle plates.

An entirely new process is that known as the Davis-Perrett electrical system of separation, employed at Leicester and other places, and referred to briefly in the article on the Leicester Corporation tramways, which appeared in last week's issue of *The Electrician*.

The illustration which we give below shows the apparatus employed in the new process. It will be seen that there are two large wooden tanks, each divided into five compartments, and each compartment accommodates 10 plain sheet-iron plates ¼in. thick. All the compartments are connected up in series across a 500-volt circuit, and there are five plates in parallel. Grooves are cut into the partitions dividing the compartments off, and also in the bottom of the tanks, and, the plates being inserted into these grooves they are rigidly supported. Iron rods,



DAVIS-PERRETT ELECTRICAL OIL SEPARATOR.

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screwed for their entire length, are used for connecting the plates together electrically, and in order to lessen the prime cost of the apparatus the plates are now being made without the small projecting lug, connection being established to the iron rod by means of a miniature fish-plate fastened to the projecting piece by means of a screw and nut. The whole apparatus is supported on insulators, and the liquid to be treated is divided into two streams at one end of the tanks. It then passes into the tanks and through each set of compartments in five parallel streams. Alternate plates are cut, as shown by the drawing, so that the liquid passes first under one plate and then over the next, so that the circulation is very thorough.

The Leicester plant is capable of dealing with 6,000 gallons per hour, and requires 12 amperes at 500 volts; in fact, that particular size of apparatus is designed for dealing with 1,000 gallons per hour per Board of Trade unit, and this is the figure upon which all the manufacturer's claims are based. Different tanks can be supplied, however, for other voltages. We are informed that the sheet-iron plates last from two to three years. After working for a certain length of time they become coated with a deposit which is easily removable by causing the current to pass through the tanks in the opposite direction. The deposit then rises to the surface and may be skimmed off. This is practically all the attention which the process requires.

One curious feature is the extremely high ohmic resistance possessed by the air-pump discharge which acts almost as an insulator. This difficulty is overcome by the addition of a minute quantity of ordinary water which immediately causes the liquid to become a much better conductor. The quantity of water necessary is practically negligible, an eighth of a turn of a ½in. cock being sufficient to cause the resistance to fall to its proper value. If, for any reason, too little or too much current passes through the tanks, the fact is indicated on the switchboard by a solenoid and plunger arrangement which lights up a red lamp. The Davis-Perrett Company have installed an electrical separator at the new generating station of the Shoreditch Borough Council, and we have seen it working most satisfactorily.

The action of the current is to cause the emulsified oil to coalesce, and when the liquid is subsequently passed through a mechanical filter there is no difficulty whatever in catching the particles of oil, thus allowing the remaining water, which is exceptionally pure, to pass to the hot well. It may be mentioned that the separator can be used in conjunction with any type of filter, the construction of the latter not affecting the efficiency of the separator in the least.

CITY AND GUILDS OF LONDON INSTITUTE.

The report of the council of the City and Guilds of London Institute was submitted at the annual meeting held on Wednesday, Lord Halsbury presiding. In moving the adoption of the report, the chairman referred to the progress made by the various institutions, and particularly that of the Central Technical College. The number of students in classes under the department of technology of the Institute was 41,000. No great improvement in the character of candidates' work could be expected until elementary school teaching was made more practical and further attention given to drawing and scientific method and English composition.

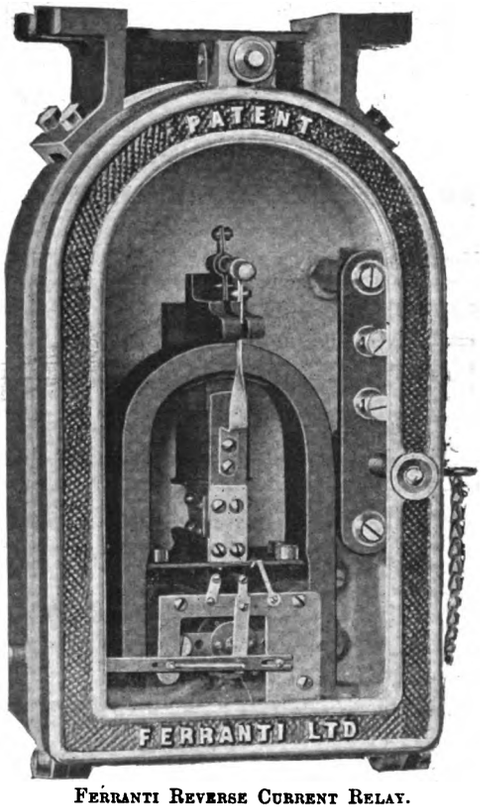
The report contains many features of interest to engineers. With a view to avoiding duplication of work in the Central Technical College and the Royal College of Science and School of Mines, the Institute entered into an arrangement with the Board of Education under which about 60 students of the Royal College should attend a special course of lectures and laboratory practice in electrical engineering at the Central on two afternoons each week during the current session, the Government making a grant to the Institute to cover the expenses of the experiment. The number of students of the Royal College who desired to avail themselves of the arrangement was greatly in excess of that anticipated, and 77 have been admitted to the lecture course, of whom, however, only 66 could be accommodated in the laboratories. The Council hope the experiment will prove satisfactory, and that the principle of the interchange of students between neighbouring colleges having been established it will be extended whenever there may be occasion to do so.

It is interesting to observe that the mean age of students at the Central is gradually increasing, the respective figures for the past three years having been 18·4, 18·6, and 18·7. Candidates for entrance to the college do not apparently realise the importance of matriculating at the university before entering the college so that they may be registered as internal students and proceed to a degree in engineering. Nevertheless, the number of students so registered is increasing, and there are now about 80 students of the college who are internal students of the university. The first year sessional examination of the college is accepted by the university as an intermediate examination on condition that the examination papers are submitted to external examiners appointed by the university, and that the written answers are sent to them for marking. The final examination for the degree is conducted entirely by the university, independently of the college examinations. The Papers are set by boards of examiners, consisting partly of external examiners who are not teachers in the university, partly of teachers recognised by the university. The entry of new students this year and the number of students in college is the largest in the history of the college; some departments are overcrowded.

Regarding the Finsbury Technical College, its work during the year past has also been important. Plans for the new buildings, which are to cost £30,000, have been prepared, and it is expected that their erection will be commenced shortly. They will provide a floor area of about 19,400 sq. ft. The number of day students has remained practically stationary for the last four years, while there was a falling off of 54 students in the evening classes last year as compared with the year before. The total expenditure of the Institute during the past year in all its departments amounted to £36,821. 2s. 9d.

A REVERSE-CURRENT RELAY.

Reverse-current circuit-breakers, although their use is largely on the increase, nearly all possess the disadvantage that the current at which they operate varies very much with the 'bus bar volts. The reverse-current relay for use on continuous-current circuits, recently put on the market by Messrs. Ferranti Limited (Garrard's patent), consists of a moving coil polarised relay. The moving coil is



Ferranti Reverse Current Relay.

operated by the fall of potential across the ammeter shunt. With current in the forward direction, the contact carried by the moving coil is held against a stop, but the effect of a reverse current, whose magnitude may be determined by a controlling spring, is to cause the moving coil to rotate and make contact in an auxiliary circuit. This auxiliary circuit is one of eight Leclanché cells, and on being completed causes a small electromagnet to attract its armature. This latter closes a pair of heavy carbon contacts which complete the circuit of the tripping coil of the circuit-breaker. The object of the auxiliary circuit is to obviate sparking due to the induction of the trip coil at the necessarily light contacts carried by the moving part of the relay proper. The trip coil is connected across the 'bus bars, and is constructed in such a manner that even if the 'bus bar voltage should fall to one-sixth of its normal value it would be sufficiently strong to open the circuit-breaker. The connections are so made that a coloured lamp is lighted immediately the relay operates, thus indicating at a distance which circuit-breaker has operated. The relay is provided with a push button, and on pressing this the device is caused to work and the circuit-breaker to open. If desired, parallel push buttons can be arranged at any convenient distances. The whole relay may be placed at a distance from the main board. We are informed that the device is already in operation in several supply stations in this country, where it has given satisfaction.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Hot Oxide Coherer.—M. Hornemann describes a new kind of anti-coherer which, under some circumstances, acts like a Schaefer plate and sometimes like a Branly coherer. It consists of a single contact between copper and lead in which the copper is oxidised sufficiently to stop any current in the cold, but not sufficiently to stop it entirely when the junction is heated. If, while it is in that condition, electric waves impinge upon it, the resistance in the junction increases, and as soon as the waves cease, the resistance falls to the normal amount. This process may be repeated always with the same result as long as its supply of heat to the junction is kept up. This must be done by applying heat to a portion of the copper in the vicinity of the junction, so as not to alter the oxidation. When the strength of the impinging waves exceeds a certain amount, the resistance suddenly falls to a very low value, and only returns on concussion, whereas in the first case the junction behaves like a self-righting anti-coherer. The author looks for the cause of the action in the thermoelectric force at the oxide junction. He found experimentally that the thermoelectric force depends upon the condition of the oxide, and it is conceivable that the differences of temperature induced by electric waves may temporarily modify it.

[M. HORNEMANN, *Annalen der Physik*, No. 6, 1904.]

Braun's Transmitter.—The theory of the two coupled electrical systems constituting the Braun transmitter has been repeatedly dealt with. Prof. Braun himself supposed that a wave of the period of the closed circuit was forced on the transmitting wire, an assumption which holds good in the case of a very loose coupling. Seibt investigated the direct-coupling without regard to the damping, and assumed, like Braun, that the secondary system is an open one. Wien dealt with inductive excitation, assuming two closed circuits, and, therefore, two degrees of freedom of the system. Both Seibt and Wien found a difference between the direct and the inductive coupling. But if in direct-coupling the secondary system may be regarded as closed, the same equations hold good as for inductive coupling so long as the piece common to both circuits may be assumed to be devoid of resistance, which is practically always the case. Zenneck has already pointed out that there is no difference in principle between the two systems of coupling. L. Mandelstam now proves the same for any coupling whatever. He assumes the damping to be small, and that all resistances contain a factor which is small in comparison with unity, and whose higher powers may, therefore, be neglected.

[L. MANDELSTAM, *Physikalische Zeitschrift*, May 1, 1904.]

Röntgen Rays in a Magnetic Field.—B. Walter has endeavoured to carry the investigation of the possible magnetic deflection of Röntgen rays in a magnetic field to the utmost attainable limit, and has succeeded in reducing the maximum to an amount 10,000 times smaller than that obtained by Strutt. In other words, he has proved that if Röntgen rays pass through a unit magnetic field, or a field about six times as strong as the earth's horizontal magnetic force in our latitudes, the radius of curvature of the rays, if not infinite, is certainly larger than the distance of the moon from the earth. He has achieved this result by using a better optical system, and by increasing the length of path of the rays to 3 metres. This is another confirmation of the undulatory character of the Röntgen rays.

[B. WALTER, *Annalen der Physik*, No. 6, 1904.]

Penetrating Radium Rays.—F. Paschen claims to have proved that the γ-rays, or penetrating radium rays, are not analogous to Röntgen rays, but are cathode rays or electrons moving with the velocity of light. This is established by the fact that they carry a negative charge, and explains why the ionisation produced in various gases by these rays does not agree with that produced by Röntgen rays, but rather with that produced by the other two kinds of radium rays. The author's crucial experiment consists simply in enclosing the radium bromide in a continuous casing of lead 1cm. thick. It is well known that the γ-rays are capable of penetrating that thickness of lead, but that the other radium rays are not. Now the author finds that in spite of the packing the positive charge of the radium preparation increases steadily by several volts per minute, which can only be due to the fact that the escaping γ-rays carry a negative charge away with them.

[F. PASCHEN, *Annalen der Physik*, No. 6, 1904.]

Röntgen Tube Regulation.—M. d'Arsonval produces a fine series of radiographs showing how they can be produced by the same tube in an identical manner after a considerable interval of time and after using the same tube for various purposes in the meantime. He uses a milliammeter specially constructed by Gaiffe, and uses it in conjunction with an alternate-current transformer from 110 to 60,000 volts. There is also a rheostat and a voltmeter on the primary from which the effective voltage in the secondary may be determined. The current is derived from the municipal installation. The rest of the arrangement is that designed by Villard. The special milliammeter is only in circuit with the X-ray tube. The radiographs reproduced show that the quantity and the quality of the radiation was the same in every case. A given tube may always be brought back to the same conditions of emission. When the pressure is the same, the intensity of the radiation is proportional to the current strength. The new apparatus enables radiographers to repeat any exposure under precisely similar conditions.

[D'ARSONVAL, *Comptes Rendus*, May 9, 1904.]

Influence of Anæsthetics on Sources of N-rays.—Meyer having recently shown that plants subjected to chloroform lose their power of emitting N-rays, J. Becquerel was led to investigate whether other sources of N-rays also suffer under the influence of anæsthetics. He found that several inorganic sources of N-rays do temporarily lose their power under the action of anæsthetics such as chloroform, ether or nitrous oxide. Calcium sulphide itself, which emits N-rays after being exposed to sunlight, shows an enfeeblement of its luminosity when a current of air laden with chloroform is passed over it. In a more significant experiment, the author covers one base of a truncated cone of copper with quartz sand and exposes the latter to sunlight. He then introduces the base into a flask, from which the upper surface of the cone projects. This upper surface is covered with the phosphorescent calcium sulphide, and indicates the N-rays emitted by the base of the cone and transmitted by the copper. The flask is provided with two other outlets, which enable the observer to direct either a current of pure air through the flask, or a current of air laden with chloroform or other anæsthetic. The author made sure that the chloroform itself emits neither N-rays nor N'-rays. He then observed that on admitting the chloroform there is a short period of one or two seconds during which the emission of N-rays is increased. After that the emission gradually decreases, without, however, vanishing entirely. When the current of pure air is turned on, the N-rays reappear slowly, showing that their emission was only suspended, and not suppressed. The author took care to eliminate any heat effects by passing the current of gas through a worm immersed in water. He puts the question as to whether the emission of N-rays is a fundamental vital process, and whether the effect of anæsthetics is simply to suspend that process. In this connection, Bose's observations of the effect of anæsthetics on the electric response in metals should be referred to.

[J. BECQUEREL, *Comptes Rendus*, May 9, 1904.]

Tractive Resistances on Various Roads.—Messrs. Max Schiemann & Co., well known in connection with trolley omnibuses, state in a pamphlet recently issued that the tractive resistance on railways is from 9lb. to 18lb. per ton, on tramways from 26lb. to 33lb., on good stone pavement from 44lb. to 55lb., on bad stone pavement from 66lb. to 78lb., on good macadam from 44lb. to 67lb., on bad macadam from 77lb. to 100lb. and on sand roads from 130lb. to 220lb.

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SINGLE-PHASE TRACTION.

MR. W. A. BLANCK, in an article which we publish on another page of this issue, discusses the question whether single-phase or polyphase generators are preferable for single-phase traction systems. This question would hardly have cropped up but for the fact that, power for power, the single-phase generator is somewhat more bulky and expensive than the polyphase machine. The author comes to the conclusion that single-phase generators are decidedly to be preferred, and in this, probably, he is in agreement with many electrical engineers who have studied the question. Taking the case of London, for instance, the incoming lines are worked to their maximum during the morning, and the outgoing lines are but lightly loaded. In the evening the reverse is the case. Thus, to provide equal loads on the two phases of a two-phase system, for instance, it would not be sufficient to connect the up-line to one phase and the down-line to the other phase; the whole system of lines would necessarily have to be divided into comparatively small sections, so that alternate sections were fed from alternate phases. This would also occasion some complications at the ends of the sections and in the method of feeding them, not to mention balancing troubles. Another debatable point is Mr. BLANCK'S proposal to use the rail as conductor, both for the low-tension and the high-tension current. This would, as the author points out, conduce to a considerable saving and to simplicity, but it would also weaken the system in the way of safety. When the single-phase system is extensively adopted in this country for traction work, doubtless the usual lines will be followed of employing concentric high-tension feeders with the outer conductors earthed at the dynamo end, and independent of the low-tension line.

It is noteworthy that during the last year or two, although single-phase *versus* continuous-current for traction has been discussed up and down, and numerous single-phase motors and methods of motor control have been described, the question of the track equipment has received less attention. Will the ultimate standard practice be to feed the motor-cars or locomotives direct from the high tension line, or will a third rail be employed supplied by transformers distributed along the line? In connection with the former of the two solutions,

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an article on "Single-phase Traction in Switzerland," which also appears in this issue, is not without interest. The Oerlikon Company has patented and partly put to test a system of current distribution and collection which aims at combining the simplicity of the overhead construction for the bow-collector with the independency of the position of the line wire, relative to the track, obtainable with the trolley of the Dickinson type. In this it appears to have been successful; but a conclusive opinion as to its success in practice cannot be given before it has been tested on a larger scale than has hitherto been the case. The principle of this system—*i.e.*, that the current-collecting device ought to follow the trolley wire and not vice versa—makes a cheap and safe overhead construction possible. One of its weak points appears to be the shifting arrangement for the current-collecting device as a whole, which is necessary for avoiding obstructions offered to it on the line, such as tunnels, bridges with small clearances, lamp-posts and so on in stations, &c. The further development of the system will be watched with interest.

The same article describes the first occasion upon which the Ward-Leonard single-phase traction system has been put into practice on an actual line. From information we have received, however, we gather that this method, in which the locomotive carries a sub-station in addition to its driving motors, is not destined to be more popular than the Heilmann locomotive, in which a whole generating station was placed on the locomotive. The recent improvements in single-phase motors point to a more satisfactory solution of the single phase traction problem.

THERMAL STORAGE SYSTEM AT THE KENSINGTON AND NOTTING HILL JOINT WORKS.

In the spring of last year the engineers of the Kensington & Knightsbridge and the Notting Hill Electric Light Companies had to consider the question of increasing the plant at their joint "bulk" supply station at Wood-lane, Shepherds Bush. It will be remembered that three-phase current at 5,000 volts is supplied from these works to sub-stations belonging to the Kensington and Notting Hill Companies, whence continuous current is furnished by means of motor-generators to the low-pressure networks of the two companies. A full description of the works appeared in *The Electrician* about 2½ years ago (Vol. XLVII., pp. 738, 779 and 818), when the plant consisted of five B. & W. boilers, and two 330kw. and three 550kw. Willans-Oerlikon alternators. Soon after that date two more generating sets of the same make had to be put in, these being of a larger size—750kw.—and three more boilers were added, this filling up all available space in the boiler house. When it was found that further extensions were required, there was still room to place a 1,000kw. Parsons turbo-generator in the engine room, but an extension of the steam-raising plant was a more difficult problem. Mr. H. W. Miller, of the Kensington and Knightsbridge Company, who is joint engineer of the joint works together with Mr. Geo. Schultz of the Notting Hill Company, was in favour of an application of the Druitt Halpin thermal storage system, and as the particular method of boiler setting that had been adopted at Wood-lane would tend to bring out to the full the advantages of this system, it was resolved to try it. The experiment has been conspicuously successful.

The main idea of the system is roughly to increase the rating of the boilers at the hours of peak load by feeding the boiler with water at boiler temperature during those hours, this water having been previously heated to the desired temperature by live steam during the hours preceding the peak hours. Additional boiler plant would, of course, only have been needed to deal with the maximum load for the two or three hours that the peak continues, and thus a substantial increase in the rate of steaming during this period is all that was required. As a matter of fact, it was found that the expedient answered even better than was anticipated, for an actual increase of boiler efficiency was observed, owing to the improvement in circulation, occasioned probably by the more steady feeding at boiler temperature when the boiler is working at its extreme output. Fig. 1 shows the arrangement adopted. The water-tube boilers, which are each capable of evaporating 12,000lb. of water per hour, have two steam and water drums, each 4ft. in diameter by 24ft. long, and the thermal storage vessels are placed directly above them, being carried at one end by a 10in. stand-pipe and at the other end by sliding cast-iron saddle pieces. The stand-pipe forms a permanent connection to the steam space of the drums of the water-tube boilers, so that the temperature and pressure in the boiler and in the thermal storage vessels are always equal. The whole of the feed-water, after passing through the feed-heaters (heated by the exhaust from the auxiliary engines) and the economisers, is introduced directly into the thermal storage vessel at the top, where, in passing through the steam, it is heated to the full boiler temperature, and it enters the boiler through the feed

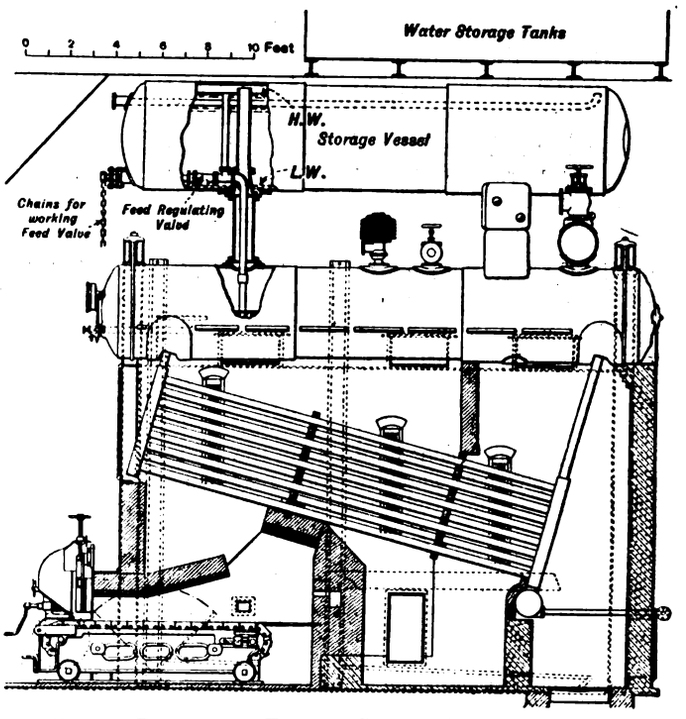

FIG. 1.—BOILER WITH THERMAL STORAGE ARRANGEMENT AT WOOD LANE STATION.

regulating cock, which is controlled by a spindle passing through a gland in the end plate of the thermal storage vessel. During times of light load the vessel is filled up, and when the heavy load comes on the feed from the pumps is stopped, and the boilers are fed from the water contained in the thermal storage vessels. It has been found that during the time the vessels are being discharged, the boilers are capable of evaporating two to three times the amount of water they can deal with when being fed from the economisers in the ordinary way.

With respect to the question of heat lost by radiation from the vessels, this is governed by the quality of non-conducting covering used. In one case in which it was measured it was found to be represented by the combustion of 1⅛lb. of coal per hour containing 12,800 B.Th.U. working at 125lb. absolute pressure on a vessel 6ft. diameter by 19ft. long. Tests made of the temperature of the feed-water entering the boiler showed that it was only eight-tenths of 1 per cent. below the temperature inside the boiler.

It should be noted that the extraordinary gain in evaporative capacity would not be obtainable in the case of every

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boiler. The boilers at Wood-lane station were originally arranged so that there should be more space for the furnace and freer access of air to it than in accordance with the usual practice. The boiler tubes were lifted 3ft. higher than usual, so that a firebrick-lined combustion chamber is formed directly over the fire. There are two firebrick arches instead of one, and the flame-plate division wall between the furnace and the middle chamber is nearer the front of the boiler than usual, so as to raise the temperature and get more work done in the middle chamber.

Fig. 2 shows the highest load-curves in January, 1903 and 1904, respectively. The latter is an abnormal one, the peak at midday being higher than between the usual heaviest hours, 5 to 7. A third curve shows a more typical one observed on January 12, 1904. From these it is obvious that if the output of the boilers can be tripled for three hours, the gain in capacity is enormous, as the boiler plant itself need then only be rated

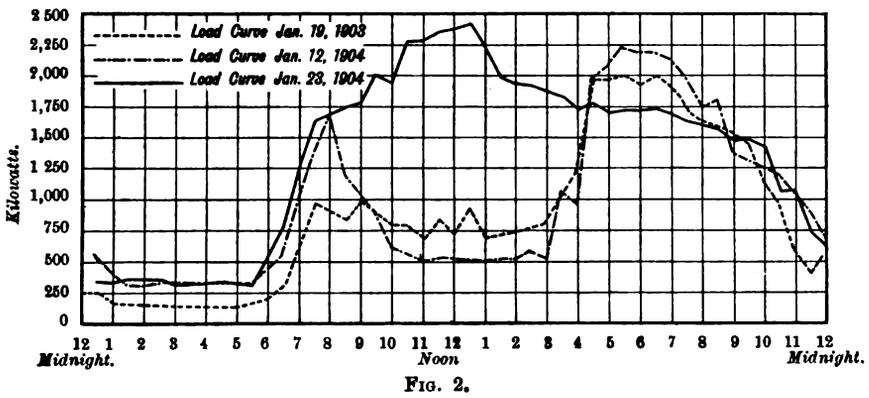


FIG. 2.

at slightly over the average load instead of at the peak load. In this connection our readers may also refer to the remarks made by Col. Crompton in the discussion on Mr. Merz's recent Paper, reported on another page of this issue.

Our thanks are due to Mr. C. M. Bennett, engineer in charge of the Wood-lane station, for courteously showing us over the works last week.

It may be mentioned, also, that the thermal storage plant originally put in at Shoreditch, was modified a few years ago, so as to store the hot feed water, as is being done at Wood-lane, instead of actual steam as was originally proposed. Although not giving such startling results as at Wood-lane, the plant at Shoreditch has been, on one occasion at least, of considerable value in dealing with the peaks of a winter load, which it would have been almost impossible to supply satisfactorily with the same boiler plant without the thermal storage attachment. The system has not been adopted, however, at the new Shoreditch station. One of the most interesting points in the results at Shoreditch, described in Mr. Newton Russell's Paper before the Institution of Civil Engineers, is that the scale from the feed water is deposited mainly in the thermal storage tank and not in the boiler tubes.

SINGLE-PHASE TRACTION IN SWITZERLAND.

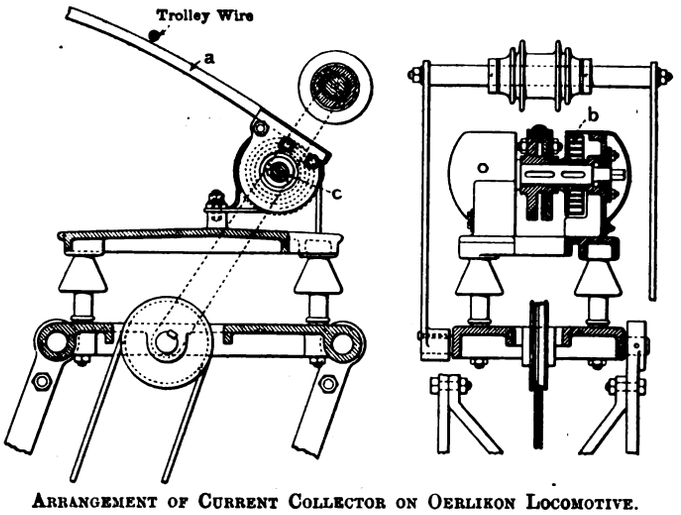
It has been known for some time that the Oerlikon Company has been carrying out experiments with single-phase traction on the Ward Leonard system between Seebach and Wettingen in Switzerland. Since this system has only been adopted, as we are informed by the Oerlikon Company, in view of the frequency of the alternating current available for the tests, the motor part of the locomotive will only be briefly described, and more attention will be given to the ingenious means employed by the Oerlikon Company for distributing and collecting the electric energy.

In the Ward-Leonard system, as will be remembered from former articles on this subject in *The Electrician*, single-phase current is transformed into continuous current by means of a motor-generator placed on the locomotive, and the motors are of the continuous-current type.

In the Oerlikon locomotive, which is stated to weigh about 44 tons, the motor-generator is placed in the centre of the locomotive. The motor is of the induction type and is directly fed by the high-tension, single-phase current from the overhead trolley line. A second, but much smaller motor-generator set produces continuous current at a low voltage for the excitation of the main continuous-current generator and the continuous-current motors. It also serves for the starting and bringing up to speed of the large motor-generator set. A 10 H.P. induction motor actuates the pumps of the air compressor. The speed of the locomotive is regulated by altering the voltage of the generator and by varying the field strength of the motors. The two single-phase motors for the small transforming set and for the air pumps are fed with low-voltage current through transformers, and are started by auxiliary phase-shifting devices. By altering the polarity of the main continuous-current generator, the direction of travel of the locomotive may be reversed.

The locomotive rests on two bogies, each of which carries a four-pole motor of a capacity of about 200 H.P. Although the motors are of the open type, they are well protected from dust and dirt from the track. Their axles are about level with the floor of the locomotive. They drive by means of gearing on to a countershaft below, which is provided with two cranks, spaced 90deg. apart. By means of these and suitable connecting rods, the motive power is transmitted to the driving wheels of the locomotive.

The overhead construction and the system of collecting the current has many points of considerable novelty. As shown in the Fig. below, the current is collected from the trolley wire by means of a slightly curved metal rod, the weight of which is kept as small as possible. It is free to turn round the pivot *c*. The rod *a* is circular in section where it is clamped to its holder, but further up it is flattened out so as to provide a large contact area. It is pressed by a spring, *b*, against the overhead wire. All other mechanical details are so clearly



ARRANGEMENT OF CURRENT COLLECTOR ON OERLIKON LOCOMOTIVE.

shown in the illustration as to need no further explanation. By reference to the figure it will be clear that the trolley wire may be placed along the side of the track or over it, or in any intermediate position. In all these positions the current will be successfully collected by the rod, and if the trolley wire is gradually conducted from the side of the track to a position above it, it will be seen that the collecting rod, too, will gradually be deflected from one position to the other. In stations, tunnels and crossings the trolley wire will generally be over the track, and current will be collected by the rod pressing against the wire from underneath. On the open track, however, it will be more safe and economical to have the trolley wire carried along the side of the permanent way. In

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this case the rod will press sideways or from above on the wire. In certain conditions (for instance, in tunnels) it is necessary to shift the whole current-collecting arrangement as a whole, so as to obtain enough clearance. For this purpoee the Oerlikon Company has suggested various means which may be worked either by hand or automatically.

In the actual trials, which have been referred to, the collecting rod had a length of 1,300mm. (4ft. 3in.) and weighed 1,300 grammes (2·9lb.), and the spring was so adjusted that the pressure at a distance of 3ft. ¼in. from the fulcrum was 6¾lb.

SINGLE VERSUS POLYPHASE GENERATORS IN ALTERNATING-CURRENT RAILWAY WORK.

BY W. A. BLANCK.

The present great interest in the development of alternating-current railways makes most timely some considerations as to the selection of the generators delivering the energy to the system particularly the choice between single and polyphase machines.

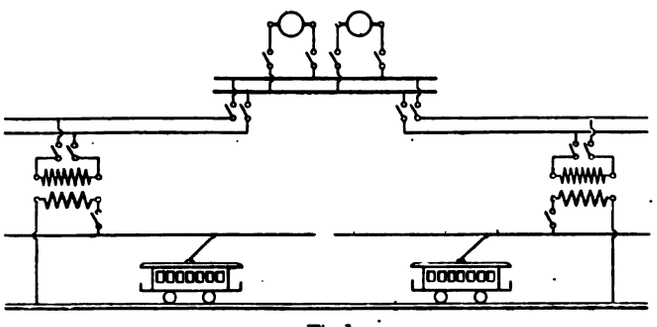

Fig. 1.

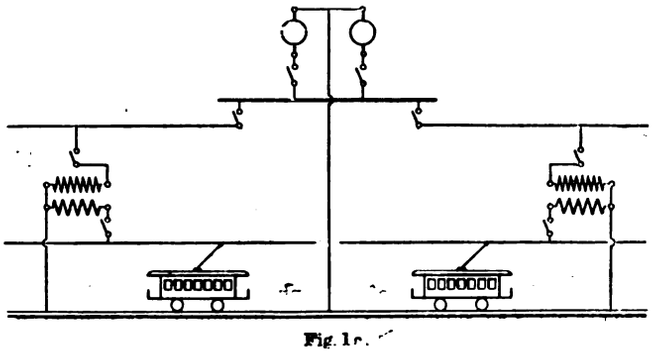

Fig. 1a.

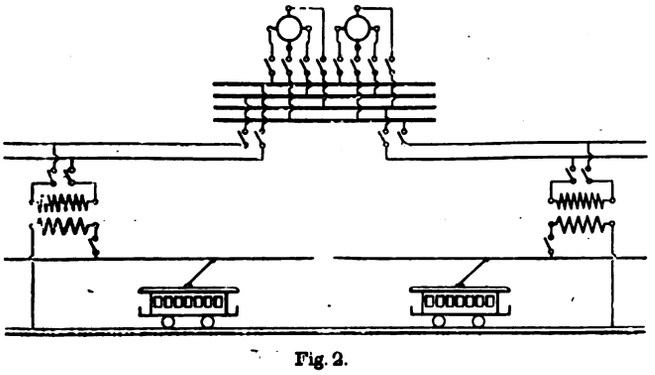

Fig. 2.

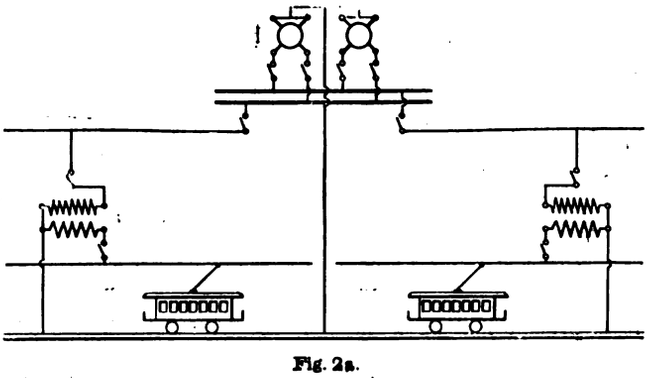

Fig. 2a.

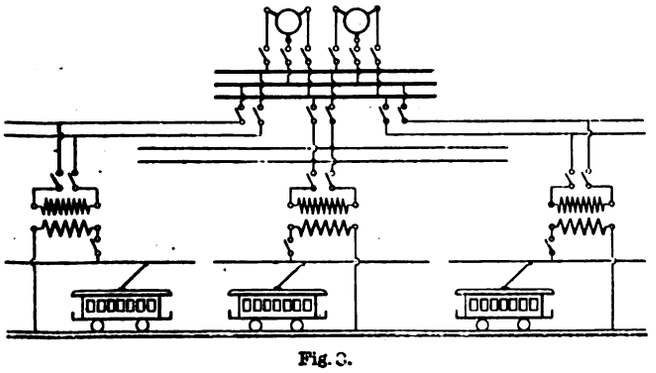

Fig. 3.

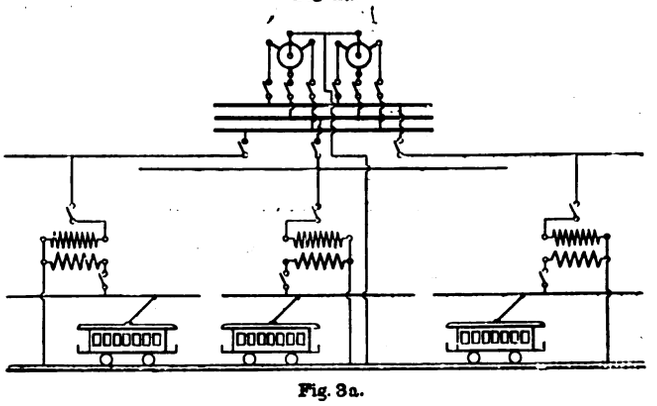

Fig. 3a.

If the road to be equipped with the alternating-current system takes its current from a power house in which polyphase apparatus is already installed, it would be natural to supply the various sections of the line from the different phases of the generators. In case of an entirely new installation, single-phase generators may be more advantageous than polyphase ones, notwithstanding the greater cost of the single-phase as compared with the polyphase generator of equal capacity.

For the purpose of discussion, three typical cases have been chosen, shown by diagrams 1, 2 and 3. In each case 20,000-volt generators are assumed to feed directly on to the high-tension 'bus bars, thus simplifying the diagrams by the omission of step up transformers. High-tension switches connect the 'bus bars to the transmission lines leading to sub-stations. In the sub-stations are installed the step-down transformers with primaries connected to the transmission line by high-tension switches. Single-pole switches are inserted between one side of the 3,000-volt secondaries and the trolley wire, while the other side and the transformer case are connected to the rails. The power house is located at the centre of the line, which is divided into sections as the case may determine. These sections are separated by suitable insulators, and arrangements are provided for readily connecting them by jumpers in case of emergency. A simplification of these cases, obtained by using the rail as a common return for both primary and secondary circuits, is shown in the corresponding diagrams (1A, 2A and 3A). It will be noted that, in case this is done with the three-phase generators, 34,000 volts must be delivered to the 'bus bars in order to maintain 20,000 volts between the transmission line and the grounded neutral.

In case 1, using a single-phase system, it is necessary to instal double-pole switches on the transmission line both in the power house and sub-station. Normally, the static strain between the transmission line and ground will be half of the impressed voltage. In case 1A with a single transmission line, it is only necessary to use single-pole switches in all primary circuits, thus effecting a very material saving in the expense of high-tension switches as well as the saving of 50 per cent. in transmission line copper and insulators. It will be noted that this arrangement subjects the transmission system and transformers to the full static strain of the impressed voltage. This will call for somewhat greater care in insulation of the transformers, and will continuously subject the insulators of the transmission line to a higher strain. The decreased number of insulators with the corresponding decrease in points at which failure can occur, however, tends to counterbalance the somewhat more rigorous requirements. Should it transpire that one line is grounded in case 1, the system can still be operated until repairs can be made, while in case 1A such a failure would necessitate the shutting down of that particular transmission line. This condition,

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however, is exactly analogous to that of a three-phase system with a grounded neutral, now so generally used.

When the system depicted in Fig. 1 is in normal operation, the adjacent sections are at the same potential, and the section insulators are subjected to no strain whatsoever, while if one section is shut down the insulator will have to withstand the full trolley potential of 3,000 volts.

Should any one section of the transmission line, or any one substation be put out of commission, it is possible, by using the jumpers mentioned above, to feed the disabled trolley section from each of the adjacent sections, thus maintaining service without excessive drop. A very important feature in the operation of this system is the fact that the full generator capacity is available at any point on the system, thus making it possible to take care of any unbalance in the distribution of the load, due to congestion of traffic at any point of the system.

In case 2 the use of two-phase generators is considered. This will be most advantageous when applied to a system consisting of a single line with the power house located at the centre. Current will be supplied to one end of the system from one phase of the generators, while the second phase feeds the other end.

In comparing the cases 2 and 2A, the conditions are exactly similar to 1 and 1A, so far as the saving in switches, copper, and insulators and the static strains are concerned. A noticeable difference exists, however, so far as operation is concerned. Since the adjacent sections are fed by different phases, the section-insulator must stand 4,200 volts when in normal operation. In case one section of the transmitting system is disabled, current can be supplied by means of jumpers only from the adjacent sections supplied by the same phase, which will result in double the drop due to a similar occurrence in case 1. Since the section of the system fed by the different phases must be entirely separated, this arrangement does not provide for an unbalance in load so well as in case 1. In fact, only 50 per cent. of the generator capacity is available on either section, a point of considerable importance in practical operation.

In case 3 the application of three-phase generators to the single-phase system is considered. This arrangement is best adapted to a railroad system consisting of main line and branches with the power house located at the junction, since it will then be possible to feed the sections without necessitating the overlapping of the transmission lines. Again, similar relations hold between 3 and 3A as between 1 and 1A so far as the saving in switches, copper and insulators and the static strains are concerned.

The insulators separating sections fed by different phases have to withstand 5,200 volts as compared with the 4,200 volts in case 2. The same limitation in feeding any section of the trolley from its adjacent section in case of a disabled transmission line hold as in case 2. So far as available generator capacity for any section is concerned, the two cases are materially different. In case 3, due to the delta connection, it is possible to utilise 66 per cent. of the generator capacity on any section, whereas in case 3A with star connection, only 33 per cent. of the generator capacity is available on any one section.

It is evident that on account of the high potentials, section insulators must be of considerably greater length than those now used on low-voltage trolleys, approximately from 4ft. to 6ft. in length. This will have a very appreciable effect on the lights when the car passes the section insulator, as well as presenting difficulties in starting which would arise should the car come to rest under the insulator. Moreover, the arcing due to the interruption of the current of high voltage is apt to prove serious. All of these difficulties can be overcome in case 1 by the use of two trolley bows one mounted over each end of the car. Since these will more than span the section insulator, the current will not be interrupted, thus materially improving the operation of the system.

This arrangement with the two bows can only be applied in case 1, as in cases 2 and 3 it would not be permissible to short-circuit two sections fed by different phases, which leaves the later cases subject to the difficulties mentioned above.

A metallic circuit telephone system installed on the same poles as the grounded high-tension line, will be subjected to higher static strains and greater inductive actions than in the case of the ordinary transmission line. The effect of induction can be overcome by frequent transposition of the telephone wires. To guard against shocks due to static strains, care must be taken to provide perfect insulation for the telephone instruments as well as for the person using the telephone.

From the foregoing discussion, it appears that it will be entirely possible to use two and three-phase generators now installed to furnish power for single-phase sytems, but that the difference in potential between sections and the small generator capacity available on any section are serious obstacles to the satisfactory operation with this arrangement.

Where entirely new apparatus is to be installed, it is undoubtedly better to use single-phase generators. Their first cost is somewhat greater, but the system is far more flexible in its ability to handle unbalanced load conditions, and with the double-bow trolley, gives perfectly continuous service under section insulators,

While the suggestion to use the rail as common return for both high-tension and trolley circuits is a radical departure from current practice, it does not involve greater risks with regard to personal safety or the continuity of the service than in the ordinary three-phase system with grounded neutral.

REVISED FORM OF BOARD OF TRADE TRAMWAY RETURNS.

The Board of Trade have issued a revised form of returns, dated May 12, 1904, and invite suggestions thereon from tramway authorities. The following is the text of the revised form:—

(1) Name of tramway or light railway. (2) Names of promoters. (3) Names of lessee or other parties working the tramways or light railway. (4) Authorised gauge of the tramways or light railway. (Note.—When the lines are leased returns should be made partly by the owners and partly by the lessees, as far as it is respectiyely applicable to them.)

Special acts, acts confirming provisional orders, or orders under the Light Railways Act, 1896, relating to the lines.

Capital Authorised.—(Note.—Where companies are registered under the Companies Acts, enter registered share capital, and loans sanctioned *at date of return.* In case of local authorities' lines, where no sum was specially authorised, enter under "Loans" amount *sanctioned at date of return.*) By shares, £ . By loans, £ . Total, £ .

Capital Paid-up.—(Note.—In case of local authorities enter under "Loans" amount *actually raised.* Where stock is issued the *nominal* value should be given.) By shares, £ . By loans (*including debenture stock*), £ . Total, £ .

Capital Expended.—On lines and work open for traffic: Permanent way, £ . Electrical equipment, £ . Electrical generating plant or stationary engines, £ . Land and buildings, £ . Other purposes, £ . On lines and works in course of construction (*including land, buildings, &c.*), £ . On horses, £ . On locomotive engines, £ . On cars, £ . Legal and Parliamentary, £ . Any other expenses not included in the foregoing (*including discount and expenses of issue of stock*), £ . Total, £ .

Length of Line Authorised.—(Note.—Exclusive of expired powers. Including additional passing-places, &c., made with consent of local and road authorities, and sidings to sheds.) Double line—(Note.—Including passing-places; see example at foot*), m. ch. ; single line (Note.—Aggregate length), m. ch. . Total, m. ch. .

Length of Line Open for Public Conveyance of Passengers.—(Note.—Notes in preceding columns as to length authorised apply to these.) Double line, m. ch. ; single line, m. ch. . Total, m. ch. .

Remarks.—(Note.—Where more than one method of traction is used a note should be added stating the lengths worked by the respective methods.)

Gross Receipts.—From passengers, £ ; from parcels and mails, £ ; from animals, goods and minerals, £ ; from all other sources, £ . Total, £ .

Working Expenditure.—(Note.—Not to include interest, rent of lines and similar charges.) Maintenance and renewal of permanent way, £ . Maintenance and renewal of electrical equipment, locomotives, stationary engines, or horses (Note.—According to mode of traction), £ . Maintenance and renewal of cars, £ . Traction expenses (Note.—Inclusive of wages and salaries), £ . Other traffic expenses not included in preceding columns (Note.—Inclusive of wages and salaries), £ . Rent of offices, stables and sheds, £ . Rates and taxes, £ . Compensation for personal injury or accident insurance, £ . Any other working expenses not included in the foregoing, £ . Total, £ .

Net Receipts, £ .

Appropriation of Net Receipts.—Depreciation fund, £ . Interest or dividend, £ . Repayment of debt, £ . Relief of rates, £ . Other purposes, £ .

Number of Passengers Conveyed.—(Note.—Including season or composition ticket holders. If not recorded enter with note—"Estimate based on receipts.")

Number of Miles Run by Cars.—(Note.—If not recorded enter with note—"Estimate based on average daily running.")

Quantity of Electrical Energy used in B.T. Units.—Number of electric cars.

Number of Horses.—(Note.—If horsed by contract, enter number usually employed.) Number of locomotive engines. (Note. Used under contract or otherwise.) Number of non-electric cars.

* *Example*: A B C D A to D is a line of route 70 chains in length, and B to C a passing-place of 3 chains; B to C should be returned as 3 chains of *double* lines, and A to B and C to D together as 67 chains of *single* line; total 70 chains.

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THE BOARD OF TRADE AND TRAMWAY ACCIDENTS.

The following is a copy of a letter issued by the Board of Trade to tramway authorities:—

March 21, 1904.

SIR: With reference to the forms which have been prescribed by this Department for the return of electrical and general accidents occurring on tramways and light railways laid on public roads, I am directed by the Board of Trade to inform you that these returns have furnished them with much valuable information, and that as a result of the experience so obtained the future reporting of accidents to the Department may be modified in accordance with the further instructions in the enclosed memorandum. The Board attach great importance to the regular forwarding of the prescribed reports, and regret to have reason to believe that all tramway and light railway authorities have not been equally careful in fulfilling this requirement. In view of the restriction now placed on the number of reportable accidents, it is hoped that in future the returns may be forwarded in all cases.

(Signed) HERBERT JEKYLL.

TRAMWAYS AND LIGHT RAILWAYS LAID ON PUBLIC ROADS.

MEMORANDUM ON THE FORMS OF RETURN OF ACCIDENTS TO THE BOARD OF TRADE.

a. Electrical.

1*a*. Guard wire pulled down by trolley ..	To be reported only if causing injury to any person, or if accompanied by heavy short circuit or alarming result.
1*b*. Trolley wire pulled down by trolley ..	
1*c*. Overhead work broken by trolley	
2. Guard wire falling on trolley wire....	
6. Failure of insulation	
1*d*. Trolley head pulled off	To be reported if causing personal injury.
1*e*. Standard damage by trolley jumping	To be reported if causing or likely to have caused personal injury.
1*f*. Trolley boom broken	
1*g*. Miscellaneous damage done by trolley jumping.....	
1*f*. Trolley boom pulled out	Should be reported in all cases.
4. Trolley wire breaking and falling	
5. Other classes of accident	Burning out of fields, failure of controller, &c., need not be reported unless causing or likely to have caused personal injury or alarming result.

b. General.

As regards the classes of accidents numbered 1, 2, 4, 5 and 6, those cases only should be reported which result in personal injury or serious damage to cars or other vehicles. All cases of cars running away should be notified whether such accidents result in personal injury or not.

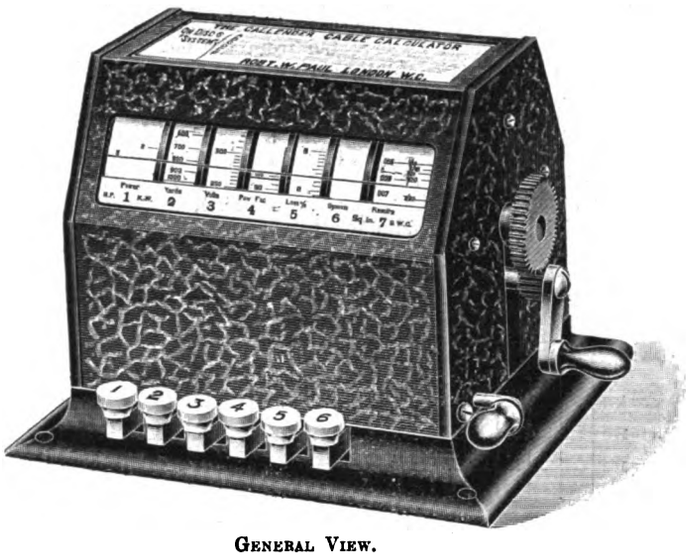
THE CALLENDER CABLE CALCULATOR.

The Callender cable calculator has been designed by Mr. H. Hastings for the purpose of easily determining the size of conductor which should be used under any given conditions. It is an apparatus which is made up of a series of discs mounted upon a common spindle, each having a logarithmic scale upon its periphery. There are six factors which determine the size of the cable—viz., power, distance, difference of potential, power-factor, loss per cent. which may be allowed, and the system of distribution employed.

In the caculating machine each of these factors is represented by a disc, and a seventh disc, which is fixed to the shaft, accumulates the sum of the movements of the other discs, thereby giving immediately the result of the conditions under which the cable has to work. The mechanism of the machine is clearly set forth in the cross-section shown. W is a window through which the discs can be seen; IL is the indicating line against which the various numbers are placed; D is a disc; FS is a friction spring which causes the disc to revolve with the shaft S; BP is a brake pad which prevents a disc from revolving with the shaft until the brake lever BL is depressed. Hence the machine is operated by releasing each disc in turn and revolving the handle, while the sum of the movements of the discs is accumulated upon the shaft to which the final disc is attached rigidly.

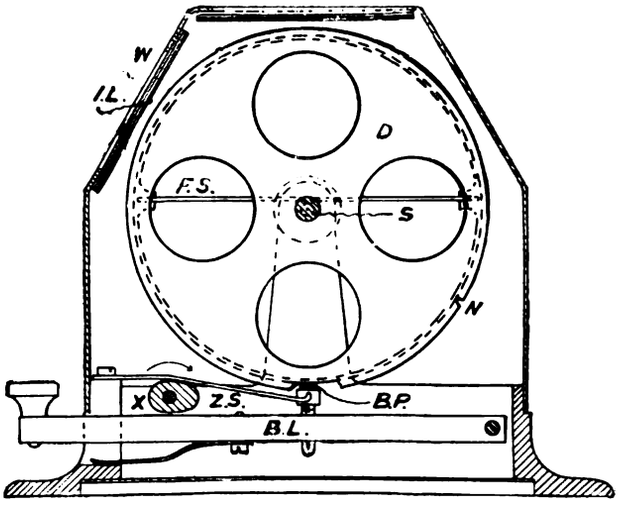
There is another part of the apparatus which is used for returning the machine to its starting position before a calculation is made. By turning the lever shown in the general view at the right-hand side of the machine, and thereby revolving the eccentric X in the cross-section, the brake lever is depressed, the brake pads are all removed from the discs, and a small spring, ZS, is raised against their edges. The discs are all revolved by means of the handle at the end, and as soon as the notch N comes round to the spring each one is held in position. When they are all at rest except the one which is fixed to the shaft, this is brought round until the word "Start" appears, when the lever may again be turned, and the operation of calculating proceeded with. The whole apparatus is enclosed in a well-finished case suitable for standing upon an office desk, and measures about 5in. by 5½in. by 4½in. high. It may be used for calculating cables under the following systems:—Two-wire or three-wire continuous-current and single-phase alternating, two-phase with four conductors, two-phase with three conductors, giving the size of the common conductor, and three-phase mesh and star (three-wire and four-wire).

The power scale is graduated in both kilowatts and horse-power, ranging from 1kw. to 1,000kw.; the distance is graduated in yards from 10 up to 10,000, and the volts are from 100 to 10,000, while



GENERAL VIEW.

the results are given in square inches and in S.W.G. From these particulars it will be seen that the scope of the machine is a very wide one. It can be used not only to find out the size of a cable when the other factors are given, but when the size of the cable is given it will calculate the loss in volts or any other of the factors



CROSS-SECTION.

provided that five out of the six are given. The mechanism is so simple that it cannot get out of order, and there is no danger of errors being introduced from this cause. The instrument is manufactured by Mr. Robt. W. Paul.

Duplex Telegraphy between Vienna and Czernowitz.—The telegraph line from Vienna to Czernowitz, about 650 miles long, has gradually become inadequate for the ever-increasing traffic between Vienna and the south-east of Europe. As a second line would have cost about £12,500, it was decided, in spite of the fact that the line consists of iron wire, to try the differential system of duplex telegraphy, the cost of which amounted to but £208. The experiment succeeded, and, according to the *Zeitschrift für Elektrotechnik*, the system has now been working satisfactorily for some weeks.

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SOME PROPERTIES OF ALTERNATORS UNDER VARIOUS CONDITIONS OF LOAD.*

BY A. F. T. ATCHISON.

(*Continued from page 105.*)

Polyphase Machines Loaded only on a Single Phase.

If the regulation of a polyphase machine symmetrically loaded be compared with that obtained when only loaded on one phase, the pressure drop in the former case will be found to exceed that in the latter. This would be expected from the fact that the armature reaction is increased by the presence of the current in the other phases. In other words, the synchronous impedance as a polyphaser should be greater than as a single-phaser.

Testing machines A and D as a two-phaser and three-phaser respectively, this is found to be the case. The short-circuit current in each phase when simultaneously short-circuited being less than that obtained on short-circuiting one alone, at the same excitation, thus giving a higher value for the synchronous impedance.

The regulation of machine A loaded on both phases is shown in Fig. 12 and that of machine D loaded on all three phases is shown in Fig. 13.

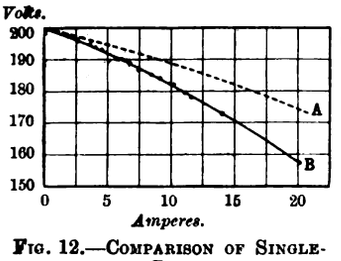

Fig. 12.—Comparison of Single- with Polyphase.

Regulation: Curve *A*, Machine A as single-phaser; Curve *B* as 2-phaser.

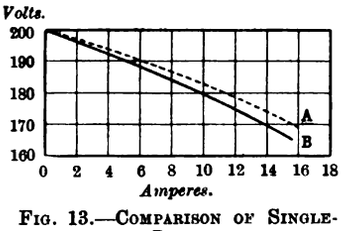

Fig. 13.—Comparison of Single- with Polyphase.

Regulation: Curve *A*, Machine C as single-phaser; Curve *B* as 3-phaser.

Also in a two-phaser the total reactive ampere-turns of the armature will not fluctuate so much as in a single-phase machine, and in the case of a three-phase armature the sum of the ampere-turns will be still more nearly constant.

The effect of armature reaction upon the field is a two-fold one—namely, a *cross*-magnetising effect due to current in phase with a "nominal" induced E.M.F. and a direct *demagnetising* effect produced by an out-of-phase current. From these considerations Blondel suggested that accurate results might be obtained by assuming two components of the reactance drop, corresponding to the power and idle components of the current.

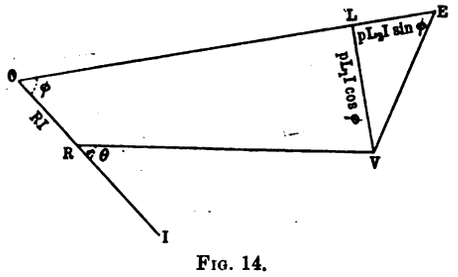

Fig. 14.

The E.M.F. $pL_1I\cos\phi$ (proportional to the load component of the current) being considered as in quadrature with the E.M.F. representing the cross-magnetising effect, and the E.M.F. $pL_2I\sin\phi$ (proportional to the idle component of current) being in opposition to the E.M.F and representing the loss of pressure due to the demagnetising action of the wattless components of current.

Or, expressed by a vector equation, the terminal P.D.

$$\overline{V}=\overline{E}-\overline{R}.\overline{I}-\overline{pL_1I\cos\phi}-\overline{pL_2I\sin\phi},$$

where E is the nominal induced E.M.F., and ϕ the angle between this and the current.

The vector diagram takes the form of Fig. 14: OE being the nominal induced E.M.F. and OI the direction of the current differing in phase from OE by the angle ϕ; OR=RI, the resistance drop in phase with OI; EL the drop due to the demagnetising component, and LV the equivalent of the cross-magnetisation.

The terminal volts are then given by the vector RV differing in phase from the cnrrent by the angle θ where $\cos\theta$ is the given power-factor of the load.

* Abstract of a Paper read before the Birmingham Local Section of the Institution of Electrical Engineers on April 20th.

It will be noticed that this method is more general by the introduction of two different coefficients of self-induction L_1 and L_2 corresponding to the load and idle components of the current.

The angle ϕ, however, cannot be readily measured experimentally, since the power-factor of the load is given by $\cos\theta$ and not by $\cos\phi$.

To obviate this difficulty and to make the problem more directly determinate, the writer suggests the following method:—

Consider the fall of pressure to be due to the three components: RI in phase with I, $pL_dI\sin\theta$ in phase with V, the terminal P.D., and $pL_eI\cos\theta$ in quadrature with V; then, since $\cos\theta$ is the known power-factor of the load, the diagram is readily determinable. The two coefficients of inductance L_d and L_e may be found as described below.

To find the terminal volts V corresponding to a current I of power-factor $\cos\theta$:

Take a line OE (Fig. 15) representing the open circuit or nominal E.M.F., and from O describe a circle with radius OR=RI, and from E describe a circle with radius $EP=pL_eI\cos\theta$; a tangent, RP,

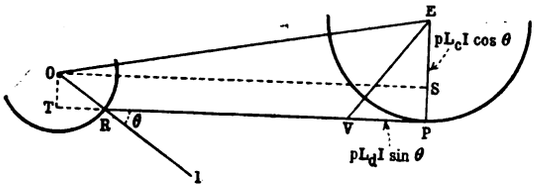

Fig. 15.

to this latter circle is then drawn from a point, R, on the first circle such that angle $ORP=\pi-\theta$; from PR is then subtracted PV $=pL_dI\sin\theta$, representing the volts lost through the demagnetising component, and the vector RV then gives the required terminal voltage.

In this diagram the only angle required to be known is θ, which is given by the power-factor of the load, the components of the current in phase and in quadrature with the *terminal* P.D. V being considered instead of those in phase and in quadrature with the E.M.F., as in the original method of Blondel. The angle ϕ (Fig. 14) which cannot be readily determined is thus eliminated from the construction.

The relation between the terminal voltage and the current on a load of any power-factor ($\cos\theta$) may be expressed analytically from the diagram.

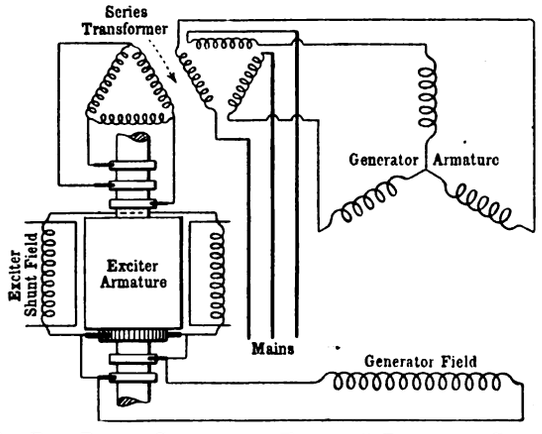

Fig. 16.—Rice-Reist "Compensated Exciter." Diagram of Connections.

Thus, drawing OS parallel to RP and completing the rectangle OSPT and joining OP, we have $SO^2=PT^2=OE^2-ES^2$; *i.e.*, $(PR+RT)^2=OE^2-(EP-SP^2)$; $(PR+RT)^2=OE^2-(EP-OT)^2$; *i.e.*, $(V+pl_dI\sin\theta+RI\cos\theta)^2=E^2-(pl_eI\cos\theta-RI\sin\theta)^2$.

In order to find the components of the reactance, the armature is fixed (*a*) with the coils immediately facing the field poles, and (*b*) with the coils midway between two adjacent pole-pieces, and then with the *field excited to its normal value* an alternating current of the given frequency is passed through the armature, and the P.D. across the terminals and the corresponding current and noted, the quotient giving the impedance for the two positions, from which can be at once determined the two values of the reactance. The armature in position—(*a*) giving pL_d, the reactance corresponding to the *demagnetising* component, and (*b*) giving pL_e, the reactance corresponding to the *cross*-magnetising component.

It is important that the measurements be carried out with the field excited, as the inductance is considerably less in this case than with the field not excited owing to the decrease of the permeability with saturation.

It will be noticed that in this way the reactance of the armature is obtained with both field and armature currents of normal values,

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and hence the fundamental objection to the open and short-circuit characteristic methods is obviated. If, instead of clamping the armature, it be rotated by an external source (the field, of course, not being excited), the quotient of the P.D. by the current works out to be almost exactly the arithmetic mean of the two values of the impedance for the armature in the two fixed positions, as would be expected; but if the speed be adjusted so as to run the armature very nearly in sychronism with the frequency of the generator supplying the current, the difference in the value of the reactance for different relative positions of armature and field poles is very clearly shown by "beats" or pulsations of the ammeter and voltmeter corresponding to the difference of the frequency of the two machines, the ammeter reading increasing when the voltmeter decreases and vice versa.

(This effect is totally distinct from the large pulsations which occur when "synchronising" alternators or synchronous motors, in which case *both* the machines are excited, and the voltmeter is connected across the two machines in *series*, and the switch between them still being *open*.) So far as the writer is aware, this effect has not been previously noticed, and it demonstrates very clearly the change in the reactance of the armature, with change of relative position of the armature coils and fixed poles.

The regulation curves of the four alternators experimented upon have been calculated graphically by this "double reactance" method (see curve C in Figs. 7 to 10), and in nearly every case the agreement between the curves calculated in this way and those obtained by experiment (curves A) is remarkably close, and coincide more nearly than those obtained by calculation from the open and short-circuit characteristics.

As has been seen above, at constant excitation, the terminal voltage of an alternator will fall to a greater or less extent with increasing load. In order to remedy this defect, attempts have been made since the early days of alternator construction to apply to the alternating generator the principles of *compounding* as met with in the case of direct-current machines.

In order to make a machine compound automatically on loads of various power-factors, an ingenious arrangement has been devised by Mr. E. W. Rice, which has been successfully employed by the General Electric Co. on some of their revolving field alternators. The device, sometimes known as a "compensated exciter," utilises the effect which armature reaction produces upon the resultant field strength of the exciter. The arrangement is shown diagrammatically in Fig. 16, the alternator itself being a three-phase machine of the revolving field type.

Mounted on the same shaft as the alternator field poles is the armature of the direct-current exciter, which is furnished with external stationary field magnets equal in number to the revolving field poles of the alternator. The armature of the exciter is fitted with a commutator at one end and three slip rings at the other in the manner of a three-phase converter, and is shunt excited from the direct-current or commutator side. The main current from the alternator—or, rather, a current proportional to this and of the same phase, derived from a three-phase current transformer in the main circuit—is lead into the armature through the three slip rings and in consequence of the synchronous rotation of the exciter armature produces a magnetic effect which is stationary in space and therefore in respect to the fixed field poles of the exciter. The effect of this reaction depends upon the magnitude and phase of the current producing it, as was pointed out above in connection with armature reaction in synchronous motors—strengthening the field if lagging, weakening it if leading and merely producing a cross-magnetising effect if in phase with the nominal induced E.M.F., and hence if the alternator field be excited from the brushes of the exciter (through a pair of slip rings) its excitation will be automatically increased as the load in the main circuit increases and also as the main load becomes more inductive; conditions which have been seen to be essential for maintaining a constant 'bus bar voltage.

The extent of the "compounding" action depends upon the relative position of the exciter armature flux and the exciter field poles, and in order that this may be adjusted if desired, Mr. H. G. Reist has designed a machine in which the exciter poles may be turned through an angle in space, thus allowing the amount of compounding on any given power-factor of load to be adjusted. Machines constructed on these lines appear to operate very satisfactorily and can supply sudden inductive loads in a manner which would be impossible in the case of an alternator dependent on the ordinary hand regulation.

(To be continued.)

The Board of Trade and Patent Law.—A question of interest to engineers and inventors has arisen in connection with the dispute between the Board of Trade and Messrs. Wm. Denny and Bros., shipbuilders, Dumbarton. The firm recently maintained that the Board had no right to make a minute inspection of the turbine machinery of a vessel the firm had built, because certain parts of the machinery had not yet been protected by patent. The Survey Court, which has taken evidence and heard arguments, has reserved its decision,

ELECTRICAL PLANT OF THE LACKAWANNA STEEL CO.*

The Lackawanna Steel Co. was incorporated in 1902, with a capital of $40,000,000, to absorb the Lackawanna Iron and Steel Co. and the Lackawanna Coal and Coke Co., the latter owning bituminous coal properties. The former operated a plant at Scranton, Pa, for the manufacture of steel rails, billets and merchant iron, and also several blast furnaces at various points. A site was purchased at Buffalo, N.Y., with a view to the removal of the Scranton plant to that point. The output of the plant will consist of finished steel made by the Bessemer and open-hearth processes. As the produce of the plant is produced from raw material exclusively, the process will involve all the operations of coking, smelting, Bessemer and open-hearth steel making and the rolling of rails, billets, shapes and plates, The manufacture of the steel will further necessitate the storage and handling of very large quantities of ore, pig iron and coal, and the production, distribution and application of various systems of power and an auxiliary plant for the maintenance of the buildings, equipment and tools.

The tract of land acquired is about 3½ miles in length and nearly ½ mile in average width, on the south shore of Lake Erie, a short distance from Buffalo. The land adjoins the extremity of the United States breakwater, which affords a safe and commodious landing at the south end of the property. Here a ship canal 200ft. wide, 21ft. deep and 4,000ft. long has been excavated parallel to the shore to afford entrance to ore carrying vessels. On the opposite side of the property a railroad has been built to connect with the trunk and branch roads entering Buffalo. The governing principle in the design of the plant has been the arrangement of the various buildings and equipment for the several processes in comparatively long and narrow areas parallel to each other and to the ship canal, such that the material in the various stages of manufacture is advanced progressively with the least expenditure of time and labour. To aid in this a system of longitudinal and belt tracks has been installed throughout the entire plant. Adjacent to the shore of the lake and extending to the ship canal is a complete coke plant, consisting of 940 by-product coke ovens with a capacity of 4,000 tons a day. To the south of this is a coal storage plant and yards for coal trains. Coal is received by rail, and about 150,000 tons will be stored for emergency use in circular piles commanded by electrically-operated revolving locomotive cranes. Parallel to and approximately 75ft. from the ship canal is located an ore dock, which is about 270ft. wide and ultimately will have a length of 2,500ft. This consists virtually of a pocket about 13ft. deep, lined with concrete and supported on piles. The ore dock has a capacity of 750 tons of ore per linear foot, which will be piled on it to the height of about 70ft. in the middle. The ore is unloaded from vessels and transferred to the former by five ore-unloading machines made by the Wellman-Seaver-Morgan Company, which travel from end to end of the ore dock and are electrically driven. Three ore-reloading machines of the same make, also electrically operated, transfer the ore to steel bins set along the opposite side of the ore dock. Here the various grades of ore from different mines are deposited in separate steel bins. After being discharged from these and weighed, the ore with the required amount of coke, limestone, &c., is then hauled by a cable up a steep incline and the contents of the car discharged by an Otis automatic electric machine into the top of the blast furnace. These furnaces extend in a row parallel to the ore dock and storage bins. At present two 300-ton furnaces are in operation, while four others of a capacity of 800 tons are in process of erection. The boiler and engine houses then follow, being arranged in a parallel group about 300ft. wide and 3,000ft. long. These separate the steel furnaces and rolling mills from the rest of the plant. Starting east from the lake shore in the various divisions enumerated, the materials are moved transversely in process of manufacture. The Bessemer works are in line with a mill for blooming and finishing heavy rail sections and one for making commercial billets, beyond which are two other rolling mills for light rails and for spliced bars and shapes. The most easterly division will contain the open-hearth furnaces, which are in line with three sets of heavy roughing mills delivering to other mills making finished plates and structural shapes. In these divisions the molten iron is received at the north end, and, passing continuously south without being interrupted or reversed, is carried in a long straight path through all the processes of manufacture. The finished steel is delivered for shipment or temporary storage at the southern extremity of the plant. In the north-east corner, adjacent to the steel furnaces, are located the foundry, machine shop and various auxiliary shops and buildings for the construction and maintenance of the plant.

The general scheme of power supply for such a large steel plant is one requiring a comprehensive treatment of the problems involved, which are not only of an engineering but economical nature as well.

* Abstracted from the *Electrical World* of New York.

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The steam engine will be used exclusively for the roughing and blooming mills, as rolling mill service has been held to be too severe for the electric motor. The gas engine, not being readily reversible, is not available for this class of work. The steam engines will be run condensing, a practice not heretofore adopted in this country. Gas engines of 1,000 H.P. and 2,000 H.P., utilising blast furnace gas, are employed to drive the blower engines of the blast furnaces. Although engines of the same type, but smaller capacity, have been employed in similar service in Germany, this is the first instance of their use in this country. What would otherwise be a waste product is thus utilised to advantage and at a greater economy in the gas engine than if used in the boiler plant, and its energy finally made use of in the form of electric current for driving blower engines. The investment required for any given capacity is, without doubt, also materially reduced. It will thus be seen that the steam and the gas engine are employed at all points which are vital to the carrying out of the various processes for the production of the finished steel. Furthermore, it will be found that the aggregate horse-power of these greatly exceeds that of the hydraulic, pneumatic and electric machinery employed. The electric drive, however, will be extensively employed for live operations, and more especially in that part not directly concerned in the production of the finished product, as in the coke and ore-handling and the auxiliary plant. The electric installation, furthermore, is of especial interest, as both direct and alternating current are used, the former for crane and variable-speed motors and the latter for constant-speed work. Hydraulic and pneumatic machinery is installed under such conditions as are most favourable for its use or where absolutely necessary, as, for instance, in the use of compressed air for the starting up of the gas engines.

As a consequence, one large central power house has not been erected. Each pair of blast furnaces is served by its own power plant operating the blower engines. Boiler houses are being erected at such points as will most economically supply steam to the engines located in the various mills. The main power house, which contains the electrical plant, as well as a pumping station which supplies the entire plant with water, receives steam from one boiler house which is located a short distance from both. Part of the boilers in the various boiler houses are fired with blast-furnace gas. To insure against interruption of service and possible breakdowns, the various boiler houses are interconnected by an equalising steam main. This will also serve to take care of any sudden excessive demand at any point in the plant. This same principle is also pursued in regard to the supply of gas for the gas engines located in the various power houses. The plant when completed will also contain a producer gas plant from which the gas will be piped to the various gas engines for use in cases of emergency. Boiler house No. 2, which is the larger one of those at present constructed or contemplated, presents several interesting features. Although this contains Cahall vertical water-tube boilers of a total capacity of 20,000 H.P., a 250 H.P. size has been adopted, each boiler having its own independent stack. Another feature which is of interest is the comparatively small coal storage capacity which has been provided, as coal is readily obtainable from the coal storage yards located near the coke plant. The capacity of the bins is merely such as to tide over any irregularities in unloading. Special precautions have been taken to prevent a shut-down. The main steam heater consists of a ring main with branches for power house No. 2 and the pumping station taken off at two points. Valves have been installed at various points such that one quarter of the total number of boilers can be cut out at any time without in any way interrupting the service.

The boiler house is of the steel skeleton brick curtain wall type of construction. It contains 80 Cahall vertical water-tube boilers arranged in two rows facing each other in batteries of four each; 48 of these are equipped with Roney stokers, whereas 32 will be gas-fired. As the surplus blast-furnace gas will be utilised in this plant, the boilers are equipped with grates for hand-firing. This will be resorted to whenever the supply or the quality of the gas is deficient. It is also necessary for starting up a boiler. The blast-furnace gas is not purified, although pockets are provided in the supply pipes at the boilers for the deposit of any dust contained in the same. It may be mentioned here that this will be the only plant requiring coal as a fuel, as the others will be gas-fired exclusively. The coal storage plant consists of a tower to the south of the boiler house. This contains two bins, one of 200 tons capacity called the service bin, and a reserve bin of 300 tons capacity. The coal in the latter is available for use in the boiler house only on being discharged and re-elevated to the service bin. The coal is discharged from railroad cars and delivered by a scraper conveyor from the hopper underneath the track to the flight conveyor, which in turn elevates the coal to either bin. A traveling coal pocket equipped with two 7-ton coal bins, receives its coal from the service bin and conveys it to any required point. Ashes are discharged in the basement into a pocket of a capacity of 28 cubic ft., which travels on an overhead trolley. From this the ashes are dumped into a skip, which elevates them to the ash bin, from which they are automatically discharged into cars as desired. All the machinery is operated by direct-current motors.

Each pair of blast furnaces will have its own power house, containing an equipment of gas engines for driving blower engines. By utilising the blast furnace gas in gas engines a saving is obtained as compared with burning gas under boilers, which has hitherto been done exclusively. Only one-third to one-fourth the gas is required by this method as compared with the other, and a further saving is made possible by the omission of the boiler equipment with its attendant cost of operation. The gas engines are of the Körting type, and made by the De la Vergne Refrigerating Machine Co. They are operated in pairs, each one being one-half the

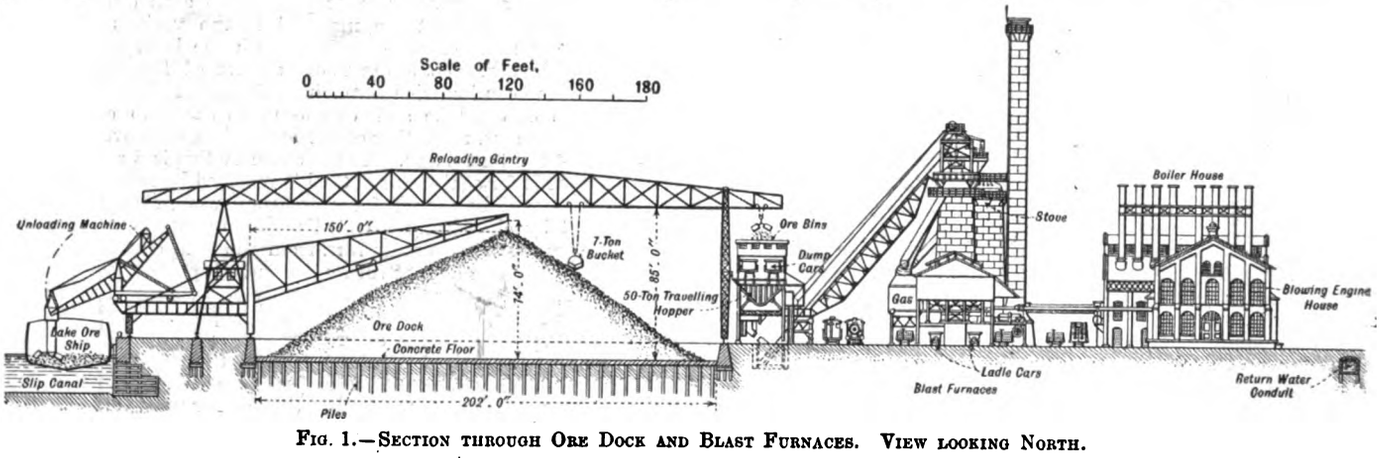

FIG. 1.—SECTION THROUGH ORE DOCK AND BLAST FURNACES. VIEW LOOKING NORTH.

capacity of the unit, and are of the double-acting two-cylinder type. The gas used is taken from the top of each blast furnace through three Downcammer flues leading to a dust collector. After being purified in centrifugal washers operated by induction motors, and its temperature reduced to about 80°F., the gas is delivered to the mains at a pressure of about 5oz. Each engine is equipped with an electric speed governor. A Monarch engine speed limit switch is belted to the engine shaft. This switch, when the engine exceeds a given speed, closes a battery circuit in which a solenoid is connected. This solenoid operates a multi-point switch, which short-circuits magneto igniters of the engine, and consequently there are no more explosions in the engine cylinder until the speed falls to normal.

The electrical equipment of the power house presents several interesting features. The size of the generators has been limited to 500kw., as gas engines of a larger size than 1,000 H.P. were not considered practicable at the time the plant was designed, although, as already noted, engines of 2,000 H.P. capacity are being installed at present in the blowing engine houses for the blast furnaces.

There are five direct and five alternating-current units of 500kw. each. Nine of these are driven by gas engines, whereas the other, a direct-current generator, is driven by a 36in. by 48in. Porter-Allen condensing engine. This unit is held in reserve for use in case the supply of gas is deficient or should fail entirely. The alternators are three-phase, 23-cycle, 440-volt machines of General Electric make, whereas the direct-current generators are 250-volt Sprague machines. As gas engines are employed to operate the alternators—a somewhat unusual condition—these are guaranteed to operate successfully in parallel on condition that the maximum variation in speed of the revolving fields shall not exceed 0·2 of an angular degree on either side, of uniform speed, and to operate without cross currents should a means be adopted for mechanically coupling together when in place. There will be some thousand

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motors eventually, of a rated capacity of about 32,000 H.P. The gas engines driving the generators are similar to the 2,000 H.P. units already described. These engines have cylinders 23¾in. in diameter with a stroke of 43¼in., being operated at 100 revs. per min. The generators are mounted on a crankshaft between the two engines. The cooling water for the cylinders is circulated by centrifugal pumps made by the Lawrence Machine Co., driven by Westinghouse induction motors. The engines are started with compressed air from the compressed air lines. There are three exciter sets, each consisting of a General Electric 125-volt, 37½kw. generator, direct-connected to a 10in. by 10in. Harrisburg Foundry and Machine Co.'s engine. There are also three 115 light, 6·6 ampere Brush series direct-current arc light machines, direct-connected to 1,000 H.P. General Electric induction motors.

The switchboard is simple in its design and substantial in its construction. It is built on a slightly raised platform, commanding a view of the electrical machinery. There are three sections, separated from each other, there being an alternating and direct current and a series arc board. The direct-current switchboard consists of five generators, one load and 14 feeder panels, the latter containing two circuits each. Each circuit is equipped with one double-pole double-throw switch, a 2,000-ampere ammeter and a circuit-breaker in one leg of the circuit only. The 'bus bar copper has been figured on a basis of 800 amperes to the square inch at normal load. Although all circuits are protected by circuit-breakers, this is done nevertheless in such a manner that certainty of operation is assured, and at times a piece of apparatus may be sacrificed in maintaining an uninterrupted service. The alternating-current board contains five generator, one exciter, one load and 20 feeder panels, each of the latter containing two circuits. These are provided with instruments and switches, as in the case of the direct-current circuits. Each circuit will eventually be equipped with an integrating meter. The alternating and direct-current switchboards were built by the Westinghouse Electric and Mfg. Co., in accordanee with the company's designs and specifications.

All feeders and mains are run in conduits, lead-covered paper-insulated cables being used. The conduit is built of tile in the usual manner, but on account of the soil, special expedients have been adopted to maintain alignment. At intervals of 30ft. to 35ft a couple of piles are driven on 4ft. centres, which are capped, and serve to support concrete steel cantilever arches, which in turn carry the current. In building the underground system, the ground is removed to the contour required, thus saving the expense of forms for the concrete arches. In the design of the distributing system the limiting condition was not the drop in potential, but rather a 5-watt loss per duct-foot in the underground system. All cables for direct-current circuits are 1,000,000 circ. mils single-conductor cables, made by the National Conduit and Cable Co. Those for alternating current are three-conductor No. 0000 cables of Standard Underground Cable Co.'s make. The yards are lighted by series direct-current arc lamps, for which ornamental cast-iron posts have been erected at various points. The buildings and shops are lighted by constant-potential arc lamps and incandescent lamps. The former are placed two in series on a 220-volt direct-current circuit. Current from the 440-volt alternating-current circuit is stepped down by means of transformers for incandescent lighting. As 25-cycle currents are employed, three lamps connected between the different phases are installed near each other, thereby obviating any disagreeable physiological effects.

The use of hydraulic and pneumatic machinery throughout the works is practically limited to such conditions as are most favourable to use of either as against electrical machinery, although the division line is not always clearly drawn, depending to a great extent upon the variability, accessibility, &c., of either. Compressed air is used for various pneumatic tools in the shops, for operating the bells of the blast furnaces, for starting the gas engines, and similar purposes. Hydraulic machinery is used for tilting converters, furnaces and mixers, for operating car pushers, hoists and transfers in the rolling mills, and in such places where a large amount of power is to be exerted with certainty within the range of a piston stroke. Although the use of the hydraulic motor is confined to the operation of cranes, hoists, shop tools and auxiliary machinery in the various processes, it nevertheless occupies no insignificant position in the operation of the works. As already stated, the application of the electric motor in many instances is of unusual interest to the metallurgical engineer, although not in itself having necessitated the solution of any new electrical problem. In many other instances electrical methods have been introduced in the various processes. In other cases original electrical problems of unusual interest to the electrical engineer have been solved. The alternating-current motor is used only for continuous service, where ordinarily a shunt-wound, direct-current motor would have been installed. The use of the alternating-current motor in such cases possesses inherent advantages, as the absence of a commutator, its dust-proof character, &c., are too well known to require extended comment. The direct-current motor of the series, compound and shunt-wound type is used for all cranes and intermittent service necessitating frequent reversals.

The electromagnet shown in Fig. 2 weighs 3½ tons, and has a lifting power of 1½ tons. The features of the design are the use of adjustable poles, which allow the picking up of the iron in any position. These are bipolar and separated some distance, so that the flux will penetrate the pole to a great depth. To separate the poles such a distance in an electromagnet of such a size requires very large and deep windings, for which it is necessary to provide special facilities for ventilating, which is accomplished by inserting fibre rods. Being used under all sorts of conditions, the magnet has been designed in such a manner as to be protected in all kinds of weather, and to permit of ready repair. It furthermore combines mechanical strength with excellent electrical features to withstand the rough handling to which it necessarily will be subjected. The installation of electric travelling gantry cranes in the yards required the placing of the conductor at such a point as not to interfere with the conveying of material in any position to any point in the yard. On account of railroad tracks which cross those of the gantries, a continuous conductor, furthermore, was not feasible, as an exposed third rail could not be adopted on account of the danger of shocks to the workmen and the possibility of a ground or short-circuit through the throwing of material across the tracks. The system finally adopted comprises a bare trolley wire stretched between strain insulators placed in a trough formed by two hardwood pieces insulated from the ground. All crossings are bridged by a cable carried in a conduit. In this way it is not possible to make a ground, the trolley wire being placed below the level of the top of the wooden strips, and surface leakage is entirely prevented. The cost of construction is small, and repairs can be readily made. As the two collectors placed on the gantries bridge any opening, excessive sparking is prevented by the collector leaving one section.

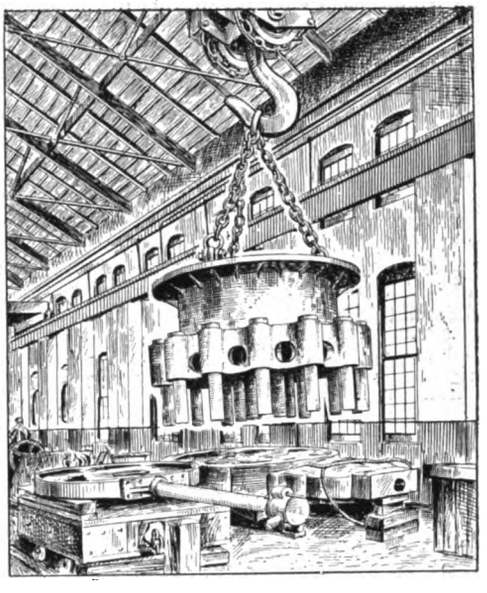

FIG. 2.—PIG-IRON MAGNET.

Certainty of operation being the most important consideration, and the service required being of the most severe character, special precautions have been taken to prevent interruption of the latter. This is well shown in the case of a system of electric locomotives for haulage which has been installed in the Bessemer plant. There are three Baldwin-Westinghouse locomotives, each equipped with two 35 H.P. motors, railway rating. The controllers, four in number, are of a very flexible nature, permitting of their movement both in a horizontal and in a vertical plane to allow of the locomotives taking curves readily, as very sharp corners are made. A very substantial trolley construction has been adopted. This consists of a 2½in. by 2⅞in. by ⅜in. T-iron, insulated from the ceiling I-beams by vulcanised asbestos plates and washers. The trolley wire proper consists of a sheet of copper 18in. by 2½in., riveted to the iron.

Several interesting applications of electrical methods are in use about the plant. One of these is a mixer valve regulator for controlling the temperature of the hot blast on the blast furnaces. This apparatus consists of a regulating pyrometer with an extended pencil room, on which a fibre cup filled with mercury is fastened, a relay, a magnet and a globe air valve. As the pencil room of the pyrometer moves up and down it makes and breaks a battery circuit at the mercury cup. In this battery circuit is connected the relay, which opens and closes a power circuit in which a large magnet is connected. This magnet controls a compressed air valve, and this compressed air valve in turn controls a large mixer valve. Another application is that of an electric burner for blast furnaces. In the case of "freezing" of tuyeres, cinder notch or iron notch, the obstruction is removed by means of an electric burner. Formerly an

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oil burner or kerosene blow-pipe was used for this purpose. The electric burner equipment consists merely of a brass clamp holding a 2in. by 72in. round carbon. A long wooden handle is fitted into this clamp in order to apply the burner when in operation. A cable is tapped into this clamp, carried through a water rheostat and connected to one side of the direct-current power circuit. The other side of the circuit is earthed to the iron framework of the furnaces when it is necessary to use the burner. A current of from 500 to 1,000 amperes at about 80 volts at the arc is required to remove the obstacles. The ore-unloading machines are electrically operated. In these the walking beam truck, walking beam and movements of a 10-ton bucket are controlled from the inside of the leg of the walking beam by means of small operating controllers connected with magnetic switch controllers, which are placed adjacent to the motors for this work. It is thus possible to control the movements of the unloader without carrying the heavy power cables down into the leg of the walking beam, where the operator is stationed, and it is thus necessary to run only small flexible wires between the magnetic switch controllers and the smaller operating controllers.

CORRESPONDENCE.

COMPLETION OF THE PRACTICAL SYSTEM OF ELECTRICAL UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The correspondence following on my letter of April 18th has, on the whole, been very favourable to the adoption of the system there proposed. That system involves getting rid of the 4π in certain equations by including it in the numerical value for μ, and the taking there of another factor, 10^7, in order to make the metre and kilogramme consistent with the ampere, volt, ohm, &c. The first of these was originally proposed by Prof. Fessenden, and the second is, so far as I know, novel.

I am glad that my calculations have been verified by Prof. Everett, who is an authority on these matters; the discrepancy between our results for the permeability of vacuum is easily accounted for. Prof. Everett calculates the unit of μ required to give the *same* unit of pole strength as the ordinary system, whereas, I have taken a different unit of pole strength as well as of permeability in order to get the ampere-turn per metre as the unit of magnetic field, and the volt-second as that of magnetic flux or pole strength. It is easily seen that my figures do belong to *one* system, whereas Prof. Everett's do not, for we know by experiment, that $1/\sqrt{\kappa\mu} = 300 \times 10^6$ metres per second.

On further consideration, I am inclined to agree with him that electricity and the coulomb are preferable as fundamentals to electrical resistance and the ohm, particularly because we have then no fractional indices in the dimensional equations. I quite admit that "kram" is not an ideal name for the kilogramme, and, in fact, I only put it forward in the hope that it would provoke someone to propose a much better one. But "kilog" will not do either, for the only reason for altering it is that it ought not to have the prefix "kilo" when it is a primary unit of the system.

Prof. Hay and Mr. Fournier d'Albe seem to question the practicability and finality of these proposals. Surely the former is aware that all practical designers already eliminate the 4π from their work in the way proposed by dealing with current-turns and current-turns per unit length instead of the standard C.G.S. units. My system *is* put forward as being both final and practicable. It does *not* alter any of the common electrical units, and it will give simple powers of 10 as the converting factors for the C.G.S. units of all non-electrical quantities. The records of terrestrial magnetism are the only things of any importance that will be seriously affected by the proposed change, and the difficulty in that one direction is not a sufficient warranty for maintaining a system that is inconvenient in other branches. It is all very well to say that the electron theory has opened up new books of knowledge, and has given us a ready-made natural unit of electricity. But I doubt whether even Mr. Fournier d'Albe ever expects the coulomb to be superseded by that unit. If he does, I am afraid it is he that "underrates the inertia to be overcome." It may, however, be possible and desirable at some future time to define the coulomb in terms of the electron instead of in the usual electrolytic way.

Both he and Prof. Kennelly seem to be doubtful of the fundamental quantities. In the present state of our knowledge there *must* be four fundamentals in a system of electrical units, and there is no reason why we should expect to be able to reduce this number. We know that $\sqrt{\kappa\mu}$ is the reciprocal of a velocity, but this only enables us to express one of these in terms of the other and length, time, mass. Mr. Fournier d'Albe seems to think that length, time and mass are "really fundamental," and permeability not. But there is no real necessity for taking any one of these. We might, for instance, take the astronomical system, in which mass is replaced by the gravitational constant; or we might take length, time and energy instead of length, time, and mass. Prof. Fessenden also fails to recognise this fact clearly in the Paper to which he refers. In the table of magnetic units there contained he gives a defining equation for pole strength which involves μ, and another for μ in terms of $\mathfrak{B}$ and $\mathfrak{H}$, which both involve pole strength. In fact, he simply goes round in a circle without being able to define any of his quantities in terms of others already completely specified.

Prof. Fessenden, in his Paper, refers to both the electromagnetic and electrostatic C.G.S. systems as being "necessary" and to the practical system as "unnecessary." I maintain that *only one* is necessary, that the practical system is the one most securely established by legal enactments and usage, and that it is, therefore, the one to be retained. The system I now put forward is not "another system" as Prof. Kennelly calls it, but merely an extension of the practical system to other quantities for which it has not been hitherto employed.—Yours, &c., DAVID ROBERTSON.

Bristol, May 21.

TELEPHONE SYSTEMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the report of the discussion on Mr. A. R. Bennett's Paper on "Corporation Telephones," which appeared in your issue of the 20th inst, Mr. Bennett appears to have said: "The great fault of Mr. Poole's system was that it was too complicated, and it was not a practical system"; also that "Mr. Poole's system required different instruments, and to adapt them would entail scrapping all the instruments in use."

Perhaps you will allow me to point out that, so far from the system referred to being complicated, all that was used or required, in addition to any instrument of ordinary battery pattern, was a commutating push button costing about 1s., and at the central office a polarised indicator in place of an ordinary one.

As regards the practical nature of the system, the fact that it was exclusively employed in Manchester exchanges from February, 1880, to 1896 (a long life for a telephone system) is sufficient proof.

Whilst on this subject I may state that the system above referred to was devised by me at the end of 1879, and I believe that not only was it the first ring-through and independent ring-off system, but it was the first in which the ring-off annunciators were connected as shunts to the main speaking circuit, a practice which was then generally regarded with disfavour, but which has now become universal and has resulted in greatly-improved speaking.—Yours, &c., J. POOLE.

London, May 24.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with interest your leading article of May 20th, headed "A Comparison of Telephone Systems." I must take the blame for the line of discussion which you deprecate, as none attaches to the other members who spoke, but I consider that I proved my points, and that the Paper and the reply to the discussion also proved them. I did not claim that figures had been put forward in bad faith, but I do claim that, in dealing with discrepancies in municipal telephone figures, explanations are frequently made which do not really explain. The reply to the discussion contains an instance of this. Mr. Bennett says that his 1897 estimate was "an esti-

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mate showing what *the existing system* at Glasgow *ought to have cost* the National Telephone Co." The italics are mine. The question of what the system of the National Telephone Co. existing in 1897 had cost was not discussed at the Glasgow inquiry. The Commissioner refused to allow it to be discussed. Mr. Bennett's estimate was headed "Estimate for Glasgow Municipal Exchange"; it described a totally different system from the existing system of the National Company, it was put in as a working estimate, it was backed by tenders from reputable firms, and it was argued over and defended as a working estimate. It is true that it was stated that the number of subscribers had been chosen with a view to a comparison with the existing system, and that Mr. Bennett said that, in the event of the Corporation building a telephone system, he should recommend a larger scheme, the cost of which, however, would not be out of proportion to the estimate for 5,200 lines. To the Select Committee of 1898, Mr. Bennett said that the 1897 estimate was not merely an estimate, but "a statement of ascertained cost," and he offered to exhibit the tenders. Enlarging upon the support of the estimate provided by the tenders, Mr. Bennett explained as follows :—

The Town Clerk of Glasgow invited tenders from three or four firms, representing the class of work done throughout, and of these tenders what was considered the best was selected from each tender, and the tenderers (the contractors) were given to understand that they might be called upon to execute the work, and they were all quite prepared to do that, so that the Glasgow Corporation, if they had been in a position to accept these tenders, would have been placed in possession of a telephone exchange with 5,200 lines, 5,200 subscribers, for the sum of £97,000 odd, which is about £18. 16s. 3d. per line.

In a letter to the *Freeman's Journal*, dated September 2, 1899, Mr. Bennett repeated the statement of "ascertained cost," and said that the estimate was correct, and as applicable to Dublin as to Glasgow. In a report to the Glasgow Telephone committee, made early in 1900, when work on the Glasgow system was about to begin, Mr. Bennett said :—

Allowing for all the facts, I am strongly of opinion that the 1897 estimate still remains substantially correct, and that 5,250 completed and 1,200 partially completed metallic-circuit lines can be constructed in the best style, and in conformity with the specification which the Post Office have annexed to the Corporation's licence, for £100,000. The committee may safely assume that the exchange would be got to work for £19 per line.

I agree with you, Sir, that it is deplorable that an Institution discussion should take a personal tone, but if the Paper had passed without discussion it would have been taken on faith by the great majority of readers of technical literature as representative of the general state of the telephone art to day.

As to the 1896 estimate for Glasgow, which Mr. Bennett now disclaims, the figures are taken from a Paper on "The Telephone Question," by Alfred R. Bennett, M.I.E.E., read before the East of Scotland Engineering Association, at Edinburgh, February 5, 1896, in which this statement occurs :—"If we had to deal with towns of the largest size, such as Glasgow, Liverpool or Manchester, the cost of the lines would be about £17 and the annual subscription necessary to work at a profit would be £5. 15s."

I wish to take this opportunity of stating that since the discussion I have found that I made a mistake as to one point in connection with the Glasgow Corporation system. I stated that among the different methods of working there was magneto ringing and magneto clearing. I have since learned that this is not so. I very much regret the error.—Yours, &c.,

HERBERT LAWS WEBB.

Westminster, S.W., May 24.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The motives agitating Count Arco when he achieved the communication to your paper of May 6th are evident, I believe, to all who read. One recalls the old fable of the fox and certain acidulated fruit, only in this case the fox claims the fruit was his own and very good before he found himself unable to grasp it. As to Count Arco's argument that the "number of apparatus" of his system now in use is greater, I will point out that to-day also there is a larger percentage of savage people on earth than civilised. The number of foot passengers also exceeds those who ride in automobiles.

True, the De Forest receiver works without a tapper. We have never employed that antiquity. I think that records, with which the public is to-day fairly well familiar, demonstrate that the De Forest system is the only one to use such a receiver with commercial success. Furthermore, the most uninformed must admit that coherer systems have never performed, and from their very nature never can perform, *commercial* work. Nevertheless, coherer speeds may satisfy our German friend. If, as Count Arco asserts, his company controls the patent on my receiver, why, it is pertinent to ask, has it remained for an American to demonstrate to the world that wireless telegraphy using an electrolytic receiver is capable of real commercial application and is not a Dutch toy?

The receiver which the London *Times* has used with such unparalleled success is covered by patents to me in England and America. Furthermore, despite the allegation that the German company and Mr. Fessenden own the device, and apparently are frank to confess its deficiencies, I will reassert that the statement made by *The Times* correspondent as to the inability of the Japanese to read or interfere with *The Times* messages is correct, possibly because the De Forest system embraces many other points concerning which Count Arco is in as great ignorance as he is concerning my receiver.

After a month's trial the Fessenden system has failed to work over the United States Government range (where the De Forest apparatus has alone been successfully in operation for months), and was ordered to be removed by the Government officials. Doubtless there are equally excellent reasons why the Slaby-Arco apparatus has failed to do such work for the London *Times* as that which so agitates Count Arco. It looks as though there might be a reason for it all.—Yours, &c.,

Lee de Forest,
For the AMERICAN DE FOREST WIRELESS
New York, May 14. TELEGRAPH CO.

SOME PROPERTIES OF ALTERNATORS UNDER VARIOUS CONDITIONS OF LOAD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to the letter in your issue of May 20th, I am obliged to your correspondent Mr. G. W. O. Howe for pointing out the correction required in the vector diagram of E.M.F.s in the synchronous motor. I had already noticed the error, and the correction will be made when the Paper is reprinted in the Institution journal.—Yours, &c.,

Cooper's Hill, May 21. A. F. T. ATCHISON.

LEGAL INTELLIGENCE.

Macartney, McElroy & Co. v. Brighton Corporation.

In the King's Bench Division on Friday Mr. Justice Grantham delivered his reserved judgment. (The action was reported in our issues of April 29 and May 6 and 20.)

His LORDSHIP said the case was one of considerable importance both from the point of view of the amount involved and from the position of the parties. Defendants claimed to deduct sums (about £9,000) which they alleged were paid to plaintiffs by their engineer (Mr. May) under a mistake from other sums due to plaintiffs—*i.e.*, the Corporation claimed the right to take advantage of work done without paying anything for it. Such a claim by an individual would be a dishonest one and could not be successfully maintained, but defendants raised legal technicalities and contended that their view must prevail. Unfortunately defendants had prepared the specification to cover two classes of work (excavation work and wood paving) to be executed (under contract) under the superintendence of the borough engineer and surveyor (Mr. May) and the tramway engineer (Mr. Holliday), but they prepared two distinct tenders for the contractors to sign and the terms of the two tenders were drafted in an entirely different manner—he supposed by the two engineers. The specification, taken by itself, was drawn in such a way as in his judgment would indicate that the person tendering for laying the wood paving was to include the cost of excavating and making foundations for wood paving, but the language of the form of tender prepared by defendants for the wood paving seemed to leave out of account the preliminary work of excavation, owing to its uncertainty, and had only included the cost of the wood paving itself; while the language of the bill of quantities and schedule of prices would indicate that plaintiffs were to be paid for that work and material according to plaintiffs' schedule of prices when the amount of excavation, &c., had been ascertained. Carefully reading the specifications, bill of quantities, schedule of prices and forms of tender, plaintiffs tendered for each class

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of work according to the forms provided, and, on the principle on which they understood it was intended they should tender, tendered for each class of work on two different principles—viz., for the whole work as set out in detail in the form of tender for the tramways, but only for providing the wood, &c., for the wood paving, leaving the amount to be paid for excavation, &c., to be ascertained in the way set out as they understood it in the schedule of prices. That was not at all an unusual way of paying contractors for such work. The uncertainty as to the amount of excavation, &c., required was clearly shown by different paragraphs in the specification and schedule of prices and the bill of quantities. Though ultimately the amounts of the two tenders were added together in the final agreement, on which the present action had been brought, yet defendants were not, in his judgment, entitled to deprive plaintiffs of their money by saying that it was a lump sum contract and could not be divided. Remembering that defendants admitted that they could have accepted the tender of one contractor for the tramways and of another contractor for the wood paving, they were not entitled to defend themselves by saying plaintiffs' was a lump sum contract, and could not, therefore, be divided up. Plaintiffs' tender for the tramways was a fair average one, but for the wood paving was about £12,000 below any others, and defendants' surveyor (Mr. May) at once saw what had happened, and sent for plaintiffs and suggested they had made a mistake or misunderstood the meaning of the tender. The matter was twice discussed by them, plaintiffs contending that their reading of it was correct, and at Mr. May's request they looked over the documents, on which they had to tender, again and again, and came to the conclusion that their reading of the documents was correct, and as the last section of the specification they thought prevented them in any way adding to or explaining their tender, they did not think any explanation was desirable. Plaintiffs said Mr. May agreed with their construction, but asked them not to say anything about it. Mr. May put a different construction on what was said; but his evidence in the action was most unsatisfactory and could not be relied upon, whether from defect of memory or other causes he (his Lordship) could not say. He admitted that he did not inform the Council that any question had arisen until nine or 10 months afterwards, when he could no longer keep them in ignorance of the dispute, although from the evidence of the various members of the Corporation it was evident they knew that plaintiffs were only tendering for the wood paving and not for the excavation work. The jury had found in favour of plaintiffs, that Mr. May agreed with them, that the tender was only intended to include in the price named the amount asked by the contractor for providing the wood, and that the other part of the work was to be paid for by measurement, and defendants were very properly bound by that finding. But not only did Mr. May admit, in the fullest manner, that he knew plaintiffs had only intended the cost of the wood and laying in the £22,000 of their tender, but individual members of the Corporation practically admitted it also, and all doubt on this point had been removed by the fact that from the first plaintiffs always sent in their demand for payments on account based on the principle that they were to be paid by the specified measure and value price for the excavation, concrete, &c., and by the tender price per superficial yard for the wood blocks. Time after time Mr. May's subordinates measured up on that principle, and Mr. May checked and approved the measurements and paid for that work sums on account amounting to nearly £10,000—in fact, paid on that principle until the £22,000 mentioned in the tender for the wood alone was nearly exhausted. Almost the only reliable piece of evidence to throw doubt on plaintiffs' content on that Mr. May and the defendant Council accepted their reading of the tender was the letter of Mr. May to the Works committee of Jan. 11, 1901, which showed, apparently, that at that time Mr. May thought they were going to cheat plaintiffs out of that £12,000 or £14,000. That was a most extraordinary document. At that time Mr. May admitted he knew that plaintiffs had not tendered for the extra £12,000 of work, and yet he was scheming how to divide the money the Corporation would gain. He thought the admissions of members of the Corporation as to their knowledge of the cost of wood paving and Mr. May's conduct, with that of his subordinates, in measuring up and paying for the work, fairly justified the verdict of the jury. It really seemed incredible to him (his Lordship) that people who would scorn to act in a dubious way in private life should act in the manner he had described collectively when they become members of a Corporation. The reason for that conduct was, he thought, not far to seek. They did not realise what they were doing. They were most of them busy men. The mayor, who was a well-known and highly-popular local solicitor, practically admitted he knew but little about it, and apparently left it to the town clerk and officials and thought it was all right. Other members of the Corporation were busy men, or had been on the Corporation many years, and everybody trusted everything to their town clerk, whereas the town clerk, who had been a most efficient servant of the Corporation for many years, was incapable of managing or directing any such work. He could not help feeling that the desire of the Corporation to retain in their service long after he was capable of serving them, one who had served them so well in the past, has had a good deal to do with the present difficulty, for it had led to a divided authority without a controlling master mind, and though the deputy town clerk was challenged with having advisedly altered the language of the tender in such a way as to show that he intended it to bear the construction of plaintiffs, he was not called at all, though it was evident that he and Mr. May had practically been responsible for everything that was done. After analysing the evidence given by members of the Corporation, his Lordship said he was confirmed in what he had said as to the individual honesty of the members of the Corporation, for Mr. Boxall, one of the learned counsel for the Corporation, during the progress of the case, had stated that he was instructed to say that if the Corporation were wrong in their reading or construction of the contract they would not rely on the certificate of their surveyor excluding the plaintiffs from being paid for the work done, and for which the surveyor had refused to certify. This was a very honourable proposal. He was surprised, however, after the promise of Mr. Boxall, that some arrangement had not been come to by defendants. The costs already incurred must be enormous, and the complications were such that the case might easily go to the House of Lords and be a harvest for the lawyers at the cost of complainants and the ratepayers of Brighton. In that dilemma what was h (his Lordship) to do? The jury had found the facts in the case clearly and distinctly. Could those findings be legally supported? In his judgment the documents in the case were inconsistent. The tender (B) was inconsistent with the specification, but the jury had distinctly found that both parties to the contract intended to mean a certain thing. Then defendants said that did not signify, as they were not like ordinary persons and were not bound by their word of honour, much less by an uncertain contract; for were they not a corporation, which was so little capable of taking care of itself that it was like an infant, specially protected by Act of Parliament, and unless the contract was under seal, they could not be made to pay for work they had ordered to be done, and which had been done by foolish though honest people? The Courts had decreed so in several cases. But in the case he was trying there was a seal attached to the contract and a stamp also. Why, therefore, if, when in an ordinary contract there had been a mutual mistake in drawing it up, and the mistake could be rectified by a court of law, should it not be rectified in a case where the contract was right in point of form and only wanted altering or rectifying in the language used, merely because it was under seal? He knew it was true, of no case where it had been done, but counsel for defendants had not mentioned any case which showed it could not be done, and on the old maxim of *ubi jus, ibi remedium*, he must hold, in that case, that the contract must be rectified by adding to the words of the tender that plaintiffs would make the excavation, concrete, &c., for the foundation for the wood paving according to the terms of the schedule of prices attached to the specification. With regard to the exact amount to be paid by defendants to plaintiffs it was, he thought, understood that it should be referred if plaintiffs and defendants could not agree on a figure. The verdict and judgment in the action must, therefore, be for plaintiffs. He gave judgment for £14,000 (subject to the amount being rectified on reference), with costs following the event.

Brighton Corporation decided yesterday (Thursday) afternoon to appeal against the above judgment.

The judgment of Mr. Justice Grantham has been the subject of much discussion in the Sussex journals and by prominent ratepayers of Brighton. The following communication has been addressed to the Corporation by the plaintiffs in the action:—

"OURSELVES V. THE CORPORATION.

"To the Mayor and Corporation of Brighton.

"Gentlemen—Seeing that our company is personally responsible for the costs of the litigation, and is not, like yourselves, free from personal pecuniary liability, with the rates to fall back upon, we appreciate the remarks of the Judge with reference to the costs which have already been, and may still be, incurred in this matter.

"Having now, however, by the verdict of the jury and the decision of the Judge, vindicated our position as contractors, and thereby, we trust, as soon as this action is finally concluded, put an end to the prejudice created with other Corporations by hostile contractors referring to the existence of this litigation, we are desirous of putting an end to it once for all, especially as, owing to the time and attention it demands, we find that it seriously interferes with our proper attention to our other business.

"We also appreciate the fact that it has involved in heavy expenses the ratepayers of Brighton, with whom we have no quarrel in any way, but rather the contrary, seeing that, as matters now stand, we have carried out for them certain works which, we have reason to believe, have given mutual satisfaction.

"Under these circumstances we are prepared, without prejudice in any way to our rights or claims, to make you the following offer, namely:—

"That the issues raised in the action which have not yet been gone into shall be mutually abandoned, and that in respect of the issue which has been tried and decided, we will accept the immediate payment of the sum of £12,000 and all costs, instead of the amount at present adjudged, namely, in round figures, £14,600, and costs as given by the Judge."

The King v. Wells and Another.

Last week a Divisional Court (the Lord Chief Justice, Mr. Justice Wills and Mr. Justice Kennedy) quashed a conviction by the Loughborough magistrates of a solicitor under sec. 1 of the Motor Car Act, 1903, on account of "duplicity." The words of the conviction were: "That on a public highway he drove a motor car at a speed or in a manner which was dangerous to the public, having regard to all the circumstances of the case."

The LORD CHIEF JUSTICE, after hearing counsel, said it was impossible to say that the only offence mentioned in the section cited was the offence of driving at a speed dangerous to the public, for it was obvious that there was also the offence of driving in a manner dangerous to the public. A person might be driving at a moderate speed and yet in a manner dangerous to the public. Therefore, the magistrates had not to consider the two things together, but ought to have considered whether defendant was driving in a manner dangerous to the public apart from the question of speed.

Bombay Tramway Co. (Ltd.) v. Bombay Corporation and Others.

Last week the Judicial Committee of the Privy Council (Lords Macnaghten and Lindley and Sir A. Wilson) heard the arguments in an appeal from a judgment of the High Court of Bombay affirming, with certain variations, a decree of Mr. Justice Fulton. The action was brought in 1901 by the company for a declaration of their rights in regard to the purchase

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of their tramway undertaking which Bombay Corporation claimed to have made under the provisions of the Bombay Tramways Act, 1874. By that act the powers of the company were to remain in force for not less than 21 years, and the Corporation were to have the right of purchasing the tramways (including plant, stores, rolling stock, &c.) either after the expiration of 21 years or at the end of any subsequent seven years. The amount to be paid was to be the actual bona fide value (exclusive of compensation for goodwill, premium, compulsory sale, or other consideration) of the tramways, such value, in case of difference, to be ascertained by arbitration. For goodwill, &c., 21 years' purchase, calculated on average profits of the three years preceding purchase, was to be paid, 4 per cent. per annum on bona fide value being first deducted. In March, 1901, the company received notice from the Corporation of intention to purchase. Mr. Justice Fulton found in favour of the Corporation's claim to purchase the tramways, and held that March 14, 1901, when the notice was given, was the date when the property passed to the Corporation, and on which ended "the three years next preceding the purchase." He also held that "track rent" ceased to be payable on that date. The High Court varied Mr. Justice Fulton's decree by delaring that the date of the award determining the valuation was to be that of the purchase, and that the liability of the company for "track rent" did not cease on March 14, 1901. It was from that decision plaintiffs now appealed. March 14, 1901, for the ownership of the tramways passing to the Corporation was agreed by both parties.

The arguments for appellants were delivered, but counsel for respondents were not called upon.

Lord MACNAGHTEN said their lordships would not disturb the arrangement between the parties as to the date, but would in other respects consider their judgment.

Newcastle-on-Tyne Electric Supply Co. v. Ferguson.

At Newcastle County Court on Friday last Judge Greenwell heard an action for the recovery of £44. 5s. 7d. from defendant, a contractor, of Newcastle, for wrongfully disturbing and damaging an electric cable laid under the public footpath. It was stated that the cable was disconnected by defendant on Dec. 10, 1902, and on Feb. 18, 1903, and for those disconnections £1. 5s. and £2. 7s. were claimed, while £40. 13s. 7d. was claimed for laying a new length of cable under the roadway in substitution for the length disturbed and damaged.

For the defence, it was pointed out that whereas the plans passed by the Corporation showed that the cable was at no place nearer than 4ft. 6in. from the face of the building, the cable was in many places laid within 9in. and 12in. Defendant's submission was that if the cable had been laid down in accordance with the plans it would not have been affected by defendant's works because those works would not have extended more than 2ft. 6in. from the face of the building.

Judge GREENWELL gave judgment for plaintiffs with costs, and said there was no ground, either in law or common-sense, for the defence set up.

Ellis v. Ellis.

His Honour Sir H. Lloyd recently gave judgment in this case, which raised a point under the Workmen's Compensation Act, as to whether the widow and children of a partner killed while at work could sue the remaining partners and recover damages. Joseph Ellis, partner in Joseph Ellis & Co., West Buckley Colliery, was doing some necessary work as working partner at a weekly wage when he was killed. The Judge awarded £250 compensation and costs.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Extension of Time.—The date for sending in applications for the position of principal of Blackburn Municipal Technical School is extended to 30th inst.

Scottish House-to-House Electricity Co. require a resident engineer at their Coatbridge generating station. Applications to the manager and secretary, Mcorgate-court, London, E.C., by June 4. See advertisement.

Bristol Electrical committee require a charge engineer. Salary £2. 10s. rising to £3 per week. Applications to the city electrical engineer (Mr. H. Faraday Proctor), Temple Back, Bristol. See advertisement.

The Governors of Huddersfield Technical College invite applications by June 11 for the position of principal. Salary £500.

Weymouth and Melcombe Regis Corporation require an electrical engineer to take entire charge of their electricity supply department. Commencing salary £250, increasing by annual increments of £25 to £300 per annum. Applications to the town clerk (Sir R. N. Howard) by June 8.

Belfast Gas and Electric committee require an electrical distributing assistant. Salary £200 per annum. Applications by May 31 to city electrical engineer, Mr. Victor A. H. McCowen.

Middlesex Education committee require an electrician to be responsible for the gas engines and dynamos at polytechnics in the county and for the care of electrical plant, also to assist in taking some of the electric light wiring classes. Salary £150 per annum. Applications to Mr. B. S. Gott, Guildhall, Westminster, by June 1.

Birmingham Public Works committee require a track engineer (£5 to £6 weekly) and an inspector (£4) for their tramways. Applications by 31st inst.

The Senate of the University of London invite applications for the professorship of civil and mechanical engineering, vacant by the retirement of Prof. W. C. Unwin. Salary £1,000 per annum. Applications by June 7.

A demonstrator and assistant lecturer in physics is required for University College of South Wales and Monmouthshire (Cardiff). Applications by June 20.

An assistant lecturer in mathematics and physics is required for the Birkbeck College, London. Applications by June 8.

Mr. W. L. Vitty, of Dudley Corporation electricity works, has been appointed assistant mains superintendent at Partick, N.B.

Amalgamated Society of Engineers.—The 53rd annual report of this society states that

The past year was characterised by dull trade and decreased employment, the donation list reaching dimensions which, excepting the period of the lock-out, had not been reached for about 10 years. Wage reductions came into operation in Scotland and on the North-East coast area at Barrow and at Belfast. The indications as to trade have decidedly improved since the commencement of 1904. The number of members in the society at the beginning of 1903 was 93,252, and at the close was 95,403. The year began with £546,367. 14s. 5¾d. in hand, and ended with £602,425. 10s. 3¼d., a saving on the year's transactions of £56,057. 15s. 9½d.

Amble.—The Council, having received a communication from the Northern Counties Electricity Supply Co. to the effect that the company have not yet considered the question of putting into operation the Amble Electric Lighting Order, have decided to ask the Broomhill Collieries (Ltd.) for terms for the electric lighting of the district.

Argentina.—The "Review of the River Plate" says:—

Rojas Municipal Council are establishing electricity works.

At Chacabuco a company entitled Sociedad Anon.-Luz Electrica has been formed.

It is proposed to form a company at Dolores for erecting electricity works. Turbine-driven generating plant is proposed.

Before the end of May it is expected to open for traffic the first section of the system of the Metropolitan Tramway Co. (Buenos Ayres), now under conversion to electric traction.

The Cia. de Luz y Fuerza de Mendoza are substituting underground for overhead cables, and have ordered from Siemens-Schuckert Werke, through their local representative (Mr. A. Parcus), additional generating plant of 720 H.P.

During 1903, for the public electric lighting of Buenos Ayres, 387 arcs and 808 incandescents were supplied with current by the municipal works; 78 15 ampere and 44 10 ampere arcs by the Primitiva Gas Co.; 612 10 ampere arcs and 10 incandescents by the Cia. Alemana Transatlantica; 1,165 16 c.p. incandescents (supplied free) by the electric tramway companies; and 458 arcs by the two dock stations of the Government. The average cost per kilowatt-hour for public lighting was 8¼c. gold. There are now 7,608 private consumers (with the equivalent of 254,032 16 c.p. lamps) who pay 17c. gold per kilowatt-hour for lighting and 7·81c. for power. During the year the maximum output which had to be provided for lighting was 7,384,689 units; for power, 2,351,275 units; and for traction, 20,049,638 units. 814 electric motors (equal to 4,242 I.H.P.) were in use in the city.

The two telephone companies in Buenos Ayres had at the end of last year an aggregate of 12,805 subscribers.

The Government have withdrawn the legal status of Bright's Light and Power Co. (Ltd.)

Buenos Ayres Municipality have been informed by their legal adviser that the mayor's proposed tax on telephone instruments would be illegal, and cannot, therefore, be imposed.

Messrs. Buxton, Cassini & Co. recently secured a contract for installing over 6,000 electric lights in the new Congress Hall.

H.M. Consul at Rosario reports that a ready market will be found there for electrical appliances.

Asylum Lighting.—Mr. H. T. Harris has been appointed consulting engineer in connection with the scheme for the electric lighting of the Clonmel (Ireland) Asylum.

Ballymena (Ireland).—The Board of Trade are asked to extend the period of the Council's 1897 electric lighting order for another year.

Barking.—Though the official accounts of the electricity department for the past year have not yet been issued, it is stated that the profit is over £240. The demand for current for power continues to increase. There are 47 motors connected of an aggregate of 388 H.P. while negotiations are proceeding for a further 400 H.P. It is proposed to erect a new power station on a riverside site where three-phase plant will be put down and current will be generated at 6,000 volts.

Barrow-in-Furness.—In future the charge for electric current for power will be 2d. per unit for the first 2,000 units per quarter, 1¾d. for the next 2,000, and 1½d. for all over 4,000.

Bath.—The receipts of the Corporation's electricity department during the year ended March were £16,665, compared with £14,958

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in the previous year, and the expenditure £8,967, against £9,047, leaving gross profit £7,652, against £5,895. The receipts for current for private lighting were £11,650, against £9,909. After taking into account the balance (£1,233) from 1903, and paying interest and sinking fund instalment (£6,584. 1s. 10d.) and placing £1,233 to reserve, £1,068 is to be carried forward. 1,357,292 units were generated, 381,155 were supplied to the public lamps, 580,390 to private consumers and 1,600 were sold by contract. There are 190 public lamps and the total maximum supply demanded was 828·7kw. The capital expenditure was £137,226. 5s., an increase of £27,798. 6s. 4d. during the year.

Birmingham.—The accounts of the electricity department for the year ended March 31 show that 4,367,164 units of electric current were sold, producing £69,421. 13s. 11d., compared with 3,737,419 units and £67,695. 17s. 3d. in the previous year.

The reduction in price has resulted in the receipts being diminished by £8,054. 11s. 6d. The gross profit was £36,930. 17s. 8d., compared with £30,593. 9s. Works costs were 1·163d. per unit against 1·460d. and total costs were 1·742d. per unit, against 2·097d. After paying interest and sinking fund charges (£26,527. 13s. 1d.) the net profit was £10,412. 4s. 7d., which has been carried to reserve, bringing this to £36,613. 12s. 8d. Considerable extensions of the mains have taken place during the year, the total being 10,051 yds. The lamp and motor connections during the year were equal to a net addition of 12,499 16 c.p. lamps.

The Tramways committee report the successful inauguration of their work in connection with the Aston route. With reference to the supply of electric energy for the route, pending the erection of the Summer-lane station, the Electric Supply committee preferred not to undertake the responsibility, and as Aston Manor Council were willing to undertake supply, it was arranged that they should do so until Dec. 31, 1906 (when the leases of the remaining steam routes in the city expire) at 1½d. per unit, Birmingham Corporation contributing £200 towards the cost of laying the cable from the Aston generating station to the city boundary. The equipment of the Dudley-road route is approaching completion, and the tramways in Pebble Mill-road authorised by the Northfield District Council's Act, 1901, are now practically completed. Proposals have also been submitted to the Committee by King's Norton Council, which are under consideration. The extension of the Small Heath route to the city boundary and the arrangement for the electrification of the old portion of the route on similar terms to those arranged for Dudley-road is also reported. The capital expenditure stands at £50,000. The three months' revenue (to March 31) was £4,428, of which there was a balance to profit and loss account of £1,664. £685 is absorbed by preliminary expenses, £296 by interest and £682 is carried forward.

Birmingham District Tramways.—King's Norton and Northfield District Council intend to lease the tramways authorised by their 1901 Act to the City of Birmingham Tramways Co. until June 30, 1911, at a yearly rent equal to 1 per cent. on the amount spent by the Council on the construction of the tramways and incidental works, in addition to sinking fund and interest charges on money borrowed (by Council) and £928 per annum for repairs of track and paving.

Blackburn.—In his report the borough electrical engineer (Mr. A. S. Giles) recommends the adoption of a uniform charge of 4d. per unit for lighting, with the option for consumers to continue on the existing maximum demand system; for power 1½d. per unit for the first 1,500 units, and 1d. above that number. The present rates are: Lighting. 6d. per unit first hour and 3d. after; power, 2½d. and 1½d. per unit, the lower rate for consumers using 100 units per quarter per horse-power installed. Mr. Giles advocates the abolition of meter rents.

Bolton.—The following reductions in the price of current have been made:—Maximum demand system, to 4d. and 1d.; motive power, to 2d. for first 1,000 units per quarter, and 1d. beyond; tramways, from 1·25d. to 1·10d. The flat rate remains at 4d.

Brighton.—At their meeting yesterday (Thursday) afternoon the Corporation decided to appeal against the judgment of Mr. Justice Grantham in the action brought against them by Messrs. Macartney, McElroy & Co. (This judgment is set out on page 241 of this issue.)

Bristol.—In presenting the account of the electricity department for the year ended March 25, the Electrical committee report that there were 2,394 consumers, an increase of 297 for the year.

The total connections were equivalent to 234,098 30-watt lamps (compared with 182,134 last year), made up of 57,332 taking energy at power rate, 168,486 at lighting-rate terms and 8,280 on street lighting, an increase of 25,305 in power connections, 23,620 in private lighting and 3,039 in public lighting. 5,317,284 units were generated. 2,461,515 units were sold for private lighting, 1,224,676 for power and 613,313 for public lighting, an aggregate increase of 889,746 units. Power consumption was responsible for 535,936. The total maximum supply demanded was 3,444kw., and the total maximum possible demand was 7,022kw. Gross receipts were £61,371. 15s. 8d. and expenditure £29,840. 15s. 8d. Dividends on stock, interest, &c., required £13,967. 0s. 10d., and repayment of money borrowed £9,356. 12s. 8d., leaving a net profit of £8,207. 5s. 6d. £2,000 has been transferred to reserve, £5,026. 0s. 2d. to depreciation and contingency fund, and the balance carried forward. Total capital expenditure is £542,243. 14s. 8d., the mortgage debt £574,080. 13s. 9d. (less £64,520. 17s. 6d. paid off). The reserve is £7,000, and the depreciation and contingency account £4,000.

The city electrical engineer (Mr. H. Faraday Proctor) states in his annual report that, owing to the disastrous fire which occurred at Temple Back works on Dec. 23, destroying the whole of the high-tension switch gear and doing some damage to other portions of the plant and buildings, considerable alterations are being put in hand. The steam turbine recently supplied, and some of the smaller sets of plant, are being transferred to Avonbank works, in order to provide suitable space for the construction of two or more fireproof switchboard chambers. The switchboards to replace those destroyed have been ordered from Siemens Brothers & Co. and will be constructed by that firm in conjunction with the Siemens-Schuckert Werke of Berlin and Cowans Limited of Salford. In consequence of the increase in demand for current for power two 210kw. dynamos have been installed at Temple Back, taking the place of alternators, and being run by existing engines. An electric service boat, which plys between the two generating stations, is found useful in economising time and expense. In addition to the two 750kw. Parsons steam turbo-alternators and the Dick-Kerr continuous-current machine, two Westinghouse exciters of 88kw. each have been installed at Avonbank, these being driven by two of the smaller engines brought from Temple Back. The boiler contract and the contract for induced draught plant (referred to in the last report) have been carried out, and the whole was brought into work at the end of last year. Five sub-stations were constructed during the year, and a large extension of the arc lighting was carried out, causing the use of 365 5-ampere arc lamps, increasing the total number of arc lamps to 674. The number of miles of cable laid has been increased from 181·4 to 227·3. The additions to the lighting demand were greater than in any previous year, while the additional demand for power was nearly double that of last year and about three times that of 1902. The total connections to the power system are now 2,306 H.P. (equivalent to 57,342 8 c.p. lamps). The revenue fell from 3·44d. per unit to 3·18d., but the net profit increased from 0·413d. per unit to 0·46d. The works cost came out at 1·11d. per unit, compared with 1·2d. in the previous year, and the total costs to 1·58d., against 1·71d. £8,225 was received from the insurance companies in connection with the fire; the amount expended to date (less £1,000 charged to reserve) is £3,142. 7s., leaving a balance of £6,082. 13s.

Cambridge.—The Council have approved the principle of the conversion of the local tramways to electric traction on the overhead system, and negotiations on the subject are proceeding between the Law and Property committee and Mr. A. A. Campbell Swinton on behalf of the Cambridge Tramways syndicate.

Colchester.—During the year ended March the revenue of the electricity department was £7,972. 19s. 10d. (an increase of £1,722 over the previous year), including £532. 15s. 3d. for 54,074 units supplied to public lamps, and £7,215. 0s. 8d. for 348,366 units supplied (at prices ranging from 7d. to 2¾d.) to private consumers.

Generation expenses were £2,835. 5s. 1d., distribution expenses £97. 18s. 1d., management £602. 17s. 5d., interest £1,343. 19s. 7d. £1,338. 13s. 7d. for sinking fund and repayment of loans, insurance, &c., brought the total expenditure to £6,692. 2s. 6d., leaving a net profit of £1,280. 17s. 4d. (an increase of £357). £780. 17s. 4d. is to be carried to reserve and renewal account, the balance (£500) being applied to the reduction of rates. The average price obtained for current for public and private consumption was 4·43d. per unit, compared with 4·83d.; the total costs were 2·20d. per unit sold, against 2·80d., and the total works costs were 1·75d., against 2·06d. There were 436 consumers, against 347 in 1903, and the equivalent of 25,836 8 c.p. lamps are connected, compared with 21,965. In future the charges for current for private lighting are to be 5d. per unit up to 2,000 units per annum, 4½d. per unit for the next 3,000 and special terms are to be arranged for quantities in excess of 5,000 units.

Crewe.—For the year ended March 31 the income of the electricity department was £6,030. 6s. 9d., including £2,619. 8s. 1d from private and £3,310. 17s. 10d. from public lighting. Expenses were £2,483. 6s. 5d., including £1,382. 7s. for generation, £85. 9s. for distribution, £412. 0s. 4d. for repair and maintenance of public lamps, £116. 18s. 4d. for rents, rates and taxes, £405. 8s. 5d. for management. The surplus was £3,547. 0s. 4d., out of which interest (£1,235. 15s. 11d.) and sinking fund instalment (£1,242. 19s. 7d.) were paid, leaving a profit of £1,116. 1s. The capital expenditure is £44,167. 3s. 3d., an increase of £580. 11s. 9d. during the year. 455,226 units of electric current were generated. The total maximum supply demanded was 313kw.

Darlington.—The official inspection of the new municipal electric tramways was made by Col. von Donop on Wednesday.

Deptford (London).—The Council have asked Messrs. Drake and Gorham, the contractors for the electric lighting of the new town hall, to give a price for the wiring work in connection with internal telephones and bells. The consulting engineers (Messrs. Medhurst and Lloyd) estimate the cost at £150.

Devonport.—The Town Council have increased the salary of the electrical engineer (Mr. J. W. Spark) from £250 to £300 per annum, and that of Mr. Stamp, assistant engineer, from £130 to £150 per annum.

The Council are recommended to reduce the charge for current for private lighting from 5d. to 4½d. per unit for the first 1,000 units per annum and 4d. after.

Dundee.—Hitherto electric current for power has been supplied at a flat rate of 2d. per unit, but the city electrical engineer (Mr. H.

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Richardson) now recommends the adoption of the maximum demand system.

Dunfermline.—The Dean of Guild Court have authorised the Fife Electric Power Co. to erect a generation station on Corporation land at the north of the town loch. The company are negotiating with the Council as to supplying electricity in bulk, and also for the construction of a tramway from Townhill to Rosyth.

Ebbw Vale.—The Council have appointed a deputation to ascertain whether the Ebbw Vale Steel, Iron and Coal Co. will undertake the supply of electricity in the district.

Edinburgh.—On Wednesday the Council adopted a recommendation that the surplus upon the past year's working of the electricity department (about £17,000) should be placed to reserve.

Councillor Mackenzie (convener of the Electric Lighting Committee) stated, in reply to a question as to a reduction of price for current, that it was nearly three years since the charge for private lighting was increased from 3½d. to 3¾d. on account of dear coal. There was no increase in the charge for public lighting then, but there had been a gradual decrease, and last year an aggregate reduction of £2,000 was made. It was the cheapest public electric lighting service in the kingdom. If not actually below prime cost the charge was as near as possible. The amount now proposed to be added would raise the reserve fund to £60,000, but in view of the capital expenditure of £900,000 it should be £30,000 more.

Councillor Mackenzie, who has been for many years convener of the Electric Lighting Committee, has resigned his seat in the Council, and the Lord Provost proposed, and Sir Andrew M'Donald seconded an expression of the Council's appreciation of the services he had rendered to the city.

Electric Haulage of Mineral Trains.—The "Financial News" says: "One of the largest borax-mining companies in California, who have hitherto employed 20 mules to haul a 20-ton load 18 miles in 24 hours on the Death Valley desert, has now installed a 275 h.p. gasoline engine and a 100kw. electric generator, supplying current to electric motors on the locomotives which have now been adopted for hauling the trains, which are made up to carry five times the previous mule-train load and run 100 miles a day."

Exhibitions.—An Electric Tramway and Railway Exhibition will be held at the Agricultural Hall, London, in July.

A medical exhibition was opened at Queen's Hall, Langham-place, London, on Tuesday, and remains open until this (Friday) evening. Among the exhibitors are the Dowsing Radiant Heat Co., the Marconi Wireless Telegraph Co. and Messrs. H. Cox & Co.

As previously announced the exhibition that was to have been held at Milan in 1905 has been postponed to 1906. Applications for space must be in the hands of the Executive committee by May 31, 1905. A prominent feature of the exhibition will be machinery in motion. The secretary is Sig. E. A. Marescotti, 4, Piazza Paolo, Ferrari, Milan, Italy.

An exhibition will be opened at Barcelona on Sept. 25 with a view to making known the mineral resources of Catalonia and the Balearic Islands. The exhibition will afford an opportunity of exhibiting electric, hydraulic and general machinery suitable for use in mining work and in the electro-metallurgical industries. Applications for space are to be made to the Fomento del Trabajo Nacional, 4, Plaza de Santa Ana, Barcelona, up to Aug. 1.

Gillingham.—The Admiralty have agreed to take electric current from Gillingham Council for three years for the electric lighting of the Naval Hospital.

Grays.—The revenue of the Electricity department for the year to March 31 was £2,604 1s. 7d., including £1,573. 3s. 9d. from sale of current for private lighting and power and £923. 4s. 11d. from street lighting. Expenditure came to £1,518, leaving £1,086 gross profit to meet interest (£684) and sinking fund instalment (£475), a deficit of £73, largely accounted for by extra expenses incurred during the year. In a report by the electrical engineer (Mr. E. D. Long), which accompanies the accounts, it is stated that there are 221 street lamps, including 19 new street lamps of the "Luna" Nernst type (18 of 200 c.p. each and one of 100 c.p.). The latter consume approximately the same energy as the old lamps, but give four times the illuminating power. The cost of renewals and extra attendance increases the cost of maintenance 33 per cent. per lamp per annum; the average life of the burner is 500 hours (requiring six or seven renewals per annum at 2s. 5d. each). Mr. Long recommends the gradual adoption of this type of lamp at street corners and in the more important thoroughfares, and the introduction of seven more circuit-switch lamp posts at suitable points in the district.

Hackney (London).—Mr. L. L. Robinson, M.Inst.E.E, A.M.Inst. Mech.E., borough electrical engineer at Hackney, has prepared an interesting pamphlet on the application of electricity to lighting, heating and cooking purposes. We have received from time to time many publications of this kind, all of which have been designed to interest local consumers in the subject of electricity supply, but Mr. Robinson's pamphlet goes a step further and provides the intending consumer with a list of the streets in which mains are laid, whether on both sides or on one side only, and the exact lay of the mains. From this list new residents in the district can ascertain at a glance whether electricity supply is available in their new residences, and consumers generally will be equally well informed as to the facilities offered. A useful "sample of consumers' accounts" is provided, which shows the cost of electric lighting to various sections of tradesmen burning varying numbers of equivalent 8 c.p. lamps from 15 to 350, the cost being given per 8 c.p. lamp per annum. A list of local contractors, illustrations of arc lamps, domestic and trade appliances, incandescent fittings, Nernst lamp equipments, &c., are furnished, and, lastly, some testimonials from users of electric light in the borough go to make up a pamphlet which affords interesting reading.

The Electric Light committee recommend payment to Messrs. J. H. Holmes & Co. of a bonus of £540 for low steam consumption of generating plant supplied. The consulting engineer (Mr. R. Hammond) in his report states:—

The results are by far the best I have ever obtained from plant of similar size, and the bonus has been thoroughly earned. The test figures are amply confirmed by the results of the actual working, and the record for last year of the lowest works cost of all metropolitan undertakings is in itself an excellent witness of the economy in working.

The committee have had under consideration the scale of charges for current, and have received several communications jointly prepared by the borough electrical engineer (Mr. Robinson) and the consulting engineer (Mr. Hammond), in which it is pointed out that a flat rate similar to that in force cannot prove entirely satisfactory to all classes of consumers. The committee therefore consider it desirable to adopt a system which will provide that each consumer bears a fair share of the capital charges of the undertaking, and recommend that at Jan. 1 next the scale of charges to consumers be:—For lighting 7d. per unit and 1d. per unit for any quantity used per quarter beyond the equivalent of one hour's supply per day at the maximum demand; for power 3d. and 1d.

Queen's road and Graham-road, Dalston, are to be lighted with 10 7-ampere arc lamps at an annual cost of £158 per annum, against £94. 14s. 8d. now paid for gas. The expense of providing the lamps, columns, cables, &c., is estimated at £705.

Hemel Hempstead —The Corporation have refused to consider proposals from a syndicate for the erection of electricity works.

International Electric Power.—Supplementing the particulars given in a note which appeared in our last issue, p. 201, we learn that the company to whom permission has been given by the Italian authorities to import electrical energy into Italy (which is generated in Switzerland) is the Societa Ceramica Lombarda, whose head offices are at Milan. The original concession was granted by Switzerland, and the Finance Minister of Italy states that there is no frontier tax imposed by Italy on electrical energy introduced from another State.

Kingston-on-Thames.—The tenth annual report of the borough electrical engineer (Mr. J. E. Edgcome) was presented to the Council last week.

Mr. Edgcome reports that no structural additions were made to the station buildings, but preparations are in hand for carrying out extensions to the engine house required for the new generating plant to be installed to meet next winter's load. A day-load condensing plant has been erected, and is now at work. An 8 h.p. single-phase alternating-current motor has been put down for driving the mechanical stokers and the scraper gear of the economisers. Mechanical stokers with patent self-cleaning compressed-air furnaces have been fitted to one of the Lancashire boilers, and tests with these stokers are being carried out. A 350 h.p. high-speed engine, direct-coupled to a 200kw. single-phase alternator will be erected for next winter's work. Extensions of the distributing mains have been made in a number of streets. Arrangements have been made for installing transformer pillars, in place of underground sub-stations, in parts of the borough where distributing centres are required. A number of motors of various sizes have been connected to the circuit, and are used for driving printing, cutting and folding machines, aerated water machinery, dentists' drills, ventilating fans, hair brushing machinery, for organ blowing, boot stitching, &c. The extension of the public arc lighting has proved very satisfactory, the automatic change-over switches have worked well, and the automatic lighting of the side lights has proved useful on the few occasions when an arc lamp has been temporarily extinguished. For the first time since the inauguration of the electricity undertaking, a net profit has been made after paying all charges (including interest and repayment of capital), and after payment of certain special charges amounting to £399. 18s. 4d. The total capital expenditure to March 31 was £86,468. 7s. 1d., an increase during the year of £3,684. 4s. 1d., but after reckoning instalments of capital repaid, the balance outstanding to March 31, 1904, was £72,782. 17s. 5d. The number of consumers has increased from 530 to 630. The system of deferred-payment wiring adopted at Kingston being now more widely known, Mr. Edgcome finds that consumers are availing themselves of this method of wiring their premises. The amount paid for coal during the year was £293. 8s. 7d. less than during the previous year although the units sold increased by 67,666. This increased efficiency was greatly due to the satisfactory working of the chain-grate stokers, and of the large condensing plant with its adequate supply of cooling water. The average cost for fuel per unit sold had been reduced from 1·536d. to 1·157d. The total works cost expenditure had been increased by £116. 13s. 5d. (from £4,930. 4s. 10d. to £5,046. 18s. 3d.), but the total revenue had increased by £1,661. 11s. 7d. (from £8,341. 1s. 6d. to £10,002. 13s. 1d.) a net increase of revenue over expenditure of £1,544. 18s. 2d. The gross profit, after paying all charges, exclusive of

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interest and repayment of capital, had increased from £3,410. 16s. 8d. to £4,955. 14s. 10d. Interest had increased from £2,022. 10s. to £2,141. 6s. 3d. and the amount for repayment of capital from £2,324. 18s. to £2,711. 12s. 9d. The net surplus after payment of interest and repayment of capital was £102. 15s: 10d.

Councillor CLARKE, chairman of the Lighting committee, in moving the approval of the minutes, said the gas company were fond of comparing the cost of gas and electricity, claiming a great advantage for the former. He thought they had a splendid illustration of the economy of the electric light at St. Peter's Church, Norbiton, where they formerly paid about £35 a year for gas, but now had the church brilliantly lighted with electricity for half that sum.

Ald. MOATT said the result of the past year's operations must be most gratifying to their engineer, to whom great credit was due, for he had never wavered in recommending the electric light.

The MAYOR said a close examination of the accounts showed that the report was not quite so good as appeared on the face of it. In 1902-3 they supplied 80,256 units for arc lighting at £882. 4s. 2d., or about 2½d. per unit; but in 1903-4 they supplied 113,343 units at £1,513. 15s., or nearly 3¼d. per unit. According to the report, establishment charges and works cost had been less, and he should like to know why the charge per unit for arc lighting had gone up. On the other hand, it was only fair to look at what the Lighting committee had done in other directions; they had paid during last year £2,141. 6s. 3d. in interest, £2,611. 12s. 9d. off capital, £399. 18s. 4d. for chain-grate stokers, and £102. 15s. 10d. for other extras, a total of £5,255. 13s. 2d. If that were a private undertaking, with a capital of £86,500, they could have paid 5 per cent. interest (£4,325), and then have had a balance of £1,030. 13s. 2d., which was a creditable result.

The electrical engineer (Mr. EDGCOME) explained that £20 a year for an arc lamp burning from dusk to dawn was insufficient; probably about £28 a year would be the right charge for such a lamp. But for an arc lamp burning from dusk till 12:30, and side lights from 12:30 till dawn, £20 just about covered the repayment of its share of principal and interest as well as the running cost. Consequently, the committee decided to adhere to £20 per lamp. The increase in cost of current per unit was because they had charged a uniform price per lamp, and each lamp had not burnt so many units.

The minutes were approved and the committee thanked for their services.

Kirkcaldy.—The Council have revised their scale of charges for electric current as from 15th inst. as follows:—

For lighting: For first 1,000 units, 4½d. per unit; for next 1,000 units, 4d.; for next 1,000 units, 3½d.; and for all in excess, 3d. per unit. *For power and heating:* For first 10,000 units per annum, at 2½d. per unit; next 90,000, 2d.; for all units in excess, 1½d.

Lancaster.—The price of electric current for power has been reduced from 3d. to 2½d. per unit.

Leigh (Lancs.)—There was a profit of £338 on the electricity department for the past year.

Light Railway.—The Board of Trade have issued an order for the construction of the Quarry Bank, Brierley Hill and Rowley Regis Light Railway.

London County Council Tramways.—Messrs. J. G. White & Co. have made such progress with the reconstruction of the Kennington-Streatham line to electric traction that a full service has been running since Saturday from Blackfriars and Westminster bridges to Brixton station.

London United Tramways.—During the Whitsuntide holidays the London United Tramways Co. found the whole of their rolling stock requisitioned to cope with the enormous crowd visiting Hampton Court and Hurst Park races. On Monday 350,000 passengers were conveyed by the electric tramcars, and the total for the three days exceeded 675,000 passengers.

The Board of Trade inspection of the Southall to Uxbridge extension is to take place on 31st inst. It is intended to run alternate cars to Hammersmith and Shepherd's Bush from the new Uxbridge terminus.

Louth.—The agreement between the Council and the National Electric Construction Co. for the erection and maintenance of electricity works for a period of years has been sealed.

Mitchelstown (Ireland).—A canvass has resulted in promises from 128 householders to become customers of the projected electricity works. The Board of Trade have notified the District Council that the scheme, which contemplates the use of overhead high-pressure mains, will only be approved upon the production of evidence that the demand for current will be sufficient to pay the working and maintenance expenses, and subject to the condition that the Board may review the situation after five years. The Council are prepared to accept these stipulations.

Municipal Telephony.—Brighton Telephone committee last week recommended the Corporation to authorise the manager of the telephone department to execute on behalf of the Corporation an agreement for the establishment of telephone call offices.

Councillor TOZER asked if it was right that the manager should be allowed to execute such agreements?

The deputy town clerk (Mr. TALBOT) explained that the form of agreement had been submitted to and approved by the committee, and he had himself also seen and approved of it. The manager had nothing to do but fill in blanks for the name and place.

Ald. REEVES said that it was unreasonable to ask the Council to agree to a resolution which they had never heard of and had never seen anything of. It was the first time he had heard of a committee of the Corporation issuing broadcast an agreement without it being first submitted to the Council. He moved the exception of this part of the proceedings.

Councillor BLACK said any delay in the execution of these agreements would not only be prejudicial to the telephone undertaking, but an inconvenience to those who desired to use the call offices.

The exception was carried by 16 votes to 11.

The profit on the past year's working of Portsmouth telephone department is £1,233. 18s. 2d. The Telephone committee report that a new extension switchboard for an additional 390 direct lines has been completed in the town hall.

Fareham Rural Council have authorised Portsmouth Corporation to erect telephone poles in connection with the extension of the municipal telephone undertaking into the Fareham district.

Natal.—The imports of electric fittings into Natal from Germany in 1903 were valued at £5,000, and from the United States at £6,000. Electrical machinery imports stand for £15,000 from Germany and £24,000 from the United States.

Nelson.—An inquiry has been held here into the application of the Council for permission to borrow £25,000 for electric lighting extensions.

Persian Telegraphs.—During 1903 the Central Persian Telegraph line was completed to Bam. Work was commenced at Kashan at the end of 1902, snow and the non-arrival of construction material delaying the work for some time. In spite of these drawbacks the rate of construction between Kashan and Yezd (237 miles) averaged 15 miles per week. On this section the extremes of cold and heat were endured. From Yezd to Kerman (218 miles) work was commenced at the end of July, 1903, and an average of 20 miles per week was maintained. In November the work was continued, and Bam was reached at the end of the year. The line, which will terminate on the British frontier at Kuh-i-Malik-i-Sia, is expected to be completed before the end of June, 1904. Four Englishmen and about 200 Persians or Indians have been employed on the work, under the supervision of the superintendent of the Central Persia Telegraph Line, Mr. W. King Wood.

The posts employed, which on some parts of the route carry two wires and are placed 20 to the mile, and on the remainder of the route carry a single wire 10 posts to the mile, are of special pattern manufactured by Messrs. Siemens Brothers & Co. They consist of four parts (a w.i. sole plate 21in. square, a c.i. socket 4ft. 6in., a parallel w.i. tube 8ft. 7in., and a taper w.i. tube 8ft. 7in.), the post made up weighing 178½lb. and measuring 20ft. 6in. in length when completed. For long spans and for use at angles a "stretcher" pole is used of the same height but designed so that an 8ft. top can be fitted. The weight of this "stretcher" pole is 230lb. There are three wires used, two weighing 600lb. per mile, and one 450lb. per mile. The two heavy wires are carried on insulators manufactured by Bullers Limited, fixed by means of insulator stalks to 24in. arms of British oak, made by Messrs. Siemens Brothers & Co., and fitted with a square-headed nut, which saves the wood from contact and so avoids shrinkage. The lighter wire is carried on an insulator in a boss screwed to the top of the pole. This wire is intended for the use of the Persian Government Administration. The total length of line from Kashan to Bazman is 732 miles, and the cost of material was £95,260, or about £130 per mile.

Plymouth.—For the year ended March 31 the income of the Corporation Tramways department was £32,068. The receipts per car mile on the Compton section were 12·98d., Peverell Park 11·01d., Prince Rock 9·95d., Beaumont-road 6·94d., and West Hoe 5·14d. The expenses totalled £28,035, leaving a net profit of £4,033, or 1·404d. per mile. The number of parcels carried during the year was 13,155, and lost articles restored 396.

Portsmouth.—The net profit of the electricity department during the past year was £4,221. £4,000 of this is recommended to be added to the reserve by the Electric Lighting committee. Mains are to be laid in the Eastney district at a cost of £500.

Presentation.—Last week Mr. J. W. Plackett, late telegraph controller at Edinburgh, was presented with a silver tea-kettle by members of the Edinburgh telegraph staff on his appointment as traffic manager in London.

Preston.—The official inspection of three new electric tramway routes was made by Major Druitt and Mr. A. P. Trotter on Wednesday. The system is expected to be in operation by Wednesday next.

Prestwich.—The Council have sealed the deed of transfer (to Salford Corporation) of the Prestwich electric lighting orders, 1900 and 1903.

Pudsey.—The Corporation, who obtained an electric lighting order in 1901, have received an offer from the Yorkshire Electric Power Co. to supply electricity in bulk.

Redditch.—The accounts of the electric lighting department were presented and passed by the Council last week.

The total capital expenditure is £21,534. 9s. 3d. an increase of £1,608. 4s. on the year. Total receipts were £3,334. 5s. 8d. After payment of expenses there was a profit of £460. 8s. 11d., an increase of £246. 8s. 3d. over 1902. Interest absorbed £537. 1s. 1d. and sinking fund £552. 16s. 4d., and after an allowance for bad debts, there was a

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deficit of £666. 18s. 4d. There were 296 consumers, an increase of 55, the equivalent number of 8 c.p. lamps connected being 15,844. 65,739 units were sold for private and 93,085 for public lighting. The number of units sold for power was 106,893. The total works costs came to 1·72d. per unit against 1·92d. in 1902. The total costs were 2·07d. against 2·32d.

Retford.—The Council obtained a provisional order in 1899, and are now making a canvass to ascertain the probable demand for electric current. The Guardians offer to take current if reasonable terms can be arranged.

Rewards for Motormen.—Portsmouth Corporation pay a 10s. bonus every half-year to each of the drivers of their electric tramcars who has succeeded in avoiding accidents during the whole period. For the six months ended March, 90 out of 101 men were so rewarded.

School Lighting.—Queen Victoria Schools, North Shields, formally opened by the mayor on Wednesday, are the first schools in the borough lighted electrically. The wiring and fitting and the effective ventilation arrangements were carried out by Messrs. Dagman and Ryder of North Shields.

Shrewsbury.—The net profit on the past year's trading of the electricity department was £353. 13s. 6d. The accounts were presented to and approved by the Council last week, when the chairman of the Electric Lighting committee (Ald. Deakin) said the success of the undertaking was due to the excellent management of the borough electrical engineer (Mr. C. M. Johnston).

Stalybridge, Hyde, Mossley and Dukinfield Tramways.—The electric tramway system was opened for traffic on Monday.

Stepney.—The cost of lighting and maintaining the 15-amp. arc lamps for street lighting during 1903 was £24. 10s. 6d. per lamp per annum, made up of £18. 19s. 1d. for current and £5. 11s. 5d. for maintenance. The 10-amp. lamps cost £18. 14s. 5d. (£13. 3s. for current and £5. 11s. 5d. for maintenance). The ½-amp. Nernst lamps used in the street lighting varied in number during the year, as did the 16-c.p. incandescents. The average cost of supplying and erecting each arc lamp was about £41. 13s. 9d.

On the advice of the consulting and resident electrical engineers (Mr. Arthur Wright and Mr. W. C. P. Tapper) the Lighting committee have submitted to the Council two recommendations on the subject of reducing the charges for current. By these proposals it is anticipated a considerable saving in the cost of street lighting will be effected, and a largely increased demand for energy for power will be created.

Stoke Newington (London).—A canvass is being made of the Lordship-road district to ascertain the amount of support which would be accorded the proposal of the Electric Lighting committee of the Council to introduce electric lighting into this favourite residential portion of the borough. It is proposed to erect a new sub-station, and for the present to continue to purchase current from the Hackney electricity undertaking. A flat rate of 5d. per unit has been fixed.

Tynemouth.—An inquiry was held last week into the application of the Corporation to borrow £15,000 for electric lighting extensions.

The borough electrical engineer (Mr. C. Turnbull) said that in the first year of working they sold 482,000 units, in the second year 820,000 units and in the third year just ended 1,103,000 units. In addition they had connected motors of an aggregate of 525 H.P., and applications were coming in rapidly. With regard to the item for mains and services in Cullercoats, he explained that the district was a long way from the power station, and the Corporation took a bulk supply from a company for that district.

Victoria (Australia).—The Government have sanctioned the construction of an electric tramway system in and between Essendon and Flemington by Mr. A. E. Morgans. The local authorities have the right to purchase at the time when the Melbourne tramways revert to the City Council, or at 20, 25, or 30 years from its inauguration. The capital cost is estimated at £100,000.

Victoria Park (W. Australia).—The Perth Electric Tramways Co. and Mr. H. Edmiston have submitted offers to Victoria Park Council for constructing 2 miles of tramway between Victoria Park and the Causeway, Perth.

Watford.—At the last Council meeting the Electric Lighting committee were authorised to purchase additional generating plant (set out in another column).

The chairman of the committee (Mr. Benskin) said there were now over 300 consumers connected to the mains and the receipts showed an upward tendency. The new plant would enable them to effect economies in the generation of current.

Weybridge.—The Council, after having counsel's opinion, have decided to apply for an injunction to restrain the Urban Electric Supply Co. from supplying electric energy to Walton from Weybridge.

Whitefield (Lancs.).—The Council have agreed to purchase the undertaking of the Bury, Rochdale and Oldham Tramway Co.s within their district, and Salford Corporation will be asked to commence the conversion of the lines to electric traction at once. With the completion of this route and the connection of the Bury system with Bolton, it will be possible to run cars from the centre of Manchester by a very circuitous route through Bury and Bolton to Liverpool.

Whitehaven.—The Council have authorised the extension of the electric lighting mains to Kells.

Wisbech.—The Council have acquired a site for an electricity generating station, which will be erected, equipped and mainiained by the National Electric Construction Co.

Wood Green (London).—An inquiry was held on Wednesday into the application of the District Council to borrow £43,200 for electricity supply.

The clerk (Mr. T. W. BRITTAIN) supplied particulars of the population, assessable value, outstanding loans, &c.

The consulting engineer (Mr. W. C. C. HAWTAYNE) gave technical details of the scheme, which was estimated to cost £43,175. Municipal works would be erected and the continuous-current three-wire system of distribution would be employed. There would be 50 arc lamps for public lighting.

The Inspector (Mr. H. Ross Hooper) inquired as to the result of a canvass, but was informed that no canvass would be made until the Council were in a position to supply current.

The INSPECTOR: But your application must be based on recognised principles from a business point of view. How many intending consumers have applied?

Mr. REED (for the Council): There have been none. But if we can show that people are paying for their lighting probably 10 times as much as we expect to charge for electricity, then we have a fair chance of succeeding. There are eight hotels in Wood Green. The price of gas was 3s. 1d., but since the electric light scheme was launched it had been reduced to 2s. 10d. There were numerous large shopkeepers and 8,609 houses in the district.

Mr. HERBERT NIELD (for the North Metropolitan Electric Power Supply Co.) asked Mr. Hawtayne if it would not be advisable that supply should be taken in bulk from outside instead of launching on an independent generating station?

Mr. HAWTAYNE replied that if they could get supplied at something less than 1d. per unit it might be worth consideration. He would not recommend Wood Green or any Council to tie themselves down to any outside company to pay anything more than ¾d. per unit.

Several local witnesses gave evidence in favour of the scheme, and the inquiry was then adjourned until June 8.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Edinburgh Corporation require tenders for the supply of copper strip for electric conductors. Specifications from the resident electrical engineer (Mr. F. A. Newington), Dewar-place. Tenders to the town clerk (Mr. Thomas Hunter, W.S.), City-chambers, Edinburgh, by June 4. See advertisement.

Conway Corporation are desirous of considering a scheme for the electric lighting of the borough and are about to appoint an electrical engineer to report. Applications by June 7. See also advertisement.

Portsmouth Town Council invite tenders for supply, delivery and erection of a steam-driven water-circulating pump, with connections, the supply and laying of cast-iron intake and discharge pipes and the supply and erection of sundry other pipe work. Specifications (after 31st inst.) from the Town Hall, Portsmouth. Specifications may be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller, Manville and Dawson), 29, Great George-street, Westminster, S.W. Tenders to the town clerk (Mr. Alexander Hellard) by noon June 11. See also advertisement.

Lincoln Corporation invite tenders for supply, delivery and erection of eight electric tramcars. Specifications, &c., from the city electrical and tramways manager (Mr. Stanley Clegg, M.I.E.E.), Electricity Works, Brayford Side North, Lincoln. Tenders (addressed Chairman and Members of the Electricity committee) to the deputy town clerk (Mr. W. T. Page, jun.), 5 and 6, Bank-street, Lincoln, by 10 a.m. of June 13. See also advertisement.

West Ham Education committee invite tenders for the electric wiring and fittings required at West Ham Park elementary schools, Stratford. Persons desirous of tendering should apply to the architect (Mr. William Jacques, A.R.I.B.A.), 2, Fen-court, London, E.C., for specifications, &c., before June 9. Tenders to the Education Department, 95, The Grove, Stratford, E., by 5:30 p.m. June 20. An advertisement contains further particulars.

Exeter Corporation invite tenders for the construction of permanent way and paving (including copper bonding) of about 4 miles of tramway, single line, with passing places; overhead electrical equipment of lines and car-shed; supplying and laying insulated cables and stoneware conductors; and for supply and delivery of 12 double-deck single-truck motor cars. Tenders to the town clerk (Mr. George R. Shorto), Southernhay West, Exeter, by noon June 9.

The Lords Commissioners of the *Admiralty* are prepared to receive proposals from persons willing to submit for competitive

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trial range-finders, both large and small, for naval use. Conditions, &c., will be furnished to bona fide inventors or manufacturers of such instruments on application to the Director of Navy Contracts, Admiralty, London, S.W. Full descriptions of the range-finders proposed must be sent in by June 30.

London County Council invite tenders for two continuous coal and ash conveyors (gravity bucket type) at Greenwich electricity generating station and for maintenance of same for 12 months. Tenders to the clerk of the Council (Mr. G. L. Gomme) by 10 a.m. June 14.

Canterbury Lighting committee invite tenders for one Lancashire or dry-back marine boiler, superheater and steam pipes, one 300kw. steam dynamo, switchboard and connections, and extensions to economiser. Tenders to town clerk (Mr. Henry Fielding) by June 1.

Erith District Council require tenders by noon June 13 for additions to and alterations at electric lighting station, and for steel bridge building and road diversion work in connection with the construction of electric tramways.

The directors of the *North-Eastern Railway Co.* invite tenders for telegraph apparatus and telegraph wire and line stores for six months ending Dec. 31, 1904. Tenders to the secretary (Mr. R. L. Wedgwood), York, by 9 a.m. June 4.

Handsworth Urban District Council invite tenders for the erection of a generating station. Tenders to the Council House by noon June 8.

Pontypridd District Council invite tenders for motors. Tenders to chairman of Electric Lighting and Tramways committee by noon June 4.

The Visitors' committee of the Parkside Asylum, *Macclesfield*, invite tenders for wiring and fittings and electric lighting plant. Tenders by June 20.

Deptford Borough Council invite tenders for two 25kw. steam dynamos and a booster and switchboard. Tenders by 4 p.m. June 21.

Stepney (London) Borough Council invite tenders by noon June 20 for wiring the Goulston-street baths.

Southampton Corporation invite tenders by 2 p.m. June 6 for cast crossings and points and mates for the tramways department.

Manchester Tramways committee require two cyclone dust-collecting plants. Tenders by 1 p.m. June 4.

Glasgow Corporation require tenders by noon 31st inst. for electric light installation, bells, &c., for Kingston Halls.

Johannesburg Council invite tenders for insulated cables and bare overhead conductors and certain accessories. Specifications, &c., after May 30, from the consulting engineers (Messrs. Mordey and Dawbarn), 82, Victoria-street, London, S.W. Tenders must reach Messrs. Mordey and Dawbarn by noon July 4.

Shanghai Municipal Council invite tenders for a concession for constructing and working about 24 miles of electric tramways on the trolley system in the streets of Shanghai. Particulars from the Council's London agents, Messrs. John Pook & Co., 63, Leadenhall-street, E.C., where plans may be inspected. Tenders to secretary of Municipal Council, Mr. J. O. P. Bland, Shanghai, China, by noon July 30.

The *Netherlands* Minister for the Colonies invites tenders (until June 15) for zinced iron wire (various) and supporters for insulators. Particulars from Mart. Nijhoff, bookseller, The Hague.

TENDERS RECEIVED AND ACCEPTED.

Govan Corporation have placed the following tenders for stores for the electricity department for 12 months:—

Dempster, Moore & Co., engine packing and gauge glasses and ironmongery; Ferguson and Timpson, klingerit jointing and graphite; British Insulated and Helsby Cables (Ltd.), lead-covered and armoured cables and rubber-covered cables, mica sheets, binding and fuse wire; Callender's Company, leadless cables and bitumen; General Electric Co., rubber solution, strip and prepared tape and solder, and carbons; Craig Sharp (Ltd,), bituminous compound; Chamberlain and Hookham, meters; Keighley Electrical Engineering Co., house fuse boxes; T. and A. Paul, iron castings; M'Dowall, Steven & Co., iron pipes; Wilsons and Union Tube Co., wrought-iron tubing; Kelvinside Brick Co., bricks; Scott and Rae, cement; Morier & Co., brushes; James Storer & Co., paints; Robinson, Dunn & Co., timber; Cruikshank & Co., joint boxes; British Thomson-Houston Co., motors (1 H.P. to 3 H.P.) and motor starters (up to 5 H.P.); Lancashire Dynamo and Motor Co., motors (4, 5, 7, 15 and 30 H.P.); Mavor and Coulson, motors (10, 20 and 25 H.P.); Sturtevant Engineering Co., motor starters (above 5 H.P.); Veritys Limited, switches (30 and 50 amperes); Bray, Markham and Reiss, switches (75, 100 and 200 amperes).

The following contracts have been let by Acton District Council:—

St. Helens Cable Co., cables, lamps, lamp-posts, street work, &c.	£31,536	15	7
Lancashire Dynamo and Motor Co., motor transformers, booster and balancer	3,425	0	0
Electrical Power Storage Co., accumulators	2,016	0	0
Cowans Limited, switchboard	1,140	0	0
James Hitchen & Son, crane	170	10	0

Glasgow Electricity committee have accepted the following tenders:—

Bladen & Co., for 15 coal chutes for wall head for northern section of Port Dundas station, at £223. 19s. 9d.

Campbell, Binnie & Co., water tank, £230.

Barrowfield Ironworks, 26 cast-iron hoppers, £168.

Witting, Eborall & Co., providing and erecting switchboards with Dorman and Smith's reverse-current circuit-breakers at Pollokshaws-road station, at £604.

British Westinghouse Co., providing and erecting switchboards at sub-stations with feeder fuses, £752. 2s.

Falkirk Iron Co., supply of cast-iron boxes required in connection with the laying of street mains for year from June 1, at £600.

Heckmondwike District Council have accepted the following tenders in connection with the extension of the plant at the electricity works:—

Thornton and Crebbin for feed pump and pipework, Dick, Kerr & Co for steam traction generator, Stirling Boiler Co. for water-tube boiler. J. G. Statter for main switchboard panels, Sturtevant Engineering Co., for induced-draught apparatus and W. T. Henley's Co. for underground feeders.

Kirkcaldy Corporation have accepted the tender of Cox-Walkers Limited for extension switchboard panel and cable connections for 430kw. generator at £200. J. E. Spagnoletti & Co. tendered at £230, W. McGeoch & Co. at £275, and the Edison & Swan Co, (Dundee) at £400.

Watford Council have provisionally accepted the tender of C. A. Parsons & Co. for a 500kw. turbo-alternator and exciter, with surface condenser and motor-driven air and circulating pumps, at £3.945, and that of Babcock and Wilcox for two boilers, chain-grate stokers and superheaters at £2,705.

Stepney (London) Council received six tenders (varying from £200 to £380) for the installation of the electric light at Limehouse Town Hall, and that of F. E. Emerson & Sons (the lowest) has been accepted.

For the installation of the electric light at St. George-in-the-East library, the tender of Ward Bros. has been accepted at £92. 4s. 6d. by Stepney Council. There were six tenders, the highest being £215.

Kilmarnock Town Council have accepted the tender of Dick, Kerr & Co. for the construction of the permanent way of additional electric tramway routes at £22,784.

The Hart Accumulator Co. have received an order for supply of storage battery of 260 Hart standard lighting type cells for Bridgwater electric lighting station.

Contracts have been placed with Noyes Bros. (Melbourne and Sydney) for the supply of polyphase generating plant and motors to Wallaroo and Moonta Mines, South Australia.

Bradford Corporation have accepted the tender of Holme, King & Co. for the construction of a storage reservoir at the electricity works at about £15,000.

The Horsfall Destructor Co. have obtained an order for a four-cell refuse destructor for Durban Corporation.

Hackney (London) Electric committee have accepted the tender of Reavell & Co. for portable motor-driven air compressor at £65.

Stafford Town Council have accepted the tender of Callender's Company for cables.

BUSINESS NOTICES.

Owing to expiration of lease the offices of Muirhead & Co. will be removed on July 1 from 54, Old Broad-street, London, E.C., to Elmers End, Beckenham, Kent. Telegrams: "Muirheads Elmers End." The offices at 12, Carteret-street, Westminster, S.W., will remain as before. Telegrams: "Secohm London." Telephone: 779 Westminster.

Bruce Peebles & Co. (Ltd.) have removed their London office to 25, Victoria-street, S.W.

The Hart Accumulator Co. notifies that Mr. F. R. Hill, recently in their service as a traveller, does not now represent them.

Messrs. S. Haynes and A. E. Favell (trading as S. Haynes & Co), electrical fittings merchants, &c., Dilk's-yard, Long-row, Nottingham, have dissolved partnership. Debts by Mr. Favell.

LIQUIDATIONS, BANKRUPTCIES, &c.

A meeting of the Electrical Copper Co. (Ltd.) will be held on June 29 at Winchester House, London, E.C., to receive an account of the winding-up.

Claims against the Telescriptor Syndicate (Ltd.) by June 8 to Mr. E. Waterhouse, 3, Frederick's-place, Old Jewry, London, E.C.

In the bankruptcy of Wm. Wenham, electrical engineer, 5, Century-buildings, London-road, Croydon, the first meeting of creditors will take place on June 3 at 24, Railway Approach, London Bridge, and the public examination on June 29 at the Court House, Park-street, Croydon.

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Sale by Auction.—Mr. Henry Sherley-Price (of Wheatley Kirk, Price & Co.) has been appointed by the Court to sell by public auction in one lot as a going concern, at the Mart, Tokenhouse-yard, London, E.C., on Tuesday, May 31, at one o'clock prompt, the extensive freehold and well-equipped car-building works known as the Castle Car Works, Hadley, near Wellington, Salop, together with the whole of the fixed plant and machinery and trade connection. An advertisement contains further information. Particulars and further information from the receiver and liquidator (Mr. H. D. Eshelby, F.C.A., of Messrs. Harmood Banner & Son), 24, North John-street, Liverpool; of Messrs. Gribble, Oddie, Sinclair and Johnson, solicitors, 38, Bedford-row, London, W.C., or of the auctioneers, 46, Watling-street, London, E.C., and Albert-chambers, Albert-square, Manchester.

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 30, Birley-street, Blackpool.

A battery of 53 21-plate Chloride storage cells is advertised for sale by Mr. E. C. Theedam, Dudley.

British Engineering Standard Coded Lists.—Vol. I. of these lists, which are issued by the authority of the Engineering Standards Committee, is just published. This volume deals with "Rolled sections for constructional iron and steel tram rails." The book is compiled by Mr. Robt. Atkinson, and is published at Salisbury House, London-wall, E.C., price 21s. nett. A section of the book is devoted to a code devised upon the usual lines of a phrase code. We notice an 11-letter word on the first page of this code. If there are many of these they are calculated to lessen the value of this part of the book. The particular example on page 271 (the word "acafroaresm") does not strike us as a particularly happy example of code vocabulary. If admissible on the score of pronunciation, it would, of course, rate as two words in a telegram. The book is very well printed and arranged, and if such a work is required its compilation has evidently been placed in good hands.

Forthcoming Book.—Messrs. Spon will shortly issue a new work by Mr. W. R. Bowker, C.E., entitled "Management of Electric Tramways and Light Railways."

Raworth's Traction Patents.—The Electric Tramways Co. of Havre have given an order for a car to be fitted with automatic regenerative control, making a total of eight tramway undertakings which have decided to introduce this system. The Havre Company works a gradient of 1 in 10, 1,100 metres in length.

Electric Driving.—As announced in our last issue, the British Electric Plant Co. (Ltd.), Alloa, N.B., have secured an order for electric motors for driving the machine shops of the Central Marine Engineering Co. of West Hartlepool. The order comprises 28 D.C. motors, ranging from 8 H.P. to 62 H.P., and aggregating over 900 H.P. The majority are very slow-speed motors and almost all are back-geared.

Catalogues, &c.—Messrs. S. Dixon & Son, Swinegate, Leeds, have prepared and published a new list of electric tramway supplies, including an automatic point shifter, which has been adopted by Leeds, Bradford and Sheffield Corporations; apparatus for automatically controlling overhead and rail points of electric tramways, automatic trolley alarms, patent turn-buckle holder for brake gear, patent speed indicator for tramways and motor vehicles, canopy trolley standards, trolley heads, wheels, &c., section insulators, gun-metal line ears, anchor ears, hangers, insulators, section and feeder pillars, frogs and crossings, main switches and switchboards, insulating materials, cutout equipments, service boxes, fuses, &c. The list is fully illustrated and attractively presented.

A new list dealing with Brooke's patent steam dryer or water separator is issued by Messrs. Holden and Brooke, West Gorton, Manchester. These dryers are made with the bodies all in one piece to prevent the possibility of leakage. The list is well illustrated.

Messrs. W. C. Burnand & Co., London-road, Sheffield, have ready a new list of Burnand patent alternating motors.

A pamphlet describing the Stella brand of alloys, manufactured and supplied by Messrs. Isaac Storey & Sons, Empress Foundry, Manchester, has just been issued, and copies can be obtained on application. The metals dealt with include manganese copper, silicon copper, anti-friction metals, phosphor tin and copper, Babbitts metal and bronze forgings.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from May 18 to 20, with the ports of destination:—

Africa—Cape Town, £77; Delagoa Bay, £210; Durban, £1,879 (including £1,280 telegraph material); Mombasa, £69; Port Elizabeth, £31. *Argentina*—Buenos Ayres, £4,174 (including £1,563 telegraph material); Campana, £180. *Australasia*—Auckland, £78; Launceston, £230; Melbourne, £1,152 (including £450 telegraph material); Sydney, £641; Wellington, £150. *Brazil*—Pernambuco, £42. *Canada*—Montreal, £16; Toronto, £20. *Ceylon*—Colombo, £99. *China*—Shanghai, £214. *Channel Islands*, £53. *Denmark*—Copenhagen, £605 (telegraph material). *France*—Boulogne, £173. *Germany*—Hamburg, £499 (including £300 telegraph material). *Holland*—Amsterdam, £75. *Hong Kong*, £103. *India*—Bombay, £520 (including £10 telegraph material); Calcutta, £965 (including £362 telegraph material); Madras, £520. *Japan*—Nagasaki, £284; Yokohama, £180. *Spain*—Bilbao, £37. **Total £13,273** (for three days), against £57,601 for one week last year (May 20 to 26).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

February 26, 1904.

4,769 B.T.-H. Co. (G.E. Co., U.S.) Alternating-current motors.
4,770 B.T.-H. Co. (G.E. Co., U.S.) Automatic regulators for alternating-current motors.
4,771, 4,772 and 4,773 B.T.-H. Co. (G.E. Co., U.S.) Controlling alternating-current motors.
4,775 T. F. RENE. Sparking plugs.*
4,783 J. PADRIS. Electric heating device.*
4,785 H. F. L. HAUTZ. Reproduction of sound by phonographic and electrical apparatus.
4,799 C. T. J. OPPERMANN. Electrically-propelled road vehicles.

February 27, 1904.

4,860 L. B. MILLER. Apparatus for demonstrating changes in fluorescence.
4,866 O. FRICK. Electric transformer furnaces.*
4,869 G. MARCONI. Wireless telegraphy. (Date applied for, Oct. 13, 1903, date of application in U.S.)*
4,874 W. H. KILBOURN and A. D. FLOWER. Kingston-on-Thames. Trolley poles.
4,875 G. MARKT. Construction of electric switch.
4,891 STANLEY BROTHERHOOD and C. W. BRYANT. Electric ignition for internal combustion engines.*

Febuary 29, 1904.

4,905 A. G. BUTLER. Southampton. Operaphone attachment.
4,918 J. CARTER, G. HALL and A. PARSONS. Manchester. Automatic circuit breaking safety appliances for trolley wire systems.
4,925 J. S. ROSS. Glasgow. Electric bell pushes.
4,927 R. GREENHALGH and W. A. BARNES. Bury. Life-guard for electric tram and railway cars.
4,937 J. D. F. ANDREWS and MANUFACTURING ELECTRIC Co. Arc lamps.
4,943 CLEVELAND BRIDGE AND ENGINEERING Co. and C. W. HILL. Electric controllers for cranes, transporters and other machinery.
4,944 C. RUSSO. Arc lamps and carbons therefor.
4,950 C. H. DE VOLL and H. S. HOWLAND. Burglar alarm.*
4,953 A. S. E. URFABRIKEN. Automatically interrupting electric current. (Date applied for March 3, 1903, date of application in Sweden.)*
4,991 A. J. BOULT. (L. Macquaire, France.) Sparking plugs for explosion engines.
5,019 J. MORTON and H. CARSON. Railway clock systems.*

March 1, 1904.

5,027 T. H. WILLIAMS. Synchronisation of clocks by electric waves.
5,054 G. SPERRYN and W. CASSELL. Birmingham. Tumbler switches.
5,058 W. R. HARVEY. Self-regulating dynamos for motor cars, &c.
5,064 D. M. DABOO. Electrical and automatic working of signals, points and crossing gates on railways.
5,071 H. R. STUART. Apparatus for regulating and controlling the voltage of alternating-current circuits. (Date applied for, March 12, 1903, date of application in U.S.)*
5,084 E. C. MCCRACKEN. Electric vehicles on overhead trolley system.
5,097 F. P. COX. Electricity meters. (Date applied for March 2, 1903, date of application in U.S.)*
5,098 C. P. STEINMETZ. Electric lamps. (Date applied for, March 6, 1903, date of application in U.S.)*
5,104 W. P. THOMPSON (Gesellschaft für Drahtlose Telegraphie m.b.H. Germany) Liverpool. Increasing the discharge energy of electrical vibration systems.*
5,105 W. P. THOMPSON (Gesellschaft für Drahtlose Telegraphie m.b.H., Germany) Liverpool. Receiving electrical vibrations utilising electrolytic cells.*
5,113 MARCONI'S WIRELESS TELEGRAPH Co. and A. GRAY. Transmitters for wireless telegraphy.
5,118 H. J. DOWSING. Electrical radiators.

March 2, 1904.

5,146 W. ARMISTEAD. Wolverhampton. Lessening sparking at brushes of dynamos.
5,147 E. TALBOT and D. MONDEY. Sheffield. Commutators for multiple cylinder motors.
5,164 CROMPTON & Co. and A. J. HODGSON. Chelmsford. Arc lamps.
5,173 E. A. ASHCROFT. Production of metals of the alkali group by electrolysis.

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5,191 J. A. Stevens. Electric and other lamps.
5,193 W. Macaulay. Antrim. Collecting gases given off by electrical furnaces.
5,213 and 5,214 W. Geipel and F. M. T. Lange. Apparatus for conversion of electrical into mechanical energy.

March 3, 1904.

26242A/03 Siemens Bros. & Co. Controlling electric vehicles from a distance. (United Telpherage Co., U.S.). (Date applied for Dec. 1, 1903.)
5,227 H. L. Doulton and C. E. Morris. Supports and guards for conductor-rails of electric railways.*
5,251 J. H. Tucker. Birmingham. Electric plug connectors.
5,269 H. F. Parshall. Electric traction systems.
5,289 R. Redpath and J. Good. Disinfecting telephone instruments.
5,293 F. Pearce and C. Couchet. Electrolytic process for manufacturing nitrites.
5,294 J. Kiewert. Electric alarms.*
5,297 M.I.P. Electrical Syndicate and A. Blackman. Accumulators.
5,298 J. L. Davies. Fuse boxes for electricity supply mains.
5,307 E. Roberts and P. Good. Fuse boxes.*
5,308 P. O. Pedersen. Electric contact devices.*

March 4, 1904.

5,321 A. Campbell. Teddington. Regulating electric voltage.
5,362 T. H. de Veulle. Coventry. Contact breakers for internal combustion motors.
5,374 J. Björnstad. Electric gear for controlling lifts or hoists.

March 7, 1904.

5,519 T. T. Dewhirst and J. Gurney. Flexible continuous covering for ploughway of electric conduit system, and apparatus on cars for manipulating same.
5,528 J. H. Brindle. Manchester. Insulating composition.
5,532 A. D. Sedger, jun. Birmingham. Sparking plugs for internal combustion engines.
5,560 I. de Kaiser. Coils for electrical machines. (Date applied for, May 1, 1903, date of application in U.S.)*
5,566 W. Heatley. Joints or connections for conductors.
5,582 E. Wilson. Blackheath. Connection with electrostatic wattmeters or watt-hour meters.
5,596 F. G. Creed and W. A. Coulson. Telegraphic apparatus.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

4,972 Méray-Horváth. Telegraphic apparatus.
7,618 Mould. Switches for starting and regulating electric motors.
7,716 Johnson (E.A.G. vorm. W. Lahmeyer & Co.). Controlling the working of periodically-operating electric machinery.
7,819 Bowring. Life-guards for electric vehicles.
9,810 Carolan (G.E. Co., U.S.). Electric fuse boxes.
10,871 Bond, Deacon and Leather. Making switch covers.
11,609 Carolan (G.E. Co., U.S.). Fuse plugs.
12,260 O'Neill. Apparatus for controlling and operating rail and overhead points of electric and other railways and tramways.
12,590 Chapman. Multiple sparking device for motors.
14,163 Le Tall (Cooper-Hewitt Electric Co.). Apparatus for electric lighting.
18,602 Taylor. Adjustable support or carrier for incandescent lamps.
18,712 Holbrow. Double-point of electric rails of the conduit system, so that car can always pick up current.
25,271 Pilsondski and De Ragosine. Application of electricity to the cultivation of plants and the like.
28,805 Schneider. Electric furnaces.

1904.

2,467 Aron. Clockwork electricity meters.
2,602 Levy. Interchangeable electric display apparatus. (Date applied for, Feb. 10, 1903.)
3,631 Heys (Varley Duplex Magnet Co.). Circuit controllers for induction coils.
3,774 Wood. Vapour electric lamps. (Date applied for, Feb. 14, 1903.)
4,138 Siemens Brothers & Co. (United Telpherage Co.). Telphers.
4,451 Sperryn and Wood. Switches.
4,646 Petmeky. Metallic circuit intercommunication telephones.
4,775 Rene. Sparking plugs for internal combustion engines.
4,891 Brotherhood and Bryant. Electric ignition for internal combustion engines.
5,071 Stuart. Apparatus for regulating and controlling the voltage of alternating-current circuits. (Date applied for, March 12, 1903.)
5,560 De Kaiser. Coils for electrical machines. (Date applied for, May 1, 1903.)

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (April 21, 1904). Price of silver 25¾d. per oz. (May 26). Consols $90\frac{1}{16}$—$90\frac{3}{16}$ for money, $90\frac{1}{16}$—$90\frac{3}{16}$ for account; 2½ per cent. annuities 89½—90 (May 26). Consols Pay Day, June 1; Stocks and Shares Continuation Days, June 8 and 27; Ticket Day, June 9; Pay Days, May 27 and June 10; Mining Share Carry-over Days, June 7 and 25.

CALLENDER'S CABLE AND CONSTRUCTION CO. (LTD.)—At the meeting last week the chairman (Mr. Hy. Drake) said that last year was the toughest year the company had had. They were, however, doing better this year. It would be seen that the directors proposed to pay a dividend of 10 per cent. and a bonus of 2s. 6d. per share on the ordinary shares, compared with 10 per cent. and 5s. bonus last year. Considering the times they had gone through, he thought that was a satisfactory result. He found that during the eight years since the reconstruction of the company the profits had averaged £46,146 per year, so that for 1903 the profits were rather above the average. The floods they had experienced at Erith had cost them more than sufficient to have paid the additional bonus. Referring to the purchase of the works of the Anchor Cable Co. at Leigh, he said those works were well built, and were newly erected. In view of the competition to which they had been and were still subjected, they thought it desirable they should become the owners of the works. The purchase was arranged by buying all the shares of the company at a large discount, so that the Anchor Company was still kept as a separate concern. The business was not a prosperous one, but it affected them considerably, and they thought it would probably affect them still more in the future.

The managing director (Mr. T. O. Callender) said they had had even heavier competition last year than in the preceding year. The financial stringency of the times came home to them particularly, as the local authorities, on whom their business so largely depended, found it difficult or imprudent to continue their expenditure, and one of the first things they had stopped had been the new works in connection with electricity supply. Many contracts were taken by their competitors at prices which he considered did not pay the money outlay, but they were not forced by the necessities of keeping their factory going into anything like that policy. They had increased their turnover on the year. Competition, although still very keen, was, perhaps, slackening a little. In any case, the position in which they stood now, with four months of the year gone, was distinctly more favourable than that of last year.

DELAGOA BAY DEVELOPMENT CORP. (LTD.)—At a meeting on Wednesday the chairman (Mr. J. C. A. Henderson) said the revenue from telephones in Lourenço Marques was satisfactory, considering the small rent paid, which was only £9. 10s. per annum, against £12 in Johannesburg; but they were negotiating with the Government to allow them to raise the rent. The tramway receipts for the last year were £2,795, but these would be considerably increased when they had increased the number of their cars. Arrangements had been made with the authorities under which the Corporation would water the tramway routes. A large site had been obtained for an electric power station in the heart of the town. They intended to lay down only 5 miles of tramway; but they increased it to 7 miles, and now it extended to nearly 8 miles. At present they were wanting 50 per cent. more cars, and they could carry a much larger number of passengers if they had the accommodation.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—An extraordinary meeting will be held on Monday to confirm the resolution passed on 12th inst.

PARIS METROPOLITAIN RAILWAY CO.—At the recent annual meeting it was announced that the profit for 1903 had been reduced in consequence of the catastrophe on the company's line in August by about £32,000. The total receipts for the year were £704,700; the working expenses £303,100. The proportion of receipts taken by the Municipal Council was £227,700. The available balance was £174,200. The proportion of working expenses to receipts was 42 per cent. The amount paid as compensation for the catastrophe in August was £46,000. The company is now working 34km. of the 42km. of line which will complete the first portion of the railway. The Bercy power station, which will ultimately supply electric power for the whole line, is nearing completion. The capacity of this station will be 14,400kw. In conformity with the requirements of the authorities, the company is renewing the whole of its rolling stock, and is adopting the multiple unit system. The rolling stock consists of 132 auto-motors, 109 first-class and 221 second-class cars. The stock on order comprises 67 bogie auto-motors, 26 bogie first-class and 28 bogie second-class cars. The lighting arrangements in each station are entirely independent of the power circuit, and extra exits have now been provided at many stations. The dividend declared was 3 per cent., plus an extra dividend of 7fr. 50c. on each 250fr. share.

REUTER'S TELEGRAM CO. (LTD.)—The report for 1903 states that the balance for distribution is £4,872. 13s. 7d., including £273. 12s. 9d. from last account. An interim dividend of 2½ per cent. has been paid, and the directors now declare a dividend of 4s. per share, equal to 2½ per cent., making 5 per cent. (tax free) for year. £137. 1s. 7d. is to be carried forward.

TYPEWRITING TELEGRAPH CORP. (LTD.)—At the meeting on Wednesday, the chairman (Mr. A. J. Parker) stated that there was a debit balance for the year of £2,555, but that the net loss was only £225. They had sold the German patent, and the patents now stood in their books at £55,245. The question of patents would have to be dealt with later. Until it could be shown that on the year's transactions the profits were in excess of the expenditure no alteration of capital or value of patents would be of any practical use. His opinion was that the real value of the patents in the United Kingdom was reduced by at least 75 per cent., and that of the foreign patents by at least 50 per cent. The sales, together with royalties, had amounted for the year to £4,161. These results were most unsatisfactory. The sales during the current year showed a material increase, but they had no increase in the home trade to report, as practically the whole of the sales were to foreign countries.

WILLANS AND ROBINSON (LTD.)—A meeting of debenture stock holders was held on Wednesday, the object being to appoint a trustee of the debenture stock of the company in the place of the late Mr. Frederick Gordon. Mr. John Frederick Robinson, M.Inst.C.E., M.Inst.M.E., was proposed, and his appointment was carried unanimously.

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ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL CO. (LTD.)—At the meeting last week, the chairman (Mr. John Macfarlan) said the period of depression on the Continent was fast disappearing, and they were in the position of having as many orders as they could conveniently deal with at prices above those of the past year. The board are of opinion that, "given ordinary times and conditions, there is no reason why dividends should not be earned." He regretted that he could not tell them that their new machine was at work producing tubes. The installation was a big job, and they had to pay particular attention to the shafting, &c., which had to be of the very best quality. The order was placed with one of the best firms in Germany, and delivery was promised for January, but, unfortunately, it was not until the end of April that the last consignment was delivered. They anticipated economies from the machine, and would leave no stone unturned to make it a thorough success. They had reason to hope that an arrangement would be come to very shortly by the various tube makers of Germany whereby price cutting would be avoided.

MUNICIPAL ISSUE.—West Ham Corporation are inviting applications for £500,000 3 per cent. redeemable stock at £84, to provide capital for extending the electric tramway and lighting undertakings, &c.

NERNST ELECTRIC LIGHT (LTD.)—An extraordinary meeting will be held on Tuesday to consider resolutions to reduce the share capital from £320,000 (in 140,000 preference and 180,000 ordinary shares of £1 each) to £90,000 in 90,000 ordinary shares of £1 each, by cancelling certain preference shares and by writing off capital which has been lost or is unrepresented by available assets to the extent of £229,740. If the scheme is finally sanctioned preference shareholders will surrender one-half their holding for cancellation, and will retain the other half as ordinary shares in the reduced capital, and each present holder of ordinary shares will surrender eight-ninths of his holding for cancellation, and retain the remaining one-ninth as ordinary shares in the reduced capital. None of the reduced shares will have any priority in the event of the return of capital upon a winding-up or otherwise.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have granted quotations to 14,000 £5 fully-paid shares of the *Bromley (Kent) Electric Light and Power Co. (Ltd.)* and a further issue of £121,895 4 per cent. redeemable first mortgage debenture stock of the *London Electric Supply Corp. (Ltd.)* The committee have been asked to allow a further issue of £31,467 4½ per cent. first mortgage redeemable debenture stock. *Edmundson's Electricity Corporation (Ltd.)* to be quoted.

WEST AFRICAN TELEGRAPH CO. (LTD.)—It is announced that the directors have declared a dividend of 6s. per share.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

HENRY WALLWORK & CO. (LTD.) (80,995).—Reg. May 17, capital £100,000 in £1 shares (30,000 5 per cent. cumulative preference), to acquire the business of engineers, founders and manufacturers of malleable castings heretofore carried on as Henry Wallwork & Co., and to carry on same and the business of brass finishers, metal workers, electrical and mechanical engineers, metallurgists, machine and engineering tool makers, manufacturers of and dealers in motors and other vehicles, engine builders, boiler makers, &c. First directors are R. Wallwork and C. H. Wallwork. Reg. office, 18, Roger-street, Red Bank, Manchester.

J. STONE & CO. (LTD.)—Reg. May, capital £700,200, in 30,000 preference shares of £10 each and 400,200 ordinary shares of £1 each, to acquire the business carried on at Deptford, London, S.E., as J. Stone & Co., and to carry on the business of electric and general engineers, manufacturers of and dealers in locomotive engines, motors, motor cars, &c., and all kinds of carriages, wagons and conveyances for use on railways, tramways, roads or otherwise, and any apparatus and conveniences for use in connection with the generation, storage, distribution, application and use of electricity, hydraulic power, &c. First directors E. J. Preston, J. T. Prestige, S. Prestige, R. T. Preston, E. M. Preston, F. G. P. Preston, A. G. Preston and W. R. Preston.

STATUTORY RETURN.

WOKING ELECTRIC SUPPLY CO. (LTD.)—The return to April 5 gives the capital as £50,000 in £1 shares (25,000 preference). 18,870 preference and 15,859 ordinary shares have been taken up. Mortgages and charges, £22,600.

MORTGAGES AND CHARGES.

EVERSHED AND VIGNOLES (LTD.)—Lien reg. May 13, for £400 4½ per cent debentures, part of £15,000; amount previously issued £13,600; trustee, Law Guarantee and Trust Society; charged on undertaking and all property, including uncalled capital.

LANGDON-DAVIES MOTOR CO. (LTD.)—Lien reg. May 11, for £200 4½ per cent. debentures, part of £6,000; amount previously issued £5,800; no trustees; charged on undertaking and all property, including uncalled capital.

LONGSTRETHS (LTD.)—Issue to M. Greenberg by way of collateral security only of £1,200 debentures, part of series created May 6, 1904, to secure £2,000, charged on company's undertaking and property, present and future, including uncalled capital. Date of issue, May 7. No trustees. No previous issue of same series.

WOKING ELECTRIC SUPPLY CO. (LTD.)—Issue on April 23 of £600 debentures, part of series created Nov. 2, 1899, to secure £25,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £23,550.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 21	1,818	+ 286	51	61,418	+ 12,548
Airdrie	,, 13	187	...	13	2,610	...
Ayr Corporation	,, 14	213	+ 2	52	13,911	+ 84
Barnsley	,, 13	161	- 12	19	3,031	- 167
Barrow	,, 18	135	+ 79	13	2,105	+ 1,277
Bexley District Council	,, 19	240	...	82	5,221	...
Birkenhead	...	...	...	...	...	...
Birmingham Corporation	,, 21	261	...	18	5,660	...
Birmingham Tramways Co.	,, 21	5,576	+ 343	20	104,881	+ 5,924
Blackburn Corporation	,, 20	228	+ 182	8	7,288	+ 510
Blackpool Corporation	,, 19	512	+ 68	7	4,606	+ 479
Blackpool and Fleetwood	,, 21	334	+ 4	21	5,259	- 252
Blackp'l, St. Anne's & Lytham	...	...	...	...	...	...
Bolton Corporation	,, 22	1,752	- 337	8	13,618	- 228
Bournemouth Corporation	,, 18	988	+ 28	7	7,658	+ 420
Bradford Corporation	,, 21	4,357	+ 714	7	31,781	+ 5,625
Brighton Corporation	,, 22	910	- 11	7	6,566	+ 27
Brisbane Tramways	Mar. 30 / April 6	2,182 / 2,554	- 135 / + 6	14	32,220	- §[1]
Bristol Trams & Carriage	May 20	5,104	+ 280	26	121,899	+ 4,786
Buenos Ayres & Belgrano	April 24	3,403	+ 539	1	3,403	+ 539
Burnley Corporation	May 21	1,011	+ 227	8	8,149	+ 1,916
Burton Corporation	,, 21	386	...	7	2,555	...
Calcutta Tramways Co.	,, 21	R33,190	+ R3,341	21	R721,978	+ R96,872
Camborne-Redruth	,, 28	155	+ 39	3	851	+ 27
Cardiff Corporation	,, 21	1,997	+ 117	7	14,338	+ 717
Carlisle Tramways Co.	,, 21	205	+ 19	20	3,684	+ 281
Central London Railway	,, 21	6,549	- 432	21	144,987	- 1,908
Chatham & Dist. Lt. Rys.	...	...	...	...	...	...
City & South London Rly.	,, 22	2,656	- 255	21	68,436	- 2,848
Cork Electric Trams Co.	,, 19	488	- 80	20	8,199	- 397
Darwen Corporation	,, 20	266	+ 37	7	1,668	- 67
Devonport & Dist. Trams.	,, 18	482	+ 66	19	8,981	+ 1,247
Dover Corporation	,, 21	201	- 15	8	1,518	- 107
Dublin & Lucan Railway	,, 22	122	+ 9	21	2,100	+ 135
Dublin Southern District	,, 20	220	+ 286	¶21	90,653	+ 2,177
Dublin United	,, 20	4,064	+ 107			
Dudley—Stourbridge	,, 13	770	+ 85	19	14,655	+ 644
Dundee Corporation	,, 18	880	+ 44	...	...	...
East Ham Council	,, 21	771	+ 111	7	5,499	+ 712
Gateshead & Dist. Trams	,, 13	886	+ 38	19	16,497	+ 886
Glasgow Corporation	,, 21	14,855	+ 876	51	696,752	+ 60,128
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 13	226	- 8	19	4,967	+ 614
Gt. Northern & City Rly.	,, 21	877	- 50	14	13,022	...
Greenock & Port Glasgow	,, 13	585	+ 14	19	9,274	+ 674
Halifax Corporation	,, 11	1,235	+ 160	7	9,598	+ 1,880
	,, 18	1,389	+ 243			
Hartlepool Tramways	,, 18	259	+ 80	19	4,897	+ 511
Huddersfield	,, 21	1,266	+ 59	7	9,259	+ 647
Hull Corporation	,, 21	2,095	+ 307	7	15,191	+ 1,154
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	,, 18	189	...	...	...	...
Ipswich Corporation	,, 21	461	...	7	3,192	...
Isle of Thanet Co.	,, 21	512	+ 26	...	...	...
Kidderminster & District	,, 18	106	+ 1	19	1,958	- 72
Kirkcaldy Corporation	,, 18	216	- 80	20	4,914	...
Lanarkshire Trams Co.	,, 19	645	...	20	11,871	...
Leeds Corporation	,, 21	5,589	+ 187	8	44,965	+ 3,648
Liverpool Corporation	,, 14	9,976	+ 160	20	193,954	+ 4,535
Liverpool Overhead Rly.	,, 22	1,643	- 6	21	32,806	+ 188
London County Council	,, 14	10,588	+ 1,292	§6	63,752	+ 13,326
Lowestoft	...	...	...	...	...	...
Manchester Corporation	,, 21	11,991	+ 180	7	82,060	+ 1,717
Mersey Railway	,, 21	1,471	+ 246	20	29,467	+ 6,695
Merthyr	,, 13	188	...	19	3,723	+ 208
Middleton	,, 13	284	+ 17	19	5,107	+ 101
Nelson Corporation	,, 21	108	+ 48	8	895	+ 412
Newcastle-on-Tyne Corp.	,, 21	3,686	+ 407	20	70,099	+ 9,068
Newport (Mon.)	,, 21	481	+ 178	7	2,558	+ 1,010
Oldham, Ashton & Hyde	,, 13	502	- 41	19	9,740	- 529
Oldham Corporation	,, 8	1,069	...	10	11,168	...
	,, 15	1,107	...			
Perth (W. A.) Elec. Trams.	,, 20	1,250	+ 194	20	27,310	+ 3,790
Peterborough	,, 13	161	+ 26	19	2,867	- 190
Poole and District	,, 18	284	+ 1	19	4,597	+ 50
Portsmouth Corporation	,, 21	1,781	+ 92	18	18,486	+ 1,372
Potteries	,, 13	1,654	+ 108	19	31,646	+ 2,607
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 13	71	- 12	19	1,220	+ 45
Salford Corporation	...	...	...	...	...	...
Sheerness	,, 11	46	- 35	19	904	- 286
Sheffield Corporation	,, 22	4,629	+ 82	§8	37,578	+ 1,067
Southampton Corporat'n	,, 19	953	+ 14	...	...	...
Southend Corporation	,, 18	307	+ 39	7	1,974	+ 170
Southport Tramways	,, 18	293	+ 30	19	5,063	+ 362
S. Staffordshire Trams.	,, 13	741	- 92	19	14,461	- 12
Stockport Corporation	,, 20	571	+ 298	7	8,735	+ 1,524
Sunderland Corporation	,, 22	1,260	+ 37	7	8,761	+ 257
Swansea Trams	,, 13	485	+ 31	19	9,035	+ 344
Taunton Trams	,, 13	50	- 7	19	946	- 69
Tynemouth and District	,, 13	220	- 19	19	4,224	- 149
Tyneside Trams Co.	,, 18	865	+ 55	20	5,996	+ 904
Wallasey District Council	,, 21	682	+ 21	§7	4,997	+ 216
Walsall	...	...	...	...	...	...
Warrington Corporation	,, 19	304	- 8	7	2,127	+ 28
West Ham Corporation	,, 19	788	...	12	6,494	...
Weston-super-Mare	,, 11	76	+ 12	19	762	- 30
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 13	354	+ 2	19	6,652	- 260
Worcester	,, 13	287	+ 132	13	3,707	+ 1,548
Wrexham	,, 13	131	+ 27	19	2,012	- 107
Yorkshire Woollen District	,, 13	548	+ 259	19	10,887	+ 4,585

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 8 days. ¶ Plus 8 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., May 25	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS 6 DAYS TO MAY 25		SHARE.	LAST DIVIDEND	NAME.	Price Wed., May 25.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS 6 DAYS TO MAY 25.	
						Highest.	Lowest.							Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.						**TELEPHONES.**		£ s. d.			
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	5½—5¾	4 18 0	April, Oct	5¼	5⅜	5	3/0	Chili Telephone (fully paid,	4¾—5¼	5 14 3	August ..	5⅛	5
St.	6%	Do. Permanent 6% Deb. Stock	130 —135	4 11 3	..	..	..	St.	6%	National Co. Pref. Stock	104 —106	5 13 3	..	105½	10
t.	34/2	Auckland Elec. Trams 5% Deb. (red.)	98 —100	..	..	100	—	St.	5%	Do. Def. Stock	87 —90	5 11 2	..	87	..
10	10/0	Barcelona Tramways Ord.	6 —8	6 5 0	..	7½	..	10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 —13	4 12 4	Feb, Aug	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..	10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 6	..	..	..	5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref...	5 —5½	4 15 3	Feb, Aug	5⅜	5⅜
100	5%	Do. 5 per Cent. Debs.	96 —99	5 1 9	..	..	..	St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.) ...	98 —100	3 11 0	June, Dec	98½	..
1	..	Bath Elec. Trams Pref. Ord.	¾—1	..	..	..	..	St.	4%	Do. 4 per Cent. Deb. Stock (red.).....	103 —105	3 17 0	..	104	103¾
1	..	Do. 5% Cum. Pref.	¾—1	..	..	..	..	..	..	Do. Do. Prov. Certs. 70% to be pd.	30 —32	..	..	30⅝	30¼
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..	1	0/6¾	Oriental	⅞—1⅛	6 6 8	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4½	5 17 8	..	..	..	1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	6 4 6	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	100	..	5	3/0	United River Plate	5½—6	5 16 8	July.....	..	..
10	3%	Bristol Tramways and Carriage Ord. ...	18 —19	4 4 2	Feb, Aug	..	..	5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 8	June, Dec	..	..
10	4%	Do. Cum. Pref. (fully paid)	10½—10⅝	3 17 8	..	..	..	St.	5%	* Do. 5 per Cent. Deb. Stock (red.).....	103 — 106	4 15 10	June, Dec	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..			**ELECTRICITY SUPPLY.**					
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100 —103	5 16 6	..	..	..	1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅛—⅜	..	..	..	..
St.	5%	Do. Pref. Ord. Stock	99 —102	5 0 0	..	101½	..	1	0/8¾	Do. 7% Cum. Pref.	1 —1¼	5 12 0	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10¾	5 11 7	..	..	..	St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	120 —125	3 12 0	..	..	..
4	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104¾	4 6 7	..	..	..	10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..	10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	British Electric Traction Ord.	9½—10	8 0 0	..	10	9⅜	10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—10⅝	5 11 6	Feb, Aug	10 1/16	10⅜	10	4/0	Do. 4½ per Cent. Deb. Stock (red.) ...	101 —104	4 6 7	..	103½	..
St.	5/0	Do. 5 per Cent. Perpetual Debs	115 —118	4 6 3	..	117⅞	116⅜	St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	3/0	Buenos Ayres and Belgrano Ord	2⅜—2⅝	5 3 9	..	..	..	5	5/6	Brompton & Kensington Elec. Sup. Ord.	10⅜—11½	4 5 1	..	10⅜	..
5	3/0	Do. 6 per Cent. "A" Cum Pref.....	5⅜—5⅝	5 4 4	..	..	..	5	3/6	Do. 7 per Cent. Pref.	10½—10⅝	3 5 1	Mar, Sept	..	..
5	3/0	Do. "B"	5 —5⅛	5 9 1	..	5 1/16	..	5	4/0	Calcutta Electric Supply Ord.	7 —7½	4 13 4	..	7⅜	..
St.	5%	Do. 5 per Cent. Debs.	106 —109	4 18 6	..	..	..	St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	107 —110	3 14 1	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	100 —103	4 19 0	..	103	—	5	4/0	Charing Cross & Strand Electric Sup.	7½—7¾	5 3 3	Feb, Aug	7⅝	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	96 —101	5 0 0	..	..	..	5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 5 9	Feb, Aug	5⅛	..
5	3/6	Calcutta Tramways	7 —7½	4 0 0	..	7 1/16	7⅛	5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	..	..	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —109	4 3 7	..	..	..	5	1/7	Do. Do. (19 8).....	4¼ - 5	..	..	4 13/32	..
1	1/0	Cape Electric Tramways Shares	2 —2½	7 11 1	..	2 1/16	2 1/16	St.	4%	Do. 4% Deb. Stock (red.).....	103 —105	3 17 6	..	104	..
St.	4%	Central London Ordinary Stock	91 —94	4 5 1	June, Dec	93¾	91½	St.	4½%	Chelsea Electric Supply Ord.....	6¼—6⅝	4 1 5	March ..	6 1/16	..
St.	4%	Do. 4 per Cent. Pref. Stock	101 —104	3 17 8	..	..	..	*	Do. 4½ per Cent. Deb. Stock (red.) ...	107 —110	4 3 0	Jn, Dec ..	..	..	
St.	4%	Do. Deferred Stock	85 —88	4 11 3	..	..	..	10	5/0	City of London Electric Lighting Ord.	10¾—11½	4 9 0	Feb, Aug	11⅛	10⅛
10	4%	Do. 4 per Cent. Debs.	110 —113	3 10 9	..	..	..	10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½ - 5	5 0 0	..	..	..	St.	5%	* Do. 5 per Cent. Deb. Stock (red.).....	121 —126	3 19 4	Jn, Dec ..	122	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..	St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	..	..
St.	2%	City and South London Rly. Con Ord.	51 —52	4 11 4	Feb, Aug	51⅛	51⅜	10	4/0	County of London Elec Supply Ord...	7½ - 8½	4 14 3	..	..	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891) ...	123 —126	4 0 0	Feb, Aug	124⅜	..	10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	..	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..	St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106 —109	4 2 11	..	108	107
St.	5%	Do. (1901)	119 —122	4 2 10	..	..	..	St.	4½%	Do. Second Deb. Stock Prov. Certs..	99 —102	4 8 3	..	101	..
St.	4%	Do. 4 per Cent. Perpetual Debs	105 —109	3 18 5	May, Nov	108	106⅜	St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	90 —95	..	..	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	99 —102	4 18 3	..	101½	100	5	3/6	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 8	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..	St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 8 0	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..	10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
10	1/8¾	Gt. Northern & City Rly. Prf. Ord. (4%)	5 —6	5 0 0	..	..	..	5	5/0	Hove Electric Lighting Ord.	7⅞—8¼	5 0 0	..	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..	St.	4½%	I of W. Elec Lt. & Power 4½% Db St (red.)	101 —103	4 7 6	..	..	..
10	10%	‡ Imperial Tramways Ord	18 —19	5 5 3	Mar, Sept	..	..	1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅛—⅜	..	..	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..	5	7/0	Kensington & Knghtsbdge Ord.....	11½ —12½	4 16 0	..	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..	5	6%	Do. 6 per Cent. 1st Pref.....	6½—7	4 5 9	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..	5	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..	3	..	London Electric Supply Ord.	1½—1¾	..	..	..	..
10	1½%	Liverpool Overhead Railway Ord	4¼ —4½	3 1 1	Feb, Aug	..	..	5	3/0	Do. 6 per Cent Pref.	4½—5	6 0 0	..	4⅝	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..	St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 —98	4 2 11	Mr, Jn, S, D	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	4 0 0	Jan, July	..	..	10	9 6	Metropolitan Electric Sup. Ord.	19½ —20½	4 5 6	April, Oct	19⅛	..
10	5/0	London United Trams. 5% Cum. Pref..	11 —11½	4 7 0	..	11⅜	11	5	1/4½	Do. 4½ per Cent. Cum. Pref.....	5⅜—5⅝	4 1 0	..	5⅜	..
St.	4%	Do. 4% 1st Mort. Deb. Stock.....	102 —104	3 18 0	..	103⅜	102⅛	St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec ..	..	..
St.	..	Mersey Con. Ord. Stock.....	6 —9	..	..	..	..	St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 —100	3 11 0	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..	100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..	10	6/0	Notting Hill Electric Ord.....	12½ —13½	4 8 11	March....	..	..
1	..	Metropolitan Electric Trams Def	⅜—½	..	..	..	..	5	4/0	Oxford Electric Ord.	5½—6⅜	5 13 0	March ..	5⅛	5⅛
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	..	..	..	St.	4%	Do. 4% Deb. Stock	98 —101	4 0 3	..	..	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..	1	..	Rand Electric.....	⅞—1	..	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922).....	105 —107	4 5 0	..	..	..	*		Royal Elec., Montreal 4½% 1st Mt. Deb.	99 —102	4 8 3	April, Oct	..	..
5		New Gen. Tract. 6 per Cent. Cum. Pref.	1 —2	..	May	..	..	5	9/6	St. James' & Pall Mall Elec. Ord.....	14 —15	4 16 8	Feb, Aug	14⅛	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	100—103	4 19 0	..	..	..	5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	8⅛	8
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..	St.	3½%	Do. 3½ per Cent. Deb. Stock (red.) ...	97 —100	3 10 6	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	9 1/16	9⅜	5	4/0	Smithfield Markets Electric Sup. Ord...	3 —3½	5 14 3	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	..	..	St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..	5	3/0	South London Electric Supply Ord.....	3⅜—4⅛	3 10 7	..	..	..
1	..	Do. 6% Pref. (£1 paid).....	..	..	April, Oct	..	..	5	2/6	Urban Electric Supply Ord.	4⅛ 4¼	5 2 6	..	4⅛	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..	5	2/6	Do. 5% Cum. Pref.	4⅛—4¼	5 2 6	..	..	..
St.	3%	Waterloo and City Ord.	90 —93	3 7 7	June, Dec	..	..	5	7/0	Westminster Electric Supply Ord.	12½ - 13½	5 0 0	Mar, Sept	13 1/16	12⅜
		TELEGRAPHS.						5	2/6	Do. 5 per Cent. Cum. Pref.	6½ —6¾	3 14 0	..	..	..
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 6	Jan, July	..	..			**ELECTRIC MANUFACTURING &c.**					
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..	1	..	Aron Elec. Meter 6% Cum. Pref.	¼—⅜	..	..	1 1/16	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..	5	4/0	British Insulated & Helsby Cables Ord.	5¼—5⅜	6 19 2	July, Feb	5⅜	..
St.	12/6	Anglo-American.....	49 —52	5 12 4	F, My, Ag, N	..	..	5	3/0	Do. 6 per Cent. Pref.....	5½—5¾	5 4 4	Jan, July	..	..
St.	25/0	Do. Preferred.....	94 —96	6 0 0	F, My, Ag, N	95½	94½	5	3/0	Do. 4½% 1st Mort. Deb. (red.)	102 —105	4 7 0	..	..	..
St.	2/0	Do. Deferred	7¼—7¾	1 5 10	F, My Ag, N	7 15/16	..	St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
100	$2	Commercial Cable Capital Stock	175 —185	4 6 6	Jn, Ap, Jy, O	..	..	5	3/0	British Westinghouse 6% Pref.....	3½—4	7 10 0	..	3⅜	3 15/16
St.	4%	Do. 4 per Cent. Deb. Stock	94 —96	4 3 9	Jn Ap, Jy, O	96	..	St.	4%	Do. 4 per Cent. Mort. Deb. Stock ...	88 —91	4 10 0	..	90⅜	..
10	5/0	Cuba Submarine Ord.	7 —8	7 10 0	Feb, Aug	7½	..	2	..	Brush Electrical Engineering	1—1	..	March ..	..	..
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb, Aug	..	..	2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1—1½	..	Mar, Sept	..	..
5	2/0	Direct Spanish Ord.....	2½—3½	5 14 4	April, Oct	..	..	St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.....	7 —8	6 5 0	April Oct	..	..	St.	4½%	Do. Perpetual 2nd Deb. Stock	73 —78	5 17 8	Jan, July	..	..
50	4½%	Do. 4½ per Cent. Deb.	99⅝—102⅝	4 9 8	Jan, July	..	..	5	5/0	Callender's Cable Construction Ord. ...	10½—11½	6 10 5	Jan, July	..	..
20	3/0	Direct United States Cable	10½—10⅝	6 0 11	Ja, Ap, Jy, O	10⅜	..	5	2/6	Do. 5 per Cent. Cum. Pref.....	5½—5⅝	4 6 11	Jan, July	..	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 —102	4 9 6	Jn, Dec ..	..	..	St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (rd.)	104 —108	4 3 3	Nov, May	..	..
St.	25/0	Eastern Ordinary	126 —131	5 7 0	Ja, Ap, Jy, O	131	128	1	7½d.	Gastner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 —89	3 18 8	Ja Ap, Jy, O	88	..	St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104 —107	3 14 9	May, Nov	106	105	3	1/6	Crompton and Co. (Nos. 1 to 54,000) ...	1⅜—2⅛	6 18 4	Jan, July	..	..
10	6/6	Eastern Extension	11⅜—12⅜	5 14 0	Ja, Ap, Jy, O	12⅛	11⅛	100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96 —99	5 2 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	104 —107	3 15 6	Feb, Aug	..	..	5	..	Dick, Kerr & Co. Ord.....	7⅜—8½	..	..	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	99 —102	3 19 0	Feb, Aug	..	..	5	3/0	Do. 6% Cum. Pref.	5 —5⅛	5 9 1	..	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞—101⅞	3 19 3	May, Nov	..	..	St.	4½%	Do. 4½% Deb. Stock	102—104	4 7 2	..	..	..
10	20.0	Great Northern (of Copenhagen)	25 —26	5 15 6	Jan, July	25⅜	25⅛	5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅛—⅜	..	Feb, Aug	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 —102	4 9 6	June, Dec	..	..	5	..	Do. (£5 paid)	¼—1½	..	Feb, Aug	..	..
25	37/6	Indo-European	42 —46	5 11 2	May, Nov	45	43½	St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 8 11	June, Dec	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..	St.	5%	Do. 5 per Cent. 2nd Deb. Stock	74 —79	6 6 7	..	..	..
10	2/0	West African Telegraph Shares	5⅛—6⅛	3 1 6	..	..	..	5	2/6	Edmundson's Elec. Corp. Ord.....	5⅜—6⅛	5 12 0	H'lf-yearly	6	..
2½	..	West Coast of America	1/16—⅜	..	..	..	..	5	3/0	Do. 6 per Cent. Cum. Pref.....	5⅜—6	5 0 0	..	5⅛	5⅛
100	4%	Do. 4 per Cent. Debs.....	97 —100	4 0 10	Jan, July	..	..	St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105 —108	4 4 6	..	107⅛	106½
10	..	West India and Panama.....	⅜—½	..	May, Nov	..	..	2	1/2½	Electric Construction Co.	1⅜—1⅝	7 2 10	Jan, July	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 7	May, Nov	6 1/32	6 3/16	2	2/9½	Do. 7 per Cent. Cum. Pref.....	2½—2⅝	5 2 0	July	..	..
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	..	..	St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 18 4	Jan, July	..	..	St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	3/0	Western Telegraph	12⅜—13⅛	5 6 6	Mr, Jn, O, D	13⅛	12⅝	10	5/0	General Electric (1900) 5% Cum. Pref...	9⅛—9⅜	5 2 6	..	..	..
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 17 9	June, Dec	..	..	St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	100 —103	3 17 8	..	..	..	5	9/0	Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	11⅝	..
		FINANCIAL, INVESTMENT, &c.						5	2/3	Do. 4½ per Cent. Pref.	5 —5¼	4 1 10	Feb, Aug	..	..
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5¼	5 9 1	..	..	..	St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 — 111	4 1 5	Feb, Aug	..	..
10	2/0	Globe Telegraph and Trust	9 —9½	5 15 8	Ja Ap, Jy O	9 1/16	9	10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 7	Feb, Aug	19½	..
10	3/0	Do. 6 per Cent. Pref.....	13 —13½	4 8 11	Ja Ap, Jy, O	13⅜	13 1/16	100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 5	Mar, Sept	..	..
8	4/0	Reuter's	6¼—7¼	5 6 8	April, Oct	..	..	10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
100	6%	Submarine Cables Trust (Cert.)	117 —122	4 18 4	April, Oct	..	..	12	36/0	Telegraph Construction & Mainten'ce.	85 —88	6 2 0	Mar, July	88	..
								100	4%	Do. 4 per Cent. Deb. Bonds, 1909.....	101 —104	3 17 8	Jan, July	101½	..
								5	..	Willans and Robinson Ord.	2½—3½	..	Apr, Oct	..	..
								5	..	Do. 6 per Cent. Cum. Pref.	3½—4½	..	Apr, Oct	..	..
								St.	4%	Do. 4 per Cent. 1st Mort. Debs.	90 —95	4 5 9	May, Nov	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

No further nominations having been received, the Council of the Institution of Electrical Engineers for next session will be constituted in accordance with the list published in our issue of April 29th. Mr. R. K. GRAY will continue as President, and will retire later on in the session in favour of Mr. ALEXANDER SIEMENS, who has already occupied the presidential chair once before, in 1894. The choice of the two new Vice-Presidents, Mr. MORDEY and Mr. PATCHELL, has been welcomed by all the members of the Institution; they have done good service on the Council and well deserve the honour conferred upon them. Mr. GAVEY, who is one of the retiring Vice-Presidents, remains on the Council as an ordinary member, and Mr. HIRST and Mr. SPARKS, who have been on the Council before, have once more been chosen as members. The new members are Dr. R. T. GLAZEBROOK, Director of the National Physical Laboratory, Mr. J. S. HIGHFIELD, Engineer-in-chief to the Metropolitan Electric Supply Co., and Mr. C. H. MERZ, Consulting Engineer to the Newcastle-upon-Tyne Electric Supply Co. and the North-Eastern Railway, Co., and part author of the excellent Paper on power-house design, which provoked the best discussion we have had this session at the Institution. As Associate Member of Council Mr. DUDDELL retires and is replaced by Mr. T. MATHER, an old friend of all old Central Technical College students. The Local Sections are represented on the Council by their Chairmen. Taken as a whole, the Council is thoroughly representative of all interests, and the members of the Institution of Electrical Engineers may leave the management of affairs in its hands with full confidence.

WE publish in another column the complete programme for the Incorporated Municipal Electrical Association meeting this year. As at the last London meeting, the majority of the Papers are on thoroughly technical subjects, and to judge by their titles and the names of their authors, both the Papers and the discussions upon them should be of exceptional interest. A large attendance of members and Corporation delegates is expected, and the number of visitors is to be limited this year, only those receiving special invitations from the Council being expected.

SYSTEMS of wireless telegraphy are already so numerous, and each particular system sustains year by year so many modifications, that Prof. FESSENDEN'S new method, described in another column, may too easily be passed over and its real novelty escape unnoticed. Whether this last proposed "system" prove practicable or not, it is, at any rate, ingenious, and seems plausible and even promising. Its novelty consists in making signals between a pair of tuned stations by varying the period of the radiation from an uninterrupted torrent of sparks—that is, by throwing the sender in and out of tune—instead of by utilising, as has been usual, controlled spasmodic discharges. With the method at present universal, since any kind of electrical kick will set any wire-condenser system into electrical vibration, the spark-gap dots and dashes are inevitably reproduced, more or less strongly, in every neighbouring receiver of any number in or out of tune with the transmitter. With Prof. FESSENDEN'S method all receivers not syntonised to a transmitter suffer merely an equable excitation, and yield no trace of the signals if the changes of period at the transmitter end be but small enough; while the tuned receiver responds sufficiently if these changes of period be but large enough. Evidently the practicability of the method depends on the magnitude of the frequency

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variation necessary to produce intelligible signals at the tuned station, this magnitude being, at the same time, limited by the presence of the stations it must not affect. When the number of stations in an area is small, the system should prove easily workable, and mutual interference be perfectly suppressed. The new method is, by the way, one which lends itself admirably to the application of those detectors which its inventor has adopted—detectors, that is to say, of the type relying on the heating effect of the electromagnetic radiation received.

YEARS ago Prof. RUTHERFORD, whose researches on the emanations of radium have since made him famous, discovered the effect produced on the magnetisation of iron by Hertzian waves, and showed that the magnetic detector was quite comparable in sensitiveness with the coherer. This was long before Mr. MARCONI had laid claim either to the invention of Hertzian wave signalling or to the magnetic detector of his own peculiar pattern. As nothing has been heard of the magnetic detector for some months, it may be assumed that it has not been found to have any practical advantage over the coherer. But now Prof. ARNÒ, of Milan, comes forward with an article of considerable interest describing a new magnetic detector in which the initial magnetisation is given by a rotatory magnetic field produced by polyphase currents in the manner devised by the lamented Prof. FERRARIS. We refer our readers to another column for the description of Prof. ARNÒ'S instrument.

ON another page of this issue will be found an abstract of a Paper on "American Electric Automobile Delivery Waggons," read by Mr. HIRAM PERCY MAXIM before the Automobile Club of America. The first point of interest lies in the fact that official trials of such vehicles have actually been organised and carried out, and, moreover, the result appears to have been highly satisfactory in that 15 out of the 17 vehicles which entered were still running when the contest closed. On more than one occasion we have commented on the fact that the Automobile Club of Great Britain and Ireland has vainly endeavoured to organise trials, and now it is to be hoped that the success of the American club will stimulate the British society to further efforts. The data relating to costs and maintenance given by Mr. MAXIM are exceedingly interesting, and, if reliable, should prove of considerable value. It should be noted, however, that he assumes a charge of 2 cents per kilowatt-hour if the battery is charged from a private installation and 4 cents if taken from the mains of a supply undertaking. Taking the mean, he then bases his calculations on 3 cents per kilowatt-hour as the price of energy, which appears somewhat low for an occasional demand.

EVEN in America there is apparently some scepticism as to the capabilities of the Edison battery, and Mr. MAXIM is of opinion that the repairs on a heavy vehicle would be rather considerable. It appears, moreover, that a 2,000lb. waggon equipped with a lead battery costs $2,500, whereas a similar vehicle equipped with Edison cells costs $505 more; the latter effects a saving in weight of 375lb., but actually requires, if the author is correct, 60 per cent. more energy than is necessary for charging a lead battery. In spite of these defects, however, there is a net saving per ton-mile of 13 per cent. It may interest our readers to mention, in passing, that a syndicate for the manufacture of the Edison cell in England is being formed, and that a site for works is already being sought.

IN another column of this issue will be found a brief account of the development of the Poulsen telegraphone since its last visit to London a year ago. When the apparatus was first exhibited in this country soon after the Paris Exhibition of 1900, everybody was impressed with the perfect manner in which it reproduced speech, and the apparent direct applicability of the instrument for employment as an auxiliary to the telephone, and it has been disappointing that such slow progress was made in adapting it to commercial use. When the circumstances are propitious, the present pattern has been found to give good results, and we trust that the instruments will now be thoroughly tested in connection with ordinary telephone instruments under practical working conditions.

AS will be seen from our article, arrangements have now been fitted to one pattern of the instrument by means of which it may be automatically switched on to a telephone line so as to receive a call and record a message in the absence of the subscriber. Whatever may be the conditions on the Continental telephone systems, we venture to suggest that the automatic switching-in of the instrument will not give sufficiently reliable results on the London telephone network. As a beginning, at any rate, it would be best to dispense with the automatic starting device, and encourage the subscriber to place the telegraphone in charge of a clerk during his absence. The calling subscriber will then know whether the message has been properly received and recorded. So long as the present methods of telephoning are followed in London, in the majority of cases all the telegraphone would record within two minutes of the ring-up would be, "Are you there? Don't go away; Mr. ——— wants to speak to you." Moreover, even when this difficulty is overcome, a device will have to be added by which the calling subscriber can cause the instrument to repeat the message back to him; so that he can know that it has been duly recorded. However, we wish the instrument every success, and feel confident that if the details of its application to existing conditions are only properly worked out by engineers well acquainted with these conditions, the telegraphone has a prosperous future before it.

LAST Friday evening, before Lord KELVIN and a very full audience, H.S.H. the Prince of MONACO discoursed in an entertaining manner on "The Progress of Oceanography." Other departments of the subject having been dealt with in Mr. BUCHANAN'S lecture last May, the branch selected was that of marine zoology. Although, as the lecturer pointed out, organisms can be dredged from depths as great as 3,000 fathoms, yet the biology of the intermediate strata of the ocean would appear to present a rich field of research, of which only the fringe has yet been touched. An obvious reason for this absence of information in the case of the larger fauna, lies in their strength and ability to elude capture, so

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that some of them have to be studied by the aid of their *disjecta membra* in the stomach of the sperm whale. In this way, for instance, the lecturer had discovered, not only new genuses, but hitherto unknown types of submarine life. His oceanographic explorations, which have now been carried on for some 20 years, assisted by a staff of an international character, render valuable service to more than one of the sciences, amongst which that of submarine telegraphy may justly be included.

SINCE the conclusion of the South African war, the Rand Central Electric Works have made considerable progress. The chairman, Sir C. RIVERS WILSON, in his speech at the annual general meeting, which is reported in our columns, called attention to the serious difficulties with which they were beset during the war, resulting in a deficit of £22,993 at the beginning of 1903. All efforts at obtaining recognition from the Home Government have been fruitless, and this in spite, it is said, of great services rendered in connection with the continued lighting of Johannesburg. However, they have wisely determined to abandon any further attempts in this direction, and have written off their losses from a reserve fund. It is gratifying to learn that the undertaking was so successful in 1903 that the deficit was reduced to £11,948, and that the anticipated profits to date have been such as to wipe out even this remainder.

THE curves, published in our Correspondence columns, relating to the calculation of the iron losses of electric machines are of great value to dynamo designers, coming, as they do, from such experts on these matters as Messrs. PARSHALL and HOBART. According to the investigations of STEINMETZ and others, the hysteresis loss is proportional to the 1·6th power of the flux density and to the frequency of magnetisation, and the losses due to eddy currents are proportional to the square values of the flux-density, the frequency and (within practical limits) to the thickness of the laminations. These two sources contribute to the iron losses, but each follows, as is seen, quite different laws, and, from an academical standpoint, it would not be permissible to combine the two and to plot the iron losses as a function of the product flux density and frequency. However, the conditions as to flux densities and frequencies obtaining in practice do not deviate too widely from certain accepted figures, and, viewed from the standpoint of the practical designer, the empirical curves given by Messrs. PARSHALL and HOBART are valuable, as they indicate a useful short cut in the calculation of electrical machinery. The curves would have gained in value if the authors had stated for what thickness of stampings they were determined

Royal Society.—Amongst the Papers down for reading yesterday were the following:—"On the Aurora Borealis and the Electric Charge of the Sun," by Prof. Svante Arrhenius, communicated by the president; "The Advancing Front of the Train of Waves Emitted by a Theoretical Hertzian Oscillator," by Prof. A. E. H. Love, F.R.S.; "On the Magnetic Changes of Length in Annealed Rods of Cobalt and Nickel," by Dr. S. Bidwell, F.R.S.; "On the Electric Effect of Rotating a Dielectric in a Magnetic Field," by Dr. H. A. Wilson, communicated by Prof. J. J. Thomson, F.R.S.

Opening of Darlington Tramways.—A portion of the Darlington Corporation electric tramways, a brief description of which appeared in *The Electrician* of May 20th, p. 170, were formally opened on Wednesday, and it is expected that the remainder will be sanctioned by the Board of Trade in a few days.

Emden–Azores–New York Cable.—The laying of the duplicate cable section of the Deutsch-Atlantische Telegraphengesellschaft between Fayal, Azores and New York was completed on Wednesday evening, giving the company two direct routes between Germany and the United States.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 18, 1902
Reissi–Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Dakar—Konakry	May 13, 1904
Gibraltar—Tangiers	May 17, 1904

University Honours.—The University of Cambridge will bestow the degree of D.Sc. *honoris causâ* upon the Hon. C. A. Parsons, F.R.S., M. Pierre Curie, Sir Andrew Noble, F.R.S., Sir William Crookes, F.R.S., Prof. J. J. Thomson, F.R.S., Prof. A. R. Forsyth, F.R.S., Prof. Dewar, F.R.S., and Prof. Larmor, secretary of the Royal Society. The University of Oxford will bestow a similar degree upon Mr. Marconi.

Lectures on Electro-chemistry.—With a view of establishing next session at the Manchester Municipal School of Technology systematic courses of study in the applications of electricity to chemistry, an introductory course of four lectures on "The Present Position of Electro-chemical Engineering" will be given by Prof. W. W. Haldane Gee on Thursday evenings, commencing June 9th, in the Physical Lecture Theatre. The lectures will commence at 7:30 p.m., and admission can be obtained on payment of a registration fee of 1s.

Tramway Extensions in London.—On Monday the service of electric tramways which connect Westminster and Blackfriars bridges with Brixton was extended from Brixton station to Water-lane. Rapid progress is being made with the electrification of the remainder of the line, which extends to Streatham, and the opening of the entire route is expected within a few weeks. All these lines form part of the London County Council tramways system.——The official inspection of the new route of the London United Tramways from Hammersmith Broadway to Uxbridge took place on Wednesday and the line was opened for traffic yesterday, Thursday.

Institution of Gas Engineers.—The annnal general meeting of the Institution of Gas Engineers will take place from Tuesday to Thursday next at the Institution of Mechanical Engineers, Storey's-gate, Westminster. Among the Papers to be read are the following:—"Roadways and their Relationship to Various Public Services," by A. E. Broadberry; "Ten Years' Experience with the Prepayment Meter," by Alfred Colson; "The Flow of Gas in Mains and Distribution at High Pressures," by Prof. W. C. Unwin, F.R.S. On Wednesday morning, June 8th, a lecture will be delivered by Prof. H. B. Dixon, F.R.S., on "The Mechanism of Combustion."

Thunderstorms.—Numerous thunderstorms broke over the South of England and the Midlands towards the end of last week and during this week, without, however, doing great damage. According to the daily papers, a man was killed last Friday by lightning while at work on the tower of the new Wesleyan Church at Long Eaton, and a horse was struck on Tuesday at Sapcote. On Friday the Grange at Ramsgate, noted for its architectural beauty, was struck by lightning and set on fire. By the time the fire was detected and overpowered a large part of the building had been destroyed. It is reported from Rotherham that four telegraph lines in Warwick-street in that town were severed by lightning on Tuesday.

Obituary.—With Dr. Friedrich Siemens, who died last week in Dresden, Germany, the last of the celebrated brothers of that distinguished German family has passed away. Dr. Siemens was born in 1826 at Menzendorf, near Lübeck, and received his education in that town. In 1848 he came to England to introduce his brother's (Dr. Werner Siemens)

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telegraphic apparatus. Afterwards he worked with his other brother, the late Sir William Siemens, and succeeded in applying the latter's regenerative principle to furnaces in combination with gaseous fuel, thereby making possible the production of open-hearth steel and the melting of glass by the continuous process in tanks. He also invented the regenerative gas burner and stove, and brought out numerous inventions connected with the glass industry.

Running Powers on Tramways.—As a result of the decision of the House of Lords Committee that running powers over the Newcastle Corporation tramways should be granted to the Tyneside Tramways Co., and of the determination of the Corporation to oppose the company's bill in the House of Commons in consequence (*The Electrician*, Vol. LII., pp. 916, 931 and Vol. LIII., p. 3), negotiations have taken place between the Tyneside Tramways Co. and the Newcastle-upon-Tyne Corporation with a view to settlement. The Corporation expressed willingness to accept the company's proposals with one or two alterations. The company had proposed that the Corporation should run cars from Newcastle into the centre of Wallsend on two routes, paying to the company ½d. for every passenger carried in Wallsend, and the Corporation asked that they should be allowed 3½d. per car-mile to cover running costs. The Corporation also offered to work the service to Gosforth Park on race days, paying to the company half the special fare to be charged on the company's portion of the line. This is how matters stand at present, but the company do not consider the Corporation's suggestions acceptable.

International Association of Academies.—The science section of the General Assembly of the International Association of Academies met in London last Friday, the president (Sir Michael Foster, M.P.) in the chair. The following resolutions were carried, and afterwards confirmed by the Association:—

Proposed by Prof. Credner: That the committee proposed by the resolution of Prof. von Bezold carried at the morning sitting of May 26th consist of the following:- MM. Schuster (chairman), de Lapparent, Mojsisovics, Agamennone, Karpinski and Mendenhall.

By Prof. Riecke: That the committee for the investigation of atmospheric electricity be constituted as follows:—MM. Edner (chairman), Arrhenius, Mascart, Righi, Schuster, Ebert and Riecke.

By Prof. Schuster: That the committee on terrestrial magnetism be constituted as follows:—MM. von Bezold (chairman), Mascart, Palazzo, Sir A. Rücker, Lord Kelvin, MM. Bauer, Litzner, Rijkatchen and Wieckert.

By Prof. von Bezold: That the three committees as above appointed are empowered to add to their number by co-opting new members without power of voting, and that if a vacancy occur in the members of a committee, the committee shall have the power to fill up such vacancy subject to confirmation by the International Association.

The members of the International Council of Academies were entertained to a complimentary banquet by the Lord Mayor on Tuesday evening.

Keyham College open to Private Students.—The following statement has been issued by the Admiralty:—

Owing to recent changes the accommodation at the Royal Naval Engineering College is now more than sufficient for the number of engineer cadets under training for H.M. Navy. In view of the exceptional opportunity for training in marine engineering and naval architecture which is afforded by the course, combining as it does theoretical study in the college with practical work in the dockyard, the Admiralty have made arrangements for the admission of a limited number of supplementary cadets as private students over and above the number of cadets entered for the service. Students so admitted will have the same advantages as the ordinary engineer and constructor cadets in respect both of the college residence and training and of practical work in the dockyard, without being under any obligation to enter His Majesty's service at the end of their period of training. The course of training taken by the students will be the same as that laid down for engineer cadets or cadets of naval construction, and will last for the same period, but it will be open to them to withdraw at any time. On the completion of the training no employment can be guaranteed, but in the event of vacancies occurring among the engineer cadets owing to exceptional causes, an opportunity will be given to the private students to compete for such vacancies, and, if selected, they will be eligible for commissions in the Royal Navy under the same conditions as the engineer cadets. They will also be eligible for admission at the end of the course to the Royal Naval College, Greenwich, under the conditions applicable to private students generally. They will be required to pay a fee of £75 per annum to cover the cost of board and residence in the college, tuition and practical instruction in the yard. The fee will be payable in three equal instalments at the beginning of each term. While under training they will be under the same regulations as to discipline, uniform, pay, leave, &c., as apply in the case of ordinary cadets. No student will be admitted without satisfactory evidence of character and of general education and ability to profit by the college training. A copy of the regulations affecting engineer cadets and of the syllabus of instruction can be obtained on application to the Secretary of the Admiralty. As only a small number of private students can be admitted, application should be made immediately, in any case before June 7.

The Electric Lighting Acts.—We referred in our issue of April 29th to the fact that the St. Pancras Borough Council was convening a conference of local authorities in order to discuss the question of petitioning the Board of Trade for the repeal or modification of clause 17 of the Electric Lighting Act, 1882, and clause 77 of the Electric Lighting Clauses Act of 1899. It has now been arranged that this conference shall take place to-morrow (Saturday) at the St. Pancras Town Hall, Pancras-road, N.W., at 12 noon. The object of the conference, as officially set forth, is:—

To consider as to the advisability of petitioning the Board of Trade to promote legislation for the repeal or modification of the undermentioned and similar clauses in the Electric Lighting Act and Electric Lighting Orders, so as to prevent actions being taken against undertakers unless serious damage or nuisance is occasioned through the carrying on of their works, and also for empowering the undertakers in that event to compulsorily acquire the interests which are affected thereby, viz.:—

Clause 71, St. Pancras (Middlesex) Electric Lighting Order, 1883—"Nothing in this order shall exonerate the undertakers from any indictment, action or other proceeding for nuisance in the event of any nuisance being caused by them."

Clause 17, Electric Lighting Act, 1882—"In the exercise of the powers in relation to the execution of works given them under this act, or any licence, order or special act, the undertakers shall cause as little detriment and inconvenience and do as little damage as may be, and shall make full compensation to all bodies and persons interested for all damage sustained by them by reason or in consequence of the exercise of such powers, the amount and application of such compensation in case of difference to be determined by arbitration."

The Manchester Section of the Institution of Electrical Engineers.—In the fourth report of the Manchester Section of the Institution of Electrical Engineers it is stated that the meetings were well attended, the average number present being about 187, as against 118 last year. The membership is now as follows: 73 members, 180 associate members, 194 associates, 102 students; total 549, the total membership last year being 472. The students' section has a membership of about 250, and three meetings have been held at which the average attendance was 100 members. An interesting departure was the joint meeting with the Liverpool Engineering Society at Liverpool. About 120 members availed themselves of the opportunity kindly afforded by Messrs. the British Westinghouse Electric and Mfg. Co. of inspecting the works of the Mersey Railway Co., and thanks are accorded to these two companies for the facilities given the visitors for a complete examination of the whole of the equipment. Regarding the central institution for the scientific societies of Manchester, the committee have nothing further to report except that the question is under the consideration of the joint committee. The report concludes with an expression of thanks to the council of the Owens College and to Dr. Schuster in allowing the use of the new physical laboratory for the meetings of the section. A list of the council for the session 1904-5 was published in our issue for April 15th.

British Association.—The preliminary arrangements in connection with the British Association meeting at Cambridge this year, which commences on Wednesday, August 17th, and concludes on Wednesday, August 24th, has now been published. The sectional officers include the following:—

Section A: Mathematical and Physical Science—President: Prof. Horace Lamb, F.R.S. Vice-Presidents: C. Vernon Boys, F.R.S., Sir John Eliot, F.R.S., Prof. A. R. Forsyth, F.R.S., Prof. J. J. Thomson, F.R.S. Secretaries: C. H. Lees (Recorder), A. R. Hinks, R. W. H. T. Hudson, W. J. S. Lockyer, A. W. Porter, W. C. D. Whetham, F.R.S.

Section G: Engineering—President: Hon. C. A. Parsons, F.R.S. Vice-Presidents: Col. R. E. Crompton, C.B., C. Hawkesley, Prof. B. Hopkinson. Secretaries: W. A, Price (Recorder), W. T. Maccall, J. B. Pearce.

Prof. Sydney Young, F.R.S., will be President of Section B (Chemistry); Prof. William Smart, President of Section F (Economic Science and Statistics); and the Right Rev. the Lord Bishop of Hereford, President of Section L (Educational Science).

The first general meeting will be held on Wednesday, August 17th, at 8:30 p.m., when the Right Hon. A. J.

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Balfour, D.C.L., M.P., F.R.S., President-Elect, will assume the presidency, and deliver an address. On Thursday, August 18th, at 5 p.m., a lecture will be given by the Registrar (Mr. J. W. Clark) on "The Origin and Growth of the University of Cambridge." Other lectures will be delivered on Friday, August 19th, and Monday, August 22nd, but they are not of electrical interest. Sectional meetings will be held on Thursday, Friday, Saturday, Monday and Tuesday, and on the Saturday also visits to places of interest in the neighbourhood will be made. The Guildhall, Cambridge, will be the Reception Room. Tickets may be obtained at Burlington House from July 4th until August 11th. After this date application must be made in the Reception Room, Cambridge.

Incorporated Municipal Electrical Association.—We are now able to give a complete programme of the ninth annual convention of the Incorporated Municipal Electrical Association, which will be held at Derby, Nottingham and Sheffield from June 29th to July 2nd.

Wednesday, June 29th.

MEETING AT DERBY, at 10 a.m., at the Technical College, Green-lane, Derby. (*Note.*—Members staying in Nottingham will leave from the Midland station at 9:5 a.m., due at Derby at 9:34 a.m., returning to Nottingham by an ordinary train.) The Worshipful the Mayor of Derby (Councillor B. Boam, J.P.) and the members of the Electricity and Tramways committees have kindly consented to be present and welcome the Association. Presidential address by Mr. T. P. Wilmshurst, chief electrical engineer, Derby. The following Papers will then be read and discussed:—(1) "The Commercial Practicability of Electric Traction by Surface Contacts," by Mr. C. E. C. Shawfield, chief electrical engineer, Wolverhampton; (2) "The Organisation and Management of a Central Station Meter Department," by Mr. A. J. Cridge (associate), Sheffield. 12:45 p.m.—Cold luncheon at the Royal Hotel. 2:35 p.m. (Midland station).—Excursion to Chatsworth House and Haddon Hall, by the invitation of the Mayor and Corporation of Derby. Ladies accompanying members and visitors are invited to join this excursion. Invitations will be issued direct by the Corporation. The electricity station and Osmaston-road car shed of the Derby Corporation will be open for the inspection of members and visitors at all times throughout the convention. The works of the Brush Electrical Engineering Co., Loughborough, will also be open for inspection during the convention.

Thursday, June 30th.

MEETING AT NOTTINGHAM, at 10:15 a.m., at University College. (*Note.*—Train leaves Derby, Midland station, at 9 a.m., due at Nottingham at 9:25 a.m.). The Right Worshipful the Mayor of Nottingham (Councillor A. Page, J.P.) has kindly consented to be present to meet and welcome the Association. The following Papers will then be read and discussed:—(1) "Polyphase Sub-stations; their Equipment and Working," by Mr. S. L. Pearce, chief electrical engineer, Manchester; (2) "Some Notes on the Bristol Electricity Works Fire," by Mr. H. Faraday Proctor, chief electrical engineer, Bristol. 1:15 p.m.—Cold luncheon at the George Hotel. 2:30 p.m.—Special cars will convey members and visitors to the electricity stations and refuse destructor, after which a visit will be paid to the Trent Bridge car depot and repairing shops. (*Note.*—Members who so wish can afterwards visit the Nottingham exhibition, which is being held in grounds adjacent to the car depot.) The Association dinner, followed by a smoking concert, will be held at the Mechanics' Institute, Nottingham, at 6:30 for 7 p.m. (evening dress). For the convenience of those coming from Derby, dressing-room accommodation will be provided at the George Hotel, where visitors' luggage may be deposited on arrival in the morning. The last train for Derby leaves Nottingham, Midland station, at 11:30 p.m.

Friday, July 1st.

MEETING AT SHEFFIELD, at 10:15 a.m., at the Town Hall, by kind permission of the Right Hon. the Lord Mayor. (*Note.*—Train leaves Nottingham, Great Central station, at 8:59 a.m., due at Sheffield 9.52 a.m. Train will leave Derby, Midland station, at 8:45 a.m., due at Sheffield at 10 a.m.). The Right Hon. the Lord Mayor of Sheffield (Councillor J. R. Wheatley, J.P.) has kindly consented to be present to meet and welcome the Association. The following Papers will then be read and discussed:—(1) "Boiler House Economies," by Mr. R. S. Downe, chief electrical engineer, Southport; (2) "The Financial Position of Municipal Electrical Undertakings," by Councillor J. R. Blakeway, chairman of the Electricity committee, Southampton. 1 p.m.—Cold luncheon at the Royal Victoria Hotel. 2:30. p.m.—Special cars will leave the Royal Victoria Hotel for the following works:—Visit No. 1: To Messrs. Hadfield's Steel Works, Tinsley. (Invitations will be issued direct by Messrs. Hadfield.) Alternative visits:—Corporation tramways, Kelham Island, and Corporation electricity works, Neepsend. (*Note.*—The Corporation electricity works, Commercial-street, which is near the Midland station, may be inspected at any time during the day or evening.) Members will return to Nottingham and Derby by any of the ordinary trains.

Saturday, July 2nd.

MEETING AT DERBY.—The annual general business meeting of the Association will be held at 10:30 a.m. in the Technical College, Green-lane, Derby, when all members, associate members and associates are particularly requested to attend. Corporation delegates other than members are invited to attend this meeting, but are not entitled to vote. (*Note.*—Train leaves Nottingham at 9:42 a.m., due at Derby 10:18 a.m.) Agenda.—(1) Election of President for 1905. (2) Place of meeting for Convention, 1905. (3) Election of officers and Council for 1905. (4) Annual report of the Council. (5) Balance-sheet for year ended December 31, 1903. (6) Presentation of associates' prize. (7) Any other competent business. A special general meeting of the Association will be held immediately after the business meeting for the purpose of considering a proposed revision of the articles of association with regard to "qualifications for membership," details of which will be previously sent to the members. It is suggested that the members should spend the week-end at Matlock Bath, the Royal and the New Bath hotels being recommended.

Electrical Trade Section of the London Chamber of Commerce.—At the last meeting of this section several matters of interest to the electrical industry were dealt with. The section considered and generally approved the provisions of the Supply of Electricity Bill—subject to slight modifications on points of detail—as being a necessary measure which will have the effect of removing the difficulties which have arisen in the past in the development of the electrical supply industry. (The Council of the Chamber subsequently endorsed the views of the section and resolved to address the President of the Board of Trade expressing the hope that in view of the urgency of legislation on the lines of the bill, the Government might see its way to grant facilities for its passage during the present session of Parliament.) A discussion also took place with regard to certain draft regulations arising out of the report of the Departmental Committee on Electricity in Mines, which, it was suggested, would affect the electrical industry generally as well as the mining industry in particular, and might also become the basis of future regulations affecting the whole electrical industry. A resolution was passed (and has since been confirmed by the Council of the Chamber) to the effect that the attention of the Home Office should be called to the matter, with a request that any draft-proposed regulations which may be under consideration may be submitted to the Chamber in order that the electrical section may have an opportunity of considering the same and submitting their remarks to the Home Office before the regulations are put into force. The Valuation Bill, as affecting electrical and other large industrial undertakings, was also considered. Certain general objections were made to the bill, more especially (*a*) that it is unsound in principle that a great spending authority such as a county council should itself be the valuation authority, (*b*) that the bodies which will control the assessments are themselves competing with traders, (*c*) that the valuation authorities will appoint expert valuers, and that there is no security under the bill that the system of payment according to the amount of the assessment secured by their efforts will be discontinued, (*d*) that there is no machinery by which a ratepayer can appeal to a competent independent court. It was agreed to co-operate with other sections of the Chamber in giving effect to the views of the section and bringing them before Members of Parliament. The Council of the Chamber subsequently referred the matter to its General Purposes committee for early action.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

THURSDAY, June 9th.

INSTITUTION OF ELECTRICAL ENGINEERS.

5 p.m. Annual General Meeting at 92, Victoria-street, Westminster. This will be followed by a special General Meeting to confirm the alteration in the Articles of Association passed on May 19th.

FARADAY SOCIETY.

8 p.m. Meeting at the Institution of Electrical Engineers, 92, Victoria-street, S.W. Papers to be read: (1) "The Hard and Soft States in Metals," by G. T. Beilby; (2) "The Electric Furnace: Its Origin, Transformations and Applications," by A. Minet.

FRIDAY, June 10th.

PHYSICAL SOCIETY.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda:—(1) "Projection of the Indicator Diagrams of a Petrol Motor," by Prof. H. L. Callendar, F.R.S.; (2) A Model Illustrating the Propagation of a Periodic Electric Current in a Telephone Cable and the Simple Theory of its Operation. by Prof. J. A. Fleming, F.R.S.; (3) Exhibition of a Gyroscopic Collimator, by M. E. J. Gheury.

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POWER STATION DESIGN.*

DISCUSSION.

(*Concluded from p. 227.*)

Thursday, May 12th.

Mr. A. VENNING criticised the statement in the Paper that the whole power station might cost even more than £40 per kilowatt. A small station with 100kw. sets would run out at £26 or £27 per kilowatt for buildings, and for plant £35 per kilowatt. On the other hand, in a large station, the plant itself would only cost £18 per kilowatt with slow-speed engines, and the buildings might figure out at £5 or £6 per kilowatt. This could not be called extravagant for a station with slow-speed engines and built on fairly good lines. A station using turbines was now being built where the total cost would run out to £14 or £15 per kilowatt, and the buildings would only cost £2 per kilowatt out of this. With regard to the economy of production and reliability of supply, the authors had quite lost sight of organisation. There was a great diversity of opinion on the question of steam piping. Naturally everyone wished to go by the shortest possible way, but where there was one header running parallel to the boilers and divided into sections, all the sections should be coupled together, for there might be a unit at one end of the header which was out of order for the time being, and if the sections of steam pipe were not interconnected the section serving the unit which was out of order was of no use in serving the remaining units. In the Neptune Bank station the authors had placed a chimney at each end of the station with economisers, but this was the very thing which it was stated elsewhere in the Paper should be avoided. The economisers, also, had been placed right under the wall, and he doubted, in case of a breakdown, whether it would be possible to get the tubes out to replace them. The Paper also drew attention to the mixture of plant seen in stations, yet in this very station there were four or five different types of prime movers, viz., high-speed three-crank, slow-speed four-crank and turbine. The question of steel frame structures for the buildings was all right as far as it went, but in certain localities it would be found that the borough surveyor had drawn up a set of regulations in connection with this, and if he put up a steel frame structure he would be breaking his own regulations. Concrete would be decidedly more expensive than brickwork. With regard to corrugated iron he did not think many people would tolerate a tin building in a nice locality in London for instance. Even in the Yorkshire power scheme, where capital expenditure had been kept to the very lowest, they had rejected corrugated iron. Uralite, however, might be used in connection with cheap power stations, because it was non-conducting and stood the weather very well indeed and was cheap in the first instance. There was nothing new in a right-angle station. In 1890 a 20,000 H.P. station had been put down in Boston, U.S.A., and another was built by the Edison Company in the same city—viz., the Albany-street station. Furthermore, at the latter station, the workshop, offices and other buildings were put quite apart from the generating station. The basement seemed a sore point in the Paper, but the basement had originated with James Watt when he put the condensing plant below the floor in his earliest engines, and it had been maintained in the textile industries. In American electric light stations it had been found to be cheaper to do this than to have a long trench for foundations and to timber the whole lot up. There was a decided advantage in a basement over either trenches or wells or pits. Trenches were usually simply receptacles for rubbish and dirt. It was sometimes thought that trouble would arise in basements through the water affecting the vacuum, but this idea was through want of knowledge of condensers. It was very well known that the water re-evaporated in the vacuum, and there need be no trouble on that point. He certainly thought, however, that the condensing plant was far better placed above the floor. It was quite as good looking as a main engine, so why should it not be placed there? He though the arrangement of the roofs in the Carville station was a bad one, there being no less than seven or nine spans. Consequently, there were four valleys, and as these were the most expensive part of a building, he thought it was possible to have extended the roof and made it run parallel with the bricks, and so have had simply one valley with a proportionately lower cost. This arrangement of the authors might have been caused by the flues, but if these were supported by the roofs it was a bad design. The whole question of an economiser was whether it economised or not. Where coal was at 4s. 6d. to 6s. per ton it did not pay to put in economisers; but when coal cost 15s. or 16s. per ton, an economiser was certainly a valuable addition to any plant. But in many economising plants too many tubes were put in. If half the number of pipes were used and a feed heater, it would be a far better arrangement and cheaper. The authors were mistaken in saying that the American practice was to omit economisers; 25 or 30 years ago economisers were put in, and one of the first was at the Albany-street station, Boston. In some Yew York stations economisers with 8,000 or 10,000 pipes were installed. Another point was that in the early days they simply took the feed water from the city mains where in the winter the water was below freezing point. It would never have done to put that direct into the economiser, so the heater was applied and the water was put in comparatively warm. They were told that the foundations for turbines were cheap, but they should not be led away by this. With vertical turbines of large size only a small space was required, but this was not so in the case of parallel turbines. One point worth mentioning was that with vertical turbines of small size existing works could be extended without any alteration in the existing foundations.

Mr. W. H. PATCHELL said that although this was one of the most interesting Papers he had ever read, it was disappointing because of the want of facts contained in it. The Paper told how to put down stations for a low price per kilowatt, but there were not two lines to say what a station had actually cost nor what the running costs had been. The question of buildings he had followed with some interest. The Paper suggested a steel structure with possibly a corrugated iron screen. In London this was not permitted, and, indeed, he (Mr. Patchell) had not been allowed to go as far as he would like to. He had wanted to adopt this principle some years ago to a certain extent, but the London County Council would not have it. A steel building, they said, was not a permanent building, and they could only grant a temporary licence for such a structure. Just at that time the Tower Bridge was opened, and as this was a steel structure he asked the Council if the sanctioning of this had been an oversight. With regard to foundations, it was not right to say that there should not be a basement. In stations with which he had been connected the foundations had had to be dug out in order to get the proper strata to stand the machinery upon, and it was then cheaper to have a basement. The remarks in the Paper as regards switch gear were very interesting, and he hoped the authors would have something more to say of their practical experience with switch gear, and more particularly with regard to excess and time relays. He was looking for a good time relay now. One which was sent him a few days previously certainly opened the main switch a certain number of seconds after the short, but even if the short were removed before the switch opened, the time arrangement went on merrily and the switch opened all the same a few seconds later.

Mr. H. L. LEACH wanted further information as to costs. He also asked if the figures in the Paper referred to units generated or units sold. He presumed they were units generated. He exhibited the table below, in which for the Newcastle-on-Tyne Company the coal figure worked out at 0·15d. per unit generated, with the fairly low load-factor of 13·98 per cent. Messrs. Merz and McLellan estimated the same 0·15d. with a load-factor of 30 per cent. Bradford worked out at 0·234d. with 20 per cent. It would be interesting if the authors would give some figures as to what output their curves were based upon. He presumed they were based upon the Carville power station. The question of steam piping was a very important one. Very few central station engineers would agree to work on what might be called a watertight compartment system—*i.e.*, special boilers for special units of plant. He did not think the authors had given sufficient consideration to the use of reciprocating engines. As a matter of fact, the Newcastle Company was working partly with reciprocating engines

* Paper by Messrs. C. H. Merz and Wm. McLellan before the Institution of Electrical Engineers. See *The Electrician* of April 29th, p. 49, May 6th, p. 88, May 13th, p. 135, May 20th, p. 185, and May 27th, p. 225.

Table *showing Relative Cost per Unit Generated in London and Provincial Electricity Works.*

Year of Working.	Station.	Units generated.	Per unit generated.				Works costs.			Load-factor.	Cost per kw.
			Coal.	Oil, water and stores.	Wages.	Repairs.	Engine room costs.	Int. & dep. at 10%.	Total costs.		
			d.	d.	d.	d.	d.	d.	d.	%	£
..	Merz and McLellan	..	0·150	0·020	0·044	0·036	0·250	0·275	0·525	30·00	30
1902	Newcastle-on-Tyne Co.	* 7,345,786	0·150	0·023	0·082	0·105	0·360	1·187	1 547	13·98	51
1902	Bradford Corporation.....	10,125,189	0·234	0·045	0·072	0·117	0·468	0·498	0·966	20·93	33
1902-3	Brighton Corporation	* 8,122,966	0·603	0·060	0·187	0·170	1·020	0·704	1·724	17·38	43
1902-3	Edinburgh Corporation	10,196,954	0·246	0·035	0·070	0·194	0·545	0·908	1·453	14·31	37
1902-3	Glasgow Corporation	13,197,612	0·226	0·043	0·122	0·252	0·643	0·748	1·391	14·01	33
1902-3	Leeds Corporation	* 5,931,533	0·210	0·023	0·127	0·105	0·465	1·533	1·998	12·31	43
1902	Liverpool Corporation	*25,762,314	0·333	0·054	0·135	0·117	0·639	0·623	1·262	25·11	32
1903	City of London Co.....	*17,419,352	0·374	0·026	0·161	0·297	0·858	..	..	12·26	..
1902	City of London Co...	*17,676,786	0·472	0·040	0·176	0·304	0·992	1·633	2·625	12·07	66
1902	St. James' and Pall Mall Co.	7,338,971	0·601	0·064	0·176	0·185	1·026	1·079	2·105	17·69	61
1902	City and South London Railway ..	† 3,781,087	0·310	0·046	0·056	0·028	0·440	..	..	49·20	..

Note.—The figures for interest and depreciation and cost per kilowatt refer only to cost of land, buildings, machinery and plant. * Calculated from units sold at the following efficiencies of distribution:—Newcastle, 75 per cent.; Brighton, 85 per cent.; Leeds, 75 per cent.; Liverpool, 90 per cent.; City of London, (1903) 85 per cent., (1902) 80 per cent. † For half-year ended June 30, 1902.

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and partly with turbines, and this showed that good results could also be obtained with reciprocating engines. The results at Bradford also indicated the same thing. He agreed with the authors, however, as to the advantages of turbines. The use of mechanical stokers was not viewed favourably in the Paper, but he disagreed with this for many reasons, and chiefly on account of the smoke question.

Mr. C. H. MERZ, in reply, said that the kind interest which had been taken in the Paper was the more gratifying because the Paper had only consisted chiefly of the compilation and discussion of a series of principles, the correctness of which most engineers would naturally be prepared to admit. These principles, however, if individually admitted, had not previously been classed together and analysed and arranged in a form which the authors had endeavoured to do, and especially not for a station of as large a capacity as those which had been discussed. The authors did not certainly claim in any way that they were pioneers in central station design, or in any particular design. They had shown specially the design of a station by Messrs. Sargent and Lundi, the eminent American engineers who had designed Mr. Insull's station at Chicago. These gentlemen, who had probably designed more central stations than anyone, had adopted in all essential features the same arrangement that had since been adopted at Carville. It was difficult for a manufacturer, or, indeed, for any engineer who had not actually had to consider the design of a whole station, to realise clearly the relative importance of the various components both from a technical and a commercial point of view. Needless to say, a manufacturer's opinion as to an individual piece of apparatus was of great value; but, when it became a question of assembling apparatus in a station, other considerations than the cost or the degree of efficiency of a particular piece of apparatus naturally stepped in. For instance, it was of no interest to hear from one manufacturer that he could supply switch gear equally efficient and at half the price of that of another manufacturer, if, when that switch gear was assembled and put into a sub-station or generating station, it resulted in a large expenditure of extra capital on the buildings. For this reason they were particularly indebted to those engineers—Mr. Jenkin, Mr. Patchell, Mr. Steinitz and Mr. Venning—who had actual experience of the design of large stations, and who had been good enough to express their views, and to criticise the Paper. The curves, which had been much discussed, had been drawn to be sufficiently near for purposes of design. They did not represent ideal figures. The figures quoted had only been mentioned in order to show how the curve was drawn, and he might say that, unquestionably, they would get considerably below these figures at Carville—in fact, they had already got below them in the comparatively old Neptune Bank station. The same applied to the figure of £30 per kilowatt. In passing he might mention that, on Mr. Leach's table, there was shown the figure of £51 per kilowatt for the costs of the Newcastle-on-Tyne undertaking. In a company which had grown as rapidly as the Newcastle-on-Tyne Company, the difference between the costs at the beginning of the year and at the end of the year were so enormous, and the difference between the load-factors and the outputs so large, that no published costs were of very much value. Major-Gen. Webber and other speakers had asked the authors to give the actual figures at Newcastle-on-Tyne and Major-Gen. Webber had also been good enough to allude to the figure of £20 per kilowatt which had been given by himself (Mr. Merz) in evidence before a Parliamentary Committee two years ago. It was not thought that at the present moment it was quite in the interests of the companies whose designs and figures had been used, nor was it entirely fair to manufacturers, that they should give the actual costs per kilowatt which were expected or had been obtained at Carville, but this much could be said—namely, that the figures were very much below £20 and also that the running costs would be very much below the figures in the Paper. The authors agreed with Mr. Addenbrooke who mentioned that the coal line in the curve ought really to rise where a low load-factor was reached. It had already been explained that this chart was only drawn with the idea of getting a general view of the question and not with the idea of being theoretically accurate down to the very lowest fraction of a penny. The authors were very much interested also in the various remarks as to the relative costs of gas engines and steam engines, and particularly in those of Mr. Addenbrooke, who referred to the use of gas engines in the South of England. Of course, they were not prepared to say that under all conditions and in all localities steam would be better than gas; but it was hardly necessary to say that, in their opinion, it was certainly better in the case of a power station located on the Tyne. The essential difference in the two designs shown by Mr. Jenkin and the design of the two stations shown by the authors was that in the former there were several generating units supplied from one steam main or two duplicate pipes, in which case, of course, there was a ring main. In the design which had been put forward in the Paper, the essential point was that one large unit was coupled to its own boilers, and not that there should be a group of boilers feeding a group of engines. Yet it seemed to the authors that, in cases where smaller units had to be adopted and where, therefore, several boilers might have to feed several engines, the advantages of a right-angled boiler house were a good deal reduced. The authors agreed with Mr. Steinitz and also Mr. Patchell that basements came naturally in the design of some stations. Nevertheless, they did think that if that was the case, the basement, unless it was a very deep one, should be left open, and only a gallery put round the turbines or the engines, leaving all the pipes and everything else open to view. Mr. Venning had rather missed the point in the Paper in this respect, and had assumed that, because they objected to basements, they liked trenches. What they had wanted to do away with was obviously both of them. Mr. Kilburn Scott had talked of a two-storey boiler house and engine room, and had been good enough to send him privately a sketch of what he had advocated. But the authors could not say that the arrangement appealed very much to them. Mr. Scott proposed to put a concrete floor between the base of the turbine and the dynamo part of it, and thus entirely separate the two; but the difficulty of not being able to get an overhead crane over all the steam machinery, which was the part that needed most repairs, was very great, and no engineer would adopt such a design.

Mr. PATCHELL: Is that on the turbine that the repairs are so heavy?

Mr. MERZ: On the steam machinery.

Mr. PATCHELL: I though the point was that there were no repairs on the turbine.

Mr. MERZ: The turbine is part of the steam machinery, and it is the steam machinery as a whole that requires more repairs than the electrical gear.

Mr. SCOTT said he had left a space all round the generator which could be covered up with iron plates which could be removed so that a crane could be let through to the bottom floor.

Mr. MERZ: In that case it practically becomes a gallery round the turbine.

Mr. SCOTT: I do not agree with that at all.

Mr. MERZ, continuing, said that Mr. Venning and Mr. Patchell had criticised the suggestion in the Paper that money should not be spent in bricks and mortar. They could see that in certain cases the reputation of the engineer might depend more upon the external architecture of his building than upon his costs, but they would wish to point out specially that a limit had been put upon the scope of the Paper by saying that it essentially covered power station design—in other words, the design of stations supplying large areas—and one of the assumptions which it was fair to make was, therefore, that the station should be outside the town where land was cheap and where all the advantages of the so-called power scheme could be had. In such cases they certainly still thought that the use of corrugated iron was not only the most economical, but lent itself to extensions and alterations in a way that bricks and mortar could not possibly do. Mr. Venning mentioned the question of using concrete instead of brick work, but this was quite a misunderstanding; they had not recommended that. In connection with the rating of plant the authors entirely agreed with the remarks of Mr. Steinitz, and were therefore necessarily at variance with Mr. Dykes, who had suggested that it was hardly correct to state that the steam engine had a greater overload capacity than the gas engine, in view of the fact that gas engines need not always be operated up to their full-load capacity. This was perhaps a prevalent view and an ordinary way of making comparisons as to capital costs between gas engines and steam engines, but it was obviously not the right one, because if a steam generator could give 50 per cent. overload for two hours it increased the capital costs very little no matter what its economy. When dealing with stations which had to supply with a 100 per cent. load-factor the question was somewhat modified, but of course no power supply scheme could hope to have such a load-factor, and with ordinary load-factors the question of overload capacity was one which would help in the reduction of the capital cost, which had been shown was at least one-half the total cost of production, to a greater extent than any other feature. The authors thought that this section of the Paper was the one which had been least criticised, but they certainly considered it the most important. Mr. Jenkin called attention in this connection to the fact that he thought it was necessary always to have two spare units, one unit which could be undergoing a regular overhaul while the other spare unit would act as a stand by to the running units. But they hardly considered this necessary under the usual conditions of power supply, which were that a station had not to operate up to its peak load for more than three months in the year, and during those three months only for two hours a day. They thought that in a station operating under these conditions the overload capacity of the machines was well able to take care of the sudden breakdown of one unit, as in such a station it might be assumed that the plant was put into thorough working order before the heavy season came on. If, however, it was necessary under certain conditions, as it no doubt was, to have two spare units such as had been described, they did not think it was necessary to reduce the size of the units as much as was sometimes done. At first sight, it would seem more economical in capital cost to provide two spare units out of a total of eight than two out of a total of five. But a little calculation would show that this was not so. Take an ordinary station for power supply purposes, having a maximum load of 3,000kw. In one case eight 500kw. machines could be put in, six giving the necessary 3,000kw. and two spare, or five 1,000kw. machines, three giving 3,000kw. and the other two spare. But it would be found that the five 1,000kw. units cost less to instal than the eight 500kw. machines, and the annual cost would also be less. The saving would be very great because, especially with steam turbines, of the saving in labour by the adoption of bigger units and the saving in coal. Mr. Jenkin also referred to the advisability of operating auxiliaries from the 'bus bars and not from the individual units direct. The authors would like to discuss that matter further because they were of the opinion that considerable economy in capital was possible by operating auxiliaries direct from the unit and not going in for the elaborate switch gear necessary for stationary transformers operated from the 'bus bars, but there was hardly time to do so. With regard to switch gear, they quite appreciated the pioneer work done by Mr. Andrews, and, needless to say, they regretted, with Mr. Andrews, that, when they had to advise upon the switch gear at Newcastle, an English manufacturer could not be found who could show a switch capable of dealing with the loads which had to be dealt with. It was not certain that they would have asked to see such a switch which had been actually adopted on a large scale, but it was not even possible to see a model in a manufacturer's works. It seemed to the authors that if manufacturers wanted to go in for large switches, it would not be a very expensive thing to make, at any rate, one complete sample. To close contracts on the basis of designs having to be submitted and criticised and altered was almost an impossi-

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bility when time was an essential element in the case. Mr. Jenkin had referred to the desirability of operating the switch gear mechanically instead of electrically. But in all cases of automatic overload it was necessary to trip the switches electrically, and therefore there could not be much objection to also putting them in electrically. Mr. Patchell had asked for further information as to overload relays and reverse-current relays. Only this much could be said—viz., that at the present moment no combination of an overload relay and reverse-current relay would satisfactorily protect a system against faults. It was impossible to get any overload relay or reverse-current relay operating at the two ends of a feeder, for instance, which, under certain conditions, would not come out when it was not wanted to and which would always come out when it was wanted to. Therefore the authors were sorry to say that the only conclusion was that at the present moment there was no relay on the market which would fulfil all the requirements.

Mr. Merz has also sent us the following reply to some of Mr. Venning's remarks, with which there was no time to deal at the meeting:—

Mr. Venning also referred to the drawing showing the general arrangement of site at Neptune Bank, and criticised the placing of chimneys at each end of the station which might be considered as interfering with extensions. On referring again to the site arrangement, however, it will be seen that there is no more room for extension on this particular site. As soon as the company obtained another site it was decided to finish off this station and not to extend it any further. With regard to the variety of prime movers at Neptune Bank, one of the requirements which were laid down as essential features of correct design was that due consideration should be given to possible changes in the type of prime mover. Thus, in this case the reciprocating engines were installed first, turbines being installed later, after they had been developed in larger sizes. Mr. Venning also referred to a very interesting point—namely, the question of dividing the roof up into a series of spans as against having one big span. Up to a certain size, of course, one span is cheaper than two or more, but above a certain size it will be found that it is much cheaper and more convenient to divide up the roof into narrower spans, especially if the arrangement of plant is such that these spans need not all be the same height. In any case, if heavy columns and elaborate bracing has to be erected to support the bunkers, it is obviously the cheapest possible arrangement to avail oneself of these columns to carry a roof span, and thus the multiple span roof as against the single span roof naturally results.

CAPE TOWN CORPORATION ELECTRICITY WORKS.

(Concluded from page 221.)

The exhaust trench also accommodates the cables leading from the dynamos to the switchboard, which is placed on a gallery 10ft. above the engine-room floor line midway along one side of the engine room. This switchboard, which is of the plug type built by Messrs. Cowans, consists of 13 enamalled slate panels, upon which the usual controlling switches, 'bus bars and instruments are mounted for controlling the generating sets and feeders. From the centre earth panel all panels on one side are positive and all on the other negative, machine and feeder panels being placed alternately. Three pairs of 'bus bars are provided, and by means of plug switches any machine or any feeder may be placed on to any pair of bars. In addition to this, each machine is provided with an Andrews automatic reverse current breaker on one pole, and a single-pole quick-break knife switch on the other. The feeders are also provided with quick-break knife switches on each pole. The centre panel contains a large Weston illuminated dial station voltmeter, which can be plugged on to any pair of 'bus bars. Edgewise voltmeters are also provided for both machines and 'bus bars for switching-in purposes. Each machine is provided with an edgewise ammeter and Thomson wattmeter, and each feeder with an edgewise ammeter. In addition to these panels, two street lighting, two station lighting, one power panel and one balancer panel are also provided. The power panel controls all motors in use at the station, and was supplied by Messrs. Cowans, Ltd. The balancer panel and balancers were supplied by the Electric Construction Co. There are two of the latter machines, one capable of dealing with an out-of-balance current of 200 and the other 100 amperes. Both machines are similar in detail, the magnets are compound-wound and cross-connected and work continuously at 220 volts. The armatures run at a speed of 1,000 revs. per min., and give 200 to 250 volts on the generating side. In the tests of the smaller machine a 50 per cent. overload was applied for two hours, and the rise in temperature was 80°F.; on applying a 100 per cent. overload for 15 minutes the temperature rose through 85°F., and the sparking, at first very slight, disappeared on a slight change being made in the position of the brushes. Subsequently, 1,000 volts alternating current was kept on for five minutes between the frame of the machine and all live conductors. For this test, the armatures and field coils of both machines were connected together and pressure applied between these and the frame. The insulation withstood this test perfectly. In a test under working conditions, the compound field coils came into action, and the self-regulation was exceedingly close. The 22kw. set also came out satisfactorily, but its behaviour under heavy overloads was not so good as that of the smaller set. Considering, however, that the Electric Construction Co. had to build the machines in an incredibly short time, they are to be congratulated on having turned out such excellent apparatus.

A 20-ton overhead hand-power travelling crane of 45ft. span by Messrs. Craven Bros. runs the whole length of the engine room, and also over the condenser room.

The condensing plant includes one grease separator of the baffle type, through which the exhaust steam is passed before reaching the condensers; one Worthington condenser, with steam-driven air and circulating pumps, capable of dealing with 20,000lb. of steam per hour; and one surface condenser, with electrically-driven air and circulating pump supplied by Messrs. Cole, Marchent and Morley, the capacity of which is 40,000lb. of steam per hour. All the plant is of the firm's standard design and is capable of dealing easily with the amount of steam mentioned and running for long periods with the minimum of attention. Messrs. Cole, Marchent and Morley provided the whole of the exhaust pipework, together with sluice valves and automatic exhaust relief valves. The air pump is of the Edwards type. The Worthington cooling tower is in the form of a cylindrical tower having a diameter of 12ft. for a height of 20ft. then tapering down to a diameter of 10ft. 6in. up to a total height of 80ft. The shell is made of steel plates riveted together, the plates being strengthened and the circular shape maintained by circumferential angle iron rings placed at suitable intervals up the tower. At the bottom of the tower is placed a grid consisting of a number of wrought-iron bars placed at 4in. centres and held in position by suitable gauge plates. This grid is for the purpose of carrying the filling in the tower. The filling consists of galvanised iron sheets rolled into pipe form having a diameter of 4½in. Each of these pipes is 2ft. in length, and they are stacked in the tower on the top of the grid just referred to until sufficient cooling surface has been provided in the tower to obtain the desired cooling results. In the case of the Cape Town tower there are eight layers of these galvanised iron pipes, all the pipes being interlocked one with the other. The water is delivered to the top of this filling and is distributed over the same by means of revolving arms, thereby ensuring

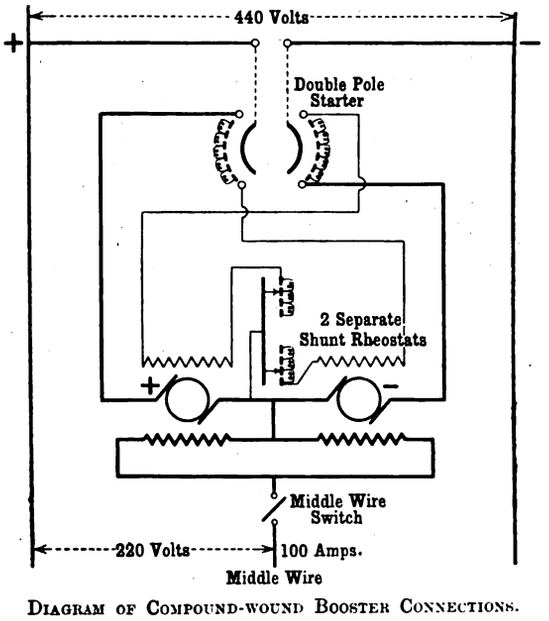

Diagram of Compound-wound Booster Connections.

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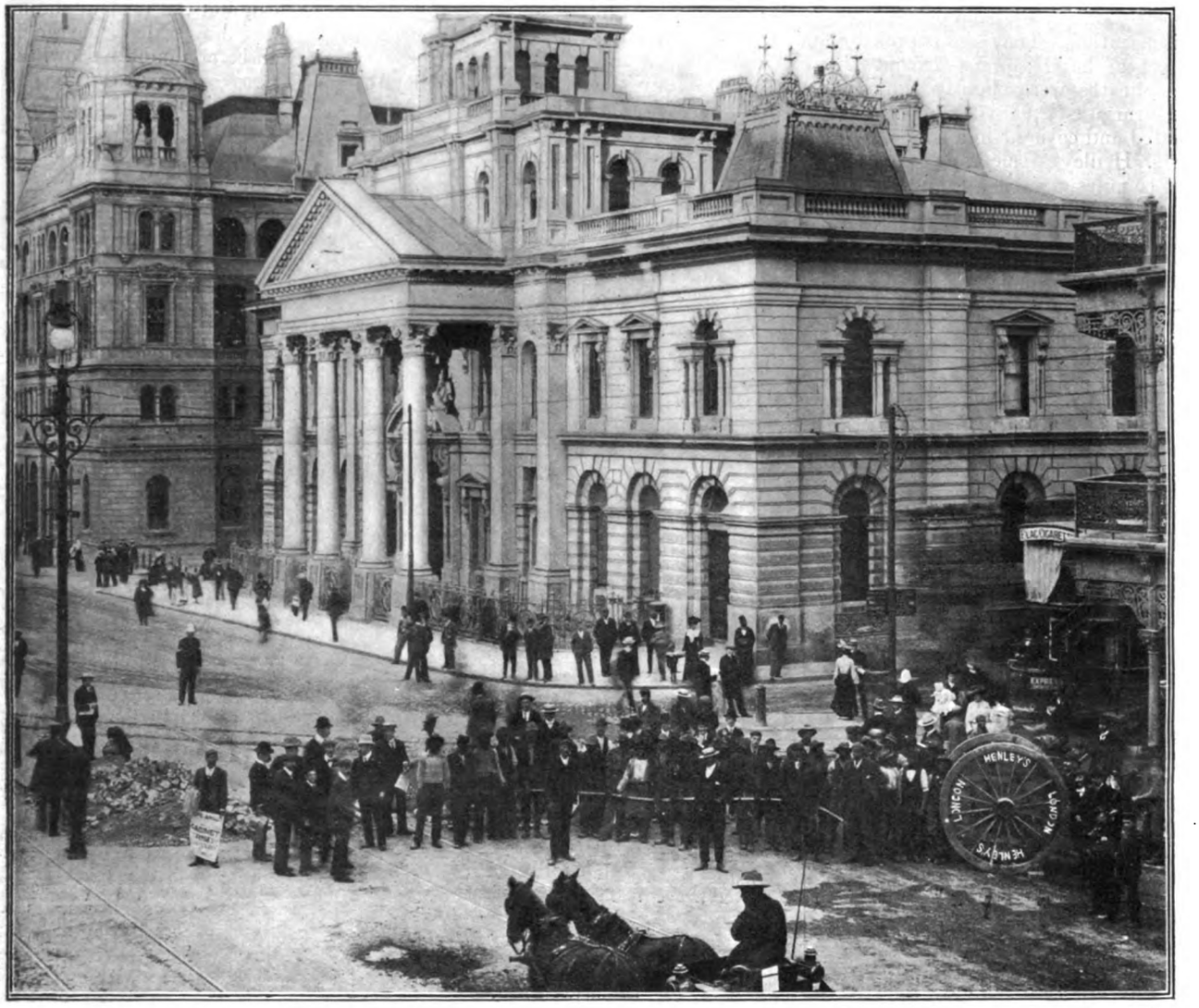
an equal distribution over the whole of the cooling surface in the tower. A manhole and platform are provided just above the top of this distributor for inspection purposes, and the tower is also stayed by steel wire guy ropes, the whole being carried on good strong concrete foundations. The circulating pump was manufactured by Messrs. Gwynne & Co., and is driven by a six-pole 60-B.H.P. motor by the Lancashire Dynamo and Motor Co. This motor runs at 400 to 500 revs. per min. at 440 volts and is of the company's standard shunt-wound type. The circulating water is at present drawn from the sea, but it is intended, at a later date, to erect the Worthington cooling tower described above on the present site of the temporary shed, as the contemplated extension of the dock area will make the present arrangement impracticable.



Laying Cables in Capetown.

A convenient part of the engine room is used as a workshop, being fitted up with two lathes, a small side-planing machine, drilling machine, emery wheels, grindstone, &c., all driven by a motor.

The test room is situated on the ground floor, in a convenient position with regard to the engine-room switchboard. The work carried on here consists chiefly of the calibration of consumers' meters, station instruments, and the testing of apparatus submitted by electrical contractors for approval. For the measurement of current, E.M.F. and resistance, the latest form of Crompton potentiometer has been installed, with a volt box wound for 750 volts. The standards of resistance consist of a four-dial manganin resistance box, with ratio arms of 10,000, 1,000, 100 and 10 ohms, and resistance ranging from 1 to 10,000 ohms; also standard resistances to carry from 1·5 to 1,500 amperes. A Seimens electric dynamometer and a shunted ammeter, reading from 0·01 to 1,000 amperes, used as working standards, can be checked by means of the standard resistances and standard cells on the potentiometer. The standard of pressure is obtained by taking the average of six Clark cells. For working standards, several Weston voltmeters are available. Two portable Kelvin testing sets with tripod and a set of 50 small portable secondary cells are used for making insulation resistance tests of house wiring, &c., but the 220-volt pressure of supply is generally used in conjunction with these instruments, in preference to the 100-volt portable battery. One end of the test room is partitioned off with black velvet curtains to form a photometric room, where the candle-power of incandescent lamps is compared by means of a Kelvin and James White standard photometer. The standard of light is a 10 c.p. Pentane lamp. Standard incandescent lamps are also used as working standards. Special means have been devised for providing the testing current, which is taken from a battery of 116 Tudor cells of 150 ampere-hours capacity, located in a well-ventilated battery room in the yard adjoining the test room. These cells are rated to give a maximum discharge of 60 amperes, the last 30 cells being connected to a regulating switch. In addition to this battery, two large cells are installed each capable of discharging at the rate of 500 amperes for one hour; by means of a change-over switch these cells can be discharged either in series or parallel. A 12kw. motor generator, by Messrs. Mavor and Coulson, is used for charging purposes, current being supplied to the motor from the station switchboard at 440 to

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500 volts. Two enamelled slate panels are fixed in the test room, upon which are mounted the necessary switches, rheostats, instruments, fuses, &c., connected with the generation and supply of testing current. There is also a set of resistances for absorbing current at 220 volts, and so arranged as to regulate current from 1 to 5 amperes in 10 ½-ampere steps, and from 5 to 50 amperes in 5-ampere steps; Carbon rheostats are used to regulate current from the large cells. The whole of this testing and standardising plant was supplied by Messrs. Kelvin and James White.

Paper-insulated, lead-covered and steel-armoured underground mains are used throughout, both for distribution and feeders; these were manufactured by Messrs. Siemens and Halske, W. T. Glover & Co., Henley's Telegraph Works, and others. Messrs. W. T. Glover & Co. supplied 2,230yds. of low-tension single diatrine cable, having a section as shown in the illustration. They also supplied 8,600yds. of 0·125 sq. in., similar to the 1 sq. in., except that the steel, lead and paper sheaths were slightly thinner. Another item by the same firm was 2,988yds. of 7/18 and 7/16 S.W.G. cable, insulated and covered in a similar fashion to the larger cables. Messrs. Henley's Telegraph Works Co. have manufactured about 15 miles of cable for the Cape Town Corporation, and the illustration which we give shows some of this cable being laid. The large building is the Standard Bank and beyond it is a portion of the General Post Office.

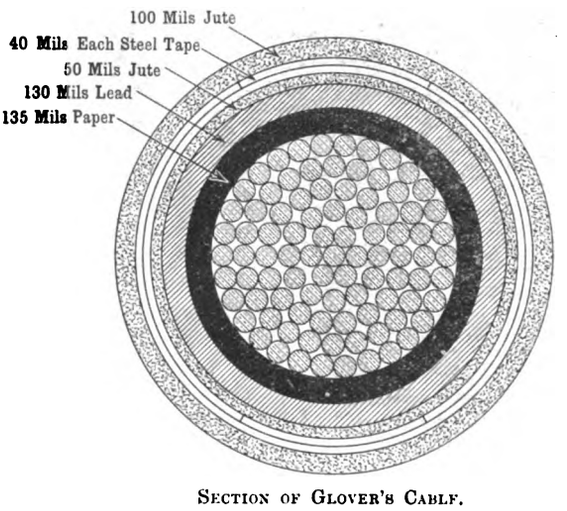
The system of charging for electricity is based on a sliding scale, arranged by means of a parabolic curve plotted upon sectional paper, and regulated so as to give a progressive decreasing rate of charge per unit. The scale commences with a charge of 1s. 6d. for the eighth unit; consumption less than 8 units is included in the standing charge of 12s. 4d. (10s. net) made for each service. After 8 units have been supplied, the rate gradually decreases until the consumption reaches 1,200 units at 1s. per unit. Quantities above 1,200 units are supplied at a flat rate of 1s. per unit. The accounts are rendered monthly, and a discount of 4d. per unit is allowed if payment is made during the month following that in which the current was supplied. The minimum monthly account of 12s. 4d. (10s. net) is payable so long as the premises remain connected, irrespective of whether current has been supplied or not. Consumers have the option of being supplied upon the above terms, or through the double-tariff system of charging, When this latter system is adopted, a special meter is installed, for which the consumer is required to pay the sum of £10 to meet the difference between the cost of installing this meter, cable, &c., and an ordinary meter. The meter remains the property of the Council. These meters are designed to register on two sets of dials, one being for day and the other for night consumption, the change over of the registering mechanism from one set of dials to the other being effected either electrically from the generating station, or by means of clockwork in the meter case itself, according to the following table :—

January ..	midnight to 6:30 p.m.	July ..	midnight to 4:45 p.m.
February ..	,, to 6:30 ,,	August ..	,, to 5:15 ,,
March ..	,, to 6 ,,	September	,, to 5:30 ,,
April ..	,, to 5:30 ,,	October ..	,, to 6 ,,
May ..	,, to 5 ,,	November ..	,, to 6:30 ,,
June ..	,, to 5 ,,	December ..	,, to 6:30 ,,

The units registered on the day dials are divided by two and added to the night units, and the monetary value obtained from the sliding scale, the usual discount, minimum charge, &c., apply as in the case of the ordinary consumer.

It should be noted that the consumer obtains a rebate of 50 per cent. on his day consumption, and with this system of charging the purpose for which the energy is required does not affect the cost to the consumer. The ordinary meters in use are the Thomson wattmeter and the Ferranti ampere-hour meter. The double tariff are ordinary Thomson watt-meters, supplied with two sets of dials and change-over mechanism, mounted in a specially designed case, and manufactured by the General Electric Co., U.S.A. Upon arrival at Cape Town, the meters are fitted with an electromagnetic device; a series cable (7/16), carrying 5 amperes, is run in the more important streets, and the magnetic coils in these meters are connected in series by it. Twin cable is used for the connection from the series cable to the meters. Pressure from the supply mains is kept on the meters during the night period. In parts of the city where the series cable has not yet been extended, "two rate" Aron meters, with self-winding time switches, are installed.

On June 30, 1895, two months after the inauguration of electric light in Cape Town, there were about 20 consumers with lamps and motors connected to the supply mains, equivalent to 2,100 lamps of 8 c.p., added to which were 408 lamps of 25 c.p., and 30 550-watt arc lamps, erected for illuminating the streets. The first motor installed was in July of the same year. Consumers were rapidly connected during the first year, but in 1897 there was a decided falling off of applicants. The method of charging at that time was a flat rate of 1s. 2d. per unit net, plus a charge of 3s. per month for meter rent. This system was, therefore, abolished, and the present sliding scale of charges adopted. That this sliding scale of charge has met with general approval there can be no doubt, but owing to the Council's inability to supply new consumers during 1898, the success of the system was not apparent until 1899. In 1900 still further reductions were made in the cost of electric energy supplied during the daytime by the adoption of the double-



Section of Glover's Cable.

tariff system of charging, which had the effect of greatly augmenting the revenue without proportionately increasing the number of new services connected. In 1902, 20 per cent. of the units were supplied for day consumption, and in 1903, it was found that 33½ per cent. were supplied for day consumption. With regard to public lamps for lighting the streets, there are at present 26 arc lamps and 825 incandescent lamps, equivalent to 3,300 lamps of 8 c.p., an increase of 64 per cent. in eight years.

We are indebted for many of the above particulars to Mr. W. F. Long, the Capetown City Electrical Engineer, and to Mr. H. D. Wilkinson, Inspecting Engineer to the Corporation, who has acted throughout in conjunction with Messrs. Davis and Soper, the London agents to the Corporation.

REPORTING THE GORDON-BENNETT RACE BY WIRELESS TELEGRAPHY.

Complete arrangements are being made by the Gesellschaft für Drahtlose Telegraphie in connection with the reporting of the Gordon-Bennett race, which is to take place on June 17th on the Taunus Course in Germany. Altogether there are to be three wireless telegraph stations, of which the two smaller ones are portable, being mounted on two-wheeled carts. The principal station, however, is a stationary installation. It is to be erected at the "Saalburg" and adjoining the temporary post office at that place. The aerial wire will be supported from a pole. Of the two other stations, one is to be situated at Neuhof, the other at Grävenwiesbach, 25km. and 70km. distant respectively. The aerials of these are to be carried in

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windy weather by six kites and in calm weather by two small balloons, being charged with 5 cubic metres of hydrogen. Each portable station is carried on two carts. One of these, called the "power-cart," is equipped with a 4 H.P. water-cooled petrol motor, which is directly coupled to a 2·5kw. alternating-current generator. Thirty litres (6·6 gallons) of petrol are carried on the cart, and this quantity is said to suffice for a telegraph service of 30 hours. Electric ignition is employed

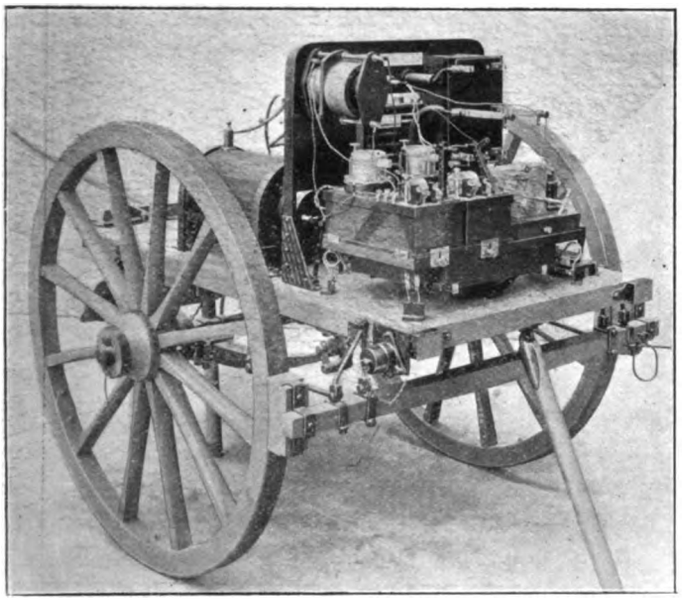

FIG. 1.—CART CARRYING WIRELESS TELEGRAPH APPARATUS. COVER REMOVED.

for the petrol motor, and the accumulators used for this purpose are automatically charged by the continuous-current dynamo which furnishes the excitation current for the alternating-current generator. Arrangements are also fitted on this cart for hauling in and paying out the small captive balloons. The second cart contains the transmitting and

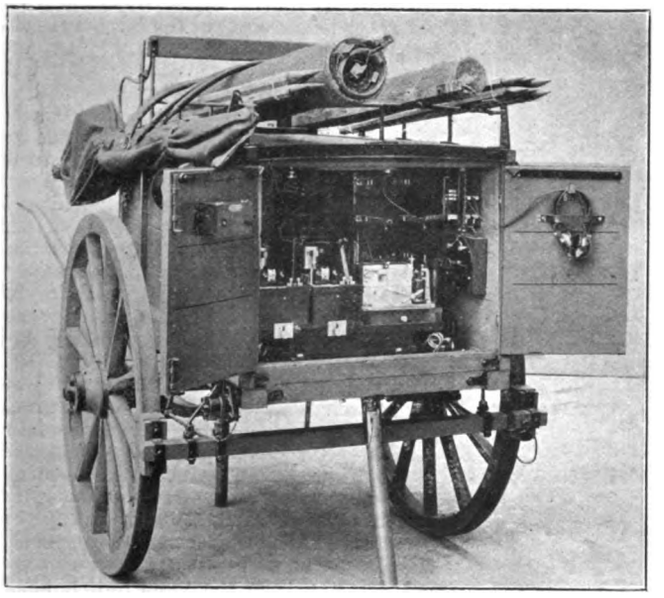

FIG. 2.—THE SAME CART WITH COVER IN POSITION.

receiving apparatus. A partition divides the space on this cart into two parts. The front compartment contains the high-tension apparatus—*i.e.*, the induction coil, the battery of Leyden jars with the variable spark-gap and the high-tension transformer. In the compartment at the back there are a Morse key, two receiving apparatus (one of which serves as reserve) and one Morse writer. Two receiver-transformers and one current reverser are fixed to the partition. On one of the sides there is a bell, and on the other side is an outfit for receiving telegrams by sound consisting of an electrolytic detector and telephone. The receiving apparatus and the Morse writer are mounted on a spring-suspended board. A third cart, serving for the convenient transport of the kites, balloons and the gas storage tanks, is optional. The portable stations are arranged for two wave-lengths—*i.e.*, 350 metres and 1,050 metres—and the change from one wave-length to the other is effected by a simple switch arrangement. The air-wire is 200 metres long in both cases. The appended illustrations show the general arrangement of the carts; Fig. 1 shows the transmitting and receiving devices of the cart with the cover removed, while Fig. 2 gives a view of the same cart with the cover in position.

A RECENT WIRELESS TELEGRAPH PATENT.

A British patent, No. 28,291 of 1903, has recently been issued to Prof. Fessenden of America. It relates to "Improvements in Wave Telegraphy," and has for its object the sending and receiving of Hertzian waves in such a manner that any number of stations, quite close together, may be worked simultaneously. The patentee describes briefly the principles which have been employed by other workers to effect syntony, but says that these methods have failed because a neighbouring station, even when not in tune, will be disturbed. To accomplish this result the signals are produced by changing the periodicity of the oscillations and at the same time maintaining their intensity constant. Referring to Fig. 1, in which are shown two resonant curves, 8, 1, 6 in full lines

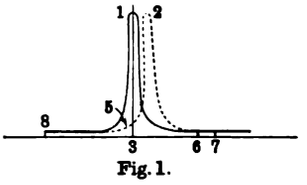

Fig. 1.

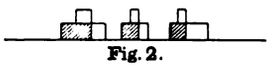

Fig. 2.

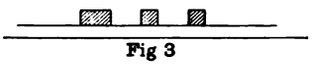

Fig 3

and 8, 2, 7 in dotted lines, if a station is in tune with the full lined curve, the intensity of the effect received will be represented by the line 1, 3. If the frequency of the transmitted impulse be changed while the intensity be maintained constant, the position of maximum resonance will be shifted to the point 2, and the intensity of the effect at the receiving station will be represented by the much shorter line 5 or 3. If, however, there happens to be in the vicinity a station tuned to a periodicity represented by 6, then, when the point of maximum resonance is shifted from 1 to 2, the effect on the near-by station will be changed from that represented by the height of the line 6 to that represented by the height of the line 7. As the difference in the height of these lines is inappreciable, the effect of sending a signal produces practically no effect on the adjacent station.

In Fig. 2 the shaded portions represent the effects produced at the receiving station by the tuned station sending the letter D, while at the same time an interfering station operated in the usual manner—*i.e.* producing its signals by changing the intensity—is sending the letter K. It will be seen that since the two effects are superimposed, an unintelligible signal is produced. In Fig. 3, however, is shown the effect produced when the herein-described method of changing the frequency, but not the intensity, is employed. Here, again, the shaded portion represents the effect produced at the receiving station by a sending station which is in tune, while the unshaded portion represents the effect produced on the same station by a near-by station which is signalling by changing the frequency but not the intensity. It will be seen that no disturbing effect is produced, and that the signal is readily understood. Put briefly, by the use of this system each station has a steady state impressed on it by other sending stations out of tune with it, and this

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state can only be varied by stations which are signalling in the proper tune. Means for accomplishing this are shown in Figs. 4 and 5. In Fig. 4 . . . . on depressing the key *e* the frequency of the oscillations will be changed, but the total energy sent out will not be varied to any great degree. Fig. 5 shows an alternative form, in which . . . . the depression of the key changes both the period of the local oscillatory circuit *bd'h* and that of the sending conductor itself. The amounts of the inductance short-circuited are so chosen that though the frequency is changed the intensity is maintained practically constant. This is readily determined by experiment or can be calculated beforehand. . . . .

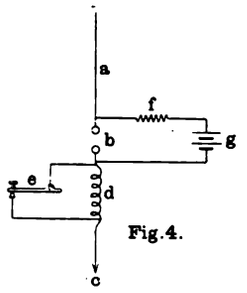

Fig. 4.

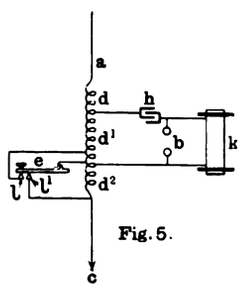

Fig. 5.

At the receiving station I prefer to employ a receiver of a type whose indications depend upon the relative and not upon the absolute amount of energy received.

Following are the claims :—

1. A system of electromagnetic wave telegraphy in which each station has a steady state impressed upon it by other sending stations, which state can be varied only by stations signalling in the proper tune substantially as described.

2. Signalling by changing the frequency of electromagnetic waves without substantially changing their intensity.

THE DICK-KERR HIGH-TENSION OIL SWITCH.

The rapidly-increasing and extensive application of high-tension currents has brought forward the necessity of providing suitable and reliable apparatus for handling such currents with safety. Soundness in design and care in construction are absolutely essential, for the slightest weakness or defect might naturally disable the system of supply and lead to most serious results.

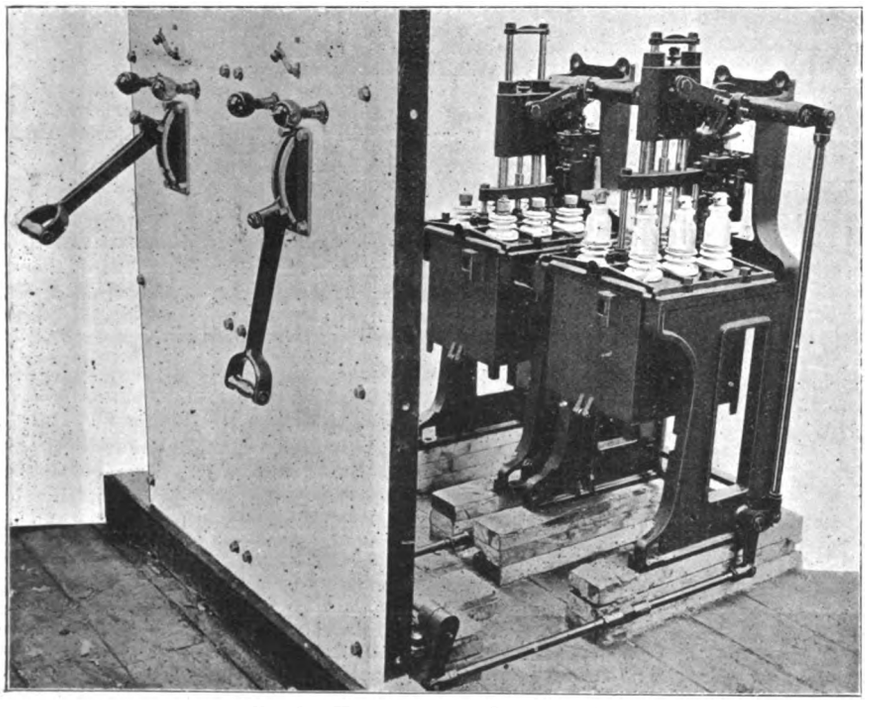
Fig. 1.—Hand-operated Oil-break Switch.

The high-tension oil switches which Messrs. Dick, Kerr & Co. have placed on the market possess some novel features; they are supplied singly or in multiples to suit any number of phases, and may be operated automatically. The main terminals are secured to vertical rods, which are highly insulated with mica sleeves and porcelain insulators with large creeping surface; they are held in position by the insulators securely fixed to a cast-iron webbed plate, which is bolted to the cast-iron frame. This plate acts as a cover to the oil box containing the switches. To the lower ends of the vertical rods the copper jaws which engage the switch blade are attached. The switch blade is carried horizontally in a heavy

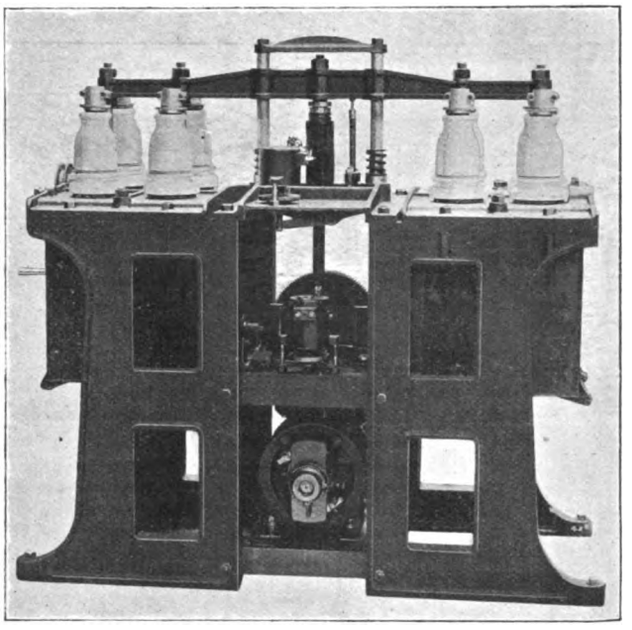
Fig. 2.—Motor-operated Oil-break Switch.

porcelain insulator and attached to a turned steel rod which is secured at the upper end to a crosshead, guide rods and weight. The switches are enclosed in a large oil box, which may be lowered by means of a winch attached to the frame. The oil box is lined with impregnated material and fitted with fireproof partitions, consisting of marble or other suitable material, for separating the various switches, and when the box is fixed in position it entirely encloses the live contacts of the switch. It is also dust-proof and oil-tight. An oil gauge is fitted to the side of the box by which the height of oil in the box may readily be observed. The top of the cast-iron frame is provided with columns for supporting the trip gear, weight and horizontal crosshead, from which depend the vertical rods attached to the switch blades. A series of links connects the trip gear, through cranks, to the operating handle mounted on the switchboard.

To close the switch, the handle must be forced down until the spring-bolt locks. This motion raises the weight and crosshead and closes the trip gear and switch. The switch may be opened by withdrawing the spring-bolt and raising the switch handle. On releasing the handle the trip gear, shown in Fig. 3, is immediately brought into action, the weight falls smartly on the cross-head and throws the switch blades out with a quick-break action. In addition to the ordinary operating handle, each switch is provided with an emergency throw-out. This takes the form of a solenoid attached to the frame of the switch, the armature of which actuates the trip-gear, The local circuit for operating the solenoid is closed by a small pressbutton switch placed immediately above the main switch handle on the board. These switches may be fitted with automatic overload and no-voltage releases.

For larger work Messrs. Dick, Kerr & Co. manufacture a special type of oil-break switch similar in design to that just described, but which is operated by a motor. This does away with the link and crank gear which connects the switch to the switchboard. In place of the switch handle on the board there are two small press-button switches marked "On" and "Off." These are joined up by clockwork and relay through a local circuit which starts and stops

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the motor. The latter is provided with a flywheel and gearing, and the gearing actuates a vertical rod engaging the trip gear for releasing the weight placed above the switch frame. The motor and gearing are made in the most compact form, and are fitted neatly under the switch frame, while the clockwork and relay are fitted at the back of the switchboard behind the press-button switches.

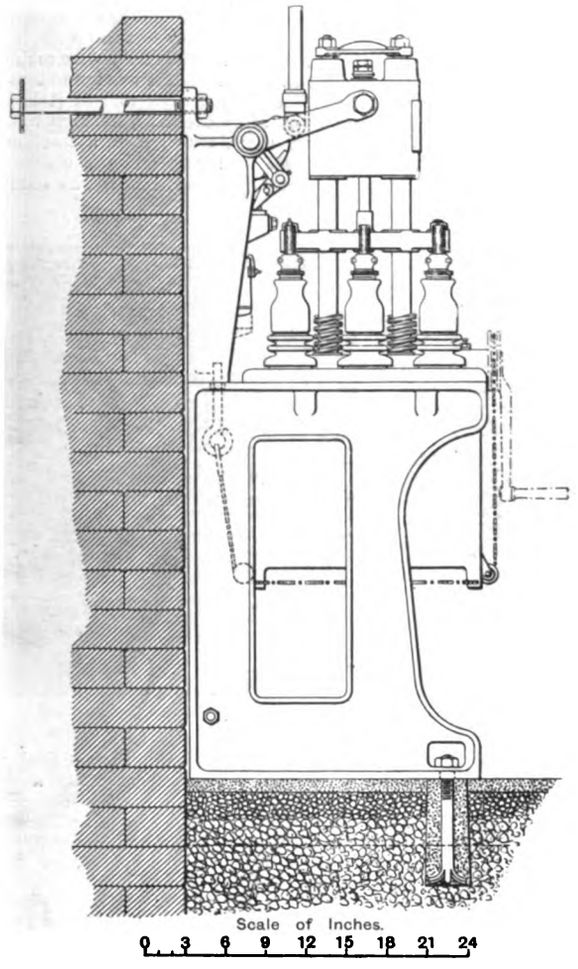

FIG. 3.—HAND-OPERATED OIL-BREAK SWITCH.

The hand-operated switches as described above are employed in the power house of the Lancashire and Yorkshire Railway in connection with the "electrified" Liverpool-Southport line (*The Electrician*, Vol. LII., pp. 852, 897, 940, 977 and 1,013).

THE STEAM TURBINE AS APPLIED TO ELECTRICAL ENGINEERING.*

BY THE HON. CHARLES A. PARSONS, F.R.S., G. GERALD STONEY AND C. P. MARTIN.

(*Concluded from page 225.*)

With reference to the original efficiency of a turbine being maintained, we may refer to the two sets of tests of the Newcastle Electric Supply Co.'s 1,500kw. after an interval of 16 months, as shown in Table II. and Fig. 6, when it will be seen that absolutely identical results were obtained in the two tests. Careful examination of the blades of some of the original machines proves that, provided the velocity of the steam is not excessive, as it is not in the Parsons turbine, there is absolutely no cutting action on the blades.

In steam turbines the governing is effected either by a centrifugal governor of a well-known type, which keeps the speed constant, or by a core sucked into a solenoid to keep the voltage constant. In most cases, however, the centrifugal is preferable, especially where there are large changes of load, as in traction work, and it is also preferable where alternators have to run in parallel. In either case the governor moves a small relay plunger which regulates the steam, admitted to a relay, which in turn actuates the main admission valve, generally of the balanced double-beat type. The exhaust from the steam relay is utilised for the steam packing the end glands. Thus, the governor, having only to move the small plunger, has very little work to do, and therefore can be made very sensitive. The sensitiveness is still further increased by keeping the whole governor gear in slight movement by connecting one of the pivots of the levers with a cam. These movements are so rapid as not to affect the even turning moment of the turbine. For parallel running of alternators, an even turning moment is of great importance, and this makes the turbine specially suitable for the driving of alternators. It might be thought that there would be difficulty in making alternators driven by reciprocating engines parallel with turbines, and vice versa, but in no case has the running not been satisfactory, and in some—for example, Elberfeld—the turbines have been found to steady the reciprocating engines. In this regard we may quote from a letter from Mr. W. H. Lindley, M.Inst.C.E., of Frankfort-on-Main, in which he says: "It is surprising to see two plants so entirely different in their speed characteristics parallel with such complete facility—the turbo running on no-load and the Sulzer engine loaded, as the case may be, from quarter-load to full-load. When paralleled we find the turbo alternators steady the steam engines, and thus favourably influence the tension in our lighting supply." It is important to note that, as in these steam turbines there are no rubbing surfaces, there is no need for internal lubrication, and therefore the exhaust is absolutely free from oil. So much is this the case that in many instances the steam condensed is used as distilled water for delicate chemical work, where the smallest trace of oil would be fatal, and also for heating in breweries and other places. This also enables the condensed steam to be returned direct to the boilers without any oil filters being used.

In the design of dynamos and alternators to be coupled to steam turbines, special regard is to be paid to the large centrifugal force to be encountered. Diameters have to be kept down, and excessive surface speed must also be avoided. Since, then, the diameter has to be small, the length must be increased in proportion, and a long core is the result, with moderate diameter, the contrary of slow-speed machines. At the same time, on account of the higher surface speed, the pitch of the poles is greater, thus giving more ampere-turns per pair of poles than is usual. In alternators this gives no trouble at all, as all that has to be provided is sufficiently strong field magnets to overcome the reaction of the armature, and sufficient magnetic resistance to allow of strong field magnets. This extra magnetic resistance can be given either in the air-gap or by saturation of the poles, as may be found desirable. These large poles also conduce to diminish magnetic leakage, and, as a result, very good regulation can be obtained. In low-voltage alternators, rotating armatures are preferable, as the iron and copper losses are much less, especially where there are only two or four poles, but rotating armatures, although satisfactory for 500 to 2,000 volts, have not been found suitable for the higher voltages of 6,000 and 10,000 which are now common, and therefore rotating fields and fixed armatures have been adopted in many of the recent alternators. For continuous-current dynamos the same remarks apply, only here sparkless commutation has to be provided for. Carbon brush blocks cannot be used, as at these speeds the brushes are apt to vibrate, and so diminish the intimacy of contact and cause heating and undue wear. The result is that it has been found best to form the brushes of wire, gauze or foil, preferably of brass, and these must be sufficiently flexible so as to maintain a good contact with the commutator over the whole section of the brush. It follows, therefore, that the properties of the carbon brush blocks in giving sparkless commutation without alteration of the lead of the brushes, cannot, in turbine-driven dynamos, be utilised, and other means must be adopted to secure sparkless commutation at varying loads. One way is to shift the brushes automatically according to the change of load, and this can be effected by connecting the brush gear to a steam cylinder controlled by a spring and supplied with steam from the point where the steam enters the turbine. At this point the pressure of the steam is proportional to the load of the dynamo, and, therefore, the piston in the steam cylinder, being controlled by a spring, takes up a position proportional to the load and thus shifts the brushes to the point of sparkless commutation. Another method is to provide commutating poles as proposed by Prof. Ryan and others, but the best method is to provide compensating winding as proposed by Prof. Forbes, Deri, &c. By these means, with the improvements recently adopted, absolutely sparkless commutation can be secured with fixed brushes up to, in plants for traction purposes, 100 per cent. overload.

The size of turbines is rapidly increasing, many of from 4,000kw. to 6,000kw. capacity now being in the course of construction, and it is anticipated that still larger plants will be made shortly. Up to the present there are about 600,000 H.P. of turbines of the Parsons type at work and on order in England and on the Continent, in various sizes ranging up to 7,000kw. In Figs. 10 and 11 are given two of the most recent types of turbo-generators, Fig. 10 being one of the two 1,800kw. plants supplied to the Mancheester Corporation for continuous-current supply at 420 volts, and Fig. 11 one of the 2,000kw. turbo-alternators for the new Carville station of the Newcastle-on-Tyne Electric Supply Co. to give alternating supply at

* Paper read before the Institution of Electrical Engineers, May 12th.

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6,000 volts, three-phase, 40 periods, for which station also two 3,500kw. plants are nearly completed. It does not enter into the scope of this Paper to describe the many other applications of the steam turbine—to marine propulsion, to the driving of fans, air compressors, blast-furnace blowers, &c., or to the lifting water to great heights by the use of high-speed centrifugal pumps, but it seems now certain that for many purposes, especially in large sizes, the steam turbine has become a most formidable competitor to the best reciprocating steam engines.

The following is an abstract of the discussion which took place in connection with the above Paper.

Thursday, May 12th.

Mr. W. B. SAYERS asked if there was any critical point in the velocity of steam at which cutting of the turbine blades did occur, and whether in other forms of turbines it was found that cutting occurred. Passing to

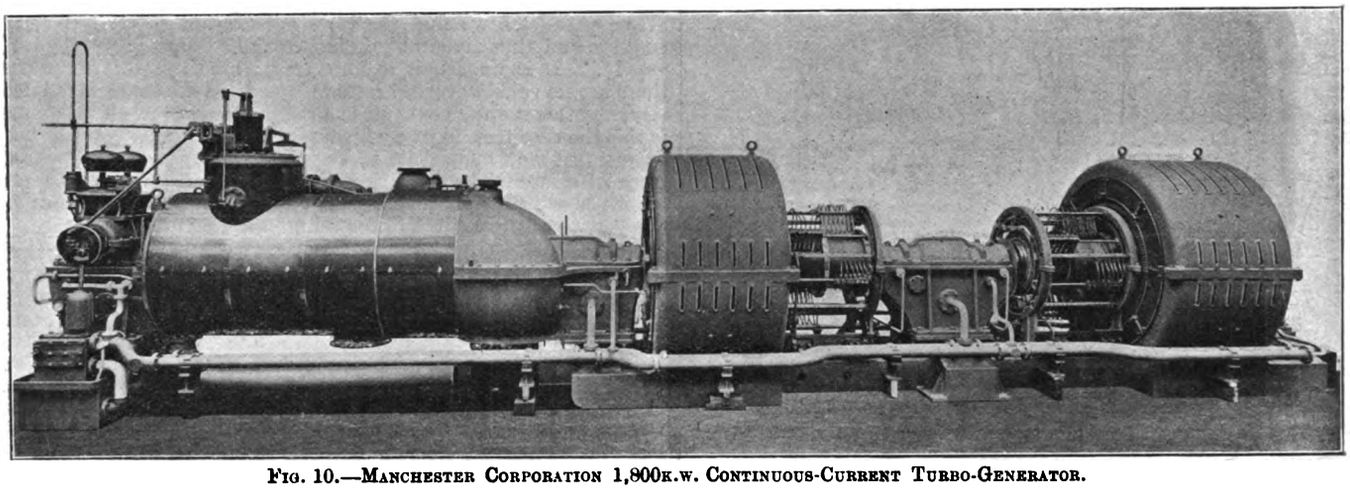

FIG. 10.—MANCHESTER CORPORATION 1,800K.W. CONTINUOUS-CURRENT TURBO-GENERATOR.

that portion of the Paper which dealt with continuous-current dynamos he referred to the following:—"Carbon brush blocks cannot be used." It had been his unfortunate luck, or whatever they might call it, to be snuffed out by carbon brushes in the earlier days and his hopes had risen a little when he read the above sentence. He would like to ask what amount of sub-division had been employed in the carbon brushes which had been used. He had heard of a firm which had used them,

sparkless commutation up to 100 per cent. overload. He would be very glad if the authors would be a little more specific as to the arrangement which had been tried and the duration of the trials, and as to any difficulties which had been encountered. Perhaps in this connection it might be interesting for him to say a word or two about his experience in conjunction with Messrs. Jackson, who manufactured the machines with his winding, and with a special arrangement of magnet poles which produced a fixed brush position under varying load. He would specially refer to two machines fixed at Ashton-under-Lyne, which had an output of 350kw. and ran at 210 revs. per min. They were two-polers, and for some years they were operated quite satisfactorily. They were maintained without any real difficulty with metal brushes, but it was found that every now and then the commutators had to be attended to, and it had since been found that carbon brushes were an improvement, the carbon brushes being considerably sub-divided. The machines were on a traction load. The experience was that when these machines and the commutators were in good order they were perfectly sparkless, but it was found that the breadth of contact of the brushes was rather a critical matter when such large variations as were experienced upon a traction load had to be dealt with. Another point was that, in designing the machines, great care had to be taken to keep the magnitude of the E.M.F.s as low as possible. In the design of modern commutating dynamos it had been found that a critical point was to keep the

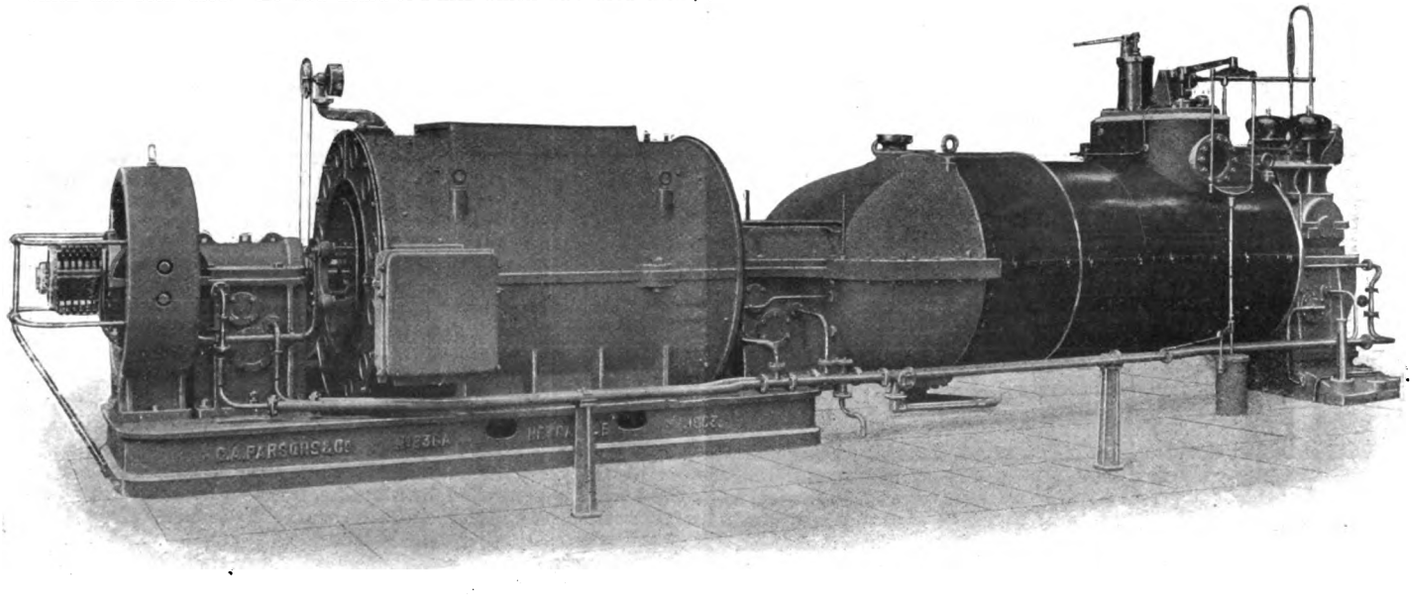

FIG. 11.—NEWCASTLE ELECTRIC SUPPLY CO. 2,000K.W. TURBO-ALTERNATOR.

but that after two months they were of no use, but it occurred to him that the solution of the use of carbon brushes might be found in a much greater sub-division of the blocks and in using small blocks and blocks generally which had a small moment of inertia. The Paper mentioned the various devices which had been successful and that by the most recent improvements absolutely sparkless commutation could be secured with fixed brushes up to 100 per cent. overload in plants for traction purposes. The arrangements referred to were by Profs. Ryan, Forbes and Deri, &c.—he himself had the honour to be included in the "&c." But it was rather a large statement to him, who had had large experience in this direction, that any of the arrangements in question would secure absolutely impedance of the coil under short circuit, or under the brush, at the lowest possible figure. In the present circumstances, however, it was not the impedance of the coil but the magnitude of the error—*i.e*, there might be a very near balance as regards percentages between the reversing force and the impedance, but if the impedance of the whole of the coil was great, then the magnitude of the error (which never balanced accurately, of course) was a very important feature. He would also like to refer to one arrangement which M. Deri used and which was described in his patent specification—viz., the use of a damping coil around the magnet poles. He would like to know whether this had been employed by the authors, because it showed that Deri anticipated the importance

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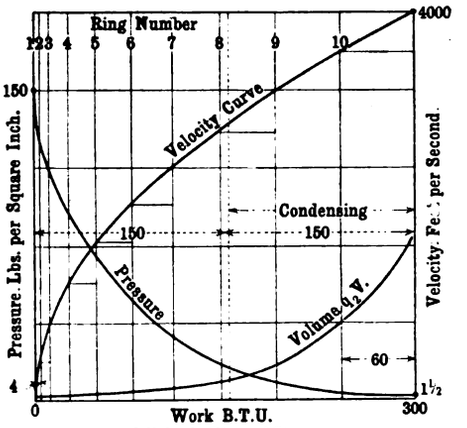
of keeping the impedance at a very low figure, and he claimed this in the specification (No. 4,784) of 1900. He himself had tried substantially the same thing in 1896 on an 80kw. machine which was being tested at Messrs. Belliss' works. He put a piece of copper on the pole tip in order to damp out the impedance to a large extent, but what he wanted to say about that was that Mr. Swinburne pointed out 10 years ago that the main impedance of a coil as a whole was very largely reduced by the field itself, and that it was very necessary for any coil which was to have any real effect upon the commutation to be close alongside the coil which was under commutation. Another way of doing this, which he himself suggested, was to embed, as far as possible, the end windings in copper. In the early days he was under the impression that the self-induction of end windings was a very small thing—almost a negligible quantity—but experience seemed to show that this was not the case, and it now appeared that means to reduce the self-induction of the end windings such as embeding them in copper or surrounding them as far as possibe in copper might have advantageous results.

Thursday, May 19th.

Mr. J. H. BARKER said he was somewhat surprised to see that the same old remark was brought up against the turbines—viz., the wearing of the blades—but his own experience had shown that after 10 years' working the blades in the Cambridge turbines were in as good a state of repair as they were at the time they left the makers' works. The table of consumptions published in the Paper emphasised his opinion that about 200 H.P. (135kw.) was an economic size, as it showed a consumption of 22·8lb. of steam per kilowatt-hour with 99deg. of superheat, against 21½lb. with saturated steam by a reciprocating engine. With the saving in oil, this practically worked out as economical as the best reciprocating engine on the market. He was glad to find a definite statement in the Paper to the effect that every inch of vacuum between 23in. and 28in. affected the steam consumption to the extent of about 3 per cent. Respecting the Newcastle-on-Tyne 1,500kw. turbo-alternator, during the discussion of Mr. Merz's Paper he had pointed out that the curve in that Paper was not quite so favourable as his own deductions led him to believe it should have been, and the authors of the present Paper had brought down the steam consumption to almost the identical figure which he gave as the likely one, viz.—16lb, of steam per kilowatt-hour if the machine had been run up to 2,000kw. It was interesting to compare the cost in this case. The cost of coal at Neptune Bank was 0·2d. per unit. Coal at 20s. per ton was 10lb. for 1d. The coal at Neptune Bank was 6s. 8d. per ton, or, say, 30lb. per 1d., and 0·2d. was equivalent to 6lb. of coal. Assuming 8lb. of steam per lb. of coal, this gave 48lb. of steam per kilowatt. Engine builders could not improve that very much, and it was a question which demanded the very serious attention of consulting engineers and station engineers as to how they could reduce this abnormal amount of steam per kilowatt at the meters. Tests showed that 14·7 was the very best result with steam-produced electricity, and even if manufacturers could reach that it meant ½lb. of coal or $1\frac{1}{2} \times 7\frac{1}{2}$ per cent. That was all the room for engine builders to gain, and yet stations were using up to 48lb. of steam per kilowatt. The augmentor was a new development and it represented a saving of 450lb. of steam on a 1,500kw. machine, or 20 H.P. at the air pump. He would like to know from the authors if 20 H.P. applied to the air pump would give the same increased efficiency that was given by this augmentor.

Mr. ROBERT HAMMOND said he had used the Parsons turbine in one isolated case only, where he had to deal with very bad foundations, and where it was necessary to put in a plant that was free from vibration—viz., at the Hotel Cecil. He did, however, feel proud to have the opportunity of expressing to Mr. Parsons the very great debt the industry owed him for the battle which he had waged in favour of the steam turbine. Personally, he had always felt afraid of the wearing out of the blades, but from the magnificent results achieved by machines in operation, this fear no longer existed. At Sheffield, they were short of space and in a great hurry, but it had been pointed out to him that there was a fine plant at the Paris Exhibition which could be sent over by parcel post and put down in a quarter of an hour, and, this plant having been installed, much magnificent work resulted. He was much impressed with the claim that the steam turbine could do without oil, but he noticed at Leeds that the cost of oil, waste, water and stores was 0·03d. per unit and there were no Parsons turbines at Leeds. At Newcastle-on-Tyne where there were turbines, however, the cost of oil, &c., was 0·12d.; at Cambridge the cost under the same item was 0·14d.; and at Scarborough it was 0·08d. With regard to the condenser, there was a statement in the Paper that it was well to use 50 times the amount of water that was evaporated into steam rather than 30 times, but he felt a little doubtful as to whether the very large amount of water which was required to gain a little extra vacuum would not involve much greater expense than the extra piece of vacuum was worth. His experience of condensing arrangements was that *these* usually gave the most trouble in a central station. Nothing was so difficult to maintain as a high vacuum, and Mr. Parsons had been unable to maintain it. Further, there were places where the necessity of using such an increased quantity of water as was represented by the difference between 30 times and 50 times unfortunately made the use of turbines prohibitive. He would also like an explanation of the falling off in efficiency at half-load. In the controversies that had taken place from time to time with regard to steam turbines, the tests at Leeds had been referred to. He had tested two 1,500kw sets side by side, one being a Belliss and the other a McLaren, and whilst in the case of the Parsons turbine, as set out in the Paper, there was a falling off in efficiency of 25 per cent. when run at half load, the falling off in the case of the Belliss engine at Leeds was only 20 per cent., and the falling off in the McLaren engine was only 13·6 per cent. So far as the actual consumption of steam was concerned, the Belliss engine, which was the lower of the two, gave 19·67lb. per kilowatt as compared with the claim in the Paper of 18lb. for the turbine. But it was only just to the Belliss to say that the water was measured into the boilers, and the 19·67 included the whole of the loss that occurred in the steam range as between the boilers and the engine, whereas he gathered that in the tests upon the turbine the actual condensed water was weighed, so that, in comparing the 19·67lb. with the 18lb. it was fair to knock off about 1lb. in order to represent the actual difference. Before the Paper finally found its place in the *Journal* of the Institution, he hoped the authors would amend the tables which described the tests at Elberfeld. In Table I. the temperature of the steam was given in centigrade and the steam pressure in lbs. absolute; whereas in Table II. the steam pressure was in lbs. above atmosphere. In Table I. also the steam pressure was set forth in figures before the stop valve No. 2 in kilogrammes per centimetre. Those members of the Institution who would be called upon to appreciate the Paper in the future would do so more if the comparisons were made uniform with the tables that followed.

Prof. DALBY said that the authors had emphasised the importance of working with a good vacuum, stating that, even when using cooling water to the extent of 50 times the amount of steam condensed, it was economical to use, in addition, a steam extractor which took 1½ per cent. of the steam. Some curves which he (Prof. Dalby) had plotted in connection with the study of steam turbines showed the necessity of keeping a good vacuum in order to obtain the highest economy from a steam turbine. Mr. Parsons has stated that the steam flowing through a turbine fell in temperature and pressure very nearly according to the adiabatic law. Assuming, therefore, the flow to be adiabatic, he would consider, first, that steam at 160lb. pressure absolute per square inch flowed into a chamber where the pressure was maintained at 1½lb. per square inch absolute, without any obstruction in the shape of turbine blades. For this purpose it should be imagined that the turbine blades and vanes were removed and the areas of the successive cross-sections so arranged that the volume accommodated itself to the requirements of the flow. In these circumstances, neglecting losses, the whole of the available energy of the steam would be utilised in producing velocity. If J = joules equivalent, 778; v = the velocity of the steam when it flowed from a chamber where the pressure was p_1 to another



Adiabatic Flow of Steam.

where the pressure was p_2, L_1L_2, q_1q_2 and h_1h_2 = the respective latent heats, dryness factors and water heats of the steam in the two chambers, the available energy of the steam might be approximately written $q_1L_1 - q_2L_2 + h_1 - h_2$, and this must be put equal to $v^2/2gJ$ in the circumstances assumed. q_1 in this expression might be put equal to unity, assuming that the steam was initially dry. q_2 may be calculated from

$$q_2 = \frac{\tau_2}{L_2}\left(\frac{L_1}{\tau_1} + \log_{\epsilon}\frac{\tau_1}{\tau_2}\right).$$

By giving a series of values to the lower subscript, the work available, the velocity produced and the corresponding volumes could be calculated. The following curves exhibited the pressure, the velocity and the volume plotted against the available work calculated in this way. If, now, turbine wheels were put in the course of the steam so that the velocity is reduced to zero, this energy of flow was gradually transformed into mechanical energy. Supposing the turbine shaft to be fitted with 10 rings of blades, and that they were arranged as regards angle of exit, &c., so that each ring changed the velocity of the steam by one-tenth of the total velocity of flow, it would be apparent from the diagram that a ring of blades near the beginning of the series utilised a much smaller proportion of the energy of flow than a ring near the end. Thus, at the first ring, the pressure dropped from 160lb. to 151lb. per square inch, and the British thermal units turned into work by the ring were only equal to about 4. Taking the last ring, the drop of pressure was about 2lb. per square inch, but 60 British thermal units were turned into work by the ring. It would be noticed, also, that of the whole available energy, half was made available by the condensing plant. The figures in the diagram were only worked out approximately, but they served to give the perspective of the subject. In an actual turbine the proportions were affected by certain practical considerations which did not lend themselves to theoretical treatment. Bearing in mind the small amount of energy obtained from the steam at the beginning of the flow, he would like to know what the authors considered the highest steam pressure at which it was suitable to work a turbine, and whether the efficiency was much reduced in practice by cutting off some of the high-pressure rings. Also, could the authors give data of the pressures measured along a turbine in order to compare them with the adiabatic pressures?

(To be concluded.)

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AMERICAN ELECTRIC AUTOMOBILE DELIVERY WAGGONS.

Trials, of the nature of endurance tests, of automobile delivery waggons for freight, express, &c., have recently been carried out under the auspices of the Automobile Club of America. Seventeen vehicles started and of these 15 were still running when the contest closed. The *Electrical World* of New York states that the data of the tests are now being grouped and analysed, as to the trips made around New York city, under the varying conditions, and the results are awaited with much interest.

In a Paper read before the Automobile Club of America as a preliminary to these trials, Mr. Hiram Percy Maxim gave some most interesting particulars relating to electric automobiles. He considers that the electric automobile has arrived at what would seem to be a fixed and possibly final type. In all but the smaller pleasure vehicles it has two series motors independently connected each to one of the driving wheels. The storage battery is carried below the body between the axles and seldom inside a part of the body. As compared with the steam, gasoline and combination gasoline and electric automobiles, the electric system is practically the only motor system in general use in commercial waggon service. In New York city alone there are now approximately 300 electric waggons and trucks in service. All waggons of 2,000lb. capacity, which is the capacity generally used by department stores and for light express service, have to make about 30 miles per day, and the battery equipment should correspond to this service. The price of such a waggon with the usual type of department store body is about $2,500. A good battery will do 95 days' work before it needs cleaning, which consists in cutting each connecting strap so that "mud" may be washed from the plates and from the jar. The cells are then reconnected or "burned" together, and after being given a slow charge are again ready for service. After this cleaning they run about 75 days more before the mud has again accumulated to a point requiring another cleaning. After this second operation it is usually found that the wooden separators, if used, require to be replaced by new ones; this latter requirement involves the separation of plates when they are removed from the jar and means more labour and a greater breakage of separators and plates than at the first cleaning. When this has been done and the battery has gone into service for the third time, it is good for about 60 days more before all of the active material on the positive plates has been shed and their useful life ended. When this point is reached a new set of positive plates is substituted and since this means the handling of fragile acid-soaked wood separators, these also must be replaced by new ones. The battery then starts out entirely fresh except for the negative plates. In most cases these hold out and show no signs of failure until the next cleaning and they do not appear to give out together as do the positives. An average might be set at one set of negative plates for every $1\frac{3}{4}$ sets of positive plates.

Taking a full year's work, the cost per annum for a battery under the above conditions is about as follows:—New positive plates, $155; new negative plates, $84; new wooden separators, $26.10; rubber separators, $4.55; rubber jars broken in service and handling, $21.70; total repair in connection with battery, $65; supplies and all other expenses, $43.50. Total, $404.85. On the basis of 30 miles per day and 288 full working days per year for such a waggon, this means 8,640 miles per year, which brings the battery maintenance expense to 4·68 cents per vehicle mile, or $1.40 per day.

As to rubber tyres, on a 2,000lb. waggon, a $3\frac{1}{2}$in. tyre is a generous one and the price of a set, allowing something for scrap, is about $188. In New York city such tyres may be depended upon for about 9,000 miles service, which is equivalent to 2·09 cents per vehicle mile, or 62·7 cents per day.

For charging, the requirement is 14·2kw.-hours per day per vehicle. If this is taken from an isolated plant, with which a stable or store may be equipped, the cost would never be above 2 cents per kilowatt-hour, and when taken from the street mains it usually amounts to something nearer 4 cents. Assuming 3 cents, on a basis of 288 working days per year, the total consumption is 4,090kw.-hours, which at 3 cents is $122.70 per annum, or 1·42 cents per vehicle-mile. For the cost of general repairs, it is stated that the annual charge will be about 4 per cent. of the price of the waggon, the batteries and tyres being left out. In the modern type of waggon, costing $2,500, the price, less batteries and tyres, is $1,827; 4 per cent. of this is $73.10 per annum, or 0·85 cent. per vehicle mile, as the average for general repairs for this size of waggon. The depreciation may be taken at 10 per cent. on a price of the vehicle, less the batteries and tyres, which would amount to $182.70, or 2·12 cents per vehicle-mile. Taking the interest on the investment at 8 per cent., this would be $125 per annum, or 1·45 cents per vehicle-mile. The various items are, therefore, as follows:—Battery maintenance, $404·85; tyre maintenance, $180; cost of charging current, $122·70; general repairs, $73.10; depreciation, $182.70; interest on investment, $125. This makes a total per annum of $1,088.35, or 12·61 cents per vehicle-mile. This amounts to $3.78 per day, or, if 250 packages per day are delivered, to 1·51 cents per package.

The Paper next took up the cost of maintaining 3-ton and 5-ton trucks. By means of an analysis similar to that which precedes, the annual cost of such a truck is found to be $1,609·77, or 23·2 cents per vehicle-mile, or 11·6 cents per ton-mile, or $5.57 per day. In a similar manner the cost of a 5-ton truck is found to be $1,760.85 per annum, or 30·57 cents per mile, or, with the average load, 8·74 cents for every ton hauled a mile, or $6.11 per day. The Paper gives a lengthy discussion of the various items in the above totals. The conclusion is that the direction for the future motor lies in reducing the cost due to the battery, tyres and depreciation. As to the battery factor, it is stated that two new automobile batteries are at present being weighed in the balance, one of these being that of Mr. Edison and the other a Planté type. The latter is an old battery conventional in form, but, owing to its construction, its active material sheds less rapidly than in the pasted type, the plates consequently lasting longer. It is stated that this battery has a most creditable record to date.

It is claimed by the manufacturers of the Edison battery that the plates never need renewing in the sense in which that term is considered in the Paper. The Adams Express Co. has for four months been operating with this battery four of its delivery waggons, and at the present time the manufacturers' claims have been fulfilled. While a much longer experience will be required to determine the value of this battery, it is theoretically directed in the proper line of improvement and, therefore, worthy of most careful consideration. It suffers, however, from its higher cost and the large amount of charging energy which is lost in recharging. The 2,000lb. waggon which now sells for $2,500 would cost $3,005 with this battery, while the saving in weight is only 375lb., and the battery requires 60 per cent. more energy than is required in charging lead batteries. In the case of the 2,000lb. waggon this means $204 per annum, instead of $122.70 with the lead battery. It would seem fair to expect more repairs with the Edison battery. An analysis of the different items shows, however, a net gain per ton-mile for the Edison battery amounting to quite a considerable amount, being 13 per cent. in the 2,000lb. waggon, 12 per cent. in the 3-ton waggon, and $12\frac{1}{2}$ per cent. in the 5-ton truck. The Planté battery above referred to, which is known as the Manchester "box" type, has a strictly Planté positive plate and a "box" negative plate, and is stated to be unquestionably the longest-lived and most robust storage battery in existence. The cost of maintenance of this battery is discussed and the calculation shows a net gain practically identical with that of the Edison battery. For instance, in the 2,000lb. waggon it will cost for maintenance 10·93 cents per vehicle mile.

The rubber tyre is stated to meet every practical requirement of automobile traction. The iron tyre, while by no means impracticable, does not enable a motor vehicle to give its best performance. Experiments with hard wood tyres in segmental blocks and with grain end-on have been tried with satisfactory results except during the winter season, when they slip on ice and snow, although very much less so than iron tyres. They are long-lived, semi-yielding, semi-noiseless, have very good wearing qualities, give good steering way, even taking car tracks at very close angles, and are very cheap. Mr. Maxim considers that while not possessing all the necessary qualifications of a truck tyre, they may yet be looked upon as indicating the direction in which development should proceed.

The Paper also contains a discussion of the maintenance charges of a gasoline vehicle. In the case of a vehicle corresponding to the 2,000lb. electric vehicle, the cost is found to be 9·12 cents per vehicle-mile, as compared with 12·61 cents for the corresponding electrical vehicle, or with 11 cents if compared with the Edison battery, or with 10·93 cents if compared with the Manchester "box" battery. For a 3-ton vehicle the cost is 16·1 cents per vehicle-mile as against 23·26 cents per vehicle-mile for the electric vehicle, 20·47 cents for the vehicle equipped with the Edison battery, or 20·36 cents if equipped with the Manchester "box" battery. In the case of the 5-ton vehicle, the figures are 21·8 cents per vehicle-mile, as compared with 30·57 cents for the electrical vehicle, 26·75 cents for the same equipped with the Edison battery or 26·55 cents if equipped with the Manchester "box" battery.

In conclusion, Mr. Maxim said that aside from the inherent peculiarities of the gasoline system which prevent it entering the field at present monopolised by the electric system, there would seem to be good reasons for believing that it will be cheaper at least than the best that we have in sight for the electric. It opens up at once the great field of suburban freight transportation which the electric cannot hope to enter, and which is already calling loudly for some kind of a motor vehicle. Mr. Maxim considers that the time has arrived when we may expect to see the gasoline commercial waggon and truck emerge from the gasoline touring car, just as the electric commercial waggon and truck emerged from the electric phaeton and brougham. As to the steam and combination systems, it is difficult to consider them other than as temporary expedients to be used only until the gasoline system takes final hold

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THE TELEGRAPHONE.

From time to time (see *The Electrician*, Vol. XLVII., p. 5, and Vol. LI., p. 611) we have recorded the progress made in the development of Poulsen's telegraphone. During the last year various improvements in details have been made in the wire-pattern telegraphone, conducing to greater efficiency and simplicity, and specimens of the improved apparatus are now on view at 28 and 29, St. Swithin's-lane, E.C.

The disc pattern telegraphone, however, has undergone practically no change. One of the telegraphones exhibited contains a short record spoken into it by the King on the occasion of his visit to the Danish works during his recent stay at Copenhagen.

In outside appearance the telegraphone of the wire pattern has hardly been altered, the most noticeable modification being, perhaps, that the screw arrangement for guiding the wire backwards and forwards while it is being reeled off one bobbin and wound on to the other has been replaced by a simpler and more silent device, consisting of a metal arm, which is pivoted inside the wooden case and protrudes through a slit in the lid of the case. This arm carries the magnets and rocks to and fro, so that the wire is wound on and off the bobbins evenly, and the magnets maintain the same position with regard to it as it moves backwards and forwards. The coils and magnets for magnetising the wire as it passes are of the same design as in the older pattern, and were fully described in *The Electrician*, Vol. LI., p. 611. Simplifications have also been made with regard to the bearings, ball bearings having been abandoned in favour of plain ones. Another modification has been introduced in connection with the driving of the instrument. Instead of employing two small electromotors, each driving one drum, one motor only is now used for this purpose. A small switching arrangement, compactly fitted into a separate little box, serves for starting, stopping and reversing the motor. An ingenious mechanism, consisting in principle of two combined free-wheel devices, automatically adjusts matters, so that the speed of the drum upon which the wire is wound is slightly in excess of that of the drum from which the wire is reeled off. The wire provided on the instruments exhibited corresponds to a 30 minutes' conversation.

Arrangements are now made for switching the apparatus on to the telephone system for the purpose of recording communications during the absence of the telephone owner. A double-pole switch is provided with three positions. In the first position the telegraphone is disconnected from the telephone line altogether; in the second position the telegraphone alone is connected to the telephone system and takes the place of the telephone receiver; in the third position, finally, the telephone and the telegraphone are both in series, and the conversation going on is recorded in its entirety. A connection of the telephone and telegraphone in shunt (in position 3) has also been tried, but it has, it appears, been given up in favour of the series connection. Assuming a telephone user wishes the calls during his absence to be recorded, he moves his switch to position 2. If now his number is rung up, an auxiliary device starts the telegraphone motor automatically which runs for a certain time, the length of which may be regulated. In the instruments shown, this time was adjusted to two minutes. When the apparatus starts, a buzzer is automatically actuated for a few moments, and this serves the double purpose of separating the different calls and for drawing the attention of the caller to the fact that the telegraphone is connected up.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Science Abstracts." May, Part 5, Vol. VII. Section A.—Physics. Section B.—Electrical Engineering. (London: E. and F. N. Spon). 1s. 6d.

"Etude sur Les Résonances dans Les Réseaux de Distribution par Courants Alternatifs." By G. Chevrier. (Paris: "L'Eclairage Electrique.")

"Fortschritte der Elektrotechnik." Edited by Dr. Karl Strecker. 3rd Volume. (Berlin: Julius Springer.) 1903. 8m.

A FERRARIS FIELD DETECTOR OF HERTZIAN WAVES.*

BY PROF. RICCARDO ARNÒ.

Ewing in his classical researches regarding magnetic hysteresis† studied the variations in the intensity of magnetisation presented by magnetic substances when they are subjected to mechanical perturbations, to vibrations and to variations of temperature.

Gerosa and Finzi recorded in 1891‡ an experimental study which they conducted concerning the changes produced in the form of the curve of intensity of magnetisation in magnetic metals by altering the magnetising force when they are traversed by a continuous or periodically interrupted or alternating current, and among the results of these researches it is particularly mentioned that for iron, steel or nickel wires the hysteresis loop regularly contracts in area on account of a given cyclic variation of the magnetising force when a continuous or interrupted or alternating current traverses the wires, so that the area of the hysteresis loop may completely disappear, the diminution being more apparent the greater the intensity of the current in comparison with that of the magnetic field.

In conformity with this study, in the same year, Gerosa and Mai§ conducted researches into the variation of magnetic intensity in soft iron in the special case in which, with a predetermined cyclic variation of magnetisation, the substance is subjected to induction due to alternating currents. Among other results they found that, if an alternating current be sent through a solenoid surrounding a bundle of wires while the bundle is also subjected to a magnetic field varying between given limits, the normal hysteresis area is greatly diminished and may even be wiped out entirely.

Later, Rutherford, Wilson and Marconi have made important inquiries which show that the alteration in the hysteresis curve discovered by Gerosa and his collaborators, occurs also when the alternating secondary current is of very high frequency, although it may also be of extraordinary small dimensions, such as is produced by electromagnetic impulses or Hertzian waves. While Rutherford studied the effects of electrical waves at one point of the magnetic cycle only, that is, with no exterior field, Wilson and Marconi were concerned in their researches with the general case of a cyclic magnetic variation.

Rutherford‖ discovered that if a series of electrical waves is caused to impinge upon a spiral winding surrounding a thin magnetised needle, a partial demagnetisation of the needle results. Wilson¶ published in 1902 the results of a series of researches which showed that if a bundle of iron or steel wires is placed within a coil traversed by a slowly alternating current or in proximity to a rotating permanent magnet, a sudden variation occurs in the magnetisation whenever a second coil wound around the bundle is traversed by electrical oscillations of high frequency. Wilson observed, too, that the sensibility is greater in the steepest part of the magnetisation curve.

Marconi,** in the same year, and independent of Wilson's researches, also showed that a variation of magnetisation always takes place in an iron or steel wire owing to the action of electric waves when the wire is passed through a magnetic cycle due to a variable external field; generally, this phenomenon was observed at any point of the cycle, but the sensibility increased with the intensity of magnetisation.

* The work described herein was performed in the electrical laboratory of the R. Istituto Tecnico Superiore of Milan (Institution Carlo Erba) in December, 1903, January and February, 1904, and transmitted to the R. Accademia deis Linceis of Rome on March 18, 1904.

† *Proc.* Roy. Soc., 1885, p. 523; 1888, pp. 325-333; 1889, p. 221. Also *The Electrician*, Vol. XIV., p. 479; Vol. XXI., pp. 83, 307; and Vol. XXII., p. 102

‡ *Rendiconti* del R. Istituto Lombardo, 1891, serie II., p. 677.

§ *Rendiconti* del R. Istituto Lombardo, 1891, serie II., p. 951.

‖ *Proc.* Roy. Soc., 1896, Vol. LX., p. 184; *Phil. Trans.* Roy. Soc., 1897, Vol. CLXXXIX., p. 1.

¶ Report of the British Association at Belfast, 1902. *The Electrician*, Vol. XLIX., p. 917.

** *Proc.* Roy. Soc., 1902, Vol. LXX., p. 341, and *The Electrician*, Vol. XLIX., p. 520.

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Working on these lines, Marconi succeeded in constructing his marvellous magnetic detector, which he applied with such great success as a receiver suitable for wireless telegraphy. After that, Sella* demonstrated that the magnetic condition of an iron, steel, or nickel wire is sensible to electrical waves even when the cycle of magnetic hysteresis is effected by a process of electric deformation instead of by a variation of the external magnetic field. Finally, Mauvain† proved by recent experiments that if an iron or steel core, subjected to a cyclic variation of magnetism, be simultaneously subjected to the continued action of a field due to electrical oscillations of high frequency, there is produced, instead of the well-known curve of magnetisation, a mere line representing the increase as well as the decrease of the magnetic field. It suffices, therefore, if the core be so thin that the oscillating field may penetrate to the centre with sufficient intensity, and if the effect of induction be symmetrical, as may be assured when the electrical oscillations are produced by applying an alternating current to the primary circuit of a Ruhmkorff coil.

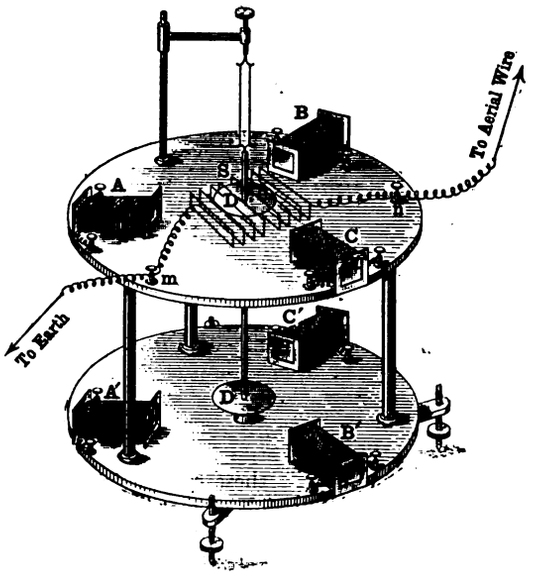
Galileo Ferraris, in his classical researches regarding electrodynamical rotations produced by alternating currents,‡ demonstrated that an iron cylinder is caused to rotate when placed in a rotatory magnetic field, even when the cylinder is sectioned in such a manner that no Foucault currents can be induced in it; the rotation is then due to magnetic hysteresis —*i.e.*, to the drag caused by the magnetisation of the iron lagging behind the rotation of the magnetic field.

If, now, Ferraris' fundamental experiment could be modified in such a way that the iron cylinder might be subjected to the action of a rotatory field—obtained by two or more alternating magnetic fields displaced in phase—and at the same time to a high frequency oscillating field, then its behaviour should be quite different to what it is when the cylinder is subjected to the mere action of a Ferraris field.

Following this line of argument, I have suspended in a Ferraris field, by means of a bifilar suspension, a disc consisting of a mixture of iron and steel powder and paraffin wax,§ on which was wound a coil having one end connected to earth and the other to the aerial wire. The Ferraris field was obtained by means of three coils, each having an iron core and situated at 120deg. from each other on the circumference of a circle. An alternating current of a frequency of about 42 ~ per sec. was sent through these coils, and Hertzian waves were set up by a Righi oscillation connected up in the usual way with one side to earth and the other to the aerial wire. After having read by means of a mirror and scale the deviation of the disc under the action of the Ferraris field alone, the oscillator was brought into action, and a distinct increase in the deviation of the disc was observed. This result—and it was a very notable result—meant that, under the conditions described, there was an increase of hysteresis in the magnetic substance upon which the experiment was performed. Afterwards, in order to increase the intensity of the Ferraris field in which the magnetic dielectric disc was hung, and thus increase the sensibility of the apparatus, I arranged the apparatus in the following manner, so that the initial deviation of the moving member would always be zero whatever the intensity of the Ferraris field. Referring to the illustration, it will be seen that two perfectly equal discs, D and D′, of magnetic dielectric material, are suspended in two magnetic fields of the same intensity which tend to turn in opposite directions; both fields are obtained by means of the electromagnets A, B, C, A′, B′, C′, inserted in the three circuits of a three-phase system. Only one of the two discs D and D′ is placed within the spiral S, of which the terminals *m* and *n* are connected to earth and to the elevated wire.

It is evident that under these conditions, whatever may be the intensity of the Ferraris field, in which the disc D hangs, it will always be possible to reduce the initial deviation of the movable portion to zero before subjecting D to the action of Hertzian waves, provided that the one field produces upon D a turning moment absolutely equal and opposite to the turning moment on D′ due to the other field. I have also replaced the magnetic dielectric discs first by two iron discs, then by two steel discs, afterwards by two cylinders, and finally by two rings of iron, steel and nickel; in every case I have observed that the effect of the Hertzian waves upon the moving portion is to increase the deviation even when considerable distances intervene between the signalling and receiving elevated wires. Lastly, I have modified the conditions of the experiments by varying the frequency of the Ferraris field from about 42 ~ per sec. to 12, 8, 6 and 4 ~ per sec., and I always obtained the same effect. This new detector may be of great utility in the laboratory, because, while very simple and easily used, it may be employed for quantitative measurements. Besides, the preliminary experiments seem to promise that the apparatus will also be of use in practical work.

While preparing this Paper I saw in *The Electrician* of March 4th that Ewing and Walter had presented to the Royal Society of London a note on the variation of



FERRARIS FIELD DETECTOR OF HERTZIAN WAVES.

hysteresis in magnetic substances produced by Hertzian waves. They had recourse to the same principle upon which Ewing's hysteresis meter is based, in which the hysteresis is measured by means of the couple produced when a magnet is rotated in the presence of the magnetic specimen upon which the experiment is performed. In some of their former experiments—when the electrical oscillations were sent through a coil at right angles to the plane of the ring-shaped magnetic specimen—they obtained but a very small variation of the deviation due to the normal hysteresis. But in subsequent experiments, in which the electrical oscillations traversed the magnetic specimen itself, which was a horizontal wire spiral, properly insulated, they obtained a very considerable deflection due to the normal hysteresis; and, what is even more important, they also obtained, by means of Hertzian waves, an increase of the deviation itself. The best speed of rotation of the magnet was about 5 or 8 revs. per sec.

Bearing in mind the results of my researches and the way in which the experiments were performed, the explanation of the increase of hysteresis, as given by Ewing and Walter, is no longer sufficient, and experimental researches should certainly be continued in order to find a full scientific explanation of the phenomenon.

* *Rendiconti* della R. Accademia dei Lincei, 1903, 2° Sunetre, p. 182.
† *Comptes Rendus*, November 30, 1903, p. 914.
‡ Atti delle R. Accademia delle Scienze di Torino, Vol. XXXIII., p. 360.
§ Birkeland was the first to suggest a way of obtaining a non-conducting and yet very homogeneous magnetic substance. This end may be achieved by mixing iron filings or a precipitate iron powder with paraffin wax and a small quantity of powdered quartz. *Comptes Rendus*, June 11, 1894, p. 1,320.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E FOURNIER D'ALBE.]

N-Ray Observation of the Spinal Marrow.—A. Broca and A. Zimmern quote some first results of their investigation of the spinal marrow by means of the N-rays. They succeeded in identifying certain nerve centres by this means with greater exactness in the living subject than had been possible by any other method. Points of maximum emission of N-rays were found at the second dorsal vertebra, the fifth and eleventh dorsal vertebræ, the second lumbar vertebra and the middle of the sacrum. These points were found to be the same in men, women, dogs and guinea-pigs. The second dorsal centre probably corresponds to the cilio-spinal centre of physiology. The second lumbar is the genito-spinal and vesico-spinal centre, as the authors were able to verify by the examination of some abnormal cases.

[BROCA and ZIMMERN, *Comptes Rendus*, May 16, 1904.]

Physiological N-ray Observations.—A. Broca gives some practical instructions with regard to the N-ray examination of the human body. The best screen to use for the purpose is made by attaching a wooden stopper to a leaden tube about 5cm. long, dipping it into a very dilute collodion solution, scratching a cross on it, filling the cross with the powdered sulphide and covering the latter with a thin layer of collodion. The screen should be excited by diffused daylight. On taking the screen over the surface of the skull, it is found that it remains darkest along certain lines which are found to coincide with the sutures. This may be explained by the circumstance that at the junctions of the cranial bones the active convolutions are necessarily furthest from the screen. The tube should be moved by the observer, and not by a second person.

[A. BROCA, *Comptes Rendus*, May 9, 1904.]

Action of N-rays.—J. Becquerel has made some experiments to determine how much of the increased luminosity and distinctness of a feebly luminous surface is due to the direct action of the N-rays upon the luminosity of the body, and how much due to their action upon the eye of the observer. It is known that there is some objective increase in luminosity in the case of small flames at all events, as shown by the photographic records, but the author shows that in the case of a feebly luminous surface the action consists in the liberation of N-rays from the surface, and these N-rays proceed to the eye together with the light rays, and impart a greater sensitiveness to the retina. He quotes the following experiment in support of this view. He interposes a plane parallel glass trough filled with distilled water between the eye and the sensitive screen. No effect of the ordinary sources of N-rays upon the screen can then be detected, owing to the N-rays being arrested. If, on the other hand, salt water is used instead of distilled water, the effects are visible again.

[J. BECQUEREL, *Comptes Rendus*, May 16, 1904.]

Microscopic Aspect of Sparking Poles.—B. Eginitis describes some peculiar effects observed on examining the poles of spark-gaps under the microscope. The appearance of knobs of manganese, iron, platinum and nickel is very different from that of knobs of lead, aluminium or tin. In the first class of metals, the ends of the poles are decorated with lines of bright points, each of which appear to have acted as the terminal point of a discharge, whereas in the second class the charge seems to proceed from a single point. In the case of lead, drops are formed, and these are sometimes observed to travel upwards over the surface of the pole. Under the microscope, the points have the appearance of craters. On increasing the inductance in the circuit, the number of points increases up to a certain amount, and then suddenly decreases. This variation, due to inductance, may, however, be brought about by other means also, such as heating, and the author thinks it is all a matter of temperature, which at a certain point changes enormously with the inductance.

[B. EGINITIS, *Comptes Rendus*, May 16, 1904.]

Anode and Cathode Spectra.—G. D. Liveing has examined a number of vacuum spectra with a view to determine the differences between the anode and the cathode spectrum, and framing a theory to account for the characteristic differences between them. He finds that hydrogen, nitrogen and the halogens give two perfectly distinct spectra, but that there is no anode light in oxygen and sulphur. Metallic vapours, such as those of mercury, sodium, cadmium and thallium, as well as carbonic oxide, show no difference between the cathode and anode spectra, and the two oxides of carbon have an identical spectrum. There are no visible spectra which can be ascribed to the compound molecules of hydrochloric acid or water, while the compound molecules of carbonic oxide and cyanogen give very characteristic spectra. The most convincing argument that the molecules of the gas emitting the cathode glow are unaltered in constitution is that in many cases the spectra are reversible. This could not be unless the molecules which produce the reversed spectra by absorption were the same as those which, under the stimulus from the cathode, emit the same rays bright. The line spectrum of hydrogen is well known to be reversed in the sun, and the reversal of C and F has often been observed in looking at a spark in dense hydrogen. The most striking case of reversal is that of the cyanogen bands. The behaviour of the metals suggests that the positive ions consist of molecules of the vapour, which, when de-ionised, vibrate to the same tune as do the like molecules under the influence of cathode rays. In this connection the monatomic character of metallic vapours may have some significance. But in any case the positive ions may very well be molecules of the vapour, and there is no reason why chemically compound molecules, such as those of carbonic oxide, should not become positive ions. In fact, these molecules often play the part of elementary atoms in chemical combination. The author is inclined to the conclusion that the explanation of the solar chromosphere and corona will be found in regarding them as a huge cathode glow.

[G. D. LIVEING, *Proceedings of the Cambridge Philosophical Society*, April 22, 1904.]

Occurrence of Radio-active Matter.—After discovering the presence of a radio-active gas in the Cambridge tap water, J. J. Thomson has made further experiments, and has found that a radio-active substance, apparently radium, is exceedingly widely distributed, and occurs in the most unexpected places. The following substances gave most unmistakeable evidence of containing a radio-active emanation:—Soil from the garden adjoining the Cavendish laboratory, Cambridge gault, gravel from a pit at Chesterton, powdered bricks, powdered glass, sea sand from the beach at Whitby (this was exceedingly rich in the emanation), blue lias from Whitby. One specimen of powdered silica contained a very large quantity of the emanation, other specimens little or none. One specimen of wheaten flour contained an appreciable amount of emanation, other specimens none. Practically all the clays, sands and gravels tested gave off the emanation. The latter, to judge from its rate of decay, seems to be the same as that given off by radium. The capriciousness of the emanation tells against its being a universal property of all matter, but the author believes that most, if not all, bodies are continually emitting a radiation which, like the Röntgen rays, can ionise a gas through which it is passed. The radiation streaming through bodies will not be all of one type, the primary will give rise to secondary, and that again to tertiary, and it is probable that in small vessels part of the ionisation in the vessel is due to the secondary and tertiary radiation proceeding from its walls. The radiation absorbed by the air is not wholly used in producing radiation of the same kind, since part of it is spent in ionising the gas, and is, on the recombination of the ions, converted into heat. The mechanical equivalent of the heat developed by the recombination of the ions in a cubic centimetre of air at atmospheric pressure and temperature is between 1 and 10 ergs per century, and this will be a measure of the amount of internal atomic energy lost by a cubic centimetre of air in the same time.

[J. J. THOMSON, *Proceedings of the Cambridge Philosophical Society*, April 22, 1904.]

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THE BOURNEMOUTH TRAMWAY ARBITRATION.

An arbitration of considerable interest to tramway engineers is now being held to determine the price which shall be paid by the Bournemouth Corporation to the Poole and District Electric Traction Co. for the acquisition of their undertaking under an agreement entered into in 1903. A lengthy report of the proceedings appears in another column of this issue, and the case will be undoubtedly valuable as a precedent. The undertaking was authorised under the Light Railways Act, and the promoters were granted a long period of years, at the end of which the line was to be purchased, not on "tramway" or "scrap iron" terms, but at fair market value.

The history of tramways in Bournemouth and the surrounding districts affords one of many examples of too narrow-minded an opposition to private enterprise for fear it should deprive the community of a possible outlet for municipal trading. In 1897 an application was made by the British Electric Traction Co. for a Light Railway Order to construct tramways from Poole, through Bournemouth to Christchurch. Of course, the greater proportion of the lines were in Bournemouth, but, although, under Light Railway procedure the Local Authorities have no veto, the Bournemouth Corporation succeeded in presenting a sufficiently strong case as to the ruinous effect of tramways upon the trade of the town, to induce the Commissioners to reject the Order. In the following year applications for the same lines were made both by the British Electric Traction Co. and by Mr. W. M. MURPHY, but were rejected owing to the short interval of time since the previous application. Persevering in their efforts, however, the British Electric Traction Co. and Mr. MURPHY, who is well known in connection with the Dublin, Isle of Thanet, Paisley and other tramway undertakings, joined forces, and succeeded, in 1899, in securing a Light Railway Order for a line between the "County Gates" on the western boundary of Bournemouth to Poole, a distance of about 3½ miles. This line is now to be transferred to the Bournemouth Corporation, but, owing to the great difference between the sum offered by the Corporation and the price asked by the Company, the present arbitration proceedings have become necessary. Until 1899 the Corporation had made no effort to introduce electric traction into the town, for the reason stated above, but hearing of the intention of the Poole and District Electric Traction Co., which had been

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registered for the purpose of working the Poole undertaking, to apply to Parliament for powers to construct lines through to Christchurch, it so far abandoned the argument it had put forward originally as to promote a tramway bill itself. When the Corporation Bill was before Parliament, the Company opposed, and, in view of the previous disposition of the Corporation, more weight than is sometimes the case was attached to the argument that the intention was merely to keep out other promoters and not actually to build the lines. In the end the Bill was passed with the provision that, if the Corporation had not constructed and opened the lines within two years from August, 1900, the Company should take the place of the Corporation, and that, in the event of the lines being built, the Company should have running powers over the lines authorised by that Act. Although the Bournemouth Corporation proceeded with the construction of their lines within the town, they were not opened to the public within the statutory period of two years, although the opening was only a few days late, and the Company, in the Appeal Court, obtained an injunction to restrain the Corporation from putting the lines into operation, as, according to the Act of 1900, their powers had expired. Obviously, therefore, the position being that the Corporation might have to pull up the lines laid, it was necessary that some arrangement should be come to with the Company, and the position of the Company was strengthened by the fact that it had secured Parliamentary powers to construct lines from the eastern boundary of Bournemouth to Christchurch, thus having feeders at both ends of the Corporation system with running powers over the latter. By the permission of the Company the operation of the injunction was suspended pending the discussion of heads of agreement, and ultimately an agreement was sealed, dated March 11, 1903, providing for the purchase of the Company's undertaking as a going concern, at fair market value, the basis of the calculation being the balance-sheet for the first nine months working of 1901, which showed a profit of £5,662. 13s. 8d.

In the Light Railway Act there is no clause stipulating for compulsory purchase by the Local Authority at the expiration of the term, as in the Tramways Act, but the Commissioners usually give such powers to the Local Authority, the price being, however, the fair market value as a going concern, but without any allowance for compulsory purchase. The Poole line of 1899 was granted a period of 35 years, purchase to take place then upon these conditions, or at any subsequent period of seven years. An extension loop to Parkstone, granted in 1903, was given 25 years under like conditions. It is not surprising, therefore, that the Company's claim amounts to a huge sum—£430,000. Against this we believe the Corporation have offered some £60,000. Of the total of £430,000 claimed by the Company, nearly £250,000 will be absorbed, according to the Company's view, as the capital value of the Poole line now working, the remainder being allocated to the value of the running powers in Bournemouth, the Poole extension of 1903, future profits on the Poole line, and the prospective value of various contemplated extensions abandoned in consequence of the negotiations with the Corporation for purchase. An interesting discussion took place on the first day on the question of depreciation as allocated in the balance-sheet of 1901, £1,000 being taken from the profits for this purpose. The Corporation contended, therefore, that in estimating the profit for 1901 this £1,000 should be deducted, and the sum actually paid away as dividend to the shareholders should be taken as a basis for the valuation of the profits. This contention appears reasonable, but this difference of £1,000 in nine months means a difference of £40,000 in 45 years, and needless to say the Company is using every argument in favour of the £1,000 being regarded as part of the actual profit. The Umpire quite rightly held that he had a free hand to consider the balance-sheet as a whole.

Before Parliamentary Committees and also before the Royal Commission on London Traffic, on many occasions the greater elasticity of the Light Railway Act as compared with the Tramways Act has been favourably commented upon, and the arbitration in question vindicates the position which we ourselves have taken up so frequently. No question of municipal trading is involved, beyond the one that the Company wished to extend its business and the Corporation desired to check it. If the Company had merely possessed powers under the Tramways Act of 1870, this would have been comparatively easy, but owing to the more favourable position of the Company, the Corporation has been practically compelled to conclude its campaign against the Company by buying it out at a fair valuation—a transaction which may or may not commend itself to the Bournemouth ratepayers as a profitable one. For this, however, the Corporation itself is entirely to blame. The Company took the initiative in its desire to provide tramways in the Bournemouth district, and would have opened lines in Bournemouth itself long before the Corporation, had it been allowed to do so. Then the Company experienced considerable difficulty in inducing Parliament to set aside the refusal of the Corporation to grant the Company running powers over the Corporation lines, although it would obviously be to the advantage of the travelling public reaching Bournemouth from the east and west that they should be allowed to continue their journey into the town without changing cars. There is at least one case in which running powers have been arranged between a company and Local Authorities, and the arrangement has worked well to the mutual advantage of both sides. Moreover, the Corporation itself works a combination of trolley and conduit tramways, and so no trouble could have been anticipated on this score. The Company, therefore, can hardly be blamed for making the most of the opportunity afforded them by the delay of the Corporation in completing its lines. The present arbitration should serve as an object lesson to those responsible for the obstructionist tactics of some Local Authorities, by bringing home to them the value of business undertakings whose progress they may impede by opposing on principle the accomplishment by private enterprise of any work that might conceivably be carried out by municipal trading. Had the Corporation been able to hold its own against the Company from the first, the country would have been deprived of an electrical undertaking representing from £60,000 to £430,000 of English capital—we cannot be more precise in our estimate of the amount, as we dare not predetermine the issue of the present arbitration.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

The Practical Physics of the Modern Steam Boiler. By Frederick J. Rowan. (London; P. S. King & Son; New York: D. Van Nostrand & Co.) 1903.

The subject of steam boilers is treated in this work in a distinctly novel fashion. The author makes no attempt to give exhaustive descriptions of boiler details, but discusses the much more difficult problems connected with the physics of steam production. His method is to quote largely from authoritative Papers on the subject, to bring together the results of experiments, and, in the discussion of these results, to try and bring out the physical principles concerned in the

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various problems handled. With this object, he treats the questions relating specifically to boiler design from a rational point of view. The usual theory is given regarding the stresses in the plates where the assumption is made that the fluid pressure is without variation of magnitude or temperature, but supplementing this, are the records of many experiments concerning the changes of shape in the boiler consequent upon the changes both of pressure and temperature. Further, the question of the variation of stress due to these variations of pressure and temperature are considered, thus bringing the subject within the region of Wöhler's experiments on stress variation.

The author gives a complete review of the problems concerned in the complicated question of combustion of fuels, pointing out that the calorific value of the fuel calculated from a chemical analysis is approximate only, and usually below the value obtained by experiment, for the reason that the chemical compounds which are formed in the process of combustion are not precisely known. The advantages of forced draught are discussed, the various systems in use are described, and a comparison is made between the results of experiment on various classes of engines. The discussion of the defects of the ordinary system of forced combustion leads the author to the suggestion of external combustion chambers.

The transmission of heat from the hot gases across the heating surface to the water is treated very fully. Although the law that the rate of heat transmission across a plate varies as the difference of temperature on the two sides of the plate is stated, and also the law which Mr. Blechyndon derived from his experiments that the rate varies as the square of the difference of temperature, the author very properly points out the limited extent to which any law can be applied in connection with the subject. Each law may be true for the particular experiments from which it was derived, but no law can be found which is universally true for heat transmission because the question is so complicated by the state of the surfaces of the plate, and it is impossible to get the physical data of the problem constant even if the material of the plate is kept the same. The author devotes by far the larger part of his remarks on this subject to the consideration of the velocities of the heat-carrying media over the heating surface, quoting and giving tabulated results of a large number of experiments bearing on the question. The important influence of the velocity of the media over the heating surface on the quantity of heat transmitted across the heating surface was pointed out by Prof. Osborne Reynold in a Paper read before the Manchester Literary and Philosophical Society so far back as 1874. The results of all the experiments quoted by the author serve to show that if any radical improvement is to be made in boiler efficiencies, in the direction of making the whole extent of the heating surface uniformly efficient, the design will have to be arranged so that the velocities of both the hot gases and the water over the heating surface may be greatly increased and properly regulated. Water-tube boilers receive a large share of attention, and the much-debated question of water circulation, the advantage of special downcomers, drowned tubes in the drum and tubes delivering above the water level are discussed mainly by means of quotations from the original memoirs of workers in the subject. A chapter is devoted to the bringing together of experimental data concerning the influence of temperature on the tenacity and ductility of metals used in boiler construction. We think an important Paper in connection with this subject has been overlooked by the author—namely, the Paper giving the results of the elaborate research made by Mr. F. W. Webb at Crewe on the effect of temperature on various alloys with which he experimented for firebox stays, and published in the *Proceedings* of the Institution of Civil Engineers, Vol. CL.

Corrosion is discussed and opinions quoted from 1843 onwards. We notice that Mr. Dewrance's theory of dry corrosion has been overlooked. This is a distinct contribution to the subject, and the Paper in the *Proceedings* of the Institution of Civil Engineers, Vol. CXLI., with the discussion thereon, might appropriately have been mentioned. A historical sketch, occupying some 155 pages, leads to a chapter on boiler tests. Here are collected the results of tests in Europe and America, and, needless to say, a summary is given of the classical tests made by Dr. Kennedy and Mr. Bryan Donkin. The book contains a mass of data, brought together from many sources and presented chiefly in tabular form. No book hitherto written on steam boilers presents such a comprehensive view of the experimental knowledge of the subject. Every engineer who has anything to do with either the design or the superintendence of steam boilers will find something in this book to interest him.

The Electrical Industry: Lighting, Traction and Power. By Adam Gowans Whyte, B.Sc. "Books on Business" Series. (London Methuen & Co.) 1904. 2s. 6d. net.

Mr. Whyte has succeeded in striking off a fluent and accurate résumé of the growth of the electrical industry in England. Throughout the volume the author is visibly labouring under suppressed enthusiasm, and, considering his subject, this is not surprising; it *is* difficult for the natural philosopher, the engineer or the sociologist to write calmly about Electricity, notwithstanding the cynics who say that its most indubitable conquest up to the present is to be found in the innumerable electrically-lighted cellars which have blossomed out under its beneficent influence into green and gilded restaurants. "Centralisation" and "unity of control" evidently find favour in the eyes of the writer of this interesting little history, and Europe and America doubtless owe much to them. Industrial concentration, amalgamation and the like require, however, for their full development humanity of the automaton type, and this is the greatest natural product of the East, not of the West. A fact which will soon sober our enthusiasm for the catchwords.

Dynamo Attendants and their Dynamos. By Frank Broadbent. 4th edition, 1904. (London: S. Rentell & Co.) 1s. 6d.

This book, originally due to Mr. A. H. Gibbings, has been entirely re-written by the present author. Besides dealing with the fundamental principles of electric machinery, as far as is necessary to enable attendants of dynamos and motors to gain an enlightened insight into the internal working of the machinery under their care, the author has compressed into this little publication much matter of direct practical value, and many hints connected with the running, upkeep, testing, repairing and fault-localising, &c., of electric machines and some of their accessories. Both continuous-current and alternating-current generators and motors are discussed, and their mechanical driving is treated at some length. Altogether, this clearly-written publication can be recommended to the men for whom it is intended, and its perusal ought to dispel once and for all the rather amazing idea (attributed, we hope wrongly, by the author to some dynamo attendants) that "the electric current is generated by the friction between the commutator and the brushes." The drawings and diagrams are on the whole clear and to the point, the illustration of the antiquated bipolar continuous-current dynamo, however, might with advantage have been replaced by a picture of a more modern pattern.

Elektrische Spektra: Praktische Analytische Studien über Magnetismus. By Johannes Zacharias. (Leipzig: Theodore Thomas.) 6m.

The author defines electricity as a wave motion of the ether, and magnetism as a pressure exerted against electric waves. He attempts to support his views by a number of experiments with iron filings, some of which are novel as regards the way in which the rods are magnetised, one of them having two adjacent similar poles in its centre. The book is, however, rendered utterly valueless by the unscientific manner in which the anthor's observations are manipulated in order to support his own crude theories. The lines of iron filings are called "magnetic waves," and the occasional shortening of rods on magnetisation observed by "Stilford Bidwell" is brought in as a proof of the author's contention that magnetism is a pressure! That there is also a lengthening of rods on magnetisation is not mentioned. It seems a pity that the money lavished on the get-up of this work should not have been devoted to the advancement of science.

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CORRESPONDENCE.

THE DESIGN OF ELECTRIC GENERATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On p. 208 of Dr. Thompson's "Design of Dynamos" (1903), and again on p. 677 of the 1904 edition of the same author's "Dynamo-Electric Machinery," the M.P. 6-200-135-500-volt, 400-ampere tramway generator described on pp. 190 to 201 of our work entitled "Electric Generators" is stated to be the best design amongst the five large continuous-current generators therein described. This is not the case. The machine does fair service at the above speed, output and voltage-rating, was built in large numbers, and is to be found in successful operation to-day in many lands. We do not consider it a good design according to the best standards, as should be evident upon inspection of its constants, which are fully set forth in "Electric Generators." This machine was not designed by the writers.

The best and most modern design amongst the five is the M.P. 6-250-320-500 volt 455-ampere machine fully described on pp. 215 to 228 of "Electric Generators."

Another excellent modern machine is the M.P. 10-550-90-550-volt 1,000-ampere dynamo, designed by Mr. Parshall in 1893, described in the *Street Railway Journal* for October, 1900, and also on p. 678 of Dr. Thompson's work. A number of these machines are in operation at Dublin and elsewhere in this country. The M.P. 16-1,000-90-500-volt 2,000-ampere design described on p. 632 of Dr. Thompson's work, and of which two are in operation at Sheffield, is also a thoroughly good machine. This was designed by Mr. Hobart in 1901.

We deem it advisable to publish this note, since Dr. Thompson's work deservedly enjoys a wide circulation, and the consequences of following on the lines of other than the most successful designs could not but be detrimental to the industry. While indiscriminate copying is, of course, to be deprecated, a judicious reference to the constants of successful designs paves the way for still further advancement.

It has been represented to us that the designs of which we have on various occasions published detailed descriptions, as illustrations of certain phases of practice in dynamo design, have been employed by various manufacturers as models. Nothing could be so unwise as such a practice. Any really complete description of a machine, together with the final test results is of great use to a designer, but only as a basis from which to work. Few machines have been built and tested without revealing, on careful analysis, the direction in which further improvements were practicable. The manufacturer who has just standardised a design cannot sacrifice the developmental costs and proceed at once with the ultra refinements of an improved design, but he will frequently have done so long before any published description is available, and the manufacturer who blindly copies such a published description, on completion of the machine, may find his competitors still in the lead with an *improved* design.

The writers would also like on the present occasion to refer to the matter of core loss calculations. On p. 229 of "Electric Generators" was given a core loss predetermination curve derived by an analysis of 23 large multipolar commutating machines, in the design of which there was a wide range of periodicities and magnetic densities. The results showed that in practice the core loss in watts per kilogramme could be derived directly from the product of periodicity and core density. This method has come in for a good deal of criticism from time to time, and it has been maintained that it stood too directly in contradiction to known theory. Nevertheless, we have found it to be a more reliable guide than any other process, either theoretical or empirical, and it is obviously far more direct than the theoretically more attractive methods set forth in most treatises on dynamo design.

The value of our method has recently been strikingly confirmed by the results of a most elaborate investigation described in a Paper contributed by Esterline and Reid to the *Transactions* of the American Institute of Electrical Engineers (Vol. XX., 1903, pp. 1,323-1,338). Messrs. Esterline and Reid's investigations comprised 12,000 observations on variously-proportioned armatures, and the practical results at which they ultimately arrived are given in the curves of Fig. 1. It will be seen that the core loss in watts per kilogramme is found to be a function of the product of periodicity and core density, the conclusion at which the present writers had arrived several years ago. In Fig. 1, it is stated by Messrs. Esterline and Reid that curve No. 1 may be taken as representative of smooth cores within either solid or laminated poles, curve No. 2 of toothed cores within solid poles, and curve No. 3 of toothed cores within laminated poles. To these curves Messrs. Esterline and Reid have added a broken line curve which they have obtained from

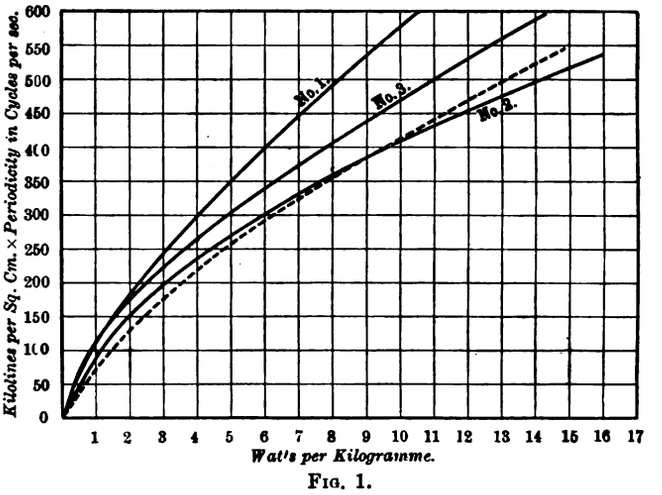

FIG. 1.

the core-loss tests of a large number of commercial machines having, in the majority of cases, toothed cores and solid cast poles.

We have re-plotted this last curve in Fig. 2, together with our own curve of 1899. The agreement is so close as to dispel any further doubt as to the best method of procedure in calculating the core losses in practical designing.

The broken line in Fig. 2 is suggested as a good representative curve for core-loss calculations.

In dealing with dynamo calculations generally, due allowance must be made for variations in materials and slight variations in dimensions and finish incident to ordinary shop methods

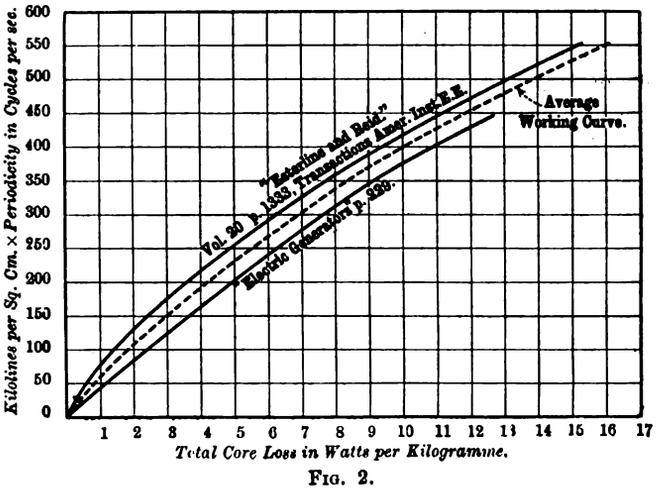

FIG. 2.

This applies more particularly to calculations of iron losses, since in practice it is practically impossible to make two identically similar cores. We do not suggest, therefore, that in a rigorous examination of results there will not be found considerable variations from the calculated results by the empirical methods suggested. The successful designer must invariably allow for such variations in material and dimensions as occur in reasonably well-regulated practice. Within these limits the method we have proposed has been found to be accurate. Within the limits obtainable in really scientific work the

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empirical way of proceeding would not be of any particular value. Dynamo design, however, cannot become a strictly scientific process until dynamos are built in a laboratory, and not in a commercial workshop.—Yours, &c.,

London, May 27. H. F. PARSHALL.
H. M. HOBART.

COMPLETION OF THE PRACTICAL SYSTEM OF ELECTRICAL UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is a feature of discussions on practical electrical units that the practical man, for whose benefit these alterations are proposed, shows a plentiful lack of interest in the matter, while all those who have contributed letters on the subject no doubt work freely in C.G.S. units or convert, without trouble, from one system to another, so that they are probably not writing from any feeling of personal inconvenience.

Now the professor may propose, but it is the working engineer who determines the acceptance of a unit, and it appears to me that his tastes have been too little considered. If we may judge from other branches of engineering, it is not found convenient to have separate names for derived units, but rather to use self-explanatory terms. Thus, velocity is measured in miles per hour (except in marine work, where knot is used); pressure in pounds per square inch; gradient, one in so many; flow of liquids, gallons per minute; angular velocity, revolutions per minute, and so forth. There is no doubt that such units are easily intelligible. Even in the electrical system, over-weighted by academic love of system as it is, practical men have invented descriptive units in defiance of orthodox creations. Witness ampere-turn, kilowatt-hour, ampere-hour, volt-ampere. In the metric system, simple and logical as it is, the litre (except in measurement of drinks, for which it is a convenient size) has been ousted by the cubic centimetre or cubic metre. This is obviously because the practical man works in mental pictures, and wants units that will convey impressions of magnitude with least trouble to his mind. Moreover, each branch of calculation deals with different magnitudes or quantities measured in different ways, and hence a special combination is needed. Thus, a railway man states velocity in miles per hour, while the lift designer prefers feet per minute; the steam engineer talks of pounds per square inch, and the turbine maker calculates in feet of head. To ignore this very reasonable tendency must result, I cannot but think, in stultification of the labours of committees and conventions.

There should be exercised a severe economy in the invention of names, only those quantities having individual names which cannot be briefly described in terms of others. As above mentioned, the coulomb is becoming obsolete as a practical unit, and probably a new unit for $\mathfrak{B}$ would be doomed to early extinction. Broadly speaking, if a quantity has a name, its time or space differential requires none; or conversely, if the differential is the more convenient—*e.g.*, the ampere—then the time or space integral is needless. On the other hand, I think nothing would be more confusing than the use of the same unit for different measurements, such as henry, both for coefficient of induction and for permeance. This proposal is surely due to a confusion of the origin and the object of units. Practical units are not made to illustrate the theory of the subject, but to permit of the easy and clear statement of numerical quantities.

Among so many suggestions I fear to enter as a godfather, but I certainly think that permeance should have a name of its own. In fact, I suggested this to the B.A. Committee on Electrical Standards some nine years ago, and I believe I was the first to propose (B.A. Report, 1895, p. 206) the inclusion of the $4\pi/10$ in the value of the permeability, so that the unit of permeance would allow of the ampere turn being taken as the unit E.M.F. These ideas were, doubtless, too revolutionary at that time, but I have good hopes that they will ultimately be accepted as the simplest compromise of the 4π question. Dr. Fleming, who was a member of the committee, did me the honour to include this among his other more sweeping proposals of change, and several other reformers have inclined to the same view.

It is interesting to note that the committee recommended 10^8 lines of force as the unit of magnetic flux, but owing to its excessive size this has not been generally adopted. It also involves the use of an inconveniently small value for permeability, though in other respects the unit has advantages. But the inclusion of the figure 10^8 as a separate item in a formula is not a great hardship, nor is it possible for the accidental omission of such a number to pass without notice.

I agree cordially with Prof. Fessenden that the ampere-turn should be the authorised unit, retaining the C.G.S. unit of magnetic flux and altering the unit of permeance. Whether the other units are to be altered may be questioned. I am inclined to the view that practical units should be made only where there is a real demand, leaving other quantities to be expressed in C.G.S. units for scientific work, and accepting the hiatus and the re-appearance of the 4π in places where it is comparatively harmless to the ordinary man. And I deprecate most strongly the substitution of a new name for ampere-turn. Objectors who say that magneto-motive force is not always due to ampere-turns have only to look at other units. Liquid or gaseous pressure is measured in pounds per square inch, although the source of the pressure has nothing to do with the weight of a pound. But in calculating strains on enclosing vessels, the unit is very convenient, and the meaning is clear and definite.—Yours, &c., FRANCIS G. BAILY.

Heriot-Watt College, Edinburgh, May 31.

P.S.—Since writing the above I notice that Prof. Perry advocated the ampere-turn, the volt-second, and the value of the permeability of air as $4\pi \times 10^{-9}$ some 16 years ago, and published his views in your columns in the issue of July 31, 1891. I had quite forgotten this.—F. G. B.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with great interest Prof. Braun's communication published in *The Electrician* of April 15, 1904, p. 1,033, in which he endeavours to prove priority over Marconi in the use of the closed oscillating circuit coupled with a radiating conductor. To prove priority, Prof. Braun calls attention to his British patent No. 1,862, 1899. This patent is identical with Prof. Braun's German patent No. 111,578, application for which was filed October 14, 1898. A study of these patents is most interesting. In Figs. 2 and 4 the antenna is connected to a Tesla or Oudin oscillator circuit by means of an oscillation transformer. The lower end of the antenna is not earthed. Neither is the antenna attuned to the frequency of the closed oscillating circuit. Under such conditions it is impossible to develop more than a negligible current flow in the antenna, and therefore it is impossible to radiate electromagnetic waves. The system is absolutely inoperative.

The first portion of British patent No. 1,862, 1899, reads as if its author was unaware of the fact that long waves and antennæ had ever been employed in wireless telegraphy prior to October 14, 1898. In fact, he divides electrical oscillations into three groups—those of commercial frequencies produced by alternating-current generators; those produced by Fedderson in his demonstration of the oscillatory nature of a condenser discharge under certain conditions (*Pogg. Ann.*, 1857-1863); and, finally, the oscillations produced by Hertz "which are of a frequency much higher than those produced by Fedderson." He then proceeds to state that "up to this time Hertzian oscillations only have been used in transmissions by wireless telegraphy"; that their employment necessitates the absence of material obstacles between the transmitting and receiving stations, and that, in fact, the interposition of "*trees, smoke, sails,*" &c., between the stations serves to cut off communication.

After this introduction he states the object of his invention—viz., the employment of waves that are of great length compared to the waves investigated by Hertz. The frequency of the waves investigated by Hertz was of the order 100,000,000 and the length of these waves was of the order 1 metre.

In October, 1898, then, we have presented to us the spectacle of a college professor, who admittedly knew nothing of the

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development of the art up to that time, advocating the use of waves longer than *1 metre*, so that he might be able to transmit signals between two stations separated by such obstacles as "trees, smoke, sails, &c."! He seems to forget the work of Marconi, who had already employed antennæ more than 150ft. in height for radiating waves of more than 600ft. in length, and he overlooks the work of Lodge, who advocated the use of inductance coils in order to decrease the frequency and to increase the length of the radiated waves (British patent 11,575, 1898, or United States patent 609,154). It should be remembered that as early as August, 1897, Ascoli had announced the law that the length of the waves radiated from an antenna was four times the height of the antenna (*Elettricista*, Rome, August, 1897).

There is absolutely nothing in British patent 1862, 1899, about *increasing the energy of radiation*. The gist of the invention is merely the employment of *slow oscillations* so as to insure the radiation of *long waves*, which had long before been obtained by the use of high antennæ by Marconi and others.

In view of the introduction to the patent, we must consider that Prof. Braun was unaware of the true nature of electrical radiation from antennæ, that he did not know that the wave length was four times the height of the antenna, and we may even doubt that he was aware that antennæ had ever before been employed.

There is nothing in Braun's patent concerning the desirability of generating persistent electrical oscillations or radiating prolonged trains of waves, although in his pamphlet entitled "Drahtlose Telegraphie durch Wasser und Luft," published in 1901, he has a great deal to say on this subject, a great deal to say on the advantage of these persistent oscillations, a great deal to say about a tuned receiving system adjusted to take advantage of the resonance resulting from these prolonged trains of waves, as well as a great deal to say on the subject of attuning the antenna to the frequency of the closed oscillating circuit and the subject of the absolute necessity of earthing the lower end of the antenna or else connecting it to a large capacity body so as to balance the upper half of the antenna. As Braun himself aptly puts it in his letter of April 15th: "The direction I had to pursue was clear to me. The only consideration then was *the means by which it could be made practical.*"

There are no directions or instructions in Braun's British patent whereby an electrical engineer of ordinary experience could "make practical," or even operative, the inoperative system therein disclosed.

It was not until long after October 14, 1898, that Braun discovered "the means by which it could be made practical." On his own admission this is true. The first intimation given the public of these "means" was contained in a Paper in *Dingler's Polytechnische Zeitschrift* in the latter part of 1901, which appeared shortly before Braun's pamphlet above referred to. This Paper stated that the length of the antenna should be one-quarter of the length of the waves to be radiated as determined by the frequency of the oscillations in the closed oscillating circuit, and this was long after Marconi's British patent No. 7,777, 1900 (published April 13, 1901), had been accessible to Braun.

As Braun states the case, "it was only very late that I published something about my work—*i.e.*, November 16, 1900—and a reference to a more correct view of the dependency on the coupling will be found on p. 51 of my pamphlet on Wireless Telegraphy, 1901." (This is the pamphlet the full title of which I have given above.) It will be in vain for Prof. Braun to try to sustain his British patent by referring to his pamphlet published almost three years after his patent application had been filed. A patent for an inoperative system is necessarily void *ab initio*, and such a patent cannot have new life infused into it by something that the patentee discovered afterwards, or, rather, something that was discovered by others for him.

The professor states, in his letter of April 15th, "I at once searched for methods of increasing the available oscillating energy *without altering the frequency of oscillation*," and yet we find, according to his British patent, that the *raison d'être* of the closed oscillating circuit is the production of *long waves* that will not be impeded or cut off by obstacles.

He also states that he considered the vague and incomplete suggestion of the inoperative system contained in his British patent sufficient to protect the more highly-developed system evolved therefrom, "otherwise," he says, "a patent application filed in the summer of 1899 would now exist," and just such an application *does exist* in the shape of his British patent No. 22,020, 1899, filed November 3, 1899, which shows the same system as is shown in Fig. 4 of the earlier British patent, with the addition of one of the numerous details necessary to make the earlier system operative—namely, an earth connection for the lower end of the antenna.

As if other proof were lacking, the professor himself has furnished proof that at the time he filed his application for his earlier patent he did not have the slightest conception of the invention for which he is now claiming priority over Marconi. The system shown in the later patent (22,020, 1899) is bad enough and useless for any but very short distances, because the antenna is not attuned to the closed oscillating circuit, but the earlier patent, which has neither ground connection nor attuned antenna is absolutely useless for any purpose. It was not until Marconi's British patent No. 7,777, 1900, was published early in 1901, that the necessity of accord between the periods of the closed and open oscillating circuits was known to the public. It was not until after the publication of this Marconi patent that Braun published the numerous modifications to his earlier system that were essential to its operativeness.

So far we have been considering the contest between Braun and Marconi on the question of priority of invention of the transmitting system employing a closed oscillating circuit associated with an antenna, but let us not overlook the fact that priority may not belong to either. That such is the case, I have only to call attention to the fact that my friend Prof Reginald A. Fessenden, on December 15, 1899, filed in the United States Patent Office, two applications which have now become patents Nos. 706,735 and 706,736, dated August 12, 1902, and which describe clearly and concisely, and without the slightest uncertainty, a closed oscillating circuit directly connected to the antenna, and, moreover, the period of the antenna is described as being equal to the period of the closed oscillating circuit, as determined by the inductance of its connections and the capacity of its condenser.

Furthermore, there is in Prof. Fessenden's case some reason for employing the means above described for producing persistent oscillations and prolonged trains of waves, because at the receiving station the antenna has a period equal to the frequency of the waves radiated by the sending station, and is connected to a closed tuned circuit, containing a condenser and a coil, which also has a period equal to that of the radiated waves. In other words, Prof. Fessenden describes and claims in the broadest terms a closed oscillating circuit for prolonging the oscillations in the antenna, and he also claims a closed oscillating circuit associated with a transmitting antenna in combination with a closed tuned receiving circuit associated with a receiving antenna, *the periods of the said four elements being the same.*

Now, December 15, 1899, antedates by four months the filing date of Marconi's British patent 7,777, 1900, and it antedates by two years the date of the first information ever given to the public by Braun as to how his early system could be made operative for the purpose of radiating electromagnetic waves.

Shortly after December 15, 1899, to wit, February 8, 1900, another American, Mr. J. S. Stone, filed in the United States Patent Office an application which is now patent No. 714,756, and which described a closed oscillating circuit inductively related or coupled to an antenna, the antenna being attuned to the period of the closed oscillating circuit, and a closed resonant circuit, attuned to the same frequency, inductively related or coupled to a receiving antenna. February 8, 1900, is likewise prior to the filing date of Marconi's British patent and is long prior to Braun's publication of the "means by which it could be made practical." In Mr. Stone's patent the reaction of the antenna on the oscillating circuit is fully discussed, and means are provided for eliminating this reaction while yet maintaining the tight coupling between the antenna and the closed oscillating circuit. This, Prof. Braun will please

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note, was 2½ years prior to Max Wien's discussion of the same subject in the *Ann. der Phys.*, 1902, p. 686.

To sum up, Braun does not deserve in the slightest degree the credit given him for introducing into wireless telegraphy the use of a closed oscillating circuit associated with a good radiating circuit or antenna. His early system was totally inoperative. His British patent 1,862, 1899, does not contain sufficient disclosure to enable any one to get the slightest benefit therefrom, and is, therefore, void. His British patent 20,020, 1899, was a step in the right direction—it added the necessary earth connection. The next step—*i.e.*. the attuning of the antenna to the period of the oscillating circuit, was not described by Braun until long after it had been described by Marconi. As to Marconi, he must certainly be considered an independent inventor of the system described in his British patent 7,777, 1900, because there was not enough in Braun's 1899 patents to assist him in making his invention, and he must be considered a highly meritorious inventor because his system is efficient to a high degree.

But then again, Marconi must concede priority to Stone, the filing date of whose U.S. patent above referred to antedates the filing date of Marconi's British patent. Finally, Stone himself must concede priority to Fessenden, whose applications were filed before his own, for a system employing a closed oscillating circuit associated with a radiating antenna. In this connection it is pertinent to call attention to the fact that no U.S. patent has been granted to Marconi for the invention described in his British patent No. 7,777, 1900.—Yours, &c.,

New York City, May 19. LEE DE FOREST.

A CRITICISM OF SINGLE-PHASE TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been much interested in the articles on single-phase traction and your leader on same, and am with you in having very little faith in the Ward-Leonard system of single-phase traction as exemplified by the Oerlikon installation. The whole thing is too much after the Heilmann absurdity to rank as a serious factor in electric traction. Even the ingenuity of the Oerlikon current-collecting device does not appeal to me, because if single-phase were to be employed, two wires would be necessary to place it on a comparative basis with the Berlin–Zossen line. The adjusting of the collecting bar to widely-varying positions of a trolley wire will, in any case, be likely to cause a tangle of overhead equipment and collecting device.

I note that at the end of your leader you say, "*The recent improvements in single-phase motors point to a more satisfactory solution of the single-phase traction problem.*" My own investigations lead me to the opinion that even in this direction there is very little to hope for in single-phase traction.

There are at the present time three kinds of single-phase traction motors. The first, identified with the Westinghouse Company, is practically an ordinary continuous-current series-wound motor, the idea being to use it on either an alternating or a continuous-current track. Naturally, as the commutator cannot be worked at a high voltage, a step-down transformer is necessary. The *repulsion induction* motor, developed by the G.E. Co. of America, does not require a transformer, because the armature is independent of the field, the brushes being short-circuited. The *repulsion series* motor of the Union Electric Co. of Berlin is similar to the last named, with the exception that a second set of brushes are set at 90deg. from the short-circuited brushes, the idea of this second set being to supply current to a series transformer with a view to decreasing sparking when running below synchronous speed, and also to improve the power-factor.

Now, in single-phase *commutator* motors the short-circuited coils under the brushes act temporarily as the secondary of a transformer. During running this does not give trouble, because the short-circuited coil is continually changing, and there is thus no time for the current to rise to a dangerous amount. But consider for a moment the conditions when starting a train on an incline with the brakes down. If current is switched on before they are released, or if the train does not start immediately, owing to the traction resistance being too great, then, owing to the armature winding acting as the primary of a transformer, and the short-circuited coils under the brushes as secondary, the latter are almost certain to be burnt out. Various proposals have been made to meet this difficulty, one being the heroic idea of placing resistances between armature winding and the commutator segments, but, clearly, if the motor stands long enough, no resistance can save it. It is, of course, impossible to employ very large resistances because the dimensions of the motor would be unduly increased, and the efficiency diminished.

Again, take the question of *torque*. This depends on the magnetic field, and in a series continuous-current motor with a certain load both field and torque are constant—that is to say, they do not pulsate. In a three-phase motor also, the torque and field are constant, and in a two-phase motor nearly so. With a single-phase motor, however, the torque varies from zero to maximum, and back to zero with every complete alternation. To show what this means, let us suppose a certain freight train on a main line requires a maximum draw-bar pull of 10 tons. Then, with continuous or three-phase motors the locomotive may weigh, say, 50 tons, but if it has single-phase motors it must weigh 85 to 100 tons.

Regarding Mr. Blanck's article on single versus polyphase generators, I take it that his arguments only stand good for single-phase traction. In any case, there is no getting away from the fact that a single-phase generator costs some 25 per cent. more than a three-phase. What should we think of a steam engineer who made a three-cylinder engine and then only ran it as a single cylinder; yet this, as a matter of fact, is more or less analogous to the single-phase machine. And what is true of the generator is also true of the motors, for when they are worked as single-phase the active material cannot be fully utilised. For a given power the machine must of necessity be larger and more expensive, and on to this the single-phase traction advocates add a commutator with all its additional trouble and expense. Statistics recently published on motors of all kinds show that more than half the break-downs are traceable to the commutator.

Now, as regards the extra wire required for three-phase, what does it really amount to? Is it not a fact that every single track tramway line in this country has two wires, whereas with a bow trolley one would do. Yet no one objects to the two wires. Once admit the principle of bare wires, and a wire more or less does not matter; in fact, there may, in certain cases, be a distinct advantage in having several wires. For example, if we assume that a certain system requires a certain amount of copper, then the more copper we put into bare wires overhead the *less* copper will be required in insulated feeders underground, and it is the insulation, excavation, laying, &c., of the latter which costs the money. The largest size of trolley wire which can be conveniently erected is 0·4in. diameter, and three such wires required for three-phase will carry very much more energy than two such wires with single-phase. For a given voltage and given amount of energy the single-phase system must necessitate more money being expended on underground feeders.—Yours, &c.,

London, June 1. E. KILBURN SCOTT.

TELEPHONE SYSTEMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Since writing you on the matter of my ring-through system, I have learnt that my claim to be the first to use a clearing indicator connected in shunt to the line is not quite correct. I am informed that the clearing-out signals employed in connection with the earliest telephone switchboards used in America in 1878 were annunciators connected in local circuits and operated by 600-ohm relays connected to the lines as shunts to earth. These were used by the Western Union Telegraph Co., and were made by the Western Electric Co. They were, however, I learn, soon discarded for the "Standard" switchboards of the latter company, in which the clearing indicators were connected directly in the speaking circuit.

The above interesting item of telephone history does not affect my other claims to have devised the first ring-through and independent ring-off system.—Yours, &c.,

London, May 31. J. POOLE.

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ROYAL COMMISSION ON LONDON TRAFFIC.

The Royal Commission on London Traffic resumed its sittings yesterday.

Sir HOMEWOOD CRAWFORD, solicitor to the City Corporation, described the unique position occupied by that body in being exempt from the provisions of the Municipal Corporations Acts, 1835-1882. There was little of electrical interest in his evidence, however, beyond a reference to the clauses which have been inserted in various tube railway bills for the protection of the City Corporation, and to the obstruction caused by the electric lighting and other companies in breaking up the streets. Incidentally, he mentioned that the superstructure of the ventilator for the District Railway in Queen Victoria-street is, by a Parliamentary provision, to be removed when the line is electrified.

Mr. A. C. ELLIS, general manager of the Metropolitan Railway, described the system owned by the Metropolitan Railway Co., and its connections. Dealing with the question of electric traction he pointed out that the company was now actively engaged in the work of equipping the London sections of their railway for electrical working, consisting of the Inner Circle, the extension to Harrow and the new Uxbridge line. A generating station had been built upon land adjoining their engineering works at Neasden, N.W, and a considerable portion of the machinery was complete and in order. The power station would be the most extensive in the kingdom owned by a single railway company. The main building, which covered an area of 3,570 sq. yds., was 318ft. long by 101ft. wide. In the engine room three turbo-polyphase alternators were being erected each having a capacity of 3,500kw., equal to about 14,000 H.P., and capable of supplying 17,000 H.P. to the track during periods of heavy traffic. Provision had also been made for the erection of additional plant, and probably a further unit would be installed at once. The boilers, of which there were 10, each had an evaporative capacity of 20,000lb. of water per hour to a steam pressure of 180lb. per square inch, superheated to a total temperature of 520°F. The three-phase generators would generate directly at 11,000 volts across each phase, and at this voltage the current would be transmitted by three-core armoured cables to nine sub-stations along the railway. At these sub-stations static transformers would reduce the current to 440 volts, it being then converted into continuous current at 600 volts, which would be the working pressure. Positive and negative conductor rails were to be used. New rolling stock, entirely of English manufacture, would be employed. This rolling stock would all be of the open-corridor type, the cars being 52½ft. long and 8ft. 9in. wide, with tranverse and longitudinal seats. The entrances would be at the ends, with sliding doors and a closed-in vestibule. As far as possible the cars would be fireproof, and all precautions would be taken with regard to the electrical apparatus to guard against fire from this cause. From the rail level to the waist of the cars the construction was entirely of metal. There was an iron floor which would be covered with asbestos and matting or other material rendered non-flammable. The underframe and seats, and seat supports, would be of steel. In the motor cars the cables would all be carried in asbestos slate casings, and no power cables would be carried through the trailer cars. Trains would consist of six cars with motor cars at each end, the combined motors having a capacity of 1,200 H.P. The two motor cars were worked in series and controlled from either end of the train. The cars would be made up of two classes. He anticipated that the carrying capacity of that portion of the railway to be worked by electricity would be increased by 39 per cent. with the increased service which it was proposed to run. Having expended over £1,250,000 upon the scheme of electrification, the Metropolitan Company suggested that it would be well to see the result of this work, and to test the carrying capacity of the railway under the new conditions before further schemes for further railways in immediate proximity to the Metropolitan Railway are authorised.

The Commission adjourned until to-day (Friday).

LIGHT RAILWAYS.

During the past month only eight applications were lodged with the Light Railway Commissioners for orders, and of these three were for amendments of existing orders and one for an extension of time. In only two of the four original schemes is electric traction scheduled. There is a bill now before Parliament to make the Light Railway Commission permanent, but something more than this is needed to stop the gradual decline in the number of schemes. The hostile attitude of railway companies and local authorities has seriously checked promotions, and an amendment of the Light Railways Act must take place before confidence is restored.

The two new electrical schemes are:—(1) Penmachno, Corwen and Bettwys-y-Coed, promoted by the Penmachno, Corwen and Bettwys-y-Coed Light Railway Co. and A. Barker and J. L. Owen. The engineers are Mansfield, Owen & Co. and R. L. Jones; the length is 28⅛ miles and the gauge 1ft. 11½in. (2) Campbeltown and Machrihanish, promoted by Argyll Railway Co. (Ltd.). The engineer is T. L. Galloway; the length is 6¼ miles and the gauge 2ft. 3in.

The following table shows the number of applications for light railways since the passing of the Light Railways Act, 1896, the bottom line of figures representing electrical schemes:—

1903.		1902.		1901.		1900.		1899.		1898.		1897.		1896.
Nov	May	Nov	May	Nov	May	Nov	May	Nov	May	Nov	May	Nov	May	Nov
17	22	20	21	44	26	27	24	43	40	54	35	30	28	28
15	12	13	16	40	22	19	17	32	21	32	18	16	10	14

PARLIAMENTARY INTELLIGENCE.

WESTMINSTER TRAMWAY TERMINUS.

In the House of Commons on Tuesday, Capt. JESSEL asked the Home Secretary whether his attention had been called to the discussion upon the suggestions of the Home Office regarding the Westminster tramway terminus of the London County Council whilst the London County Council (Tramways and Improvements) Bill was before Committee (see *The Electrician*, May 13, p. 150).

Mr. AKERS DOUGLAS, in a printed reply, said that he proposed to ask the House to deal with the point in question on the report stage of the bill.

ELECTRIC LIGHTING (LONDON) BILL.

The County of London and Brush Provincial Electric Lighting Co. has deposited a petition in the House of Commons praying to be heard by counsel against the Electric Lighting (London) Bill.

OTHER ELECTRICAL BILLS.

In the House of Commons on Tuesday, the Govan Burgh (Electricity) Bill and the University of Leeds Bill were read a third time. The Derbyshire and Notts Electric Power, the Leicestershire and Warwickshire Electric Power, and the West Riding Tramways Bills were read a second time. On Wednesday the Chesterfield Tramways and Improvements Bill was read a third time.

LEGAL INTELLIGENCE.

Poole and District Electric Traction Co. v. Bournemouth Corporation.

ARBITRATION.

At the Surveyors' Institution, Westmister, on Friday last week (May 27), an arbitration was commenced to determine the price which the Bournemouth Corporation shall pay to the Poole and District Electric Traction Co. for the purchase of their undertaking, as provided for in an agreement dated March 11, 1903, and confirmed by the Bournemouth Corporation Act of the same year. Mr. William Eve (for the Corporation) and Mr. Leslie Vigers (for the company) acted as arbitrators, with Mr. A. T. Lawrence, K.C., as umpire. The counsel engaged were Mr. Balfour Browne, K.C., Mr. C. A. Cripps, K.C., and Mr. C. C. Hutchinson for the company, and Mr. H. Lloyd, K.C., Mr. Williams and Mr. Jeeves for the Corporation.

Friday, May 27.

Mr. BALFOUR BROWNE, K.C., in opening the proceedings for the Poole and District Traction Company, said that the arbitration arose out of an agreement dated March 11, 1903, made between the company and the Bournemouth Corporation providing for the purchase by the Corporation of certain undertakings belonging to the company. The history of the undertaking was as follows:—Prior to 1899 the British Electric Traction Co. endeavoured to obtain powers for the construction of light railways the whole way from Christchurch to Poole, via Bournemouth, and at the same time Mr. W. M. Murphy was endeavouring to obtain similar powers. After an inquiry the Light Railway Commissioners refused both applications, chiefly owing to the opposition of the Bournemouth Corporation, which was to the effect that tramways through the streets of Bournemouth would ruin the trade of the town. A second application was also refused on account of the short interval of time between that and the previous application. In 1899, however, an application to construct a line from the County Gates, Bournemouth, to Poole was granted, and the Poole and District Electric Traction Co. was registered, both the British Electric Traction Co. and Mr. Murphy taking a certain proportion of the capital. This line was opened for traffic on April 6, 1901. In August, 1899, the company gave notice of its intention to apply to Parliament for powers to construct tramways from the County Gates, through Bournemouth, to Christchurch, but the Bournemouth Corporation, hearing of this intention, themselves promoted a provisional order for these lines. The company opposed, but eventually the provisional order was granted to the Corporation, with certain suspensory powers which were contained in sec. 6. This was to the effect that, if the Corporation did not construct the lines within two years, the company should be allowed to do so, but that, in the event of the Corporation constructing the lines, the company was to have running powers over them. The Corporation did commence to construct the lines, but inasmuch as they were not completed within the statutory period, the company made an application to the High Courts claiming that the powers of the Corporation had ceased, and that the lines laid, but not completed, should be pulled up. Mr. Justice Swinfen Eady gave judgment in favour of the Corporation, but an appeal was allowed. The powers of the Corporation having been found by this appeal to have lapsed, it was necessary that some arrangements should be come to with the company, the injunction to restrain the Corporation from opening the lines being suspended with that object in view. The agreement already referred to was arrived at, and it was confirmed by the Bournemouth Corporation Act of 1903. The main clause of the agreement was as follows:—"The Corporation shall pay to the company a sum to be ascertained, in case of difference, by arbitration, equal to the fair market value as a going concern of the Poole undertaking, and for the purposes of determining such market value the arbitrators or umpire shall take as the basis of his or their calculation the balance-sheet

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of the company made up to Dec. 31, 1901. . . ." This balance-sheet was for about nine months, and the profit shown was £5,622. 13s. 8d. Therefore the arbitrator had to take that figure and multiply it by a number which he would fix as the proper number of years over which the purchase should extend. That was so far as the basis of the calculation extended. The question of future profits would also have to be taken into account. In the Poole Light Railway Order of 1899 a period of 35 years was granted to the company during which it could not be acquired by any of the local authorities through whose districts the lines passed, and under the agreement the right of purchase was transferred to the Corporation. The figure which should now be adopted as the number of years depended upon the security, and in this case there was the best security that could possibly be obtained. He would ask, therefore, that 30 years should be taken, and that as the basis of the calculation was to be upon the profit for the first nine months' working, a multiplier of 40 should be adopted. The Poole line was 3¾ miles in length, it was 3ft. 6in. gauge, and had cost £64,000 to construct. It was a single line with passing places. The company owned no generating station, current being obtained from the Bournemouth and Poole Electricity Supply Co. under two agreements dated 1900 and 1902 at 1⅛d. per unit, the minimum supply being 300,000 units per annum. Both these agreements would be taken over by the Corporation. Under the agreement of March, 1903, the Corporation was also to purchase all the other rights and privileges of the company, and the arbitrator was also to take into account the prospective profits of the company and the value, if any, of the running powers which it possessed over the Bournemouth lines. Therefore, besides the Poole line already referred to, the following would have to be considered:—The Poole Light Railway Extension Order of 1903, which authorised a loop line from Branksome to Parkstone, joining the Poole line further on; the powers of the company under the Christchurch Act of 1900, which authorised a line through Pokesdown; the value, if any, of the running powers in Bournemouth, and the value of the company's projected extensions which had been abandoned owing to the agreement with the Corporation. Certain other definite sums were mentioned in the agreement as payable by the Corporation, but these would not be mentioned in the course of these proceedings. The running powers which the company were given under the Corporation's provisional order of 1900 he regarded as extremely valuable, not so much from the profit which would be made in Bournemouth as from the extra traffic on the Poole line owing to through running. Having a tramway already in operation at the west end of Bournemouth, and powers to construct another at the east end, there would eventually exist, had the lines remained in the hands of the company, feeders at both ends of the town, and the value of these to the revenue of the company would have been exceedingly great. The terms of purchase by the local authority under the Christchurch Act were 35 years at fair market value, and 25 years for the Parkstone extension.

Mr. STEPHEN SELLON, consulting engineer to the British Electric Traction Co., examined by Mr. C. A. Cripps, K.C., said he was chief engineer to the company when the Poole line was promoted. The number of passengers carried upon the line was increasing every year, as well as the receipts. The population showed an increase of 27 per cent. between the censuses of 1891 and 1901. His calculation of the value of the Bournemouth-Poole line which was now working, was that the profit shown in the balance-sheet of 1901—viz., £5,622—as mentioned by Mr. Balfour Browne should be multiplied by 40—*i.e.*, on a 30 years' basis—which would give a total of £224,880. With regard to prospective increase in profits during the unexpired term of the 1899 Light Railway Order, and the Extension Order of 1903, he said that although the 1902 and 1903 accounts showed a larger profit than 1901, during 1902 a large amount of traffic was lost upon the Poole line owing to the suspension of the omnibus service which ran into Bournemouth from the County Gates terminus, due to the construction of the Corporation tramways. The moment the Corporation lines were completed this traffic was recovered. The following figures gave the results of the working of the line since the opening:—

—	Car miles.	Passengers.	Receipts.	Receipts per car mile.
April-Dec., 1901..	228,000	1,568,676	£10,642	11·65d.
1902.....	330,000	2,188,000	13,409	9·74d.
1903.....	338,500	2,428,230	15,540	11·02d.

The results up to May, 1904, averaged over the whole of 1904, showed that this increase would be maintained. Since 1901 there had been an increase of 15 per cent. in passengers, 14½ per cent. in car mileage and 8 per cent. in receipts taking the same nine months into account. In the future also there would be a reduction of working expenses, as although at first only 11 cars were in service, there were now 17, and these were just beginning to have their largest earning capacity. For the next 15 years he estimated that there would be an annual increase in both traffic and profit of 2½ per cent. and in respect of this increase, calculated for the 30 years, he claimed £53,916. In respect of the running powers of the Bournemouth lines he claimed a sum of £41,471. There were 6¼ miles over which running powers were in the hands of the company, and these lines carried 80 per cent. of the total Bournemouth traffic. He considered there were enormous advantages from such running powers, and only quite recently a Committee of the House of Lords had given the Tyneside Tramways Co. compulsory running powers over the Newcastle Corporation lines. Dealing with the Poole and District Extension Order of 1903, he said he regarded this as a most important branch. Since the order was granted, properties had been cut up for building purposes, and he estimated that the traffic on this line would average out to the same as on the Poole line, where the average fare was 1½d. per passenger. For the purposes of the claim in respect of the extension order, however, he had assumed an average fare of 1d., and calculating 768,000 passengers per year at this figure, a net revenue would be arrived at which would be less than upon any similar line he knew of. It would, therefore, be a moderate estimate. The net value of this extension he put at £38,370. The Christchurch and Pokesdown lines he worked out upon the basis of an average fare of 1½d., with the same average earning capacity per mile and over the same period of years as the Poole line, and the same annual increase of 2½ per cent. would increase the claim by another £54,750. There would also have to be included certain sums as representing the feeding value to the main line of some extensions not yet authorised, but which had been negotiated for and would have been continued but for this arbitration. There was also the question of the parcel traffic.

Cross-examined by Mr. H. LLOYD, K.C.: He attached great importance to the running powers, notwithstanding the intervention of the piece of conduit tramway owned by the Corporation. At one time he had had great fears concerning this, but in the light of subsequent experience these had disappeared. He had no recollection of ever saying to the officials of the Corporation that if £90,000 for the whole undertaking were offered he would recommend his board to accept it.

But we offered you £60,000, and that was your reply?—I never heard of it, and it is absolutely incorrect.

Has depreciation been allowed for before the profit of 1901 was arrived at?—I do not know.

Should it have been allowed for?—Yes.

In your estimates of the value of the undertaking you have allowed 20 per cent. for depreciation?—Yes.

Your profit of £5,622 for 1901 was before any depreciation had been allowed for?—It may have been.

Mr. LLOYD drew the attention of the Umpire to the fact that the allocation of the profit for 1901 included £1,000 for depreciation.

Mr. BALFOUR BROWNE objected, as he claimed that this was an endeavour to go behind the agreement, which stated that the balance-sheet of 1901 should be the basis. Therefore, the profit for that year should be considered as £5,622, as shown therein.

Mr. LLOYD asked for the Umpire's ruling on the point, as according to this the Corporation would have to pay about £40,000 for nothing.

The UMPIRE said it was quite clear that the balance-sheet for 1901 had to be taken as the basis of the arbitration, but he saw a difficulty in considering only the one figure £5,600. The terms of his reference were to include, also, anything else that would affect the question of arriving at a fair market value of the undertaking. He would give a decision in the morning, and he considered the point of such importance that he would be prepared to state a case for either party if they objected to the decision he gave.

Saturday, May 28.

The UMPIRE said that, after careful consideration, he had come to the conclusion that the point involved was not such an important one as he at first had thought. He must stick to the balance-sheet, and evidence that would elucidate the meaning of that balance-sheet he could not exclude. Practically speaking, the whole of that balance-sheet must be looked at. Mr. Sellon himself had shown that some item for depreciation was necessary, and, therefore, the cross-examination of Mr. Lloyd was quite admissible.

Mr. BALFOUR BROWNE said he would reserve the right to ask for an adjournment if the cross-examination endeavoured to go behind the balance-sheet.

The UMPIRE said that he would be pleased to do anything to facilitate obtaining the opinion of the Court if necessary.

Mr. LLOYD then continued his cross-examination of Mr. Sellon, and said that his calculation of the net profit available for distribution in 1901 was £3,183, making allowance for depreciation and reserve.

How many car-miles did you run during the nine months of 1901?—228,000.

And you would expect your 2½ per cent. increase to commence from that date?—Yes.

But, as a matter of fact, your 1903 accounts show a profit of £5,668. 14s. 5d. That is for a twelvemonth, and is practically the same as the nine months in 1901?—Yes; but you are simply taking the amount allotted as profit in 1903. The actual money was more than the 2½ per cent. increase, and the passengers also showed a larger increase.

And your working expenses also?—Not necessarily.

Well, then, if your traffic has increased and your working expenses decreased, how is it that you get less profit?—That is a matter of balance-sheet. It is not my business to make out the balance-sheet.

But your two balance-sheets are made out in precisely the same way?—This evidence must be given by the company itself,

But there is a slight decrease in your receipts per car-mile?—That has nothing to do with it. You may be running a larger number of car-miles with less receipts.

With regard to the feeding effect of the various extensions which you have allowed for, would it be possible to work the Poole line as it is with all the extra traffic you estimate?—No, but I have allowed for a large capital expenditure to meet the necessary extensions.

What would it be necessary to do?—Well, first of all, with the exercise of the running powers over the Bournemouth lines, it would be necessary to arrange for a four minutes' service and this would involve the lengthening of seven of the existing passing places and the construction of two additional passing places, and the expenditure upon these for the first year would be £2,900. There would also be required three additional cars with shed accommodation. This would absorb another £5,300. The next increase I have anticipated is the opening of the Parkstone loop, and assuming it would be opened at the end of March, 1905 (as it would have been), this would necessitate the doubling of the track between Branksome and

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Poole at a cost of £9,215. No further doubling of the track would be necessary until 1914, when the whole of the track from Bournemouth to Poole would have to be doubled. In 1914, also, there would have to be 11 extra cars with shed accommodation, equipment, &c., and the whole would cost £29,960. Discounting these figures to get the present value of these extensions, &c., brought the total amount down to £36,539.

On the Parkstone extension you have charged us both with the future profits and the feeding effect. What is it going to cost to construct?—£18,502.

Then there are some lines not yet authorised. When did you first contemplate the Canford Cliffs line?—In 1898.

Why was it not gone on with?—There have been some difficulties about land.

Are you any nearer to carrying it out now?—Not that I know of.

Continuing: The total cost would be £8,000 for the 2 miles of line. It was true that there were very few houses along the line at present, but when it was constructed the district would develop.

How have you arrived at the conclusion that the line would be a remunerative one?—I have not said it would be a remunerative one. I have only charged you with the feeding effect.

Would your company construct an unremunerative line because of the feeding effect?—Certainly.

What would be the cost of the Poole Harbour extension which you contemplate?—£10,516 for the half-mile, the extra cost as compared with the Canford Cliffs line being due to the street widenings.

What would be the cost of the Christchurch lines which you have power to construct?—A tender for £66,000 was actually let.

To whom?—The British Electric Traction Co. But the Bournemouth Corporation will not have to take over that agreement.

Why was not the contract carried out?—For several reasons; first, because of the negotiations with the County Council as to the construction of a new county bridge. Then we were in negotiation with the Bournemouth Corporation as to the paving in Pokesdown, and then this agreement to purchase our undertaking was taken into consideration. I consider it a very valuable line, and the traffic would very quickly be considerable.

With regard to the valuation of the Poole main line, which are the worst months in the year for tramway traffic at Bournemouth?—December, January and February.

Would it not then be obviously unfair to multiply the profit for the nine months of 1901 by 40 instead of 30, because of the fact that you have excluded two of the worst months in the year?—No.

Continuing: At the present time the Poole line carried the population of Bournemouth, Branksome and Poole 35 times over annually, and he expected to do the same when all the contemplated lines were opened, despite the increase of population that would ensue. With regard to the state of repair of the Poole main line, he had never had any complaints as to this. If the Branksome Urban District Council, as was indicated, was dissatisfied, it had the power to repair the sides of the track and charge the company with it. [A large number of photographs were shown to witness.] These photographs showed wear due to ordinary circumstances, and which would have been repaired by the company when they deemed this was necessary. He could point to numbers of equally unsatisfactory spots upon the Bournemouth Corporation lines. When the Umpire was taken over the line recently no question of the bad state of repair was raised.

Mr. LLOYD: Why have you taken different periods for different portions of the undertaking in calculating the value?—Because we regard the Poole main line as equivalent to a lease in perpetuity. The varying periods for the lines, apart from the main line, is with reference to whether they were authorised or not.

If all your prospects were achieved, what would be your carrying capacity over the Poole main line?—12,000,000 passengers annually.

Supposing I paid you the £430,000, which is your total claim, I should then have to find the capital to construct the Christchurch line, the Parkstone line, the Poole Harbour line and the Canford Cliffs line in addition. Supposing that 5 per cent. is a fair return, what amount of traffic should I have to carry in order to pay it?—That is a very difficult question

It is, and it works out to a very big amount.

Re-examined: The Bournemouth Corporation was successfully working a combination of the overhead trolley and the conduit system, and inasmuch as the working expenses were 5 per cent. less than those of the company, there would appear to be no difficulty. The value of the running powers, therefore, would not be decreased by this fact. If the £5,622 profit for 1901, as shown by the balance-sheet, were not taken as the basis of the arbitration, it would be taking away all the advantage that the company gained by agreeing to sell upon the profit for that year. This was the first case in which a tramway with 35 years' working, and then purchase as a going concern, had been transferred before the period had expired. A tramway company with a lease in perpetuity, such as this practically was, was much better than a railway as an investment, and was quite on a level with a water company. The fact that local authorities were granted very long periods for loans for tramway purposes pointed to the fact that a tramway was a permanent investment. Rhondda had been granted 40 years in which to repay its tramway loans.

(To be continued.)

Cunningham v. Robertson.

At Marylebone (London) County Court on Tuesday, before Judge Stonor, K.C., plaintiff (an electrical engineer) sought to recover £30. 7s. from Mr. R. Robertson, electrical engineer (trading as R. S. Robertson & Son) for work done and materials supplied. The case had been remitted from the High Courts.

Mr. LINCOLN REED, for plaintiff, stated that defendant had work to be done at large bank buildings and other premises in London and at his own premises, and he sub-let the work to plaintiff. An estimate was given and accepted for a portion of the work, but defendant disputed having ordered certain "extras," for which plaintiff now claimed.

DEFENDANT denied having given orders for the extras; on the contrary, he said he cautioned plaintiff against doing any additional work.

Judge STONOR held that plaintiff had not proved an order for certain portions of the work, but that defendant was liable to pay for certain of work done by plaintiff. Judgment would be for plaintiff for £26 and costs.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Governing Body of Northampton Institute, London, E.C., require for 1904-5 session an instructor in mathematics (£100 per session) for the engineering department, and also a junior demonstrator, a junior technical assistant, and a junior lecture assistant for the electrical engineering department. Further particulars from the Principal (Dr. R. Mullineux Walmsley). Applications to be in by 11th inst. See also advertisement.

A junior lecturer in mathematics is required for University College, Nottingham. Salary £130, rising by £10 a year to £180. Applications (on forms supplied by the Registrar) by June 20. See also advertisement.

An experienced engine fitter is required at Wimbledon electricity works. Applications to chief engineer. See advertisment.

The Electricity committee of the City of York require a charge engineer. Salary £100 per annum. Applications to the city electrical engineer, Mr. C. A. Midgley, Foss Islands-road, York, by June 13. See advertisement.

The Governors of Huddersfield Technical College invite applications by June 11 for the position of principal. Salary £500.

Weymouth and Melcombe Regis Corporation require an electrical engineer to take entire charge of their electricity supply department. Commencing salary £250, increasing by annual increments of £25 to £300 per annum. Applications to the town clerk (Sir R. N. Howard) by June 8.

The Senate of the University of London invite applications for the professorship of civil and mechanical engineering, vacant by the retirement of Prof. W. C. Unwin. Salary £1,000 per annum. Applications by June 7.

A research fellowship in pure or applied physics of the value of £125 is vacant at the Victoria University of Manchester (Owens College). Applications to registrar, from whom conditions may be obtained, by June 13.

An assistant lecturer in engineering is required for Swindon and North Wilts. Technical Schools. Salary £150. Applications by 11th inst.

Paisley District Tramways Co. require a manager. Salary £300 to £400 per annum. Applications to Mr. J. Barber Glenn, 74, Cheapside, London, E.C.

The Metropolitan Asylums Board require an electrical engineering draughtsman. Applications by June 11.

Mr. D. H. Simpson, an assistant at the York electricity works, has accepted an appointment with Messrs. Davidson & Co., engineers, of Belfast.

EDUCATIONAL NOTICES.

Technical Instruction in Germany.—Continuing his reports upon technical instruction in Germany, Dr. F. Rose, H.M. Consul at Stuttgart, has prepared a report entitled "Technical Instruction in Naval Architecture and Engineering." In the numerous technical schools in the German Empire where advanced and secondary instruction in all matters relating to naval architecture and engineering are given, the first year's course for students includes experimental physics, physical measurements and higher mathematics. The second and third years' courses are wholly devoted to theoretical and practical engineering and ship design. The fourth year's course includes practical work in the electro-technical laboratory, experimental electro-technics and the various methods of ventilating and heating warships and merchant vessels. In addition to these subjects, optional lectures and work include magnetic and electric units and measurements, the physical basis of electrotechnics and electro-magnetism and induction. The report completes an interesting and instructive series.

In the schools for locksmiths and blacksmiths in Saxony (Germany) there is a special branch of study comprising a course for advanced training in electrical subjects. This includes telegraphs, practical work in electricity, electro-technical drawing, "special electrology" and practical electrical workshop instruction, in which

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students are drilled in the work of constructing and laying telegraphs, telephones and lightning conductors, as well as in designing and constructing machinery for various applications of electricity. An exhaustive series of excursions to electrical and engineering works is arranged by the principals of these "special" industrial schools for the sole purpose of training young men to become competent and skilful locksmiths and blacksmiths.

Argentina.—The Retiro-Once section of the Anglo-Argentine Tramway Co.'s electric lines was recently opened for traffic.

It is said that arrangements are being made for the transfer of the Anglo-Argentine Company's Rosario tramways to an English syndicate, while a representative of a German syndicate is in Rosario seeking a concession for electric tramways.

The lighting department of the Buenos Ayres Municipality has made new regulations with regard to electric lighting of theatres, &c., which include the placing in iron piping of all wires within reach of the public. No wood casing is to be allowed.

Birkenhead.—A discussion took place at the Council meeting on Wednesday on a proposal to apply for sanction to a further loan of £20,000 for additional feeders and cables and for purchasing electricity meters and house-service materials, &c., during the next three years. The proposal was adopted.

Birmingham.—An inquiry was held here on Tuesday into the application of the Corporation to borrow £447,129 for electricity supply extensions.

The town clerk (Mr. E. O. Smith) said the undertaking was acquired from a company in 1899, when the Corporation obtained powers to supply electricity to the whole of the city. The original company's works, being confined to a limited area, were not of that extensive character that was necessary for the purpose of adequately supplying electricity to a great city like Birmingham. As soon as the Corporation acquired the undertaking they began to look for a site for a power station adequate for the purposes, and they were fortunate enough to obtain the almost ideal site of the old General Hospital. In June, 1902, an inquiry was held into application for sanction to borrow for 28 years £251,974 for the electric supply department, which included £128,890 as the estimated cost of the equipment of a generating station on this site. At the time that proposal was made there were tramway projects in contemplation, but these were in suspense. A demand was arising for electrical current for other purposes. Owing to uncertainty as to tramway development and other causes, only a portion of their original scheme was proceeded with and only a part of the amount then sanctioned (£84,196 out of £251,974) had been spent. Since the Corporation had purchased the undertaking of the company they had always made a profit, though it was not a large one. The uncertainty as to the tramways was now clearing up. The Corporation was actually running a short line to Aston, and other developments would come in the near future. In 1906 a large system of tramways, at present leased to a company, would fall in to the Corporation, and would be immediately worked by electricity as a municipal undertaking, and this would mean a large demand for electric current. At present the Aston line was supplied with current by Aston Council by an arrangement of a temporary nature, but as soon as Birmingham had completed their works they would not only supply current for that line but also for the much longer length of line which would fall in in 1906. In 1911 the whole of the leases of the tramways would fall in, therefore a large electrical enterprise would be necessary for working them. There was also an increasing demand for current for private lighting and power for which provision must immediately be made. The present works were at times taxed to their utmost capacity, and there was no possibility of any considerable extension being made. The scheme now submitted was so planned as to allow for extension from time to time as the need arose.

Referring to the item £58,336 for underground cables, the Inspector pointed out that it would be necessary to get the sanction of the Board of Trade to the portion which referred to tramways as distinct from lighting, and it was agreed that Mr. R. A. Chattock, the city electrical engineer, should dissect the items in order that the necessary application should be made to the Board of Trade.

Technical evidence in connection with the application was submitted by Mr. Chattock.

The accounts of the electric supply department, abstracted in our last issue, were adopted by the Corporation at their meeting on Wednesday.

On Tuesday Ald. Beale submitted the report of the Tramways committee, and said that a provisional agreement had been come to with the City of Birmingham Tramways Co. for the immediate electrification of the Small Heath route and for the future working of the line. The report was adopted.

Blackburn.—The Council have approved the recommendation of the borough electrical engineer (Mr. A. S. Giles) to revise the charges for electric current and to abolish meter rents. The charge for lighting will be a uniform 4d. per unit, or 6d. per unit for the first hour and 3d. after.

Board of Trade and Patents.—The Court of Survey in Glasgow has now given its decision in the appeal by Messrs. Denny Bros., Dumbarton, against the Board of Trade surveyor's refusal to grant a declaration to enable them to get a passenger certificate for a new turbine steamer unless he was allowed to make a test of the condensers.

The Court, in granting the appeal, point out that the test is a new departure in survey practice, and that the onus lay on the Board, as the party proposing to make a departure in its practice, to show that there were circumstances justifying such departure. The proposed test was unreasonable. While the Board have a great duty to the travelling public, they also have a responsibility to the shipbuilding and allied industries, and must not, in their zeal for public safety, necessarily impose restrictions on an industry, and especially upon an industry in its development stage.

Bolton.—In future the charge for electric current will be 4d. per unit for the first three hours of maximum demand, and 1d. after; for motive power the charge for the first 1,000 units in any one quarter will be 2d per unit, and for all in excess 1d. per unit; and for the tramways 1·10d. per unit.

The chairman of the Electricity committee (Dr. Panton) stated on Wednesday that the output of the department for the past year was 5,056,898 units, an increase of more than 1¼ million units. The sale of current had brought in £37,285, an increase of £5,228 over the previous year. The gross revenue was £39,309, generating cost being £14,914, and the gross profit £24,395, an increase of £3,588. The net profit was £7,480, and it was proposed to place £6,818 to relief of rates. The cost of production was 0·707d. per unit, the lowest but one in the kingdom.

Brazil.—The "Diario Official" of May 5 contains a decree approving the draft of a contract between the Minister of Industry, Transport and Public Works and Eugenio de Andrade, civil engineer, for the construction and working for 70 years of a standard gauge electric railway from Rio de Janeiro to Petropolis.

Brighton.—We notified in our last issue that the Corporation had decided to appeal against Mr. Justice Grantham's judgment in the action brought by Messrs. Macartney, McElroy & Co. A long discussion took place at last Thursday's meeting of the Council at which this decision was arrived at.

Ald. Sendall said the question of the contract with Messrs. Macartney, McElroy & Co. had resolved itself into a moral rather than a financial one. So far as the particular contract in dispute was concerned, this was only £2,600 lower than that of Messrs. Nuttall & Co. in a total amounting to between £103,000 and £104,000. Other tenders differed with that of the accepted tender to the extent of from £3,000 to £4,000. These figures were for tenders for the whole of the work. The total estimates of their two officers, Mr. Holliday (the tramways manager) and Mr. May (the borough surveyor), were within £315 of the actual amount of Messrs. Macartney, McElroy & Co.'s tender. The chief point of difference between the accepted tender and those of the other tenderers was for the wood paving, and when this difference was discovered Messrs. Macartney, McElroy were written to, and an interview took place between the Council's officers and the contractors in order that this point might be raised. Mr. McElroy, who represented the contractors on the occasion, retired after the interview and called a meeting of his directors, and the company ultimately decided to persevere with their tender, which was accepted by the Council. Unfortunately, Mr. May did not acquaint other officials of the Corporation or its members of the interview, so that they were unaware that any question of the kind had arisen. This was an initial blunder, which Mr. May perpetuated in foolishly and unwisely allowing certificates to receive his signature for amounts which were not based upon his reading of the contract; but this did not, of course, affect the question in dispute. As to the result of the action before Mr. Justice Grantham, they had taken counsel's opinion, and they were strongly advised to appeal. Ald. Sendall then moved that the appeal be prosecuted.

Councillor Holloway (chairman of the Works committee) seconded.

Councillor Jarvis strongly condemned the course proposed to be taken. It was, in his view, an unfortunate blunder to have gone into Court with the matter at all. The Council were committed to pay the money, and he had taken legal opinion and was advised that the appeal would inevitably fail. It was proposed that the appeal should be taken on a point of law, but the point of law had been definitely argued before Mr. Justice Grantham. The Council had actually paid £9,000 on account of the very claim in dispute. One of their officers had made a mistake, and that was the least and the most that could be said, and it was ridiculous that they should take up the position that they were not responsible for their surveyor's action. The officials concerned in this matter were the same officials as were always left to settle the contracting business of the Council, and this would be taken into account in the Appeal Court. The plaintiffs in the action had made an honourable and reasonable proposal for settlement, and he thought the Council should accept that offer.

The Mayor (Ald. Marx), interrupting, said he would point out that an offer was made on behalf of the Corporation to the contractors at the time of the trial, and there had been other negotiations for a compromise, bu without result.

Councillor Jarvis (continuing) complained that such offers to compromise had never been before the Council. If they went to the Court over this offer by the contractors they would assuredly fail. It was true they had had the advice of counsel to proceed with this appeal, and counsel had, he understood, pledged their reputations as to success. This was all very well, but would the learned counsel pledge their fees on the success of the Council in the appeal. That would reduce the Council's risk considerably. He thought from the legal advice he had received they had not the slightest chance of winning the appeal; but even if they were successful, how would their reputation as a public body stand? To appeal in an action of this sort was gambling with the ratepayers' money.

Councillor Kidd supported the proposal for an appeal, and urged that the specifications and bills of quantities clearly stated the requirements of the Council. He would point out that the contractors had had ample time to make themselves acquainted with all the details of the specifica-

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tions, that their attention was called to their low price for the supply of wood paving, and that they had had every opportunity of withdrawing their tender if such had been their desire. The lowest tender received was £102,487, the second £104,975, and the highest (the 11th tender) was for £121,327. Messrs. Macartney, McElroy & Co.'s tender was the lowest. All the firms other than the plaintiffs who had sent in tenders had written to say that their offers included the excavating, concreting and floating, for which Messrs. Macartney, McElroy & Co. had now claimed £14,600. Adding this sum to the amount of their tender brought it up to between £117,000 and £118,000, which would have made their tender ninth in the list instead of lowest. He therefore considered that it was in the interests of the ratepayers that this appeal should be prosecuted.

Councillor HEUN strongly opposed the appeal, and said that if anything like the same attention had been given by the Works committee to specifications and similar matters in the past as had been given since the action the muddle they were now in would not have occurred. Surely it was necessary to have more than the bare assurance of the borough surveyor in the payment of no less than £9,000 beyond the amount of a tender.

The MAYOR pointed out that clause 129 of the contract provided that a certificate of the engineer should be official and binding upon the Council.

Councillor HEUN (continuing), asked how it was there was no dispute on other portions of the work. Mr. Holliday had drawn up specifications for the contract, and there had never been any dispute. He urged that there was an honourable way out of the difficulty by acknowledging that one of their officials had made a mistake, and for the Council to accept the responsibilty of such an error.

Councillor HARDY considered they were morally bound to pay, and they should do so with the best grace possible.

Councillor PENFOLD said in the ward he represented (Hanover) 90 per cent. of the electors were against the appeal. If, as the mayor had pointed out, an offer to compromise had been made to Messrs. Macartney, McElroy & Co. by the Council, and as they knew they had a compromise offer from the firm since the action, it was clearly a case in which an arrangement should be come to without incurring further legal expenses.

Councillor Lintott opposed the appeal, which Ald. Reeves supported, and the discussion was continued by Councillor Tozer (against the appeal), Councillor Black (who suggested a compromise), Councillor Martin (against), Councillor Sone (against), and ultimately, on a division being taken, 29 voted for and 15 against the appeal being proceeded with. The names of the councillors voting were :—For the motion—The mayor (Ald. Marx), Ald. Botting, Buckwell, Carden, Sir J. Ewart, Martin, Reeves, Sendall and Stafford, and Councillors Bedford, Beryl, Black, Blaker, Booth, Briant, Broadbridge, Bullock, Galliers, Greenyer, Holder, Holloway, Kidd, Lynn, Mayston, Smithers, Tester, Titcomb, Wilson and Yates (29). Against—Councillors Brown, Hardy, Heun, Jarvis, Lawson, Lintott, Martin, McClean, Pankhurst, Pannett, Penfold, Sone, Stringer, Tozer and Whittome (15).

The receipts of the electricity department for the year ended March were £88,306. 5s. 9d., and the expenditure £49,970. 16s., balance £38,335. 9s. 9d., against £35,184. 5s. 11d. from the previous year. After adding the balance brought forward £46,320. 13s. 6d. was available to pay interest (£15,636. 15s. 7d.) and sinking fund (£15,739. 9s. 11d.). £4,734. 13s. 9d. has been transferred to reserve and £3,250 to relief of rates. The balance of £6,959. 4s. 3d. has been carried forward.

Bristol.—At the meeting of the City Council on Tuesday the report and accounts of the electricity undertaking, abstracted in our last issue, were presented by the chairman of the Electrical committee (Ald. Pearson) and adopted.

Another report from the committee recommended the expenditure of further capital upon extensions. The committee pointed out that it was necessary, in consequence of the growth of the undertaking, to complete the second instalment, and put in the foundations of the third instalment of the new station at Avonbank. That meant £74,000 on the first account for machinery, and £15,000 on the second for foundations. The fire at Temple Back station made it advisable to construct fireproof switch rooms there, at an estimated cost of £3,980, and on account of the damage done by the fire, two additional direct-current generators had to be obtained at £1,060. It was further desirable that additional plant should be procured at an estimated cost of £10,960. Moreover, £21,500 was required for additional mains, meters, sub-stations, transformers, &c. The total proposed new capital expenditure was £126,500.

The recommendations of the committee were adopted, as were those relating to the acceptance of tenders for a new roof for the Temple Back station at £1,663. 9s. 3d., and the increase of the salary of the mains superintendent from £180 to £200 per annum.

Derby.—It has been decided by the Tramways committee to pay motormen 6d. and conductors 5d. per hour. It was expected that the Osmaston-road route would be completed in about 10 days.

Devonport.—The accounts of the electricity department for the year ended March show total capital expenditure of £96,130. 17s. 1d., increase £7,981. 16s. 5d. during the year. The total amount borrowed is £102,832. 3s. 5d., borrowing powers not yet exercised £10,772.

Receipts from sale of current were £12,412. 3s. 8d., including £6,632. 2s. 11d. for current supplied to Devonport and District Tramways Co.; £2,279. 5s. 6d. to Plymouth, Stonehouse and Devonport Tramways Co.; £2,522. 9s. for private lighting in Devonport; and £603. 8s. 9d. in Stonehouse and £374. 17s. 6d. for public lighting in Devonport. Miscellaneous receipts rents, &c., made the total £12,710. 13s. 6d. Generating costs were £3,704. 18s. 1½d., cost of distribution £184. 7s. 3½d., management expenses £865. 1s. 3d., other expenses making the total £6,301. 6s. 1½d., leaving a gross profit of £6,409. 7s. 4½d. £1,669. 6s. 4d. was applied to redemption of stock, £2,824. 15s. 16d. to payment of interest and £556 to meeting amount disallowed by Local Government Board, the net profit being £1,359. 4s. 10½d. 1,504,085 units were generated, 1,349,645 sold (85·3 per cent. for traction, 12·7 per cent. for private and 2 per cent. for public lighting). The total net costs per unit generated came to 0·945d. against 1·325d. in 1902-3. There are 142 private consumers with the equivalent of 15,151 8 c.p. lamps. The plant installed at the works has a capacity of 1,360kw. The price charged for current varied from 7d. to 1½d. per unit and averaged 2·232d.

Dewsbury Tramway Accident.—An official inquiry was conducted on Tuesday by Major Druitt into the accident which occurred recently at Dewsbury. Evidence was given by the drivers and conductors of the damaged cars and by indepeudent witnesses of the occurrence.

Direct Telegraphic Communication with Germany.—The General Trade committee of the Liverpool Chamber of Commerce have been agitating for some time to obtain the establishment of direct telegraphic communication between Liverpool and Emden, Germany, and in a recent communication the Postmaster-General (Lord Stanley) says he is paying special attention to the working of the direct lines between Liverpool and Hamburg and Liverpool and Bremen, and will take all steps in his power to improve the service.

Dundee.—For the year ended April 30 the total revenue of the electricity department was £27,226. 16s. 4d.

Of this £14,377. 14s. 7d. was from private lighting (against £12,600 in previous year), £1,335. 4s. 4d. for power (against £554. 16s. 2d.), £1,065. from public lamps (against £1,026), and £10,448. 17s. 5d. from tramways (against £9,859. 19s. 11d.) Working expenses were £18,127. 17s. 11d., including generation, £10,136. 13s. 10d.; distribution, £4,288. 3s. 3d.; rents and taxes, £2,438. 3s. 11d.; and management, £810. 18s. 11d. After meeting interest and sinking fund charges there was a surplus of £23. 15s. 4d. The revenue estimated for the current year is £27,588. 15s. 4d., expenditure £27,420, leaving a surplus of £168. 15s. 4d. The anticipated revenue is based on a reduced charge (1¼d., instead of 1½d.) per unit for current supplied to the tramways.

Eccles.—The deficit on the electricity undertaking for the past year was £257, compared with £476 in the previous year.

Edmonton.—The Council have decided to invite the Tottenham and Edmonton Gas Co. and the North Metropolitan Electric Power Supply Co. to state the terms upon which they would lease the Council's provisional electric lighting order, and also to request the consulting engineer (Mr. Robert Hammond) to submit an amended scheme for putting the order into operation in the compulsory area.

Electric Illumination at the Albert Hall, London.—A feature of interest in connection with the Charing Cross Hospital ball, held on Tuesday evening at the Albert Hall, was the use on a large scale of electric lamps for the artistic illumination and decoration of that great place. The installation is to remain intact for some days, and will be used in connection with other social functions. Altogether some 2,500 8 c.p. glow lamps of various colours are distributed in smaller or larger groups throughout the building. Current at 200 volts is taken from the mains of the Kensington and Knightsbridge Company. Electricity is conducted to all parts of the building by a twin flexible cable of a brownish colour. Each core is of about 4mm. diameter, and consists of 80 strands of fine tinned copper wire insulated with half-vulcanised compound rubber, the whole being protected by two substantial cotton braidings, impregnated with brown paraffin wax. Long lengths of these cables are used, stretching from one group of lamps to another. Lamp fittings are inserted at any desired place by means of needle points, which penetrate the braiding and the rubber and make electrical contact with the stranded cores. The lamp-holders are of the ordinary bayonet type, with the two needle points referred to protruding from the bottom. A yoke of stamped metal embraces the cable, and when the holder is fixed the cable is gripped between these two parts. Indiarubber packing pieces are used to prevent the metal from fraying the braiding. The needle points are driven home by two small screws within the lamp-holder, and when putting up the lamps an electric bell is employed to indicate whether metallic contact with the core has been made. Of the various fancy groups the most noteworthy is the "sun-dial," in which 820 gold-tinted electric lamps are arranged to represent 14 sun rays. The whole is suspended at the height of the third tier. An iron hoop, about 20ft. in diameter, forms the centre, and from this 14 cables radiate to various points of the hall. The lamps are fixed to the cables at intervals of from 1ft. to 2ft., and the shades of the lamps take the form of yellow flowers, made of impregnated linen. Numerous garlands and isolated fancy lamp decorations (of which those over the royal boxes are especially pretty) are distributed over the balconies and the organ. The installation was carried out by Messrs. L. and R. Heymans, of 126, Aldersgate-street, London, E.C., who are representatives of M. H. Very, of Paris.

Exeter.—The Council have adopted the Tramway committee's recommendation not to lease the tramways to a company. The

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Electric Lighting committee recommend the expenditure of £4,000 upon additional electrical plant to provide for the supply of current for the first section of the electric tramways, which is expected to be ready for opening about the end of October. The committee's report has, however, been referred back to enable them to consider the question of adopting turbine-driving plant.

Fatality.—A fatality similar to that which happened on the electrified section of the North-Eastern Railway at Newcastle is reported to have happened on the recently-opened Lancashire and Yorkshire electric line near Southport. A boy named Jones, aged 13, was trespassing on the line, and came in contact with the live line, death following from electric shock.

French Indo-China.—During the 18 months ended June 30, 1903, new telegraph lines were erected in French Indo-China, covering in all a length of from 500 to 560 miles. About 620 miles of old lines were replaced, aud 16,000 wooden posts were replaced by 4,500 iron posts. There are in this district about 5 miles of subaqueous telegraph cables, and the total length of telephone wires is over 140 miles.

Gloucester.—The Corporation have increased the salary of the city electrical engineer (Mr. W. J. Bache) to £300 per annum. Mr. Bache is also to be allowed to take two pupils at the electricity works. Increases in the salaries of other members of the staff have been granted.

Gravesend.—The Council have decided to apply for a provisional order to extend their area of supply to include Rosherville.

Hackney (London).—On Thursday last the Borough Council adopted the recommendations given in our last issue as to lighting by arc lamps Queen's-road and Graham-road at a cost of £705, and also as to altering the scale of charges for electrical energy.

Halifax.—The Council have decided to construct tramways from Brighouse to Bailiff Bridge and to obtain Parliamentary powers to construct tramways from the present terminus to the junction of Wakefield main roads and from West Vale to Elland. The syndicate which recently submitted proposals for the construction of tramways outside the borough have been informed that their offer cannot be entertained.

Hastings.—The Council have decided to sanction the expenditure of £3,416. 10s. upon electrical plant, after rescinding a resolution recently passed to defer the outlay for 12 months.

Heaton.—The Town Improvement committee have sanctioned the application of the Newcastle-on-Tyne Tramways committee to erect certain overhead wires for electric lighting.

Hull.—The revenue of the electricity department for the year ended March 31 was £37,887. 5s. 4d., including £3,088. 12s. 1d. for private lighting, £6,408. 16s. 8d. for power, meter rentals £1,016. 4s. 11d., and public lighting £291. 10s. Expenditure was £19,660. 8s. 1d., including generation expenses £13,041. 9s. 7d., cost of distribution £1,573. 13s. 7d., maintenance of public lamps £138. 4s. 9d., rents, rates and taxes £3,102. 5s. 11d., management expenses £1,567. 9s. 7d, special charges £154. 10s. 5d., and bad debts £82. 14s. 3d., leaving a gross profit of £18,226. 17s. 3d. to meet interest (£8,423. 9s. 4d.) and sinking fund instalments (£6,985. 1s. 10d.). £1,176 has been written off meters, and the balance (£1,639. 6s. 1d.) carried to reserve, bringing this to £11,752. 10s. Total capital expenditure is £282,910. 1s. 1d., an increase of £30,363. 19s. 11d. during the year. 4,537,420 units were generated, 2,971,428 units supplied to private consumers, and 45,760 to public lamps (32). There are 2,267 customers, and the total maximum supply demanded was 3,090kw.

The Corporation have been requested to quote terms for a supply of electricity for power and lighting at the starch works of J. Reckitt & Sons (Ltd.), whose demand is estimated at 560,000 units per annum. The borough electrical engineer (Mr. H. Bell) considers that an extension of plant costing £4,600 will be required to meet the demand. The Council have decided to enter into an agreement for the supply of current for lighting and motive power for the city stations, docks and sidings of the North-Eastern Railway (about 1½ million units per annum), and this will necessitate an extension of plant estimated to cost £2,300.

Ilford.—An inquiry was held last week into the application of the Council for sanction to borrow £40,000 for the extension of the plant at the electricity works and for excess expenditure.

The clerk to the Council (Mr. J. W. Benton) said loans of £64,867 and £31,718 had been granted, but these had been exceeded by £11,300.

Mr. B. Bailey, chairman of Tramways committee, said that there had been a surplus of £4,000 upon the tramway and of £2,000 upon the electric lighting undertaking. The surplus would be set aside for depreciation, which had not yet been provided for.

The consulting engineer (Mr. W. C. C. Hawtayne) gave evidence as to the "free" wiring arrangements, which had been of assistance in developing the demand for current for lighting.

The electrical engineer (Mr. A. H. Shaw) also gave evidence.

In future 1½d. per unit will be charged for electric energy supplied to the tramways department.

Islington (London).—The Electric Lighting committee recommend the Borough Council to adopt the suggestion of the borough electrical engineer (Mr. A. Gay) to provide additional steam valves and pipes, to carry out a modification of the existing steam mains, and to provide an automatic flue gas analysis recorder, and that the fitting shop engine be supplemented by a motor at an estimated cost of £450.

Keighley.—On Tuesday the Council docided to apply for sanction to a loan of £11,500 for electric lighting extensions.

Lancaster.—The charge for current for power has been reduced from 3½d. to 2½d. per unit. The electrical engineer (Mr. W. A. Tester) is to be allowed to take pupils at a fee of £100 each for two years, the fees to be divided between himself and the Council.

Leeds.—Each arc lamp on the tramway poles in the centre of Briggate, Boar-lane and Duncan-street and part of North-street, is to be replaced by two small enclosed arc lamps fixed on double arm brackets projecting 8ft. from the tramway poles on either side and parallel with the car track. The lamps and swan-neck brackets now fixed to side poles in certain thoroughfares are also to be removed, and small lamps, attached to the side of the bracket arm of each pole, are to be substituted.

Light Railways.—Messrs. McDonnell Mackey, G. H. Newborn and C. D. Nicholson are applying for an extension of time for complying with the Tickhill Light Railway Order, 1901.

The Cheltenham and District Light Railway (Extension No. 3) Order has been submitted to the Board of Trade for confirmation. Objections by 25th inst.

Lincoln.—The Corporation will take over the undertaking of the tramway company on July 1, and will proceed to convert the Bracebridge line to electric traction.

Liverpool.—A proposal to apply for sanction to a loan of £400,000 for electricity extensions was before the Corporation on Wednesday.

Mr. Dart, chairman of the Electric Power and Lighting committee, said the committee have already spent £1,500,000. Of the further capital now asked, £325,000 represented work to which the committee was committed. The quantity of electric energy used this year was 21 per cent. more than last year.

The recommendation, however, stood over for further consideration.

Newcastle-on-Tyne.—An agreement has been made between the National Telephone Co. and the Post Office for an interchange of telephone communication between the two telephone systems existing in the Newcastle area on payment of 1d. per call. The agreement will come into operation as soon as arrangements can be completed.

Nottingham.—For the year ended March the income of the electricity department was £71,854, and the expenses £36,978, the gross profit being £34,876. The reserve fund, towards which £6,541. 13s. 7d. was devoted during the year, now stands at £22,022. 12s. 6d.

In his report the borough electrical engineer (Mr. H. Talbot) states that the horse-power installed at the three generating stations is as follows —viz., Talbot-street 8,925 H.P., St. Ann's (power station) 4,200 H.P., Eastcroft 480 H.P.; total, 13,605. The total extensions of distributing mains during the year were 5·01 miles, the mileage of mains at the end of the year was 47·4. The number of applications received on March 31 was 2,557, compared with 2,238 at March 31, 1903, representing 239,866 8 c.p. compared with 208,306. The number of motors connected had increased from 392 to 498, and the total horse-power from 1,346 to 1,776. The number of units sold was as follows:—For lighting, 3,285,986, for power, 1,047,223, for traction, 3,768,601, total, 8,101,810, against 6,510,476 in 1903. 46 per cent. of the lighting units were sold at the reduced rate of 1½d. per unit.

The Electricity committee had deemed it advisable, considering that the electricity undertaking had been established and in full working order for nearly 10 years, and that since the commencement no outside expert opinion had been given as to the position of the undertaking, to obtain a report from an independent electrical engineer. They accordingly asked Dr. A. B. W. Kennedy to make an inspection of the undertaking. In the course of his report, Dr. Kennedy stated that the condition of the stations and plant was satisfactory. The committee had been fortunate in that, although the output had increased very rapidly, the area within which they had to supply still remained of such dimensions that they could supply it from their two principal stations without the use of high-pressure currents transmitted from a distance, and, therefore, without any of the losses due to transformation, which were unavoidable under those circumstances. He considered the capital expenditure had been extremely well kept down in relation to the amount of plant purchased. At present there was in the stations 8,430kw. of plant, and the total capital expenditure had been £400,918, or £47·4 per kilowatt. The average expenditure upon electric lighting plant throughout the country, even in places larger than Nottingham, had been much greater than that. In spite of the continued reduction in the charge for electric energy, the total income had continued to increase in a most satisfactory manner, the increased output much more than balancing the decreased charge per unit. In the first three full years' working (comparing the years ending March, 1896, and March, 1899) the gross income increased from £4,353 to £12,925, and in the last-named year the gross expenditure, including capital charges, was £9,348, or 72·3 per cent. of income. In the last three full years' working up to March, 1904, the income increased from £32,070 to £71,492, the

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total increase in eight years being 16·4 times. The committee had reduced the average charge per unit in 1904, however, to 38 per cent. of that charged in 1896, and in spite of this the total expenditure was still under 83 per cent. of the gross income.

The income of the tramways department was £128,202. 15s., and the expenditure, including interest, sinking fund, &c., £101,720. 4s. 2d., leaving a balance of £26,482. 0s. 10d., of which £13,000 has been contributed to the general district rate account, and the remainder (£13,482. 0s. 10d) carried to reserve, which now amounts to £34,038. 13s. 1d. The car-miles run were 2,512,001, an increase of 394,799 over previous year, but in consequence of wet and cold in summer and dense fogs in winter, the receipts in one week were reduced by over £600, and the average receipts fell from 13·06d. to 12·24d. per mile.

North-Eastern Railway.—On Monday next the North-Eastern Railway Co. will extend their electric train service from New Bridge-street station to Monkseaton.

Obituary.—We regret to record the death of Col. B. H. Martindale, C.B., late R.E., which occurred on the 26th ult, at his residence, Weston Lodge, Albury, near Guildford. Col. Martindale was a director of the City of London Electric Lighting Co. (Ltd.) and was an associate member of the Institute of Civil Engineers. He was in his 80th year.

We also have to announce the death of Mr. Leonard Cooper, of Harrogate, who died on 29th ult., in his 64th year. He was managing director of the Cooper Patent Anchor Joint Co.

Pembroke (Ireland).—An inquiry was held here last week into the application of the District Council for sanction to borrow £25,000 for electric lighting extensions. The clerk (Mr. J. C. Manley) and the consulting engineer (Mr. Robert Hammond) gave evidence in support of the application.

Poplar.—The Borough Council have asked the London County Council to sanction a further loan of £59,000 for extensions of the electricity undertaking.

Presentations.—The staff of the Glasgow Corporation Telephone Department on Tuesday evening presented Mr. A. R. Bennett with an illuminated address on the occasion of his retirement from the office of general manager. The chair was occupied by ex-Bailie Alexander, convener of the Telephone committee.

In making the presentation, Mr. Macfee referred to Mr. Bennett's distinguished career as an electrical engineer, and more especially to his strenuous efforts in connection with municipal telephony. On behalf of the staff he wished to convey to Mr. Bennett their heartiest appreciation of his ability, and to assure him of the respect and admiration in which he was held. In reply, Mr. Bennett thanked the staff for their kindness and for so loyally supporting him in his work, and impressed upon them the necessity of exercising their best efforts in carrying on the operations of the department. The address was designed by Mr. Twining, chief draughtsman of the department.

At the conclusion of business at the Wimbledon Council meeting last Wednesday, the chairman (Mr. Apperson, J.P.) on behalf of the councillors, presented Mr. H. Tomlinson-Lee, the chief electrical engineer, with a silver rose bowl on the occasion of his marriage, which took place on Saturday. Mr. Apperson testified to the zeal and ability with which Mr. Tomlinson-Lee had carried out his duties, first as assistant electrical engineer and subsequently as chief engineer.

Prompt Repairs.—At Dundee the laudable practice has been adopted of drilling the breakdown "squad" of the electricity department for cases of emergency. On the occasion of a surprise call last week two electricians turned out with the "town ladder" vehicle in 90 seconds.

Rickmansworth.—The District Council has decided to ask the Board of Trade to revoke the Rickmansworth electric lighting order.

Rotherham.—The Corporation have granted increases of salary of £50 each to the borough electrical engineer (Mr. E. Cross) and the tramways manager (Mr. W. Grant).

St. Helens.—There was a profit on the past year's working of the electricity department of £2,599 compared with £576 in the previous year. The Council have notified the New St. Helens and District Tramways Co. of their intention to apply, under the arbitration provisions of the tramway agreement, for a re-adjustment of the yearly sums payable for electrical equipment and current supplied to the tramways.

St. Pancras (London).—Some time ago a dispute arose between the Electricity committee and Messrs. Oetzmann & Co. in regard to the system of charging for electric current, the points at issue being whether Messrs. Oetzmann and private consumers generally were not entitled to be supplied at the lowest charge made to any consumers, such as hospitals, places of worship and theatres, and whether they were not entitled to have part of their premises supplied at a flat rate and the other part on the maximum-demand system. At the Council meeting on Wednesday the committee presented a report to the effect that, as Messrs. Oetzmann had not notified their intention, if their demands were not complied with, to legally contest the matter, and as a special sub-committee had gone into the subject, the firm's contentions be not acquiesced in. Counsel's opinion, which had been taken, was to the effect that municipal authorities were entitled to charge different rates where special circumstances existed, and that the firm's contention that one part of their premises should be supplied at one rate and the other at another could not be maintained.

When the report came up for adoption, the chairman of the committee announced that it would be withdrawn, but declined to assign any reason for this course.

The same committee recommended that the whole of the additional arc lamps be of the overhanging type. In reply to criticism on the extra expense involved (£1,276), it was stated that inquiries made from districts where overhanging lamps were in use had elicited replies unanimously in their favour. The recommendation was adopted.

The chief electrical engineer (Mr. Sydney W. Baynes) reported that, to meet increased demand in the southern district, an additional feeder was required, estimated to cost £2,500. This was agreed to.

The Council resolved to petition for the elimination of clause 6 (1) in the Supply of Electricity Bill.

Sheffield.—The accounts of the Electric Supply committee for the year ended March show income £57,100. 10s. 9d., and expenses (including cost of generation, distribution and management) £18,097. 10s., leaving gross profit £39,003. 0s. 9d. Interest absorbed £21,969. 3s. 10d., and sinking fund £11,603. 10s. 4d., leaving a surplus of £5,430. 6s. 7d., compared with £6,533. 15s. 6d. in 1903, and £5,604 in 1902. The surplus has been carried forward.

The total output was 3,960,049 units, against 2,919,722. There has been a steady rise in the number of lamps connected, the figure having gone up from 169,000 8 c.p. in April, 1902, to 275,000 in March, 1904.

South Shields.—An inquiry has been held here into the application of the Corporation for permission to borrow £12,046 for extensions of the electricity undertaking.

The town clerk said £7,215 was required for extensions of mains, &c., and £4,831 for excess expenditure. The number of consumers connected increased last year by 10 per cent., and it was desired to provide for at least 500 new consumers. He estimated the cost of providing meters, &c., at £8 per consumer, or £4,000, the mains at £5 each (£2,500), and in addition £320 was required for fuse boards at sub-stations, making £6,820. Some extensions to mains were required, which had recently been carried out at £395. He added that the total amount of the loans previously sanctioned was £152,821.

Southwark (London).—The Commissioners under the London Government Act, 1899, have prepared a draft scheme with reference to the Newington electric lighting undertaking, which provides (inter alia) that the expenses and receipts from the undertaking shall be divided amongst the several parishes in the Metropolitan Borough of Southwark in proportion to their rateable value.

Stepney (London).—At the meeting of the Borough Council last week the following resolutions were adopted:—

That the charges for electricity be as follows:—(*a*) For lighting, from June 1, 8d. per unit for the first 30 hours' use of the maximum demand during each of the six months ending March, and for the first 20 hours' use during each of the six months ending September, and 1d. per unit beyond; and (*b*) for motive power at 480 volts, and for all purposes other than lighting, as from July 1, 1d. per unit.

Stepney holds the record for the lowest charge for current in London on the old tariff, and the engineer and manager (Mr. W. C. P. Tapper) anticipates that the reductions now made will again considerably reduce the average charge to consumers. The flat rate of 1d. per unit for motive power will undoubtedly result in a large demand for electricity for that purpose.

Stoke-on-Trent.—The Council have applied for sanction to a loan of £1,250 for electric light fittings for the municipal buildings.

Sunderland.—The annual report of the electricity department, signed by the borough electrical and tramways engineer (Mr. J. F. C. Snell) and the chairman of the Electricity committee (Ald. W. Bruce), has been issued, and states that the undertaking continues to make steady progress. Last year a relatively large output had been obtained owing to the shipyard and engine works demand. In spite of the large amount of capital undeveloped owing to recent large extensions and an increase in rates and taxes, the gross profit was £16,359. After deducting interest and sinking fund, the balance (£1,246) has been added to reserve. There were 950 consumers on March 31, and the number of lamps connected was equal to 197,683 8 c.p., compared with 154,923 on the corresponding date in 1903. The number of units sold was 3,508,137, against 2,848,283. The total capacity of the electricity works (including spares) is 5,530kw. The capital expended is £51 per kilowatt, which is below the average for the municipal undertakings in the United Kingdom. The total outlay at the end of the year was £284,917, an increase of £58,921 over 1902. The total revenue was £36,128. Costs were £19,769 (£10,371 works costs, or 0·917d. per unit, and £9,398 standing costs). The total costs were 2·333d. per unit. 1,034,499 units of current were sold for lighting, 608,800 for motors, 1,562,748 for tramways, and 302,092 for public lighting. During the year the extra high-tension pressure three-phase 5,500-volt system was satisfactorily inaugurated, and a successful supply had been given to the North-

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Eastern Marine Engineering Co. and to William Doxford & Sons since Nov., 1903. Three 1,100 H.P. and a high-tension switchboard had been installed, and four sub-stations had been completed and started up. Important extensions are in hand for supply to the Sunderland Shipbuilding Co. and Messrs S. P. Austin & Son's shipyard.

The assessment of the electrical undertaking has been increased by £3,000, and it has been decided to enter an appeal against the increase.

Application has been made for sanction to borrow £25,000 for machinery, &c., for Hylton-road and Dunning-street stations, and the Hendon and Monkwearmouth sub-stations.

Swansea.—On Wednesday the borough electrical enginner (Mr. C. A. L. Prusman) reported that during the past month the equivalant of 581 8 c-p. lamps had been applied for, making a total of 55,510.

The balance-sheet for the year to 31st March showed gross profit, after meeting all necessary charges, of £5,794. 19s. 6d. Interest absorbed £3,121. 15s. 4d., leaving a net balance of £2,673. 4s. 2d., which, together with balance from last year (£1,810. 6s. 11d.) made £4,483. 11s. 1d. Sinking fund would require £2,452. 0s. 1d., leaving an available surplus of £2,031. 11s. Interest and sinking fund had been calculated to 31st December only. The rectification of this would reduce the net balance to £744, which it was decided to carry forward.

The Rand.—Mains are being laid from the Brakpan station of the Rand Central Electric Works for the supply of electricity for power to the Central Geduld Gold Mining Co.

Trade Union Amenities.—It is reported from Chicago that a strike was recently started through a proprietor having the temerity to work one of his own machines. Mr. Thomas E. Donnelly, a member of the printing firm of R. R. Donnelly & Sons Co., stopped after office hours and worked upon one of his own machines, without having consulted the operators' union. This was more than the union could tolerate, and a strike was ordered!

Tariff Changes.—In the new tariff schedules of the Mexican Government which came into effect on April 1, 1904, copper wire insulated with any material for use in electric lighting is admitted free; copper, brass or white metal wire is subject to a duty of 20 cents per kilogramme; copper or brass wire covered with cotton, silk or similar substance, 50 cents per kilogramme; cables of copper, brass, bronze or white metal covered with any material, but without metallic sheath, 5 cents per kilogramme; insulated cables with metallic sheath, free of duty; posts, cross arms and pins of iron or steel for overhead electric lines, $1.50 per 100kg.; primary, storage and other electrical batteries, free; incandescent electric lamps, commutators, fuses (mounted or unmounted), cut-offs, rosettes, contact pieces and safety devices, 10 cents per kilogramme (this is a reduction of 5 cents per kilogramme on incandescent lamps); arc lamps, 5 cents per kilogramme (previously admitted free); instruments and apparatus for all scientific purposes, free.

Tunbridge Wells.—In presenting the report of the Lighting committee at the Council meeting on Wednesday, the mayor (Ald. E. Robb) said the progress made by the electricity undertaking was satisfactory.

He denied that the department was in an unsatisfactory condition, or that there were any general complaints as to management. It was proposed to seek Parliamentary powers to further develop the undertaking, to sell or let on hire electric motors, lamps, &c., and to wire houses. Elsewhere the municipal authorities purchased motors, and it was reckoned that that would mean at Tunbridge Wells a considerable profit to the Corporation.

Ald. STONE thought the proposal outlined by the mayor was municipal trading of an objectionable kind. The proposal meant unfair rivalry with ordinary traders, and the Act of Parliament would mean at least £1,000 even if unopposed, and perhaps £5,000 if opposed, as opposed it would be. The burgesses of Tunbridge Wells did not want to dispose of the electric light undertaking, but they did not want to bear the expenses of an Act of Parliament for risks at once speculative, hazardous and expensive.

Councillor HICKS said that, as to the management of the works, his two years' experience was that the engineer (Mr. Boot) had done all he could for the undertaking and for the good of the borough. Municipal trading was—well, immoral trading, and the burgesses had returned to the Council by a large majority those who were opposed to it.

Ultimately the proposal to obtain Parliamentary powers was rejected by 13 votes to 9.

Walthamstow (London).—The Council on Friday resolved that three 275 H.P. Westinghouse gas engines and dynamos, with a spare armature, be provided as additional generating plant.

The electrical engineer (Mr. F. A. Wilkinson) reported that since the loan of £5,200 for free wiring had been expended, there had been a great falling off in the demand for small house property being electrically lighted, and he suggested that £500 be taken from profits of the undertaking for the purpose of carrying out installations. In order to make the money go as far as possible, he proposes to strictly limit the number of points in each house to six. In order to meet the large demands of other residents Mr. Wilkinson proposes to allow 16 lights in larger houses on the free wiring system, providing the tenants are willing to pay an additional ½d. per unit, making 1d. per unit in all for the accommodation of free wiring.

After discussion the Council decided to ask the Local Government Board if they will entertain an application for an additional loan for the purpose.

Mr. Wilkinson also reported that, as recently erected 32 c.p. lamp brackets had proved satisfactory, the question of electrically lighting the whole of the side streets might be taken into consideration.

On the recommendation of the Lighting committee, the electrical engineer was instructed to prepare particulars of the number of lamps required and the total estimated cost.

Water Power in Germany.—It is stated that the German Government is organising a project for exploiting the water power of the country on a large scale. Water-level observations are to be compiled from the year 1896, water volumes ascertained, and particulars as to the power used by manufacturing plant using water power are to be tabulated. Similar information is to be prepared for each particular industry as well as for agriculture.

Watford.—An inquiry was held here last week into the application of the Council for sanction to borrow £26,000 for electric lighting extensions. The clerk (Mr. H. Morten Turner) and the engineer (Mr. W. H. F. Colebrook) gave evidence in support of the application. There was no opposition.

Wireless Telegraphy.—It is announced that the first wireless telegraph station in Argentina has recently been established at Buenos Ayres at the Boca generating station of the German Electric Light Co. The work has been carried out by the Gesellschaft für Drahtlose Telegraphie on the company's Telefunken system. The object of the installation is to carry out experiments with the steamship "Cap Blanco," which is furnished with a complete installation on this system, and is expected to arrive shortly.

By an Act (No. 11 of 1903) of the New Zealand Legislature it is provided that

The Governor may, from time to time, establish stations for the purpose of receiving and transmitting telegraph messages within New Zealand, or between New Zealand and parts beyond New Zealand by what is commonly known as "wireless telegraphy," including in that expression every method of transmitting messages by electricity otherwise than by wires, whether such method is in use at the time of the passing of this Act or is hereafter discovered or applied. Any person who erects, constructs or establishes any station or plant for the purpose of receiving or transmitting communications by wireless telegraphy without having first obtained the consent of the Governor-in-Council, is liable to a penalty not exceeding £500, and any plant, machinery, instruments and material used by him for such purpose may be forfeited and dealt with as the Commissioner directs.

Reuter's Agency states that the Marconi wireless telegraph stations at Bari and Antivari (Montenegro) have been erected a month and are in regular working order. Mr. Marconi will personally open them in July next on his return to Italy. The high power station at Coltano (Pisa) will be the largest in the world, and will be built entirely of stone. It will be ready in August or September, after which the engines and other apparatus will be installed, so that it may begin working not later than the beginning of 1905. This station (runs the announcement) "will be able to communicate with Great Britain, Canada, the United States and the Netherlands, as well as with all vessels in the Mediterranean, the Baltic, the Red Sea, the Atlantic Ocean and the Indian Ocean." Mr. Marconi has, it is further stated, signed contracts with Chile and Argentina to construct telegraph stations.

Workhouse Lighting.—Ormskirk Workhouse is to be lighted electrically, and the Guardians have applied for a loan of £5,000 to defray the cost.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Wimbledon Urban District Council invite tenders for supply, delivery and erection of two water-tube boilers, economiser, feed pump and pipe wrok. Specifications, &c., from the chief electrical engineer (Mr. H. Tomlinson-Lee). Tenders to chairman of Electric Lighting committee, electricity works, Durnsford-road, Wimbledon, by noon June 17. See also advertisement.

Wimbledon District Council also invite tenders by 7th inst. for mosaic paving of engine room floor at the electricity works.

Leigh Corporation invite tenders for one 300kw. steam-driven set and switchboards. Specifications, &c., from the town clerk, Mr. Peregrine Thomas. Further particulars from the consulting engineer (Mr. G. F. Metzger), 3, York-street, Manchester. Tenders, addressed to chairman Electricity committee, Town Hall, Leigh, Lancs., by June 21. See also advertisement.

Metropolitan Asylums Board invite tenders for the supply of builders', engineers', smiths', plumbers' gas fitters' and miscellaneous ironmongery, engineering stores and electric accessories. Forms

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of tender from the offices of the Board, the Embankment, London, E.C., and tenders by 10 a.m. June 15. An advertisement contains further particulars.

West Ham Education committee invite tenders for the electric wiring and fittings required at West Ham Park elementary schools, Stratford. Persons desirous of tendering should apply to the architect (Mr. William Jacques, A.R.I.B.A.), 2, Fen-court, London, E.C., for specifications, &c., before June 9. Tenders to the Education Department, 95, The Grove, Stratford, E., by 5:30 p.m. June 20.

Exeter Corporation invite tenders for the construction of permanent way and paving (including copper bonding) of about 4 miles of tramway, single line, with passing places; overhead electrical equipment of lines and car-shed; supplying and laying insulated cables and stoneware conductors; and for supply and delivery of 12 double-deck single-truck motor cars. Tenders to the town clerk (Mr. George R. Shorto), Southernhay West, Exeter, by noon June 9.

The Scottish office of the *May-Oatway Fire Appliances (Ltd.)* invite tenders for wiring the installations set out in an advertisement in another column. Tenders close 8th inst. Particulars from the managing director, 49, Queen-street, Glasgow.

The Lords Commissioners of the *Admiralty* are prepared to receive proposals from persons willing to submit for competitive trial range-finders, both large and small, for naval use. Conditions, &c., will be furnished to bona fide inventors or manufacturers of such instruments on application to the Director of Navy Contracts, Admiralty, London, S.W. Full descriptions of the range-finders proposed must be sent in by June 30.

Portsmouth Town Council invite tenders for supply, delivery and erection of a steam-driven water-circulating pump, with connections, the supply and laying of cast-iron intake and discharge pipes and the supply and erection of sundry other pipe work. Tenders to the town clerk (Mr. Alexander Hellard) by noon June 11.

Lincoln Corporation invite tenders for eight electric tramcars. Tenders (addressed Chairman and Members of Electricity committee) to the deputy town clerk (Mr. W. T. Page, jun.), 5 and 6, Bank-street, Lincoln, by 10 a.m. June 13.

London County Council invite tenders for two continuous coal and ash conveyors (gravity bucket type) at Greenwich electricity generating station and for maintenance of same for 12 months. Tenders to the clerk of the Council (Mr. G. L. Gomme) by 10 a.m. June 14.

Conway Corporation are desirous of considering a scheme for the electric lighting of the borough and are about to appoint an electrical engineer to report. Applications by June 7.

Kingswinford Rural District Council invite tenders, by noon 20th inst., for four electric or gas driven pumps at their sewage pumping stations.

Handsworth Urban District Council invite tenders for erection of a generating station. Tenders to Council House by noon June 8.

The Visitors' committee of Parkside Asylum, *Macclesfield*, invite by June 20 tenders for wiring and fittings and electric lighting plant.

Deptford Borough Council require two 25kw. steam dynamos and a booster and switchboard. Tenders by 4 p.m. June 21.

Sheffield Tramways committee require tenders by 6th inst. for nine months' supply of coal to Kelham Island power station.

Wolverhampton Lighting committee invite tenders by 10th inst. for 12 months' supply of fuel to the electricity works.

Oldham Electricity committee want tenders by 7th inst. for 12 months' supply of coal.

Gravesend Town Council invite tenders by June 9 for stone-breaking machine, &c., with electric motor.

The *Prussian* State Railway Authorities, Bromberg, invite tenders until June 15 for an electrically-operated locomotive turntable. Particulars from and tenders to Die Königl, Eisenbahn Direction, Bromberg.

TENDERS RECEIVED AND ACCEPTED.

Twickenham Urban District Council have accepted the following tenders:—

Simpson & Co., pumping machinery, at £6,800.
Meldrum Bros., refuse destructor, at £2,665.
Aiton & Co., flues and boiler auxiliary plant and pipework, at £1,459.
Taylor & Son, boilers, at £1,360.

The following tenders were received by the Metropolitan Asylums Board for the electric lighting of the Western Hospital and Ambulance Station:—

Donnison, Sillem & Co. (*accepted*)	£3,270	Buchanan and Curwen	£4,530
Alliance Electrical Co.	4,287	Eastlakes Limited	5,820
Bergtheil and Young	4,367	Drake and Gorham	6,261

At the meeting of Sunderland Corporation Electricity and Lighting committee last week 13 tenders were received for motor generators and these were referred to Mr. J. F. C. Snell for analysis and report. There was also a number of tenders received for three-phase cables, and the committee recommend for acceptance the tender of the Electrical Company.

The following tenders were received for wiring electric bells and fire alarms at the infirmary of the Wandsworth (London) Union;—

Bakewell & Co. (accepted)	£129 10	Tucker & Co.	£179 10
J. Wilson	139 7	Comyn Ching & Co.	205 0
Clements, Booker & Co.	147 10	Private Wire and Installation Co.	216 9
Keeling, Teale & Co.	168 10	Elec. Eng. & Maint. Co.	226 0
C. Ross	170 0	E. Streather	275 0
G. & H. Turner	175 14		

Aberdeen Gas and Electric Lighting committee have accepted the tender of Babcock and Wilcox for overhead coal bunkers and bucket-type conveyors, and that of the Blake and Knowles Steam Pump Works for surface condensers for Dee village generating station.

Mysore Government have placed orders with Escher, Wyss & Co., Zurich, for turbines of 1,250 H.P., with the General Electric Co (U.S.A.), for five electric generators, and with Messrs. Mechan & Sons, Glasgow, for mains, sluices, valves, &c., for the Cauvery (Kolar Gold Fields) generating station.

Sydney (N.S.W.) City Council have accepted the tender of Dick, Kerr & Co. for additional generating plant (including Willans engine and Allen condensing plant) at £23,811. The British Westinghouse Co. also tendered at £23,651. The Brush Company submitted the lowest tender.

The Scottish office of the May-Oatway Fire Appliances (Ltd.) have accepted the tenders of Wm. Douglas (Ltd.) for wiring fire alarm installations at Moss' Empire Theatre and at J. Taylor & Sons' cabinet works, Edinburgh, for direct connection with the fire brigade; and contracts have been let to Troup, Curtis & Co. for similar installations on the premises of Stapley and Smith and McIntyre, Hogg, Marsh & Co., London, and to the Private Wire Installation Co. for similar work on W. L. Lucas & Co.'s London premises. With regard to the installations in the 67 buildings of J. and P. Coats (Ltd.) at Paisley, which were divided into seven contracts, the tenders of the National Telephone Co. were accepted for contracts 1, 5 and 6, those of J. Kilpatrick & Son for contracts 2 and 3, and those of Wylie and Lockhead (Ltd.) for contracts 4 and 7.

Ayr District Lunacy Board have accepted the following tenders:—
Sir Hiram Maxim Electrical and Engineering Co., boiler, feed pump, piping, &c., £829.
Bruce Peebles & Co., steam dynamos, switchboard, tools, &c., £1,616.
Lowdon Bros., wiring and mains, electric light fittings, &c., £2,607.

Messrs. Isaac Storey & Sons (Ltd.), Empress Foundry, Cornbrook, Manchester, have received (through Bruce Peebles & Co.) an order for six sets of surface-condensing plant in connection with the electrical equipment of Chatham Dockyard.

St. Pancras (London) Borough Council have accepted the tender of Reavell & Co. for a duplex air compressor at £73. 14s. 6d. W. H. Bailey & Co. tendered at £95, J. McDonald & Son at £108, and A. and Z. Daw at £151.

The Hart Accumulator Co., Marshgate-lane, Stratford, E., have secured an order for the supply of a battery of 122 of their standard lighting cells for Gransha Lunatic Asylum, Londonderry.

Bristol Corporation have placed an order with Bruce Peebles & Co. for a 400kw. generator.

Colchester Town Council have accepted the tender of Mather and Platt for a dynamo at £840.

Derby Tramways committee have accepted the tender of Newton Bros. for wiring the car sheds at £193. 3s. 6d.

Hull Telephone committee have accepted the tender of Collier Bros. for copper wire for £570. 8s. 10d.

Gloucester Corporation have accepted the tender of the Municipal Appliances Co. for a sand-drier for the tramways at £40.

BUSINESS NOTICE.

J. H. Tucker & Co., in order to deal with increasing business at their London office, have removed from 3, Bury-street, W.C., to larger premises at 217, Shaftesbury-avenue, W.C. Mr. G. T. Baker continues in charge.

LIQUIDATIONS, BANKRUPTCIES, &c.

C. M. Downie (trading as the Lighting Corporation) electrical engineer, 4, Bloomsbury-street, W.C., and 28, Heathville-road, Crouch Hill, N., London, has been adjudicated bankrupt. Mr. C. J. Singleton, 8, Staple-inn, London, W.C., is trustee.

J. J. and H. K. De Lacy (trading as De Lacy Bros.), electrical engineers, 58, Old Hall-street, Liverpool, have been adjudicated bankrupt. Mr. T. Tranter, 51, North John-street, Liverpool, is trustee. Liabilites estimated £1,700, assets £1,100.

Under the failure of David Todd Cameron, trading at Devonport as D. T. Cameron & Co., electrical engineers, liabilities are £213. 8s. 4d., assets £49. 11s. At Stonehouse Bankruptcy Court on Tuesday the public examination took place. Debtor commenced business with a capital of about £200. Examination concluded.

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Consequent upon the acquisition of the undertaking of the Dover Electricity Supply Co. by the Corporation, the company is being wound up voluntarily. Sir W. H. Crundall and Mr. R. P. Sellon are liquidators.

A meeting will be held on July 7 at 11, Queen Victoria-street, London, E.C., to receive an account of the winding-up of the Giffre Electro-Chemical and Power Co. (Ltd.).

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (inclnding a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 30, Birley-street, Blackpool.

A small electric lighting plant is advertised for sale in another column. Particulars of Messrs. King & Son (Ltd.), Horsham, Sussex.

A battery of 53 21-plate Chloride storage cells is advertised for sale by Mr. E. C. Theedam, Dudley.

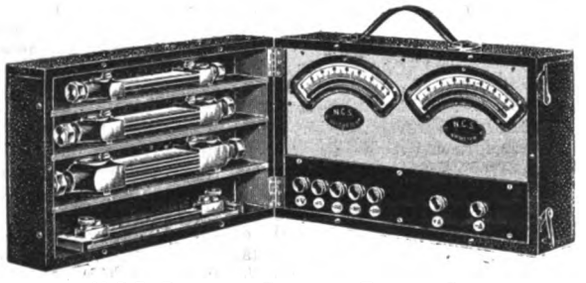
Electric Candle Lamps.—Various designs of candle lamps are on the market, and have been a favourite form of table illumination for many years past. Previous attempts to adapt the "candle" for table lighting have not been particularly successful, from various causes. In describing recently the stands at the exhibition held at Wimbledon, we made reference to a display by the Sir Hiram Maxim Electrical and Engineering Co. of the "Huntalite" patent electric candle lamp. This is certainly a nearer approach to the actual appearance of a genuine wax candle than anything we have seen previously, and lends itself readily to decorative designs. Our illustration shows that Mr. Hunter, the inventor of the "Huntalite" lamp, has been very successful in his design, which approximates to the diameter and length of an ordinary wax candle, the clear glass cone at the top being melted right on to the opal tube. When the lamp is switched on the filament assumes the appearance of a candle flame very closely. We understand that the cost of the candles is not much in excess of the ordinary flame or crinkled lamp, and as no special fitting is required for use with them they actually prove cheaper. New filaments can be fitted readily. We learn that the demand for the lamps has already been very large. Certainly the display made at Wimbledon attracted much attention.

Hunter's Electric Candle Lamp.

"Berliner" Telephones.—The art of effective advertising is really a simple one, in fact, the more simple the adverisement the more telling and effective. The telephone is not an instrument that lends itself to display, but whatever is to be effected in this direction has, we think, of late been accomplished by the Berliner Telephone Mfg. Co., 200, Upper Thames-street, London, E.C., who have issued some very effective announcements concerning their manufactures. An excellent example is shown in the company's announcement in our present issue.

Catalogues.—A new list dealing with some adaptations of the "Pivot Combination." patented by Mr. A. P. Lundberg, 477-487, Liverpool-road, London, N., has just been issued. Mr. Lundberg's quarter-of-a-century experience, and the good name his goods have attained, is a guarantee of technical correctness and good workmanship and finish.

A new list of N.C.S. dead-beat moving-coil ammeters and voltmeters has just been issued by Messrs. Nalder Bros. and Thompson, 84, Queen-street, Cheapside, London, E.C. These instruments have been supplied to all the principal municipal electricity undertakings in the country, to the Post Office, the Indian Government, the chief lines of railways in Great Britain, and, in fact, wherever electricity supply is established, electric working on railways has been put into operation, or where isolated installations have been put down. The new catalogue is very compact, and illustrations are given of types of instruments in most general use. A portable combined testing set specially designed for rapid and accurate measurement of current and E.M.F. is shown in the illustration herewith. This consists of two moving-coil instruments mounted in the same case, and enabling simultaneous observations of current and E.M.F. to be made. The current shunts are arranged in one side of the carrying case, and two instruments and voltmeter resistances in the other.


N.C.S. Portable Combined Testing Set.

A new list of Nernst lamps is issued by the Nernst Electric Light (Ltd.), 82, Victoria street, London, S.W., and all the latest types and models of these lamps are illustrated and described. The accompanying illustration Fig. A shows a 1,000 c.p. Nernst lamp specially manufactured for use in projection lanterns of large size, and Fig. B is designed to take the "Brilliant" replacement piece and resistance, and to fit on the pin in the tray of the lantern. For use in small halls or lecture rooms this type of Nernst apparatus is found to give excellent results. No heaters are fitted with these lamps, so that it is necessary to light them by means of a spirit lamp or gas flame after they have been switched on. The list is strong in globes and shades for use with Nernst lighting.

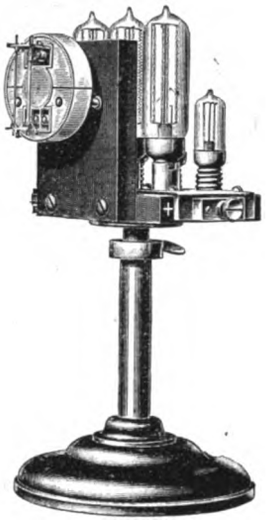


Fig. A.—Nernst 1,000 c.p. (200-volt) Projection Lamp.

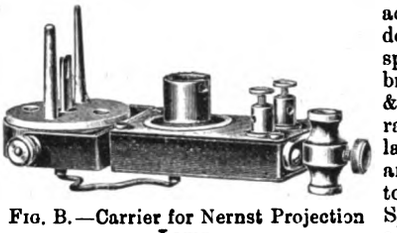


Fig. B.—Carrier for Nernst Projection Lamp.

The 2nd edition of the General Electric Co.'s motor accessories list is issued, and deals with ignition coils, sparking plugs, contact-breakers, switches, batteries, &c., also small motor-generators for charging accumulators, instruments for testing and other items of interest to the motor-vehicle industry. Special attention is called to a "Protected" pattern of sparking plugs, and motor cyclists will be interested in a pocket form of measuring instrument described. Carriage electric lamps suitable for interior and exterior lighting are also listed. The General Electric "Progress Sheet" for May is also to hand, and lists some improvements in watertight electric light fittings. A new pattern of electric cigar lighter is also shown.

Messrs. Gent & Co. have a new list of patent watchmen's clocks and electric tell-tales ready. The firm have made a speciality of this class of apparatus for many years past, and are responsible for a large number of installations of tell-tale clocks, &c., in asylums, hospitals, factories, warehouses, &c. Messrs. Gent claim that their electric tell-tale is impossible to falsify, while it is equally impossible to make any purely mechanical appliances absolutely proof against tampering.

Two circulars, Nos. B1072 and 1080, issued by the British Westinghouse Co. deal respectively with tramway controllers and tramway motors. Both lists are well illustrated, and give constructional details of the machines. In the pamphlet on tramway motors the particulars given relate to the No. 200 motor for service on cars of moderate speed and seating capacity.

Mr. Herbert Perkin, of Prudential-buildings, Leeds, has ready a new list of time and labour-saving appliances.

The Temperley Transporter Co., 72, Bishopsgate-street Within, London, E.C., forward an advance copy of their new (1904) catalogue, which is profusely illustrated with typical examples of the company's specialties for the rapid and economical "transporting" of materials of all kinds. This class of machinery is coming into very general use, and the publication of the catalogue is timely. It is the most comprehensive work of the kind every published.

The Mirrlees-Watson Co., Glasgow, are issuing an illustrated sheet list of surface-condensing plant.

Forthcoming Book —Messrs. Whittaker & Co. will publish shortly a new work by H. M. Hobart, M.I.E.E., entitled "Electric Motors, their Theory and Construction."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from May 21 to 31, with the ports of destination:—

Africa—Alexandria, £350; Beira, £152 (telegraph material); Cape Town, £2,041; Durban, £1,329 (including £25 telegraph material)

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East London, £1,012 (including £218 telegraph material); Port Elizabeth, £16. *Argentina*—Buenos Ayres, £1,991. *Australasia*—Auckland, £500 (including £458 telegraph material); Christchurch, £17; Fremantle, £244 (including £180 telegraph material); Melbourne, £15; Perth, £958; Sydney, £1,468; Wellington, £1,070 (including £1,013 telegraph material). *Belgium*—Ostend, £126 (telegraph instruments). *Brazil*—Rio Janeiro, £59. *Canary Islands*, £19. *Ceylon*—Colombo, £161. *Channel Islands*, £46. *China*—Shanghai, £24. *Denmark*—Copenhagen, £40. *France*—Boulogne, £20; Paris, £46. *Germany*—Emden, £75; Hamburg, £249. *Gibraltar*, £935. *Greece*—Piræus, £60. *Holland*—Amsterdam, £20; Rotterdam, £43. *Hong Kong*, £627. *India*—Bombay, £85; Calcutta £1,303 (including £325 telegraph material); Madras, £394. *Malta*, £18. *Mauritius*, £28 (telegraph material). *North Atlantic*, £16,100 (submarine cable). *Portugal*—Lisbon, £90; Oporto, £383. *Siam*—Bangkok, £260. *Straits Settlements*—Penang, £146; Singapore, £147. *Sweden*—Stockholm £62 (telegraph wire). *Uruguay*—Monte Video, £25. *Zanzibar*, £170 (telegraph apparatus). Total (for 11 days), £32,924 against £7,931 for eight days last year (May 27 to June 3).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1903.

3,620A McELROY. Dynamos. (Date applied for Feb. 16, 1903.)
6,477 PHELPS and BOWIE. Electro-therapeutic high-frequency apparatus. (Post-dated April 17, 1903.)
8,048 HEAP. Phase-measuring instruments for electric currents.
8,256 WESTINGHOUSE. Controlling systems for electric motors.
8,279 and 8,280 VON ZWEIGBERGK. Switches.
8,343 HEYWOOD and HEYWOOD. Reversing switch.
8,447 KÜHN. Electrically-operating ships' steering gear.
8,550 JAMES and BRYAN. Control of electric vehicles.
8,560 SAHULKA. Electrical combined with compressed air or other motive fluid system of driving, especially applicable to locomotives and other motor carriages of electric railways.
8,607 GONDRAND and CELESTRE. Accumulator plates.
8,669 CAROLAN (G.E. Co., U.S.). Training mechanism for searchlight projectors.
8,670 CAROLAN (G.E. Co., U.S.). Alternating electric current meters.
8,774 WHEATLEY (Lewis and Armitage). Wireless telegraphy.
8,791 FERGUSON and KELVIN AND JAMES WHITE (LTD.). Electrostatic voltmeters.
8,800 ECKSTEIN and KRAUSE. Interlocking switches and cutouts for mines
9,131 SELLICK. Plug and socket connections and switches for electrical purposes.
9,535 LACKIE, CALDERWOOD and MACEWEN. Electric time-relay switches.
9,808 CAROLAN (G.E. Co., U.S.). Emergency brakes, vehicles or trains.
9,956 SIMPSON and THOMLINSON. Automatically operating fire alarms.
10,504 SYKES. Switches for railway point and signal mechanism.
10,702 LAMPSON. Electric advertising devices and street indicators.
11,473 WHALLEY. Electric cables.
11,607 CAROLAN (G.E. Co., U.S.). Bases for incandescent lamps.
11,725 CAROLAN (G.E. Co., U.S.). Switching mechanism for controlling alternating-current motors.
11,727 CAROLAN (G.E. Co., U.S.). Recording instruments.
12,313 CAROLAN (G.E. Co., U.S.) Electricity meters.
12,837 CAROLAN (G.E. Co., U.S.). Electric motors.
12,954 CAROLAN (G.E. Co., U.S.). Magnetic brakes.
13,009 MAJOR. Trolley heads for electric vehicles.
13,153 CHISHOLM. Shadeholders for electric lamps.
13,226 HAMILTON-ADAMS. Enclosed arc lamps.
13,358 SHEPHERD. Electric couplings.
14,168, 14,169 and 14,174 LE TALL (Cooper-Hewitt Electric Co.). Systems of electrical distribution.
14,380 VAN RADEN and ROBINSON. Contact breakers for induction coils.
14,539 BRITISH WESTINGHOUSE CO. Armature coils for dynamo-electric machines.
14,814 BROUNGER and HAYWOOD. Resistances or rheostats applicable as a regulator, motor-starting switch or the like.
15,059 SIEMENS BROTHERS & CO. (Siemens and Halske A.G.). Electrical winding apparatus.
15,317 COLLIS, COLLIS and HEAD. Apparatus for electric deposition of metals.
17,814 HADDAN (Rué y Montparlé). Safety collision devices for electric tramcars.
20,313 WEDEKIND and PÖRSCKE. Production of a porous hard electrode mass insoluble in alkalies from metallic oxides or metallic powders.
24,909 STEINMETZ. Luminous vapour electric lamps and methods of making same. (Date applied for Nov. 17, 1902.)
26,144 REUTER. Electromagnetically-operated apparatus for controlling the inlet devices of steam and gas turbines.
26,230 INTERNATIONAL TROLLEY CONTROLLER CO. and KYNOCH. Combined trolley arm and brake controllers for electric tramcars.
26,352 EMONDS. Vacuum arc lamps with external air-cushioned regulating device.
27,712 ABEL (Siemens and Halske, A.G.). Electric glow lamps with metallic filaments.
28,699 RUGH. Telegraphy.

COMPANIES' MEETINGS AND REPORTS.

Rand Central Electric Works (Ltd.)

The annual ordinary general meeting was held on Tuesday, Sir C. RIVERS WILSON, G.C.M.G., C.B., presiding.

The SECRETARY (Mr. H. Rogers) read the notice convening the meeting, and the auditors' report.

The CHAIRMAN then said: Gentlemen, although we are not in a position to announce the payment of a dividend to the shareholders, yet we are able to congratulate you upon the great improvement in our position, and upon the fact that our prospects are excellent. The war, you will remember, terminated at the end of May, 1902, and our position at that time was as follows:—We had, on Jan. 1, 1902, a deficit of £25,231, brought about by the circumstances of the war, which almost put an end to our working. We were working at a loss, and, at the same time, we had to keep up very considerable payments on account of depreciation. The war over, we began slowly to resume a more favourable position, so that by the end of 1902 we were able to make a slight reduction in the deficit, amounting to £2,238. Therefore, we stood to begin the year 1903 with an adverse balance of £22,993. The accounts vary very little from those of the previous year. There has been a slight increase on account of construction of works, amounting to £1,857, mainly caused by providing a compound for the Kaffirs and new quarters for the married men. Under the head of "Mines Installation" there has been an increase of £4,362, which is almost exactly the increase which we showed last year. The causes of that are chiefly on account of the extension of the town lighting of Johannesburg. I am sorry to say that all our efforts to obtain from His Majesty's Government recognition of our very reasonable claim for damages incurred during the war have not met with that success which we expected, and certainly which we deserved. Fortunately, we had what I may call a little nest egg—a small reserve which we had accumulated in the early period of our history, and we were able to apply that in writing off the claim against the Government. The original claim amounted to £4,138. In the year 1902 we wrote off £1,408, and now we have written off the remainder, amounting to £2,729, and there is an end of that. The small balance on account of that reserve fund has been transferred to profit and loss. As usual, we have applied liberal and substantial amounts to depreciation. In a business of this sort it is absolutely essential for the credit and solidity of our undertaking that this should be most carefully attended to. The total amount of this depreciation is £17,962, spread over various items, which is about £6,000 more than the amount applied for depreciation in 1902, but, of course, in that year we were working to a less extent than in 1903. The general basis for the assessment of depreciation is that which is provided in the original contract with Messrs. Siemens and Halske. We have more or less followed those figures, and given a liberal interpretation to them. With regard to the profit and loss account, the only matter I need call your attention to is the increase in the expenditure on account of working expenses and maintenance of plant, as compared with the preceding year, which amounts altogether to about £4,300, and is caused by the increased output as well as by certain considerable repairs which had to be undertaken in connection with our boiler plant chiefly. Our total income for 1903 amounted to the respectable figure of £71,820, which shows an increase over 1902 of £18,856, of which £18,043 is in respect of increased revenue from electricity supply and the rent of plant. The result of the operations of the Company shows a reduction of the adverse balance with which we commenced the year, of £22,993, by the sum of £11,045, after, as I have described to you, liberal allowances for depreciation, so that on Jan. 1 of this year there remained an adverse balance of £11,948. We are now in full work, and are taking steps for considerably increasing our operations. The estimated profits for the first quarter of the current year amount to about £10,000, which is within about £2,000 of the amount of the adverse balance which I have just mentioned. Therefore, I think we may consider that, beginning with the month of April, we start nearly clear, so that when we next have the pleasure of meeting you we shall be able, I trust and expect, to ask you to vote a recommencement of dividends upon a satisfactory basis. And, now, as regards the future, we have contracts at the present time for the whole of our available power. Our contracts are numerous, and some of them we must expect to fall out from time to time, but others will supply their places. We are working at full power; in fact, we are obliged to bring into full operation our reserve engine. You will remember that I told you last year we anticipated an increase in the prosperity of our Company, and were already taking steps for providing additional power. At that time we considered the desirability of extending our plant upon the same system as under the original organisation, but in view of the continued and now pretty well assured success of the turbine system, we have carefully examined whether it would not be desirable to adopt for future extensions that system in preference to the old system. It has the merit of being more economical in its original installation and also more economical in its working. After careful consideration, and taking the best technical advice we possibly could, and having also the advantage of the advice of our expert Director, Mr. Gorrissen, we came to the conclusion that we should be acting prudently and for the benefit of the Company in ordering at once a turbo-generator with all the necessary appliances. Under the advice and with the assistance of Messrs. Siemens and Halske, we have ordered the necessary turbine plant, and we expect that early in the autumn the first instalment will be set up and in operation at Brakpan. In the first instance, the amount of power installed will be about 400kw., but the boiler plant which will be erected at the same time will suffice for the extension of the plant on the same system to about 400kw. more, or 800kw. altogether. The total cost of erecting this turbine will be altogether about £12,000—a much

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smaller amount than we contemplated when it was a question of putting up a steam engine; and we should probably be able to add another dynamo of the same description for about £3,000 or £4,000, so you will see that for a total outlay of some £15,000 or £16,000 we should get a large and profitable extension of our plant. We are able to provide the amount for these extensions out of cash balances, which amounted at Jan. 1 to over £40,000, an increase on last year of over £20,000, so we have ample funds for providing not only the present extension but future extensions also without borrowing or without increasing the capital of our company. The new electro-turbine is being obtained from Switzerland. I now move the adoption of the report and accounts.

Mr. G. ZWILGMEYER seconded the motion and it was carried unanimously.

The retiring directors, Messrs. H. Strakosch and C. Gorrissen were re-elected, as were the retiring auditors.

A vote of thanks to the chairman and directors terminated the proceedings.

BARCELONA TRAMWAYS CO. (LTD.)—At the meeting on Monday Mr. J. B. Concanon said the directors considered the report an unsatisfactory one. They had lost in receipts about £5,900. Cost of current had been reduced by £1,728. The traffic expenses increased by £148, and the cost of maintenance increased by £2,120. There was a further increase in 1903 over 1902 of £1,920 in Government and municipal taxation, but of that increase, £556 should have been charged in the 1902 accounts. Mr. H. Brown and Mr. N. Kennedy went to Barcelona in January, and as a result of their visit changes were made in the local administration. The company had had during the last two or three years several strikes, and they had compromised them. They appointed as traffic manager Mr. Foronda, a gentleman of good position in Spain (a Madrid man), an officer in the Spanish army, and a man whom they believed to have plenty of grit and pluck, and their instructions were that they would have no more shilly-shallying and making of concessions, which they did not think were deserved, to the men, but that whenever a conductor was found to be acting dishonestly he should be immediately discharged. This had caused trouble, both to the new manager and to Mr. Brown, who were both compelled to carry revolvers. A conspiracy had been formed by three men to assassinate Mr. Brown and Mr. Foronda. One of the men had turned informer, and all three were arrested, and each man said it was the other two men who had formed this plot. However, they were only kept in prison for a very short time, as there appeared to be no law in Spain to detain beyond 36 hours a man who only threatened to assassinate. From this strong policy, by May their receipts had increased to £2,166. The increase was attributable entirely to the fact that the men they found robbing them had been dismissed. The total increase in the receipts of the combined systems on May 28, 1904, was £7,520, or £5,350 in gold.

BELLISS AND MORCOM (LTD.)—The directors' report for the year ended March 31 states that, after making ample provision for depreciation and contingencies, and payment of preference dividend, the credit balance is £41,754. An interim dividend has already been paid on the ordinary shares at the rate of 5 per cent. per annum, and it is now proposed to issue to the ordinary shareholders four bonus shares for every 10 shares held by them, to pay a further dividend on the ordinary shares, making 12½ per cent. for the year, to place £10,000 to general reserve, and to carry forward the balance.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—A meeting was held on Monday, under the presidency of Mr. H. Wolfenden, to confirm the resolution passed at an extraordinary general meeting on May 12, reducing the company's capital from £1,000,000 to £941,090, by cancelling paid-up capital which has been lost, or is unrepresented by available assets, to the extent of £2. 10s. per share on each of 23,564 B shares of £5 each. The resolution was confirmed.

PENARTH ELECTRIC LIGHTING CO. (LTD.)—In the report for 1903 it is stated that the capital expenditure amounts to £22,671. 4s. 10d. The gross revenue was £981. 5s. 3d., and the expenditure £1,068. 0s. 8d., leaving a debit balance of £86. 15s. 5d., added to £129. 4s. 1d. from last account, making £215. 19s. 6d. The equivalent of 5,030 8 c.p. lamps were connected to the mains, an increase of 46 per cent.

REUTER'S TELEGRAM CO. (LTD.)—Admiral Sir John Hay presided at the meeting on Wednesday, and said that the company had been put to great expense in regard to the Somaliland campaign without any adequate return, and very great expense was involved in reporting the naval and military operations in the Russo-Japanese war. Interpreters were indispensable, because messages sent over the Japanese field wires must be written in Japanese, which meant that the telegrams must be first translated into the language at the front, and then retranslated into English at the base. The most rigorous censorship was in force on the Russian as well as on the Japanese side which explained the meagreness of many reports received in this country. The company had many triumphs to record in the matter of early information concerning military and naval events of the war, and the company's prestige as a distributor of news stood as high in Japan and China as on this side.

SHEERNESS AND DISTRICT ELECTRIC POWER AND TRACTION CO. (LTD.)—The directors' report for 1903 states that the capital expenditure at the end of the year was £60,492. 5s. 3d. The gross receipts from the light railways from April 9 to Dec. 31 amounted to £3,189. 9s. 4d., and from the supply of electricity to £1,353. 3s. 7d. After deducting expenses (£4,498. 1s. 9d) the credit balance was £78. 11s. 3d., and is carried forward. The light railways (about 2½ miles in length) were opened for public traffic on April 9, 1903. Electric supply was commenced on the same date. Exclusive of traction-load, the installations connected to the mains at Dec. 31 were equivalent to 3,477 8 c.p. lamps. The average rate received from lighting consumers was 4·2d. per unit.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

SPRAGUE ELEVATOR CO. (LTD.) (81,047)—Reg. May 21, capital £5,000 in £1 shares, to carry on business of constructors of and dealers in lifts, elevators, cranes, hoists and lifting machinery and apparatus, machinery and appliances used in connection therewith (whether worked by electrical or other power), hydraulic, electrical, mechanical and general engineers, electricians, suppliers of electricity, &c.

VERNON MECHANICAL AND ELECTRICAL REGISTERS (LTD.) (81,086)—Reg. May 27, capital £25,000 in £1 shares, to acquire the inventions of Albert Marsh relating to (inter alia) delivering, receiving and registering tickets and checks, with the British-American patents and rights obtained or applied for in respect thereof, and to carry on the business of manufacturers of and dealers in mechanical and electrical indicating and registering appliances, tickets and checks, &c. Reg. office, Eldon-street House, London, E.C.

STATUTORY RETURNS.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The return to May 11 shows the capital as £450,000 in 18,000 shares of £25 each, 17,000 of which have been taken up. £25 per share has been called up and £425,000 has been received. No mortgages or charges.

OKONITE CO. (LTD.)—In the return to April 12 the capital is given as £120,000 in 32,000 preference and 16,000 ordinary shares of £2. 10s. each, all of which have been taken up. £2. 10s. per share has been called up on 100 ordinary and 110 preference, and £525 has been received. £119,475 is considered as paid on 47,790 shares. Mortgages and charges, £65,900, of which £35,400 debentures are in the hands of the trustees of the company.

SOUTH LONDON ELECTRIC SUPPLY CORP. (LTD.)—The return to March 22 gives the capital as £325,000 in 65,000 shares of £5 each, all of which have been taken up and paid for in full. No mortgages or charges.

WILLANS AND ROBINSON (LTD.)—The return to April 27 shows capital £750,000 in 75,000 6 per cent. cumulative preference and 75,000 ordinary shares of £5 each, of which 66,666 preference and 66,666 ordinary have been taken up. £5 per share has been called up on 52,203 preference and 52,204 ordinary shares, and £522,035 has been received, £144,625 is considered as paid on 14,463 preference and 14,462 ordinary. Mortgages and charges, £246,760.

MORTGAGES AND CHARGES.

CHURCH STRETTON ELECTRIC SUPPLY CO. (LTD.)—Trust deed dated May 19 has been registered to secure £5,000 debentures, created May 13, 1904, charged on certain land at Church Stretton, the provisional electric lighting order granted to the Church Stretton Land Co. for the district of Church Stretton and the parishes of All Stretton and Little Stretton, Salop, and the company's other assets (present and future), including uncalled capital. Trustees, Sir R. G. Head and Major A. P. Bethune.

INDIA RUBBER, GUTTA PERCHA AND TELEGRAPH WORKS CO. (LTD.)—Issue on May 17 of £1,000 second debentures, part of series created April 12, 1904, to secure £100,000, charged on company's undertaking and property, present and future, including uncalled capital, subject to £300,000 debentures issued in 1896. No trustees. Previously issued of same series, £99,000.

CITY NOTES.

MEMORANDA—Bank rate 3 per cent. (since April 21, 1904). Price of silver 25 7/8d. per oz. (June 2). Consols 90⅛—90¼ for money, 90⅜—90½ for account; 2½ per cent. annuities 89⅜—89⅞ (June 2). Consols Pay Day, July 1; Stocks and Shares Continuation Days, June 8 and 27; Ticket Days, June 9 and 28; Pay Days, June 10 and 29; Mining Share Carry-over Days, June 7 and 25.

BANBURY AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The total expenditure to end of 1903 was £17,951. 8s. 10d. A partial supply of electric energy was commenced on Feb. 6, 1903, and the continuous supply was inaugurated on Aug. 9. The gross revenue was £560. 3s. 11d., and expenditure £555. 2s. 11d., leaving a credit balance of £5. 1s. The equivalent of 3,916 8 c.p. lamps were connected to the mains at Dec. 31. The average rate received for electric current from lighting consumers was 4·4d. per unit.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—The directors have declared a dividend on the ordinary shares of 12 per cent. per annum, less tax, for the half-year to March 31, making 9 per cent. for the year.

COUNTY OF DURHAM ELECTRIC POWER SUPPLY CO.—The capital expenditure at the end of 1903 was £85,021. 6s. The total revenue amounted to £15,138. 19s. 7d., and the expenditure to £13,259. 1s. 3d. After providing for interest (£489. 6s. 11d.) and adding £448. 17s. 3d. from last account, the balance was £1,839. 8s. 8d. £250 is to be placed to depreciation and reserve, and a dividend of 2 per cent. per annum on the ordinary shares is declared. The directors propose laying a trunk main from Gateshead to Jarrow, where a large demand for power has arisen. In addition to the agreement with the Newcastle-on-Tyne Electric Supply Co. for a supply to this company of electric energy in bulk, an agreement was entered into in February last for bulk supply from the Priestman Power Co. These additional sources of supply will enable the company to meet the demand for power without incurring an immediate and large capital outlay for generating plant. Additional capital, however, must be raised for transformer plant and mains.

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COUNTY OF SURREY ELECTRICAL POWER DISTRIBUTION CO. (LTD.)—The capital expenditure during 1903 was £7,174. 14s., making a total of £44,007. 17s. 4d. The gross revenue was £2,032. 17s. 4d. and the expenditure £2,064. 12s. 2d. The debit balance of £31. 14s. 10d. is carried forward, together with £733. 13s. 3d. from last account. 170,313 units were generated and 104,382 units sold. The total maximum supply demanded was 119kw. The equivalent of 10,507 8 c.p. lamps are connected to the mains, an increase of 105 per cent. A new 300kw. generating set has been installed. The total capacity of the generating plant at the Sutton power station is equivalent to 600kw. An application has been made to the Board of Trade for a provisional order for the parishes of Cheam, Cuddington and Ewell. An optional agreement has been entered into with the British Electric Traction Co. for the acquisition of that company's interests in the authorised tramways and light railways in Croydon and District.

COUNTY OF NORTHAMPTON ELECTRIC POWER AND TRACTION CO., (LTD.)—The total capital expenditure at Dec. 31, 1903, was £18,742. 9s. 2d. The power station at Wellingborough commenced to give temporary supply to a few consumers on Dec. 17, 1902, and on Feb. 11, 1903, permanent supply was inaugurated. The gross revenue for the year was £712. 17s. 11d. and the expenditure £1,072. 4s. 2d., the debit balance being £359. 6s. 3d. At the end of 1903 the equivalent of 3,029 8 c.p. lamps was connected, 71,301 units were generated and 49,946 sold.

LEWES AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—During 1903 the capital expenditure was £2,206. 16s. 11d., making a total outlay of £24,477. 3s. 7d. The gross revenue was £1,276. 6s. 1d., an increase of £362. 3s. 10d. over 1902. Expenditure amounted to £1,322. 18s., leaving a loss of £46. 11s. 11d., to which is added the debit balance of £72. 9s. 6d. from 1902, making the total debit £119. 1s. 5d. The installations connected to the mains at Dec. 31 were equivalent to 5,527 8 c.p. lamps, an increase of 40 per cent. for the year.

LISBON ELECTRIC TRAMWAYS (LTD.)—After charging interest and amortisation on debentures of the Companhia Carris de Ferro de Lisboa, there is a net profit of Rs. 516,904.264 (£91,803. 4s. 7d.) to be carried to credit of London profit and loss account. After payment of debenture interest and other charges and expenses, the balance is £59,814. 13s. 4d., added to £6,080. 12s. 10d. from last year, making £65,895. 6s. 2d. Arrears of preference dividend to Dec. 31, 1902, required £12,000, 6 per cent. for 1903 £25,533. 3s. 8d. £20,000 has been transferred to depreciation reserve, leaving £8,362. 2s. 6d. to be carried forward. The business continues to expand, the receipts for 1903 amounting to Rs. 1,115,722.067 (£198,133. 12s. 10d.), against Rs. 965,547.142 (£166,283. 19s. 4d.) in 1902. During the year £19,667. 18s. 5d. was expended on construction, including an additional unit of plant at the power house.

MEXICO ELECTRIC TRAMWAYS (LTD.)—The result of the operations for 1903, after charging interest on debentures of Compañia de Ferrocarriles del Distrito Federal de Mexico, and after payment of the 3½ per cent. guaranteed on the share capital of that company shows a net profit of $314,566.55 (£27,157. 11s. 7d.) to be carried to credit of London profit and loss account. Adding interest received, and after charging expenses and obligations, &c., against same, the net balance is £35,545. 8s. 1d., which, added to balance from last year, makes £35,728. 8s. 2d. The usual preference dividend has been paid (absorbing £30,000), and £5,728. 8s. 2d. is carried forward. The total distance of the company's line now operated by electricity is 129km. A new 800kw. unit of plant is being added to the power station to meet demands of increased traffic. During the year 36,478,584 passengers were carried against 31,132,030 in 1902, and the receipts amounted to $2,799,282.84 against $2,400,787.83. Traffic receipts, since the commencement of present year, have been well maintained, and business generally in Mexico is improving.

NERNST ELECTRIC LIGHT (LTD.)—At an extraordinary meeting on Tuesday, the resolutions for the reduction of the company's capital (set out in our last issue) were passed with one dissentient. A confirmatory meeting will be held on 20th inst.

NEW GENERAL TRACTION CO. (LTD.)—Subscriptions are invited for an issue of £80,000 4 per cent. prior lien mortgage debentures of £100 each in this company. The list closes on Monday.

NORTH METROPOLITAN ELECTRICAL POWER DISTRIBUTION CO. (LTD.)—At Dec. 31, 1903, the total capital expenditure on the Barnet electric supply was £22,623. 5s. 4d. The gross revenue for the year was £2,169. 4s. 9d., compared with £1,742. 1s. for 1902, and the expenditure (excluding proportion of managerial expenses charged to general revenue) was £1,545. 3s. 9d. The equivalent of 5,103 8 c.p. lamps were connected to the mains, an increase of 40 per cent. An additional 100kw. generating set was erected during the year. The total capital expenditure on Hertford electric supply was £7,855. 18s. 3d. The gross revenue was £1,248. 9s. (increase £486. 18s. 9d. compared with 1902), and the expenditure (excluding proportion of managerial expenses) £734. 18s. 8d. During the year the supply was taken in bulk from the North Metropolitan Electric Power Supply Co. The equivalent of 4,388 8 c.p. lamps were connected to the mains, an increase of 59 per cent. The total revenue for the year was, therefore, £3,418. 16s. 6d. Deducting expenditure (£2,619. 12s.) and adding balance (£198. 13s. 3d.) from last account, £997. 17s. 9d. remained for allocation. After paying the preference dividend, 2½ per cent. is recommended on the ordinary shares.

PROVINCIAL TRAMWAYS CO. (LTD.)—An ordinary dividend of 3s. per share has been declared.

ROSS ELECTRIC LIGHT AND POWER CO. (LTD.)—At the meeting last week the directors reported that, after payment of all expenses and charges, the balance was £48,

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to grant quotations to a further issue of £75,000 5 per cent. debenture stock of the *Electric Lighting and Traction Co. of Australia (Ltd.)* and further issues of 50,000 ordinary £1 fully-paid shares and 50,000 7 per cent. cumulative preference £1 fully-paid shares of the *Electrolytic Alkali Co. (Ltd.)*.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended		Amount.	Inc. or Dec. (a)	Aggregates. No. of weeks.	Amount.	Inc. or Dec. (a)
			£	£		£	£
Aberdeen Corporation	May	28	1,375	+ 241	52	62,794	+ 12,790
Airdrie	,,	20	193	...	15	2,804	...
Ayr Corporation	,,	21	248	- 27	2	552	- 14
	,,	28	304	+ 13			
Barnsley	,,	20	170	- 11	20	3,201	- 178
Barrow	,,	20	148	+ 89	15	2,253	+ 1,366
Bexley District Council	,,	26	240	...	33	5,661	...
Birkenhead	,,	29	1,172	+ 40	...	...	...
Birmingham Corporation	,,	28	300	...	19	5,961	...
Birmingham Tramways Co.	,,	28	6,483	+ 1,157	21	110,864	+ 7,081
Blackburn Corporation	,,	27	1,155	+ 162	9	8,893	+ 699
Blackpool Corporation	,,	26	1,667	- 186	8	6,275	+ 1,568
Blackpool and Fleetwood	,,	28	1,597	+ 1,173	22	6,855	+ 921
Blackp'l, St. Anne's & Lytham	,,	26	718	+ 718	30	6,187	+ 5,609
Bolton Corporation	...		...	...	...	...	...
Bournemouth Corporation	,,	25	1,884	+ 421	8	9,037	+ 841
Bradford Corporation	...		...	...	...	...	...
Brighton Corporation	,,	29	1,192	+ 201	8	7,758	+ 228
Brisbane Tramways	April	13	2,095	- 342	15	34,315	- 376
Bristol Trams & Carriage	May	27	6,202	+ 309	1	6,202	+ 309
Buenos Ayres & Belgrano	,,	1	3,295	+ 189	2	6,698	+ 728
Burnley Corporation	,,	28	1,190	+ 353	9	9,339	+ 2,269
Burton Corporation	,,	29	426	...	8	3,945	...
Calcutta Tramways Co.	,,	28	ʀ31,459	+ʀ2,017	22	ʀ753,487	+ʀ98,389
Camborne-Redruth	,,	30	132	- 65	4	483	- 38
Cardiff Corporation	,,	28	2,526	+ 430	8	16,865	+ 1,148
Carlisle Tramways Co.	,,	28	230	- 1	21	3,884	+ 260
Central London Railway	,,	28	6,693	- 125	22	151,680	- 2,089
Chatham & Dist. Lt. Rys.	,,	19	601	+ 96	21	11,871	+ 1,958
	,,	26	718	+ 161			
City & South London Rly.	,,	29	2,675	- 58	22	66,111	- 2,406
Cork Electric Trams Co.	,,	16	509	- 94	21	8,709	- 420
Darwen Corporation	,,	27	241	- 53	8	1,909	- 120
Devonport & Dist. Trams.	,,	20	580	+ 168	20	9,561	+ 1,410
Dover Corporation	,,	23	264	+ 41	9	1,777	- 67
Dublin & Lucan Railway	,,	29	200	+ 77	22	2,299	+ 211
Dublin Southern District	,,	27	1,197	+ 160	¶22	96,278	+ 2,328
Dublin United	,,	27	4,427	+ 147			
Dudley—Stourbridge	,,	20	836	+ 57	20	15,491	+ 701
Dundee Corporation	,,	25	860	+ 25	...	...	...
East Ham Council	,,	28	943	+ 201	8	6,441	+ 903
Gateshead & Dist. Trams.	,,	20	901	+ 59	20	17,398	+ 945
Glasgow Corporation	,,	28	14,993	+ 242	52	711,607	+ 60,282
Glossop	,,	21	104	...	22	2,134	...
	,,	28	134				
Gravesend—Northfleet	,,	20	257	+ 19	20	4,523	+ 633
Gt. Northern & City Rly.	,,	28	937	+ 60	15	13,959	...
Greenock & Port Glasgow	,,	20	547	- 2	20	9,821	+ 672
Halifax Corporation	...		...	...	...	...	...
Hartlepool Tramways	,,	20	294	+ 86	20	5,121	+ 547
Huddersfield	,,	28	1,719	+ 457	9	10,979	+ 1,094
Hull Corporation	,,	28	2,420	+ 628	8	17,610	+ 1,777
Ilford District Council	,,	28	656	+ 158	8	4,106	+ 696
Ilkeston Corporation	,,	25	208	- 45	...	...	...
Ipswich Corporation	,,	28	751	...	8	3,943	...
Isle of Thanet Co.	,,	28	953	+ 370	...	...	...
Kidderminster & District	,,	20	119	+ 8	20	2,072	- 65
Kirkcaldy Corporation	,,	25	228	- 38	21	4,438	...
Lanarkshire Trams Co.	,,	16	671	...	21	12,542	...
Leeds Corporation	,,	28	6,979	+ 1,208	9	51,944	+ 4,817
Leicester Corporation	,,	28	1,603	...	2	2,315	...
Liverpool Corporation	,,	21	10,354	- 62	21	204,208	+ 4,472
Liverpool Overhead Rly.	,,	29	1,908	+ 245	22	34,714	+ 383
*London County Council	,,	21	11,451	+ 557	§7	80,203	+ 13,888
Lowestoft	,,	21	164	...	¶44	8,648	...
	,,	28	286				
Manchester Corporation	,,	28	14,712	+ 2,142	8	96,772	+ 3,859
Mersey Railway	,,	28	1,824	+ 293	21	31,301	+ 6,988
Merthyr	,,	20	201	+ 5	20	3,924	+ 213
Middleton	,,	20	343	+ 44	20	5,451	+ 145
Nelson Corporation	,,	28	139	+ 70	9	1,084	+ 482
Newcastle-on-Tyne Corp.	,,	28	4,026	+ 700	21	74,125	+ 9,768
Newport (Mon.)	,,	28	650	+ 170	8	4,208	+ 1,809
Oldham, Ashton & Hyde	,,	20	550	- 8	20	10,291	- 532
Oldham Corporation	...		...	...	...	...	...
Perth (W. A.) Elec. Trams.	,,	27	1,347	+ 164	21	28,557	+ 3,954
Peterborough	,,	20	160	+ 13	20	2,527	- 177
Poole and District	,,	20	286	- 4	20	5,183	+ 45
Portsmouth Corporation	,,	28	2,887	+ 609	19	15,818	+ 1,982
Potteries	,,	20	1,671	+ 89	20	33,317	+ 2,646
Reading Corporation	...		...	...	...	...	...
Rochdale Corporation	,,	30	195	+ 30	9	1,148	+ 82
Rothesay	,,	20	89	- 38	20	1,908	+ 7
Salford Corporation	,,	28	4,082	+ 471	9	35,388	+ 5,458
	,,	30	5,344	+ 1,399			
Sheerness	,,	18	57	- 11	20	961	- 298
Sheffield Corporation	,,	29	5,560	+ 967	§9	43,184	+ 2,033
Southampton Corporation	,,	16	1,141	+ 72	...	...	...
Southend Corporation	,,	25	440	+ 138	8	2,414	+ 296
Southport Tramways	,,	20	315	+ 27	20	5,878	+ 389
S. Staffordshire Trams.	,,	20	789	- 131	20	15,251	- 143
Stockport Corporation	,,	27	708	+ 346	7	4,460	+ 1,887
Sunderland Corporation	,,	29	1,655	+ 465	8	10,415	+ 721
Swansea Trams	,,	20	792	+ 129	20	9,627	+ 473
Taunton Trams	,,	20	19	- 8	20	995	- 77
Tynemouth and District	,,	20	261	- 12	20	4,485	- 161
Tyneside Trams Co.	,,	25	538	+ 133	21	6,583	+ 1,037
Wallasey District Council	,,	28	880	+ 156	§8	5,877	+ 378
Walsall	,,	28	650	...	21	10,091	...
Warrington Corporation	,,	26	370	+ 13	8	2,497	+ 35
West Ham Corporation	,,	26	1,247	...	13	7,742	...
Weston-super-Mare	,,	18	79	+ 1	20	841	- 29
Wigan Corporation	...		...	...	...	...	...
Wolverhampton District	,,	20	389	+ 16	20	7,041	- 244
Worcester	,,	20	314	+ 146	15	4,020	+ 1,689
Wrexham	,,	20	105	- 15	20	2,148	- 122
Yorkshire Woollen District	,,	20	620	+ 279	10	11,007	+ 4,865

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 8 days. ¶ Plus 8 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., June 1.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to June 1 Highest.	Business, Week to June 1 Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	5 —5⅛	4 15 3	April, Oct	5 1/16	5 1/16
St.	6%	Do. Permanent 6% Deb. Stock	130 —135	4 11 3	..	133	132
t.	34/2	Auckland Elec. Trams 5% Deb. (red.)	98 —100	.. ..	..	99⅝	..
10	10/0	Barcelona Tramways Ord.	6 —8	6 5 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 6	..	..	..
100	5%	Do. 5 per Cent. Debs.	96 —99	5 1 9	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	3/32 —¾	.. ..	..	..	..
1	..	Do. 5% Cum. Pref.	1/32 —1	.. ..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	.. ..	..	..	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	3¾—4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98 —103	4 9 1	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	18 —19	4 4 2	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10½—10⅝	3 17 8	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100 —103	5 16 6	..	..	..
St.	5%	† Do. Pref. Ord. Stock	97 —100	5 0 0	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10⅝	5 11 7	..	10⅛	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104⅞	4 6 7	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	9⅜—10⅛	7 16 0	..	10	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅛—11	5 9 1	Feb, Aug	10⅞	10⅜
St.	5/0	Do. 5 per Cent. Perpetual Debs	115 —118	4 6 3	..	117⅞	..
5	3/0	Buenos Ayres and Belgrano Ord.	2⅜—2⅞	5 3 9	..	2⅜	2⅛
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼—5½	5 4 4	..	..	..
5	3/0	Do. "B"	5 —5½	5 9 1	..	..	..
St.	5%	Do. 5 per Cent. Debs.	106 —109	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	100 —103	4 19 0	..	102½	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	96 —101	5 0 0	..	..	..
5	3/6	Calcutta Tramways	7 —7½	4 0 0	..	7⅞	7 1/16
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —109	4 3 7	..	..	..
1	1/0	Cape Electric Tramways Shares	2 —2½	7 11 1	..	2⅛	..
St.	4%	Central London Ordinary Stock	92 —95	4 4 2	June, Dec	..	..
St.	4%	Do. 4 per Cent. Pref. Stock	101 —104	3 17 8	..	103	102
St.	4%	Do. Deferred Stock	83 —86	4 13 0	..	..	..
100	4%	Do. 4 per Cent. Debs.	110 —113	3 10 9	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2%	City and South London Rly. Con. Ord.	50 —52	4 11 4	Feb, Aug	51	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —126	4 0 0	Feb, Aug	..	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 —109	3 13 5	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	99 —102	4 18 8	..	..	..
10	6 0	Dublin United Trams. (1896) Ltd., Ord.	12⅜—13⅜	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8½	Gt. Northern & City Rly. Prf. Ord. (4%)	5 —6	5 0 0	..	5⅜	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	.. ..	..	..	..
10	10%	‡ Imperial Tramways Ord	18 —19	5 5 3	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	1½%	Liverpool Overhead Railway Ord	4¼ —4½	3 1 1	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	4 0 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11 —11½	4 7 0	..	11½	11⅛
St.	4%	Do. 4% 1st Mort. Deb. Stock	102 —104	3 18 0	..	103⅜	103
St.	..	Mersey Con. Ord. Stock	6 —9	.. ..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	.. ..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	.. ..	..	..	..
1	..	Metropolitan Electric Trams Def	1/32—¼	.. ..	..	..	..
1	0/6	Do. 5% Cum. Pref.	¼—1	5 0 0	..	..	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..
100	4¼%	Do. Sterling 4½% Debs. (1922)	105 —107	4 5 0	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 —2	.. ..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	100—103	4 19 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	.. ..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	.. ..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	.. ..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	89 —92	3 7 11	June, Dec	90	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 6	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	.. ..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	.. ..	..	..	..
St.	12/6	Anglo-American	48 —51	5 14 8	F,My,Ag,N	49	48
St.	25/0	Do. Preferred	92 —94	6 1 1	F,My,Ag,N	95½	87
St.	2/0	Do. Deferred	7 —7½	1 7 6	F,My Ag,N	7¼	7⅛
100	3?2	Commercial Cable Capital Stock	175 —185	4 6 6	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 —96	4 3 9	Jn Ap,Jy,O	94½	..
10	5/0	Cuba Submarine Ord.	7 —8	7 10 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100⅝—103⅝	4 9 0	Jan, July	..	..
20	3/0	Direct United States Cable	10¼—10⅜	6 0 11	Ja,Ap,Jy,O	..	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —103	4 9 0	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	126 —131	5 7 0	Ja,Ap,Jy,O	130½	128⅝
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —90	3 17 9	Ja Ap,Jy,O	89	87⅜
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 6	May, Nov	106⅜	106
10	6/6	Eastern Extension	11⅜—12⅜	5 14 0	Ja,Ap,Jy,O	12⅜	11 1/16
St.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 15 0	Feb, Aug	105	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	99 —102	3 19 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅝—101⅞	3 19 3	May, Nov	..	..
10	20 0	Great Northern (of Copenhagen)	25 —26	5 15 6	Jan, July	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 —103	4 9 0	June, Dec	..	..
25	37/6	Indo-European	42 —45	5 11 2	May, Nov	44⅜	..
100	4%	Pacific&Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..
10	2/0	West African Telegraph Shares	1⅛—1⅜	3 1 6	..	..	..
2½	..	West Coast of America	1 1/16—1⅛	.. ..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 10	Jan, July	..	..
10	..	West India and Panama	⅜—½	.. ..	May, Nov	..	..
10	8/0	† Do. 6 per Cent 1st Pref.	5¼—6⅛	9 12 0	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	.. ..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 18 4	Jan, July	..	..
10	3/0	Western Telegraph	1⅛—1⅜	5 6 6	Mr,Jn,O,D	13⅜	12⅛
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 17 9	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	100 —103	3 17 8	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
10	5/0	†Globe Telegraph and Trust	8¾—9½	5 19 0	Ja Ap Jy O	9⅛	8½
10	3/0	† Do. 6 per Cent. Pref.	13 —13½	4 8 11	Ja Ap,Jy,O	13⅛	13
8	4/0	Reuter's	6¼—7¼	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	117 —122	4 18 4	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed., June 1.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to June 1 Highest.	Business, Week to June 1 Lowest.
		TELEPHONES.		£ s. d.			
5	3/0	Chili Telephone (fully paid)	4¾—5¼	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	104 —106	5 13 3	..	105	104
St.	5%	Do. Def. Stock	85 —88	5 13 7	..	87½	86
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 —13	4 12 4	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	11 1/16	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5¼	4 15 3	Feb, Aug	..	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —100	3 11 0	June, Dec	98⅜	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 —105	3 17 0	..	104⅛	103½
		Do. Do. Prov. Certs. 70% to bepd.	30 —32	.. ..	..	31⅜	30⅛
1	0/8⅜	Oriental	1⅛—1 1/16	6 6 3	April, Oct	1 1/16	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	6 4 6	..	..	..
5	3/0	United River Plate	5½—6	5 16 8	July.....	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 —106	4 15 10	June, Dec	104½	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Greenwich. Dist. Ord. (f.p.)	⅛—⅞	.. ..	..	..	..
1	0/8⅜	Do. 7% Cum. Pref.	1 —1½	5 12 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. &con.)	120 —125	3 12 0	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
St.	4%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
		Bromley (Kent) El. Lt. & Power Shares	5½ — 6	.. ..	..	..	..
St.	4½%	Do. Do. 1st Debs	100 —103	4 7 5	..	104⅝	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	10¾—11½	4 5 1	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10½—10⅝	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7 —7½	4 13 4	..	..	..
St.	4%	†Central Elec. Sup. Co. 4% Guar. Db. Stock	105 —108	3 14 1	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7¼—7⅜	5 3 3	Feb, Aug	7⅜	7 1/16
5	2/3	Do. 4½ per Cent. Pref.	5⅜—5⅝	4 3 6	Feb, Aug	5½	5 3/16
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	..	..	..
5	1/7	Do. Do. (19.3)	4¼—5	.. ..	..	4 15/16	..
St.	4%	Do. 4% Deb. Stock (red.)	103 —105	3 17 6	..	105	..
5	3/6	Chelsea Electric Supply Ord.	6¼—6⅝	4 1 5	March ..	6½	6⅜
St.	4%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —110	4 3 0	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10⅜—11½	4 9 0	Feb, Aug	11½	10⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	..	..
10	4/0	County of London Elec. Supply Ord.	7½—8¼	4 14 3	..	8⅜	8
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	11⅞	..
St.	4¼%	Do. 4¼% Deb. Stock (all paid) (red.)	106 —109	4 2 11	..	107½	107
St.	4½%	Do. Second Deb. Stock Prov. Certs.	99 —102	4 8 3	..	..	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	90 —95	.. ..	..	..	..
5	3 6	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 8	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 8 0	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	.. ..	..	..	..
5	5/0	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
St.	4½%	I. of W. Elec Lt. & Power 4½% Db St (red.	101 —103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf	1 3/32—1 5/32	.. ..	..	..	..
5	7/0	Kensingtn & Knghtsbdge Ord.	11½—12½	4 16 0	..	..	..
St	4%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
		Kensingtn. & Kngtbg. Co. & Notting Hil Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	104	..
3	..	London Electric Supply Ord.	1½—1⅝	.. ..	..	..	..
5	3/0	Do. 6 per Cent Pref.	4½—5	6 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 —98	4 2 11	Mr,Jn,S,D	..	..
10	9 6	Metropolitan Electric Sup. Ord.	19½—20½	4 5 6	April, Oct	19⅞	..
5	1/4½	Do. 4½ per Cent. Cum. Pref.	5⅜—5⅝	4 1 0	..	5 1/16	5½
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort	109 —113	3 19 6	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.	97 —100	3 11 0	..	97½	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
10	6,0	Notting Hill Electric Ord.	1⅝—13½	4 8 11	March....	..	..
5	4/0	Oxford Electric Ord.	5½—6¾	5 13 0	March ..	5½	..
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 3	..	..	..
1	..	Rand Electric	1 3/32—1 5/32	.. ..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb	100 —103	4 7 9	April, Oct	..	..
5	9 6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	14⅛	..
5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3 —3½	5 14 3	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	3/0	South London Electric Supply Ord.	3¾—4¼	3 10 7	..	..	..
5	2/6	Urban Electric Supply Ord.	4⅜ 4¾	5 2 6	..	..	..
5	2/6	Do. 5% Cum. Pref.	4⅝—4⅞	5 2 6	..	..	..
5	7/0	Westminster Electric Supply Ord.	12⅜ - 13½	5 0 0	Mar, Sept	13⅜	12 1/16
5	2/6	Do. 5 per Cent. Cum. Pref.	6¼—6¾	3 14 0	..	..	..
		ELECTRIC MANUFACTURING &c.					
1	..	Aron Elec. Meter 6% Cum. Pref.	1/4 - 3/8	.. ..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord	5¼—5⅜	6 19 2	July, Feb	5 1/16	..
5	3/0	Do. 6 per Cent. Pref.	5¼—5½	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —105	4 7 0	..	103½	..
St.	4½%	British Thom's'n-Houst'n 4½% 1st Mt. Db	101 —103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	2½—3⅜	8 0 0	..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	£7 —90	4 10 9	..	..	..
1	..	Brush Electrical Engineering	½—1	.. ..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1—1½	.. ..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	73 —78	5 17 8	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord. xd & bonus	10 —11	5 13 8	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5⅞	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.	104 —108	4 3 3	Nov, May	..	..
1	9⅜d.	†Castner-Kellner Alkali Co. (fully paid	6⅜—⅞	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅜—2⅛	6 13 4	Jan, July	1⅜	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.	96 —99	5 2 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7⅜—8½	.. ..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5 —5⅛	5 9 1	..	..	..
St.	4½%	Do. 4½% Deb. Stock	102—104	4 7 2	..	..	..
		Edison & Swan United("A"Sh.)(£3 pd.)	½—¾	.. ..	Feb, Aug	..	..
5	..	Do. (£5 paid)	½—1½	.. ..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.	72 —77	5 3 11	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	74 —79	6 6 7	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5⅛—6	5 16 8	H'lf-yearly	5⅝	5⅜
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅝—5¾	5 2 6	..	5¾	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.	105 —108	4 4 6	..	..	..
2	1/2½	Electric Construction Co.	1⅜—1⅝	7 2 10	Jan, July	1⅝	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2¼—2½	5 2 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.	97 —100	4 0 0	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—9⅝	5 2 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	11½	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.	107 —111	4 1 5	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks	19 —20	5 0 0	Feb, Aug	19⅝	19½
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.	99 —102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref	10½—11	4 10 11	Mar, Sept	..	..
15	36/0	Telegraph Construction & Mainten'ce	35 —38	6 2 0	Mar, July	38	36½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
		Willans and Robinson Ord.	2½—3½	.. ..	Apr, Oct	2⅝	..
		Do. 6 per Cent. Cum. Pref.	3½—4½	.. ..	Apr, Oct	..	..
St	4%	† Do. 4 per Cent. 1st Mort. Debs.	89 —94	4 5 1	May Nov	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

THE report of the Council of the Institution of Electrical Engineers was accepted practically without discussion at a thinly-attended annual general meeting yesterday afternoon. In connection with the Articles of Association, it is stated that the Council and members of the Elections and Transfers Committee are of the opinion that greater definition is necessary in the statement of the qualifications to be required in candidates for admission to the class of Associates. The Council have the matter under consideration, and it is hoped that some reasonable solution of the problem will be found at an early date. Probably there are few members of the Institution who will not agree that some revision of the Articles relating to Associates should take place. Something has already been done in this direction by dividing the student section into two classes, senior and junior, and allowing members to remain in the former grade until 26 years of age, when they can become Associate Members without any intermediate step. But the students have not availed themselves of this privilege to any great extent, we believe. Possibly the simplest alteration would be to lower the age limit for Associate Members from 25 to 24 or 23, so that young electrical engineers would not consider it *infra dig.* to remain as students until they could qualify for Associate-membership and the Associate class would then be confined to non-engineering members and members of allied professions.

IT is pleasing to observe that the Institution, as a whole, is making very substantial progress, a net total of no less than 668 names having been added to the register during the year. Naturally this has increased the revenue, but the large surplus of receipts over expenditure (£2,911), as compared with £951 in 1902, is due, in great measure, to the unification of the rates of subscriptions. While dealing with financial affairs, however, the Council regrets that the number of annual contributors to the Benevolent Fund is steadily diminishing, instead of increasing with the growth of the Institution. A grant from the income of this fund to the late secretary's widow has been authorised. In referring to the change which has taken place in the secretarial staff, the report pays a tribute to the President, who devoted a very considerable amount of his time to the affairs of the Institution during the interval between Mr. MCMILLAN'S death and the appointment of Mr. LLOYD. It was largely owing to Mr. GRAY'S unremitting attention that the continuity of the work of management went on without break or interruption, and every member is therefore indebted to him for thus voluntarily adding to his already heavy duties.

THE conference which was held at the St. Pancras Town Hall on Saturday at the instance of the St. Pancras Borough Council, a report of which appears in another column, does not appear to be treating the point at issue in quite the way which it should. There seems to be some fear that the new Electricity Supply Bill, now before Parliament, will prejudice the rights of local authorities by giving the Board of Trade a freer hand to permit competition than has hitherto been the case. Moreover, while the delegates to the conference are sure that they themselves want the right to acquire land compulsorily, the majority of them are not so certain that they desire companies to be given the same power. The real object of the delegates is, apparently, to place those undertakings which have obtained the land for their generating stations by agreement, in the same position as regards liability for actions for nuisance from vibration as those which have obtained their land by compulsory purchase. Clause 1 of the Bill already referred to empowers the Board of Trade to authorise, by Provisional Order, the compulsory acquisition of

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any land specified in any previous order or Act of Parliament, and we would strongly advise municipalities to support this Bill, which will give them all the powers they can reasonably expect to obtain. The suggestion that a separate Bill should be promoted, or that a clause should be inserted in the existing Electric Lighting Acts, to this effect, but retrospective in its action would end in failure, and would possibly also seal the fate, or at all events delay the passing, of the more important Electricity Supply Bill—a measure to which no one viewing the subject with a broad mind could possibly object.

As will be seen in another column, the Royal Commission on London Traffic, which has been sitting since April, 1903, has now concluded the hearing of evidence, and it is to be hoped that the final report will be published before the period for depositing notices for the next session of Parliament comes round. Those of our readers who have followed the reports of the proceedings which have appeared in our columns will probably have formed some idea of the opinions of a few of the Commissioners upon certain points, but we will not attempt to anticipate what the reports as a whole will contain. On the engineering questions involved much interest will attach to the report of the expert sub-committee, consisting of Sir JOHN WOLFE BARRY, Sir BENJAMIN BAKER, and Mr. W. BARCLAY PARSONS, which was appointed as a result of the visit to the United States last autumn. On general questions it is safe to say there will be some disagreement amongst the various Commissioners, and the conclusions arrived at should prove interesting reading.

THE "pourparlers," which we may presume have now developed into "negotiations," between the Government and the National Telephone Co. for the acquisition of the company's system are advancing slowly, and Lord STANLEY'S statement in the House of Commons on Wednesday that he cannot promise any definite result this session is disappointing. As is seen by the description of the new Holborn exchange in this issue, the National Telephone Co. still endeavours to improve its service and keep it well up to the latest advances in telephone engineering; yet a unification and nationalisation of the telephone system is urgently needed.

AN interesting legal point has been raised by the Tunbridge Wells Town Council in connection with the right which shareholders in gas undertakings may or may not have to speak or vote on electric light matters at Council meetings. Mr. W. C. CRIPPS, the town clerk, sought counsel's opinion on the subject, and Mr. ALEXANDER MACMORRAN, K.C., in his written reply, says that although the point has never been expressly decided, yet there has been a general consensus of opinion to the effect that shareholders in the local gas company are disqualified to speak on the subject on the occasions mentioned. Moreover, the present LORD CHIEF JUSTICE, Mr. Justice WRIGHT and Mr. ASQUITH, K.C., have all at various times upheld this view, and Mr. MACMORRAN suggests that the MAYOR should rule out of order any gas shareholder who speaks or votes on electric matters in Council. This is undoubtedly an important point, and counsel's opinion must be regarded as correct, not only from the legal aspect but also from the moral standpoint.

British Association.—*Nature* makes the announcement that Prof. George Darwin, F.R.S., has been elected President of the British Association for the meeting to be held in South Africa next year.

Personal.—The Council of University College, London, have appointed Dr. Gregory Foster to be Principal of the College, in succession to Dr. Carey Foster. The appointment will date from September 1st next.

Royal Commission on London Traffic.—In our issue of April 20th, Mr. Charles Carpenter, chief engineer of the South Metropolitan Gas Co., is reported to have said that an arc lamp costs from £30 to £40 per annum. The report should have read £20 to £30 per annum.

Ladies' Automobile Club.—At the initial run of the Ladies' Automobile Club of Great Britain and Ireland yesterday there were six electric cars out of a total of 50. The cars started from the Carlton House-terrace, opposite Waterloo-place, and went to Hyde Park and on to Ranelagh. The president of the club is the Duchess of Sutherland.

York and the British Association.—On Monday evening a deputation from the Yorkshire Philosophical Society waited upon the Corporation of York with a view to inducing the City Council to invite the British Association to hold its annual meeting in York in 1906. On the motion of the Lord Mayor, it was unanimously resolved to forward the invitation. York was the scene of the first B.A. meeting that was ever held, and since then it has been twice honoured by the presence of the Association, once in 1844 and again in 1881.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Cayenne—Pinheiros	Aug. 18, 1902 ..	—
Beissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Dakar—Konakry	May 13, 1904 ..	—
Gibraltar—Tangiers	May 17, 1904 ..	June 8, 1904
Accra—Lagos	June 1, 1904 ..	—
Nagasaki—Fusan	June 7, 1904 ..	—

Employment of Motors for Drawing in Cables.—The *Electrical World* of New York calls attention to the increasing use of electric automobiles for industrial purposes in America, especially by the New York Edison Co., which has about a score of these vehicles in its service. Some of these are employed in transporting the officials and inspectors from point to point, some in handling lamps and supplies, some in conveying heavy material and some in such work as hauling in underground cable. In fact, 4,400ft. of high-tension cable was safely hauled in in a 10-hour day, and 500ft. in 18 minutes by an electric vehicle.

Electric Ore Finding.—A demonstration of Messrs. Leo Daft and Alfred Williams' system of finding ore by means of electricity was given at the Westminster Palace Hotel on Monday. Mr. Williams gave a brief résumé of the work which had been done, and Prof. S. P. Thompson showed how the apparatus worked by means of a large tank filled with soil in which were buried metallic bodies. After stating that the apparatus, when in the hands of any experienced operator, would be of use for finding certain ores, Prof. Thompson proceeded to find some "make-believe" ore in the large tank. A full description of the system may be found in *The Electrician*, Vol. L., p. 977.

Royal Institution.—Prof. Svante Arrhenius delivered at the Royal Institution on Friday last the closing evening discourse of the season. His subject was "The Development of the Theory of Electrolytic Dissociation." He treated it mainly from the historical standpoint, showing how the modern view of the nature and the mechanism of electrolysis had arisen out of the atomic theory. He corroborated his ardently expressed belief of the truth of the dissociation or ionic theory by citing the innumerable instances in which diverse properties of electrolytes—chemical as well as physical—altered with increasing dilution in exactly the manner to be expected from the theory. In this connection an interesting series of slides was shown illustrating Ostwald's investigations on the absorption spectra of solutions of certain chemical compounds whose hydrogen was gradually replaced, atom by atom, by other elements.

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The Institution of Electrical Engineers.—*American Meeting.*—We learn that the arrangements for the entertainment of the Electrical Engineers and their ladies during the visit to America are rapidly taking definite shape. In a letter, communicated to us, addressed to the President by Mr. Calvin W. Rice, vice-chairman of the Electrical Congress Reception Committee, who has in hand the organisation of the details of the programme, the latter states that preparations of an elaborate nature are in progress for the entertainment of the Institution of Electrical Engineers. The party will be taken charge of throughout their entire trip by the American Institute of Electrical Engineers, and entertainments will be organised in each city visited. Reception committees are also being formed at every stopping place whose business it will be to take charge of the ladies of the party. No fears need be entertained regarding hotel accommodation at St. Louis, and rooms may be booked there for members weeks in advance without incurring any risk of having them on their hands in the event at the last minute of being unable to go to St. Louis, as owing to the great demand for rooms during the time of the Congress cancellations can easily be effected.

Wireless Telegraph Notes.—The Washington correspondent of the *Birmingham Daily Post* states that the U.S. Navy Department has asked the permission of Congress to control all the wireless telegraph stations on the coast and islands of the United States. The department wishes to use the Telefunken system, and enjoy a monopoly of it for use in connection with ships of the navy and for the collection of meteorological information to be transmitted to the various hydrographic offices. The other Government departments are likely to oppose this request on the part of the navy to use the Telefunken system. The army uses the De Forest system, and the treasury and agricultural departments different systems.

It is announced that the Argentina Government have decided not to entertain the proposals made by Mr. Marconi for the establishment in Argentina of a large wireless telegraph station. Negotiations have been going on for a long time past, and numerous inspired statements concerning this project have from time to time been published.

It is also reported that Mr. Marconi is about to return to Cape Breton, and that he is in communication with the Dominion Government regarding the use of the land lines. New machinery and instruments have been installed at the wireless station at Table Head, which is, it is stated, to be used as a repeating station between Wellfleet (Canada) and Poldhu.

A New Power-factor Indicator.—A power-factor indicator of novel design has been devised by M. Carcano, and is described by M. G. Semenza in a recent issue of the *Electrical World* of New York. A number of coils, partly in series and partly in shunt to the circuit of which the power-factor is desired, are so grouped around a pivoted metal disc that the latter is rotated whenever the currents flowing through the two sets of coils are not in phase. The arrangement acts, indeed, just like an induction motor. By altering the reactance of the shunt-circuit by means of a variable resistance, however, matters can be so adjusted that the currents are in phase. The disc then stops rotating, and the resistance inserted into the shunt circuit is a measure of the power-factor. This method, it will be noted, is a zero-method, and it is stated to give accurate results. Another way of obtaining equality in phase of the currents through the shunt coils and series coils repectively, consists in applying a suitable E.M.F. (the phase of which may be readily varied) to the shunt coil. This E.M.F. then combines with the E.M.F. across the conductors, with the result that the current through the shunt coil is in phase with the series current. With polyphase distribution such an auxiliary and variable E.M.F. is easily obtained, and M. Semenza describes such an arrangement for a three-phase supply in the article referred to.

Dielectric Hysteresis Loss in Cables.—As the result of a series of experiments conducted on a three-core high-tension paper insulated cable, Herr Paul Humann, in an article published in the *Elektrotechnische Zeitschrift* of May 5th, comes to the conclusion that the dielectric hysteresis loss of a cable is proportional to its capacity. The experimental cable was 890 metres long with 25 sq. mm. conductors, the thickness of insulation between the conductors themselves and between any conductor and the lead sheath being 6·8mm. When one conductor was tested against the other two conductors and the lead sheath with an alternating current of a frequency of 53 cycles per sec. and at voltages ranging fron 5,600 to 9,600 volts, the dielectric loss varied from 43·5 to 144 watts per mile. The insulation resistance was 13,000 megohms per mile and the capacity 0·242mfd. for the same length. When testing two conductors against the third and the lead sheath, a capacity of 0·39mfd. was found, and the dielectric losses were, as mentioned above, proportional to these capacities. This observation of proportionality between capacity and dielectric losses was confirmed on testing all three conductors against the lead sheath. Finally, the author gives some numerical examples of the dielectric losses. Assuming a cable of the size mentioned above, and 100 miles long, to be transmitting power at a pressure of 5,000 volts across the terminals, then the annual loss through dielectric friction will amount to 37,000 kw.-hours if the neutral point is earthed, but to 56,700 kw.-hours if one phase only is connected to earth. For a terminal voltage of 10,000 volts, the corresponding figures given by the author are 148,000 kw.-hours and 227,000 kw.-hours respectively.

Electric Oven for Bakeries.—A bakery, the heat for which is generated electrically, has recently been put in operation in Montauban. According to *Cosmos*, the conversion has been carried out without any essential alterations in the construction of the oven and heating by wood may be reverted to whenever required. The oven is circular in shape, with a diameter of 10ft. 6in. and a maximum height of 1ft. 7½in. It is completely closed save at the front opening. Twenty resistances, each absorbing 700 watts, are placed upon a platform of girder-work, which by means of pulleys, may be lowered and raised. These resistances are divided into four groups. Two groups, consuming 37·5 amperes each, are placed in the centre of the oven, while the remaining two groups, consuming 25 amperes each, are placed nearer to the side of the oven. Current is taken at a pressure of 110 volts from the town supply, the resistances being all connected in parallel. At starting, the resistance frame is lowered. After 1 hour 26 minutes —*i.e.*, after 20·625kw.-hours have been expended, the temperature of the oven has attained its proper value. The resistance platform is then raised in the manner indicated above, and the unbaked loaves (weighing 2·2lb, 4·4lb. and 6·6lb. respectively) are inserted, the further manipulations being carried out in the usual manner. The consumption of energy is simultaneously reduced to 5·5kw.

The Electric Transmission of Designs.—Mr. Arthur Korn, a German physicist, has developed an improved system of electrically transmitting photographs, drawings, &c., which is of sufficient interest to warrrant a brief description. From a booklet just written by Mr. Korn on the subject, it appears that the system is based, like most other attempts in the same direction, on the property of selenium to change its electrical resistance with the intensity of illumination. The selenium cell, connected in series with the line wire, is fixed inside a glass cylinder on the outside surface of which the negative photographic film of the design to be transmitted is mounted. A strong beam of light is focussed by a lens on to the periphery of this glass cylinder, which rotates slowly and is shifted slightly after each revolution a little (1mm.) in the direction of its axis. The spot of light (about 1mm. square) thus travels gradually over the whole surface of the film and illuminates the selenium cell behind it. If, for instance, the beam of light strikes a transparent part of the film, then the selenium cell, being strongly illuminated, will have a comparatively small ohmic resistance, and a correspondingly higher current will flow from the sending to the receiving station, where the arrangement is in principle much the same, the order of operations being naturally reversed. As the source of light, a Crookes tube has been chosen, as this not only emits rays which are very effective photographically, but is also very sensitive to changes in the current when exhausted to a vacuum of from 0·5mm. to 2mm. This vacuum tube is fed by an induction coil, the circuit containing several spark-

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gaps which are lengthened and shortened by means of a relay actuated by the incoming line current. The sensitive paper on the glass cylinder (which rotates synchronously with that at the transmitting end) is consequently traversed by a fluctuating beam of light from the Crookes tube, a photographic record, corresponding to the original design at the other end of the line, being thereby obtained.

Institution Premium Awards.—In making the awards of premiums, the Council have followed precedent and have not taken into account the Papers contributed by present members of Council; and Papers, other than those by students, which were not in type by the end of April, 1904, have been reserved for consideration in awarding premiums in 1905. Certain Papers which were received too late for consideration in 1903 have been taken into account this year. The Council have awarded the following premiums for Papers and communications:—

The Institution Premium, value £25, to Prof. R. Threlfall, for his Paper "The Testing of Electric Generators by Air Calorimetry"; the Paris Electrical Exhibition Premium, value £10, to Dr. Hans Behn-Eschenburg, for his Paper on "The Magnetic Dispersion in Induction Motors, and its Influence on the Design of these Machines"; three extra Premiums, value £10 each, one to Mr. A. C. Eborall, for his Paper "Electric Traction with Alternating Currents" (Manchester Local Section); one to Mr. M. B. Field, for his Paper "A Theoretical Consideration of the Currents Induced in Cable Sheaths, and the Losses occasioned thereby"; and the other to Messrs. Edgcumbe and Punga, for their Paper "Direct-reading Measuring Instruments for Switchboard Use"; two extra Premiums, value £5 each, one to Mr. A. M. Taylor, for his Paper "Network Tests and Station Earthing" (Birmingham Local Section); and the other to Mr. W. Brew, for his Paper "Three-phase Working, with Special Reference to the Dublin System" (Dublin Local Section). An Original Communication Premium, value £10, to Mr. J. E. Dowson, for his communication "Gas Power." Students' Premiums.—The First Students' Premium, value £7, to Mr. H. W. Taylor, for his Paper on "Armature Reactions in Alternators, with some Notes on the Running of Motors." The Second Students' Premium, value £5, to Mr. F. Creedy, for his Paper on "Alternating-current Commutating Motors." The Third Students' Premium, value £4, to Mr. R. J. Kaula, for his Paper "On the Testing of Alternating-current Machinery." An Extra Premium, value £4, to Mr. L. A. Lewis, for his Paper "Notes on Commercial and Experimental Testing of Continuous-current Machinery." The Willans Premium, value £25 (as already announced), to Mr. P. V. McMahon, for the Papers he read in 1899, "Electric Locomotives in Practice and Tractive Resistance in Tunnels, with Notes on Electric Locomotive Design," and in 1903, "The City and South London Railway: Working Results of the Three-wire System applied to Traction, &c." The Salomons Scholarship, value £50, to Mr. A. B. Chalkley, of King's College, London. The David Hughes Scholarship, value £50, to Mr. J. S. Westerdale, of University College, London.

Automatic Controller for Electric Circuits.—An English Patent (No. 6,719 of 1903) has recently been granted to Mr. Thorsten von Zweigbergk, covering an automatic controller for electric circuits. As will be gathered from the description below, the device may be used for various purposes. One particular field of employment, as pointed out in the specification, is in connection with electric trains where there are a number of motors on different cars of a train all operated from one starting switch at the head of the train. The device consists essentially of a small bipolar continuous-current motor, the action of which results in the gradual cutting-in or cutting-out of the starting resistances of the main motor or a group of motors, as the case may be. One of the field coils of the auxiliary motor is in series with the armature of this small motor, and this circuit is connected in shunt across the power supply. The other field coil is connected in series with the main motor. The coil first mentioned, called the "shunt" coil, is opposed in action to the second or "series" coil. While, therefore, the one coil tends to rotate the armature in one direction, the other field coil has the opposite effect. One end of the shaft of the small motor is cranked, and a spring, connecting this crank with a fixed point on the motor, tends to bring the armature always into the same position. This arrangement minimises the risk of the starting lever coming to rest between two contacts. The rotation of the armature is transmitted to the lever of the starter by a one-toothed pinion and a toothed segment. When the main motor is to be started, current is switched on to the shunt circuit of the small motor, and the armature of the latter begins to rotate and cuts out resistance in the circuit of the main motor. This cutting-out of resistance continues until the current of the main motor has reached a certain value, when the action of the series field coil balances that of the shunt coil, and the armature remains stationary until the main current has died down, owing to the building up of the large motor. In order to stop the motor the shunt coil of the auxiliary machine is short-circuited. The series coil now effects a rapid backward rotation of the small armature and of the starting lever.

The International Electrical Congress at St. Louis.—In connection with the St. Louis Congress, which will be held from September 12th to 17th inclusive, the following Papers are down for reading before Section B (General Applications):—

Prof. E. Arnold, "Direct-Current Commutation"; Dr. O. S. Bragstad, "Compensated Alternators"; Col. R. E. Crompton, "Standardisation of Dynamo-Electric Machinery and Apparatus"; M. Andre Blondel, "Calcul des Alternateurs"; Profs. Drs. Elster and Geitel, "Über die Natürliche Radioactivität der Atmosphare und des Erdbodens"; Herr C. Feldmann, "The Distribution of Voltage and Current in Closed Conducting Networks"; M. A. Heyland, "Self-Regulating and Compounded Synchronous Machines"; Mr. W. M. Mordey, to be announced; M. A. Nodon, "Rectifiers"; Sir W. Preece, "Electricity in Ancient Egypt"; Prof. C. A. Adams, "Magnetic Leakage in Alternating-current Machinery"; Mr. C. Day, "Electric Motors in Shop Service"; Mr. J. W. Esterline, "Carrying Capacity of Cables and Conductors"; Mr. H. W. Fisher, "Sparking Distances Corresponding to Different Voltages"; Prof. H. J. Ryan, "The Design of Insulators"; Mr. D. B. Rushmore, "The Regulation of Alternators"; Prof. E. B. Rosa, "The Influence of Wave Shape upon Alternating-Current Meter Indications"; Dr. Clayton H. Sharp, "The Equipment of a Commercial Testing Laboratory": Prof. H. B. Smith, "Very High Voltage Transformers."

Those down for reading before Section C (Electrochemistry) are as follows:—

Prof. Dr. S. Arrhenius, "Methods of Determining the Degree of Dissociation"; Geh. Reg. Prof. Dr. W. Borchers, "Electrometallurgy of Nickel"; Mr. Sherard O. Cowper-Coles, "Electrolytic Methods for the Rapid Production of Copper Sheets and Tubes"; Dr. F. Dolezalek, to be announced; Herr J. Sigfried Edstrom, "Electrical Extraction of Nitrogen from the Air"; Dr. H. Goldschmidt, "Alumino-Thermics"; Prof. Dr. F. Haber, "Electrolytische Zerstörungen in der Erde"; Dr. P. C. L. Heroult, "Electrometallurgy of Iron and Steel"; Mr. J. Swinburne, "Chlorine Smelting"; Prof. W. D. Bancroft, "The Chemistry of Electroplating"; Mr. A. G. Betts and Dr. Edward Kern, "The Lead Voltameter"; Prof. H. S. Carhart and Dr. C. A. Hulett, "The Preparation of Materials for Standard Cells"; Mr. Thos. A. Edison, "Alkaline Batteries"; Dr. K. E. Guthe, "The Silver Voltameter"; Mr. Carl Hering, "The Units Employed in Electrochemistry"; Mr. J. T. Morrow, "Notes on Electrolytic Copper Refining"; Prof. J. W. Richards, "The Energy absorbed in Electrolysis"; Prof. T. W. Richards, "The Relation of the Theory of Compressible Atoms to Electrochemistry."

The chairmen of the respective sections are Profs. C. P. Steinmetz and H. S. Carhart, and the secretaries Prof. Samuel Sheldon and Mr. Carl Hering. On p. 88 of *The Electrician* of May 6th there appeared the titles and authors of Papers to be read before Section A (Theory).

Darlington Tramways.—Some particulars of the Darlington Corporation tramways appeared in a note in *The Electrician* of May 20th, p. 170, and the formal opening of the system was announced on p. 255 of last week's issue. The following additional details relating to the permanent way are of interest. The contract for this work was secured by Messrs. J. G. White & Co., and 1·75 single miles of existing horse tramways were lifted, the roadway being lowered under two railway bridges, one on the North-road and the other on the Haughton-road. On the greater part of the roads the old levels in the centre were raised. In roadways where the old tramway existed the concrete was left in place. The gauge of the old horse line was 3ft., and that of the new electric lines 3ft. 6in.; the distance between centres of track was increased from 7ft. 9in. to 8ft. 3in. on curves of 5 chains and less and to 11ft. where centre-pole construction was employed. With the exception of 1 mile, where re-dressed setts were laid, scoriæ bricks form the paving material. The bricks and re-dressed setts were pitch-grouted to within 1½in. of the top and then grouted with 3 to 1 cement. The amount of wood paving is small. For the track or paving foundation concrete 6in. thick was used, composed of 1 part of Portland cement, 4½ parts of clean stone or slag free from sulphur, and 1½ parts of clean, sharp sand. The packing below the rails and the bedding below the pavement consisted of 3 to 1 concrete. The rails were supplied by Messrs. Bolckow, Vaughan & Co. to the following specification:—Carbon, from 0·4 to 0·5 per cent.; manganese, from 0·7 to 1 per cent.; sulphur, not to exceed 0·08 per cent.; phosphorous, not to exceed 0·08 per cent; silicon, not to exceed

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0·09 per cent. They are 45ft. long, of the usual girder type, 6½in. deep, weighing 90lb. per yard, groove $1\frac{1}{16}$in., depth $1\frac{1}{16}$in., "Dicker" joints. The tie-bars are of Bayliss, Jones and Bayliss make, screwed both ends and spaced 9ft. apart. The points and crossings at the six passing-places and at double-line junctions consist of one dummy point and one movable point 10ft. 9in. in length, with side spring keeping the tongue set on one side. They were manufactured by Hadfield's Steel Foundry Co. At single and double-line junctions, car sheds and cross-overs, one automatic point and one movable point, with bottom plunger and spring for keeping the tongue set on either side, have been laid. Cast-steel drain boxes, by Messrs. Askham Bros. and Wilson, were inserted where needed, and cast-iron boxes by Messrs. Wenham and Waters. For bonding between the four track rails at the middle of each passing-place, and at intervals of 120ft. of single track, No. 0000 solid cross-bonds were used, with pin terminals. Cross-bonds were also used between the two tracks every 240ft. At the joints two Neptune bonds were employed. All bonds were covered with non-corrosive, alkali and acid-proof paint.

The Mendel Railway.—This railway, which was built chiefly for tourists, and traverses the Mendel Pass in Austria, was described in a recent issue of the *Elektrische Bahnen*. The first part of the line, 1·4 miles long, extends from Kaltern (altitude 1,330ft.) to St. Anton (altitude 1,675ft.) and is constructed as a full gauge, single-track electric railway on the 500-volt continuous-current tramway system. Nearly 50 per cent. of the track lies in curves, the sharpest of which has a radius of 390ft. The maximum grade on this part is 6·2 per cent., the average grade being 4·7 per cent. Rails of the Vignoles type, weighing 68lb. to the yard, are used, and current at a pressure of 500 volts is collected from the overhead line by two bows. A train is made up of a motor car and a trailer, the total carrying capacity being 50 passengers. Each motor car weighs 16·85 tons, and each trailer about 11 tons. The motor car is provided with two motors (60 H.P. to 100 H.P.) each. The second portion of the line consists of an electrically-operated cable railway, 1·47 miles in length, which leads from St. Anton up to the top of the Mendel Pass (4,500ft.) This is a single track with a turn-out in the middle. The gauge is 1 metre, and one-third of the line is taken up by curves, the sharpest of which has a radius of 820ft. The gradients vary from 16·5 to 64 per cent., the average being 38 per cent. On this section the rails weigh 54·5lb. to the yard. Single cars, holding 52 passengers each, are employed. They are fitted with a hand brake and an emergency brake of the rail-grip type. The latter operates automatically if the normal speed is exceeded, if the car descends too low into the station or if the cable breaks. It may also be put into operation by hand. A steel cable, consisting of 102 strands with a diameter of 2·4mm. each, has been employed, the outside diameter of the cable measuring 35mm. It is 8,830ft. long and weighs 9·0 tons. Its breaking strain is 70 tons, but as the maximum strain on it is only 7 tons there is a large margin of safety. Some 450 cable guide-trolleys are distributed over the track. The cars move at a constant speed of 5ft. per second and they weigh, empty, about 6·3 tons. Both portions of the railway system are operated by continuous current. This is produced by a 100 H.P. motor-generator, which receives its primary energy in the form of three-phase current at a frequency of 42 ∼ per sec. and at a pressure of 3,600 volts from a water-power station 7½ miles distant. Continuous current is generated at 650 volts. A storage battery of a capacity of 248 ampere-hours, and consisting of 324 cells, is provided. The steel cable is wound in three turns around the cable drum, this being rotated through a double transmission gear by a 100 H.P. shunt motor, running at 600 revs. per min. Communication between the car and the station, which is situated at the top of the line, is maintained by a signal system, which employs the rails as the return conductor. In special cases telephonic conversation between the car and the station can be established by means of a portable telephone and a double overhead wire running along the track. The cost of the first portion is stated to have been £17,000, the second part costing £38,400.

A Long-Span Transmission Line.—A 250-volt continuous-current power line from the Carrie furnaces, situated on the Monongahela river, just below Braddock, Pa., to the Homestead steel works is described by Mr. B. Wiley in the *Electrical World* of New York. The power house is near the pole on the far side of the river, and the point of distribution about 500ft. from the pole on the near side. The one particular feature is the excessive span adopted, the distance between supports being practically 1,000ft. The span consists of four 800,000 circular mils aluminium cables anchored to steel structural towers on either side of the river. These towers are of heavy material and securely braced by four 1¼in. tie rods. The conditions that formed the basis of the calculations were as follows:—Line voltage, 250; load to be carried, 800 amperes; drop of voltage permissible, 40 volts; necessary size of copper conductor, 1,000,000 circular mils; necessary size of aluminium conductor, 1,600,000 circular mils (duplicate lines of 800,000 circular mil cable were used for convenience of construction); maximum sag allowable at 212°F., 35ft.; maximum wind probable pressure, 40lb. per square foot; minimum temperature, 20°F.; probable ice coating, ¼in. thick. The tensile strength of hard-drawn alumium wire is 35,000lb. per square inch, its conductivity 63, as compared with copper at 100, and the coefficient of expansion 0·0000231 per degree Fahrenheit. On making calculations it was found that the maximum strain per cable was 19,000lb. or, per tower, $4 \times 19{,}000 = 76{,}000$lb. The horizontal component due to the wind pressure is transmitted to the foundations and the direct pull to the steel brace rods behind. The method of stringing the cables was very simple. They were wrapped on a large reel, which was set in a securely anchored frame and arranged to revolve on a shaft. This equipment was placed on the near side of the river. It was provided with a brake, or, rather, sufficient friction to stop the reel as soon as the tension on the cable was released. The free end of the cable was passed through an ordinary snatch block hung at the top of the near tower. On the far side of the river, just behind the tower, was placed an electrical winch, and from the drum a 1½in. hemp line was passed through a snatch block at the top of the tower and carried across the river by a boat. The rope was fastened to the cable on the near side and pulled across by the winch, the boat supporting the end and thus being towed back for the return trip with rope for the next cable. When all but a few turns of the cable had been reeled off, a line was fastened a few feet from the end still on the reel. When the end reached the top of the tower, this line was used as a temporary anchor while the bolt was being placed. The 1½in. line was replaced by a 2in. line, and sufficient slack was then taken up to allow the anchor bolt of the far end to be fitted into place. As these bolts were made extra long, there was still considerable sag in the cable, hence the tension was not great. The bolts were then adjusted to give the required sag. It was about 30 minutes' work to run a cable after starting it from the reel.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, June 10th.

PHYSICAL SOCIETY.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda:—(1) "Projection of the Indicator Diagrams of a Petrol Motor," by Prof. H. L. Callendar, F.R.S.; (2) A Model Illustrating the Propagation of a Periodic Electric Current in a Telephone Cable and the Simple Theory of its Operation, by Prof. J. A. Fleming, F.R.S.; (3) Exhibition of a Gyroscopic Collimator, by M. E. J. Gheury.

TUESDAY, June 14th.

JUNIOR INSTITUTION OF ENGINEERS.

6:30 p.m. Visit to the motor car works of Messrs. D. Napier & Son.

WEDNESDAY, June 15th.

ROYAL METEOROLOGICAL SOCIETY.

4:30 p.m. Meeting at 70, Victoria-street, Westminster. Among the Papers to be read is one by the Rev. C. F. Box on "Effects of a Lightning Stroke at Earl's Fee, Bowers Gifford, Essex, April 13, 1904."

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Meeting at 20, Hanover-square, W. Among the Papers down for reading is the following:—"A Direct Proof of Abbe's Theorems on the Microscopic Resolution of Gratings," by Prof. J. D. Everett.

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THE NEW HOLBORN TELEPHONE EXCHANGE.

Omnibus riders from Oxford-street to the City will shortly miss one of their most interesting, if not one of their most picturesque, landmarks. We do not refer to the old buildings at the entrance to Staple Inn, but a specimen of a different class of architecture—one, however, that will also soon cease to have more than antiquarian interest. The imposing iron derrick that surmounted the Holborn telephone exchange at the top of St. Andrew's-hill is being dismantled, and the exchange has been removed to new quarters in the Birkbeck Bank-buildings. Following its policy of improving its London telephone service to the utmost, the National Telephone Co. commenced some time ago to remodel its 57 exchanges in the metropolitan area. London-wall, Kensington and Battersea have already been converted to the central-battery system, and the Holborn exchange has undergone a similar alteration. In this last case, however, something more was involved than a change-over from one system to another, for the exchange itself has been moved nearly half a mile—that is to say, the old exchange at the top of St. Andrew's-hill has been placed out of commission, and the new one in the Birkbeck-buildings takes its place.

In all, 5,443 subscribers' stations are connected to the Holborn exchange, representing about 4,600 direct subscribers' lines; and no less than 792 junction lines are also required, as but 18 per cent. of the calls are local. The new exchange, however, is designed for an ultimate capacity of 8,700 direct subscribers' lines. Fig. 1 is a plan of the switchroom showing the arrangement of the boards. An interesting feature is the increased number of supervisors, monitors and enquiry clerks. Everything depends upon successful and efficient supervision now that, by the perfection of the central battery system, the operator's duties have become far easier and more mechanical than formerly. Instead of the switchroom being under the control of a clerk-in-charge assisted by one or two monitors or supervisors as formerly, two classes of monitors are now employed. It was found that the monitors were practically kept to their desks all the time by enquiries and so on, and this gave them little opportunity to walk about behind the operators and administer advice, assistance and reproof immediately it was needed. In the new exchange the actual supervising operators walk up and down all the time, and can thus keep the operators well under control, while a number of monitors are set aside to answer enquiries, receive complaints from subscribers and to listen in at the operators' circuits. In addition, there is a chief operator over the monitors and supervisors and a switchroom manager.

The central battery system has been adopted in its entirety at the new exchange, but as the system has already been described fully in our columns on previous occasions, we need do no more than refer in this article to some of the improvements and modifications in detail. One of these is in the addition of three lamps next to the pilot lamp at each operator's position, for the purpose of assisting both the operating and the supervision. The pilot lamp is connected up in the usual way to the relays associated with it, so that it glows whenever one of the subscriber's calling lamp lights up Next to this is a red lamp, which lights up when connection has been made to a junction line leading to an Outer London exchange, this being to remind the operator to press twice on the meter key instead of once, as 2d. instead of 1d. is charged for calls to Outer London on the message rate system. This is effected by an additional contact on the order wire key associated with the junctions in question. On the right of this lamp is a green "instruction circuit" lamp. This is used in cases when the monitor or manager wishes to question all the operators simultaneously in order to trace out a particular call or for some similar purpose. At each operator's position there is a key associated with this lamp, and when the lamp glows this key is depressed and the operator's instrument is then connected to the "instruction

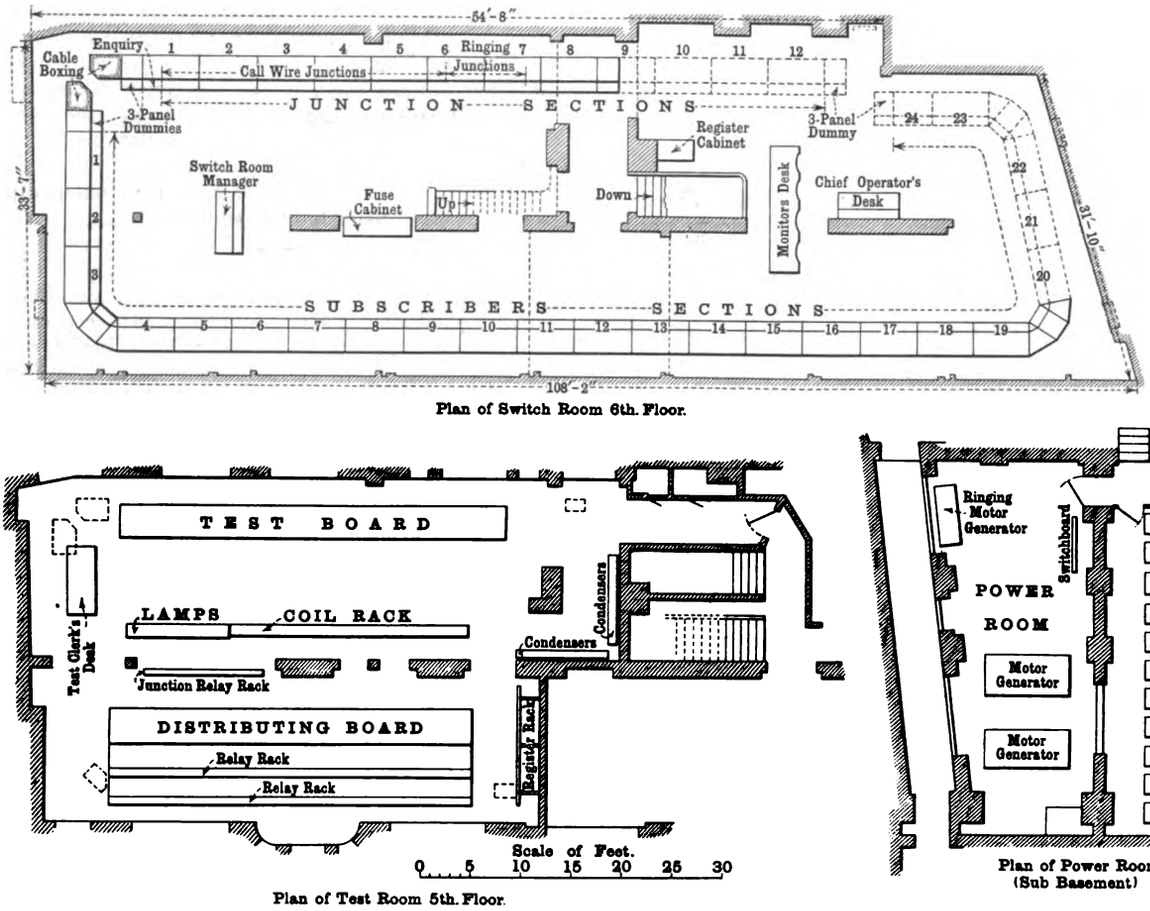

FIG. 1.—PLANS OF SWITCHROOM, TEST ROOM AND POWER ROOM IN BASEMENT.

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circuit." The lamp is extinguished on the operator pressing the key, and if the question does not concern her she simply releases the key again and does not reply. As the green lamp continues to glow until the key is depressed, the supervisors are able to see that every operator has attended to the "instruction call." Fig. 2 shows the connections of this circuit.

On this diagram a modification in the connections of every operator's speaking set may also be seen. Instead of the receiver being connected directly to the secondary of a simple induction coil through the listening key, the winding of this coil is divided into two halves, each of 135 ohms resistance, and one terminal of the receiver is connected to the middle point, while a supplementary resistance of 370 ohms is placed in series between the other terminal and one terminal of the induction coil winding. The primary of the induction coil and the transmitter is connected in a somewhat similar manner as seen in the diagram, the resistances in this case being 18 ohms, 18 ohms, and 55 ohms. The object of this arrangement is to prevent the operator's own microphone from acting as a transmitter to her own receiver. It is practically a three-wire connection so balanced that while speech from the subscriber's line is audible in the receiver no noise is transmitted from the operator's own microphone.

Returning to the supplementary lamps in a line with the

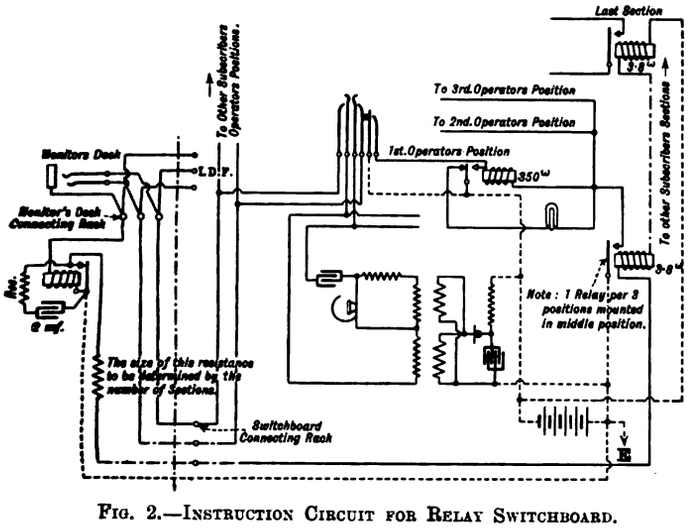

FIG. 2.—INSTRUCTION CIRCUIT FOR RELAY SWITCHBOARD.

pilot lamp, the fourth lamp on the right is associated with the meters, or "registers" as they are now called. If the operator's register has recorded properly it closes an auxiliary circuit and lights this lamp. After every call has been put through, the operator has to press the register key, one of which is placed between each pair of plugs and their clearing lamps on the key shelf. The operator does not know whether a subscriber is on the message rate or unlimited service rate, but has to record each call in this way, and the total number of calls each operator registers is also recorded. If the subscriber is on the unlimited service tariff no meter is provided for him, and the call is only registered on the operator's register. An additional key is provided for recording "service" calls. The meter racks are on the fourth floor together with the test racks, distributing boards and relay racks—which are all of standard patterns—and the test clerk has his desk in this room.

An interesting innovation in the switchroom is the automatic lighting for night work. At night time, when a subscriber rings up, the night bell rings, and in addition the pilot lamp at his position lights up. The night operator then has to go from board to board until he finds it. The new arrangement consists of connecting the lamps, above the switchboard, lighting up each operator's position to a relay circuit in such a way that a lamp above the particular section lights up automatically as soon as the subscriber calls. When the operator replies the lamp is kept alight until she goes out of circuit. The relay for this purpose is inserted in the pilot circuit, and has a second holding down coil added, and a solid armature connected to a simple switch.

The power plant is in the basement of the building, and is of the usual pattern. There are two 12kw. motor generators made by the Western Electric Co., who have, it may be mentioned, supplied the entire equipment for the exchange. These machines are run off the Charing Cross Company's mains, taking current at 200 volts, and supplying current at 30 volts on the generator side for charging the central battery—11 Chloride cells, each containing 51 plates of the pattern usually employed in telephone exchanges. It is estimated that there will be an output of 3,400 ampere-hours per day for the 5,400 subscribers' stations. The power plant also includes two 150-watt motor generators for the ringing circuits and the busy-backs, and the usual power switchboard.

The change-over from the old to the new exchange was made on Saturday, May 14th. All the subscribers were first disconnected from the old equipment, and then at once connected to the new exchange. Things are now practically complete, and "Holborn" subscribers—among them *The Electrician*—are looking forward to considerable improvement in their telephone service.

PROPOSED ALTERATION OF THE ELECTRIC LIGHTING ACTS.

A conference, arranged by the St. Pancras Borough Council, was held on Saturday at the St. Pancras Town Hall, with the object, as set forth on p. 256 of our last issue, of considering the advisability of petitioning the Board of Trade for the repeal or modification of clause 17 of the Electric Lighting Act, 1882, and clause 77 of the Electric Lighting Clauses Act, 1899, relating to liability for action for vibration. The agenda paper was as follows:—To consider as to the advisability of petitioning the Board of Trade to promote legislation for the repeal or modification of the undermentioned and similar clauses in the Electric Lighting Act and Electric Lighting Orders, so as to prevent actions being taken against undertakers unless serious damage or nuisance is occasioned through the carrying on of their works, and also for empowering the undertakers, in that event, to compulsorily acquire the interests which are affected thereby—viz.:

Clause 71, St. Pancras (Middlesex) Electric Lighting Order, 1883—"Nothing in this order shall exonerate the undertakers from any indictment, action or other proceeding for nuisance in the event of any nuisance being caused by them."

Clause 17, Electric Lighting Act, 1882.—"In the exercise of the powers in relation to the execution of works given them under this act, or any licence, order or special act, the undertakers shall cause as little detriment and inconvenience and do as little damage as may be, and shall make full compensation to all bodies and persons interested for all damage sustained by them by reason or in consequence of the exercise of such powers, the amount and application of such compensation in case of difference to be determined by arbitration."

Invitations were accepted by 68 local authorities and electric lighting companies, and over 100 delegates were in attendance.

The MAYOR of ST. PANCRAS (Mr. T. H. W. Idris) presided, and in making a few remarks referred to the cases of "Knight *v.* the Isle of Wight Electric Light and Power Co." and "Colwell *v.* St. Pancras Borough Council" (which have been reported fully in our columns), in which injunctions had been granted against the electric lighting authority to remove the alleged vibration, although no damage was clearly proved. In the case of St. Pancras they had been compelled to pay exorbitant demands in order to avoid the effects of the injunction. The anomalous position was that those who had acquired the land for their generating stations by compulsory purchase were exempt from such actions.

Mr. DAVENPORT, solicitor to the St. Pancras Borough Council, who was then called upon to speak, said he had taken counsel's opinion upon this matter, and this was to the effect that any attempt to secure an alteration of the electric lighting acts would not meet with success. The best thing to do was to draft a petition to the Board of Trade and Parliament to adopt a retrospective clause putting lands that had been acquired by agreement in the same position as those acquired compulsorily; in other words, the conference should pass a resolution supporting sec. 1 of the new Electricity Supply Bill if it were made retrospective as far as possible.

Mr. J. BOWERS (deputy town clerk, Glasgow) said there had been no decision in Scotland to the effect that land acquired compulsorily was in a different position to land acquired by agreement. In the St. Pancras order there was a special clause stating that nothing in that order should relieve the promoters from liability to action for nuisance. He was in doubt as to the position of the Borough Council, even if the alteration asked for were made, with such a clause as that in their order.

The CHAIRMAN pointed out that Mr. Davenport had only dealt with metropolitan orders. Anything eventually settled by the conference would be intended to apply all over the kingdom.

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Mr. J. BUSSEY (Poplar) said he did not see how the conference could possibly come to a resolution that day without the subject matter of the resolution before it. Would it not be advisable to appoint a small sub-committee to draw up a scheme of action and submit to another meeting of the full conference later on.

Mr. MARLOW REID (Wood Green) and Mr. F. E. GRIPPER (Edmundson's Electricity Corporation) supported this proposal. The latter gentleman said that the real question was as to whether such actions as those referred to could not be settled in another way. He was quite certain that if the Isle of Wight case could have been investigated on the spot by an independent engineer, and a report sent to the Courts, a different decision would have been given. Since the company had acquired the property of the petitioners no vibration had been detected.

Bailie WILLICK (Glasgow) thought it too early to appoint a sub-committee, as suggested.

After further discussion,

The CHAIRMAN put it to the meeting that a sub-committee should be appointed to consider the question and report to a later conference, and this was carried unanimously.

The following gentlemen were thereupon nominated and elected to serve upon this sub-committee.

Ex-officio.—Ald. T. H. W. Idris (Mayor of St. Pancras and chairman of conference). *Elected.*—Messrs. T. H. Morris (Acton), A. Slatter (Barnes), J. Bussey (Poplar), W. Whyte (Hornsey), C. Newton Russell (Shoreditch), E. Laverack (Hull), J. Bowers (Glasgow), P. W. Carey (Cardiff), F. M. Bowey (Sunderland), G. Howarth (Manchester), J. Sheehan (Hackney), H. James (St. Pancras), G. Hickling (St. Pancras), Sydney Morse (British Electric Traction Co.), F. J. Walker (St. James' and Pall Mall Electric Light Co.), A. A. Campbell Swinton (Cambridge Electric Supply Co.), F. Harman Lewis (Leyton), R. B. Nicholson (Lowestoft), F. E. Gripper (Edmundson's Electricity Corp.), G. R. Hulme (County of Surrey Electrical Power Distribution Co.), H. B. Renwick (County of London Electric Supply Co.), J. H. McGaul (Birkenhead), A. J. Lees (Beckenham).

THE LEEDS ACCOUNTS.

The Leeds Corporation electricity works have for some years past been able to show results as to works costs among the lowest in the United Kingdom. We gave a brief résumé of the leading figures of the 1903-4 accounts in our issue of May 20th, but the following more detailed analysis will, doubtless, be of interest to our readers. The total works cost of generating and distributing the 6,271,186 units sold from March 26, 1903, to March 25, 1904, was £17,033, excluding "management charges," interest, sinking fund, &c. This works out to 0·651d. per unit. The corresponding figures for the preceding year were 4,448,650 units, £11,524 and 0·621d. per unit. The following table gives the various items, and also the management charges, interest, redemption fund, &c. :—

	Year ended March 25, 1903.	Year ended March 25, 1904.
Units sold to consumers	4,323,821	6,094,016
Units sold for public lighting	124,829	177,170
Total units sold	**4,448,650**	**6,271,186**
	Per unit sold. d.	Per unit sold. d.
GENERATING COSTS.		
Coal	0·282	0·242
Oil, waste, water and stores	0·028	0·027
Wages at stations	0·166	0·125
Repairs and maintenance	0·084	0·144
	0·560	0·538
DISTRIBUTING COSTS.		
Wages	0·039	0·046
Repairs, water, stores, &c.	0·022	0·067
	0·061	0·113
Total works costs	**0·621**	**0·651**
MANAGEMENT CHARGES, &c.		
Rents and rates	0·081	0·075
Salaries, stationery, and establishment charges	0·186	0·246
	0·267	*0·321*
Sundry charges incidental to change of voltage and system of supply	0·191	0·028
Interest	1·210	1·000
Redemption fund	0·695	0·765
Total costs, including interest and redemption fund	2·984	2·765

The capacity of the generating plant has not been added to since the previous year, and is 8,740kw., the maximum load having been 5,040kw., as against 4,126kw. in 1902-3. Taking the total units sold given in the table above, the load-factor works out to 14·2 per cent., as against 12·3 per cent. in the preceding year. The connections to the mains have increased from the equivalent of 231,734 8 c.p. lamps to 307,849, and the number of consumers from 3,202 to 3,988. There are 122 public arc lamps (as against 93 in the previous year), the number of units supplied for street lighting being 177,170 (in 1902-3, 124,829). 1½d. per unit is charged for public lighting, 4d. per unit (less 5 per cent. discount) for private lighting, and 1⅛d. to 2d. per unit (less 5 per cent.) for power. The total horse-power of motors connected to the mains on March 24, 1904, was 2,903, an increase of 102·2 per cent. during the year. 1,665,359 units have been sold for power, representing 732 units per horse-power installed, as compared with 837 during 1902-3. The revenue per horse-power installed was £3. 18s. 4d.

The following is an analysis of the capital expenditure up to March 24, 1904, showing the expenditure on the various items per kilowatt installed in the generating station, and the percentage which each item represents on the whole capital expenditure.

Account.	Total, March 25, 1904.	£ per kw.	Per cent. of total.
Land	£30,748 3 7	3·5	4·1
Buildings and foundations	121,212 2 5	13·9	16·2
Machinery	174,007 5 10	19·9	23·1
Mains and services	299,840 4 2	34·3	39·8
Sub-stations and transformers	81,934 9 5	9·4	10·9
Meters	22,290 14 11	2·5	3·0
Electrical instruments	13,513 7 9	1·5	1·8
Loose plant and tools	1,639 6 0	0·2	0·2
Office furniture and fittings	779 19 2	0·1	0·1
Coal barges	3,438 8 2	0·4	0·4
Cost of provisional order and transfer of undertaking	3,104 14 10	0·3	0·4
	£752,508 16 3	86·0	100·0

The total works costs for the year 1903-4 were, as has been stated, £17,033. Adding to this £1,951 for rents and rates, £6,428 for management charges, &c., and £771 for sundry charges incidental to changing the voltage and the system of supply, there is a total of £26,183. The income by the sale of electricity, and meter rents being £75,720, this leaves a balance of £49,537. This balance is disposed of as follows:—Interest, £26,087; to redemption fund, £20,020; balance (being surplus profit), £3,430. No sum is set aside for depreciation, but there is a reserve or equalising fund to which the surplus profit of 1902-3 has been added, and which now amounts to £10,159.

The Humming of Dynamos.—Herr J. Fischer-Hinnen, in an article in the *Zeitschrift für Elektrotechnik* of June 5th, investigates the causes of and the remedies for the "humming" of dynamos. This humming noise appears to any considerable extent only in machines with laminated poles and a small number of slots per pole (six to nine) and increases generally as the air-gap decreases. The note given off by various machines was determined by Herr Fischer-Hinnen by means of tuning forks of known frequencies, and it was found that these figures agreed in every case with the number of armature teeth that passed a given point in a second. It may, therefore, be inferred that the sound is produced in the laminated poles by the variations of the flux due to the teeth, and it is evident that the strength of the hum increases with diminishing numbers of teeth per pole. As result of a number of tests, the author has found that if the equation $\frac{b-0{\cdot}7r}{(D+2\delta)\pi}N_1 = a$ whole number $+0{\cdot}5$, be fulfilled, then humming will not occur at all or only to a small extent. In the above equation, b = peripheral width of pole shoe, r = radius of the rounded-off portion of pole tip, D = diameter of armature, δ = air-gap, and N_1 = number of slots. Although the above equation was correct with regard to the machines tested, Herr Fischer-Hinnen does not put it forward as being reliable in all cases, as it takes no account of the slot width.

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DERBY ELECTRICITY WORKS AND TRAMWAYS.

Members of the Incorporated Municipal Electrical Association who visit Derby this year will find much to interest them in the Corporation electricity works and tramways. The electricity works were one of the early single-phase stations, but they are

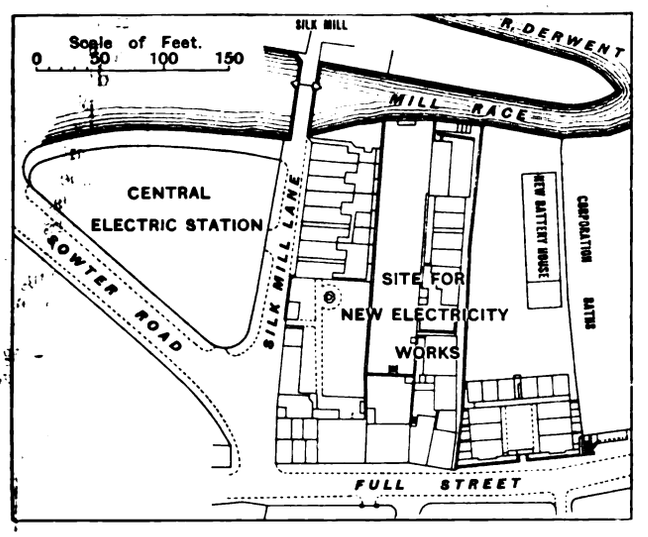

FIG. 1.—SKETCH SHOWING SITE OF EXISTING AND PROPOSED ELECTRICITY WORKS.

now being brought completely up to date so far as the electrical plant is concerned, and, thanks to the exertions of the borough electrical engineer, Mr. T. P. Wilmshurst, they have a motor load on their single-phase mains larger than that possessed by many continuous-current stations of like size. The addition of tramways is being made the occasion for changing over the central portion of the town from the single-phase to the continuous-current three-wire system, and for the continuous-current supply for the two purposes, steam turbo-generators have been put down. In addition, the principal streets of the town are lighted by arc lamps, both alternating and continuous, and a large number of incandescent and Nernst lamps are also employed for public lighting. The low frequency of 40~ per second, adopted almost haphazard for the alternating-current supply at the outset, has proved a valuable aid in extending the single-phase motor load.

The Derby Corporation obtained its provisional order in 1890, and called in Messrs. Bramwell and Harris as consulting engineers. The site shown in Figs. 1 and 2 was selected, and separate generators put in for arc lighting and private lighting. Three Siemens continuous-current arc lighters each supplied 40 10-ampere arcs in series, and for the private lighting three 30kw. and three 60kw. Siemens alternators were put in, which furnished current at 2,000 volts, 40 ~ per sec., to transformer sub-stations, whence it was delivered at 100 volts at the consumers' terminals. All these sets were directly coupled to Browett-Lindley engines, and the exciters were separately driven by little 13 H.P. sets. To the credit of the makers it should be added that the arc-lighters are still running on load every night.

The first extensions consisted of two 150kw. Siemens Browett-Lindley sets, and then a 700kw. Ferranti-Ferranti set, followed at short intervals by two more Ferranti machines of the same size. Additional arc lighting was provided for from the 200-volt alternating mains, each arc being connected across the mains through a "compensator." Larger sub-stations being required, rooms and cellars were employed. The latest addition to the plant has been three 300kw. Parsons continuous current turbo-generators for supplying either the continuous-current lighting network in the centre of the town or the tramways, and the extension of the street lighting is supplied partly from the new continuous-current mains and partly on the Gilbert alternate current series system.

The map (Fig. 3) gives an idea of the distribution of the load. The tramway lines have only been laid to the south of the town for the present, the lines to the north being postponed until the completion of a large sewerage scheme, which will necessitate the re-making of a number of main roads. It is hoped that one or two lines of tramways will be open by the I.M.E.A. meeting at the end of the month, and that the whole of the southern lines will be completed by August Bank Holiday. These will amount to an equivalent of 11 miles of single track, most of the routes being double-tracked. The shaded part of the map, within a half-mile radius of the generating station, is being converted from alternating to continuous current. Fig. 1 shows the new site that has been bought for the purpose of erecting new works in time for further extensions, the peculiarly-shaped site opposite being now quite filled up. A battery house has already been erected on the new site.

At present the boiler plant consists of five B. & W. boilers

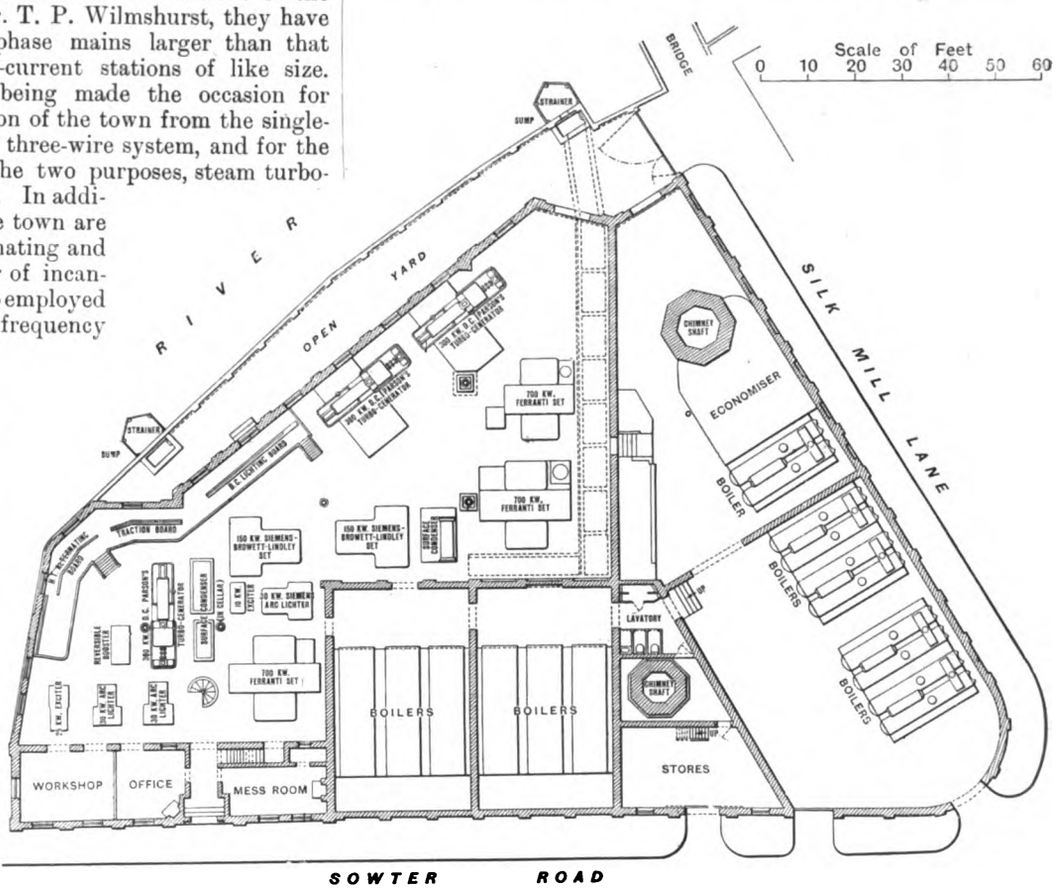

FIG. 2.—PLAN OF ELECTRICITY WORKS.

(each evaporating 12,000lb. per hour from and at 212°F.), fitted with superheaters, purifiers and motor-driven chain grate stokers, three Danks Lancashire boilers, 7ft. by 28ft., with Meldrum forced draught and McPhail superheaters, and three Fletcher Lancashire boilers of the same size, fitted with Vicars stokers.

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The coal is brought by road and tipped directly into the hopper of a bucket elevator which conveys it to the bunkers over the boiler house, thence there is a push-plate conveyor serving the B. & W. boilers, and a worm conveyor for the Lancashires. A McPhail water softener, in which live steam is passed through the feed-water is provided for the Lancashire boilers. Green economisers are used, the water being fed warm into them after passing through the condenser hotwell. Three Weir steam-driven feed pumps are provided, a three throw Hayward-Tyler pump, worked by a Langdon-Davies motor through Humpage reduction gear, one steam-driven duplex feed pump and an injector. Ejector condensers are employed for the engines of the Ferranti sets, but the Parsons sets have independent surface condensers.

The three new generating sets follow in general lines the parallel compound type of turbine described in the Paper by Messrs. Parsons, Stoney and Martin recently published in *The Electrician*. They are rated for a normal load of 300kw., but can give an output of 350kw. for one hour without overheating. Steam is supplied to them at a pressure of 120lb. per square inch, and with about 50°F. of superheat from the Lancashire boilers and 120deg. of superheat from the B. and W. boilers. Each set has its own surface condenser, placed beneath it under the floor of the engine room, the combined circulating and air pump of the condenser being motor-driven. It is found that the water from the turbine condensers is so clean that it can be employed for filling up the batteries. The vacuum augmenter described in the Paper above referred to is not employed. A

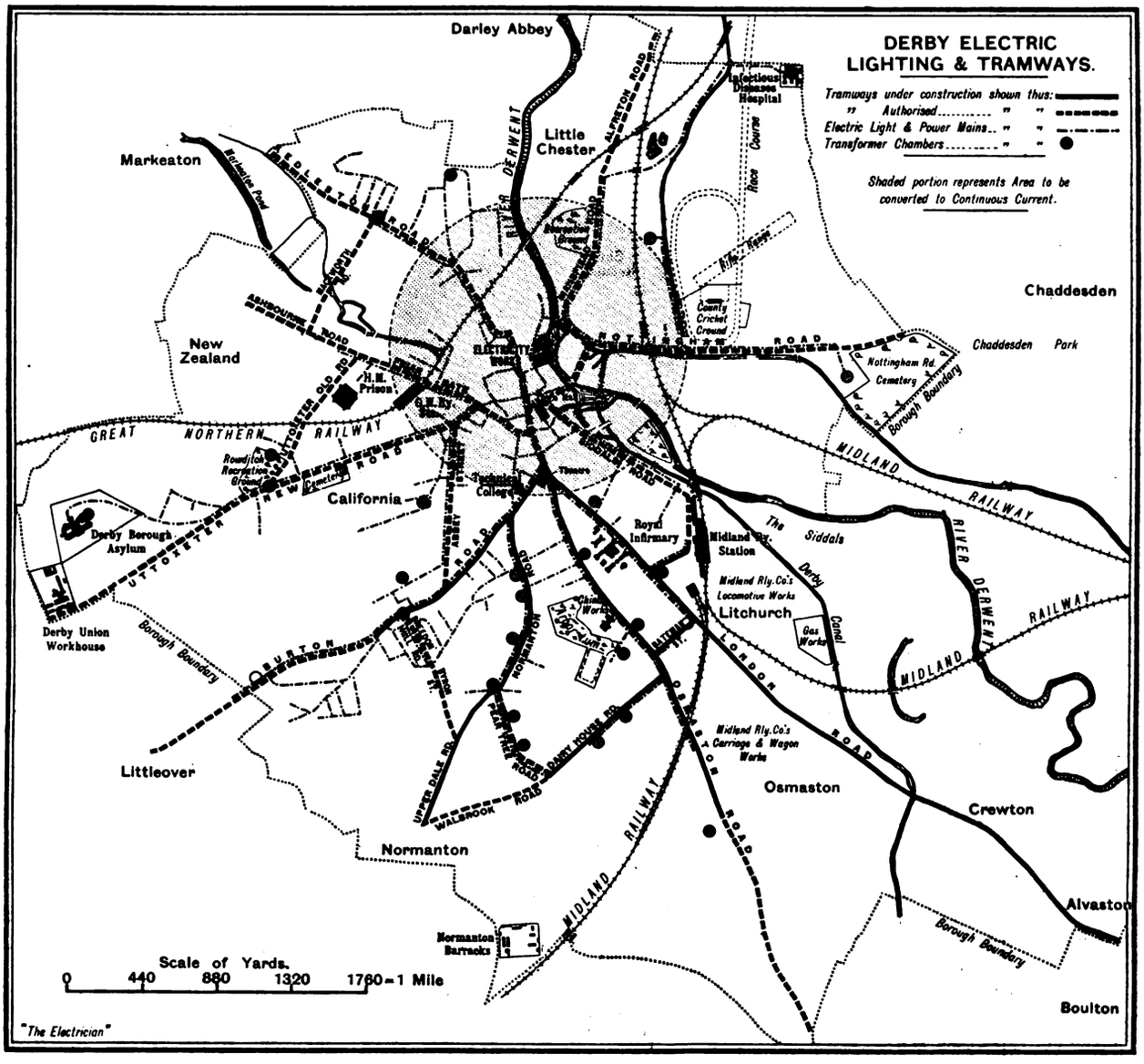

FIG. 3.—MAP OF DERBY, SHOWING TRAMWAY ROUTES, LIGHTING MAINS AND POSITION OF WORKS AND SUB-STATIONS.

A useful piece of apparatus used in conjunction with each of the B. & W. boilers is the "Phœnix" draught gauge, supplied by Messrs. Sanders, Rehders & Co. This enables the stoker to regulate accurately the supply of air to the boiler furnaces, and a log is kept by the stoke-room foreman, so that a check is maintained. Fig. 4 is a section of the apparatus. A brass bell, C, floats in glycerine contained in a cylindrical vessel, A. A tube, B, fixed to the outer vessel A leads air from above the boiler furnace to the interior of the bell C. The level of C will depend on the draught, and the motion is communicated to the needle on the dial by means of rack-and-pinion gear.

Two independent ring mains supply steam to the engine room. new feature on the turbines is a device to minimise the air-leakage at the bearings. The exhaust steam from the steam-relay of the governor is blown through the bearing in a contrary direction to that in which the leakage would take place, and this is found to reduce the leakage considerably and maintain the condenser vacuum. A vacuum of 27in. to 28in. is aimed at. The guaranteed steam tests with steam superheated to 50°F. and a vacuum of 27in. are 22½lb. per kilowatt-hour at full load, 25½lb. at half load and 31½lb. at quarter load, the corresponding figures for full and half load when exhausting into the atmosphere being 36lb. and 46lb.

The dynamos driven by the turbines are fitted with a compensating winding, a number of series turns being

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embedded in the pole shoes. This has been found to prevent sparking between no-load and full load with a fixed brush position. The commutators are of the usual corrugated type which Messrs. Parsons fit, the brushes being of gauze and bearing against the commutator merely by gravity. Vanes are fitted at the end of the armature, so that air is forced through it and assists ventilation. The dynamo can be run as a shunt machine, giving 620 amperes at 480 volts for lighting, or as a shunt or compound machine at 500 to 560 volts

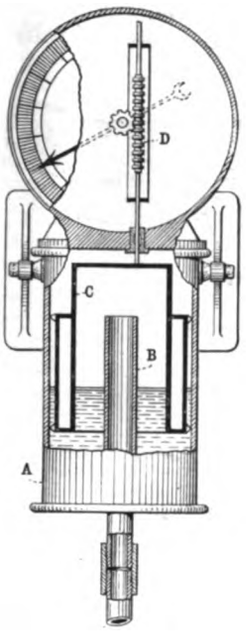

FIG. 4.—THE "PHŒNIX" DRAUGHT GAUGE.

the "Turnbull and McLeod" patents, which are owned by the company. In external appearance this latter machine is merely a four-pole dynamo driven by a four-pole motor; but, while the motor is nothing more than a shunt motor, the booster itself has four field windings (see Fig. 6). One of these (A) is a shunt winding across the booster terminals, excited by the difference of potential between the battery and the 'bus bars. B is an auxiliary shunt winding, which the makers call the "potentiometer shunt," connected straight across the 'bus bars. C is a series coil between the negative dynamo terminal and the negative main, and D is a series coil of a few turns in series with the armature of the booster itself.

The object of the reversible booster is, of course, to keep

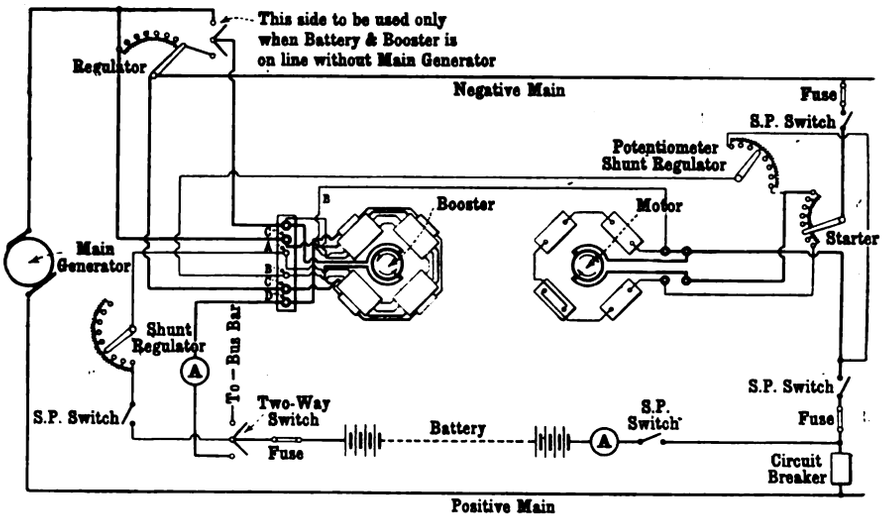

FIG. 6.—CONNECTIONS OF LANCASHIRE DYNAMO & MOTOR CO.'S REVERSIBLE BOOSTER FOR TRACTION.

for traction. Fig. 5 is a general view of one of the sets. They are not bolted down to foundations, but are merely placed in their drip pans without additional precautions. The speed of these sets is 3,000 revs. per minute.

Two boosters have been included among the recent extensions, both having been supplied by the Lancashire Dynamo

the load on the dynamos practically constant, the battery discharging when the load rises above the normal and charging when it becomes less than the normal. Taking into account the large variations in the voltage of a battery (not only with varying current but with the same current at different times), it is evident that the first requisite is an exciting coil which shall always make the sum of the battery and booster voltages practically equal at all times to the 'bus bar voltage. This is accomplished by putting on the coil A, excited by the

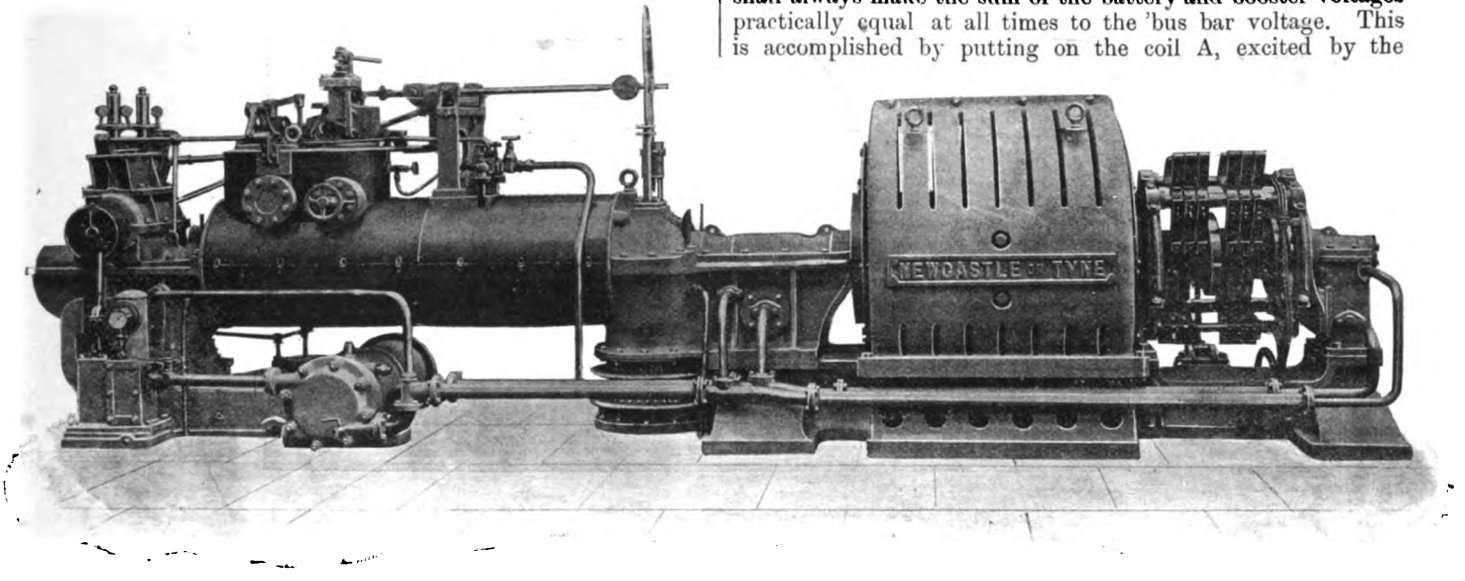

FIG. 5.—300KW. PARSONS' CONTINUOUS-CURRENT TURBO-GENERATOR.

and Motor Co. One is an ordinary shunt-wound reversible motor-driven booster for charging and discharging the cells on the lighting mains, and can deal normally with a current of 100 amperes, raising the pressure by 70 volts, and will deal with 200 amperes for one hour. The traction booster offers several interesting features, however; it is an automatic reversible booster and provision has been made with considerable ingenuity for almost every possible contingency. It is constructed under

difference between the battery and 'bus bar voltage. If the booster is worked on the straight part of the characteristic, it will be seen that this coil can be made to give a voltage on the booster armature always equal to the difference between the battery and dynamo voltage; also a very slight increase or decrease in the excitation will cause the battery to charge or discharge. The second shunt coil, B, across the 'bus bars tends to increase the voltage on the booster, which, again,

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would increase the effect of coil A, and the battery would charge heavily; as, however, B is opposed by C, which is a series coil in the dynamo circuit, the arrangement is stable when the current in C is such that its magnetising effect just balances that of coil B; and as B is a constant shunt coil, the current in C must always be constant, which is what is required. The series turns D, added in the battery or feeder circuit, make up for the armature reaction and CR drop of the booster itself. If the dynamo tries to take an overload, the coil C would overpower B and the battery discharge until equilibrium was restored; on the other hand, if the dynamo current tries to reduce on light load, coil B overpowers C and the battery charges until they are balanced.

The makers point out that, as the booster depends for its control on the dynamo current, and not on any balancing of voltage depending on the dynamo characteristic, compound machines can be used as well as shunt, and all trouble from hunting and kindred causes is avoided. Most boosters which do not depend on the falling characteristic of a shunt dynamo rely on the drop in volts on the battery and booster in discharging, which is balanced by a series coil in the feeder; if this coil is not exactly of the right strength, the battery discharges too much or too little, usually varying with the state of the battery. The particularly valuable property of a coil in the dynamo circuit consists in the fact that it can be made as strong as desired, and always balanced by a regulator on the shunt coil to fix the dynamo current at anything required, and if the current should vary acts with very great force to bring it back to the normal again, thus making the booster very stable and greatly facilitating paralleling.

If it is desired to use the battery and the booster on the line without the generators, coil A is disconnected and coil C connected to help coil B, giving the battery a constant voltage with varying load.

The field magnets are laminated throughout, including the yoke, giving the quick reversal so necessary for traction work. The booster is designed for a working current of 200 amperes normal, and 300 amperes for 1 hour, and to supply 70 volts for prolonged periods and 120 volts as a maximum. The machine runs normally at 800 revs. per min.

The two balancers are each made up of two 20kw. four-pole machines, also made by the Lancashire Dynamo and Motor Co.

The switchboards are on a gallery in the engine room. The old Siemens board for the high-tension circuits has been remodelled and is employed for the majority of the high-tension feeders, a Ferranti board having been put in for the generators and one set of feeders. Messrs. Johnson and Phillips have supplied the two continuous-current boards for lighting and traction (Figs. 7 and 8). The lighting board has three generator panels to the left, with two voltmeters on a swing bracket at the side, one connected to the 'bus bars the other for connection to the incoming machine when running up. The panels themselves each contain an ammeter, fuses and switches on each pole, a reverse-current circuit breaker and the field switch and rheostat handle. Next come the booster and battery panel, a double panel for the balancer, the middle-wire panel, and on the right four feeder panels. The latter are similar to the generator panels with the omission of the return-current circuit-breakers and the addition of integrating meters. At the end of the feeder panels are two illuminated dial feeder voltmeters on a bracket, similar to the voltmeters at the other end of the board. The generator and feeder panels are arranged so that the top half is the positive side and the lower half the negative, the distance between the positive and negative 'bus bars at the back of the board being about 2ft. 6in.

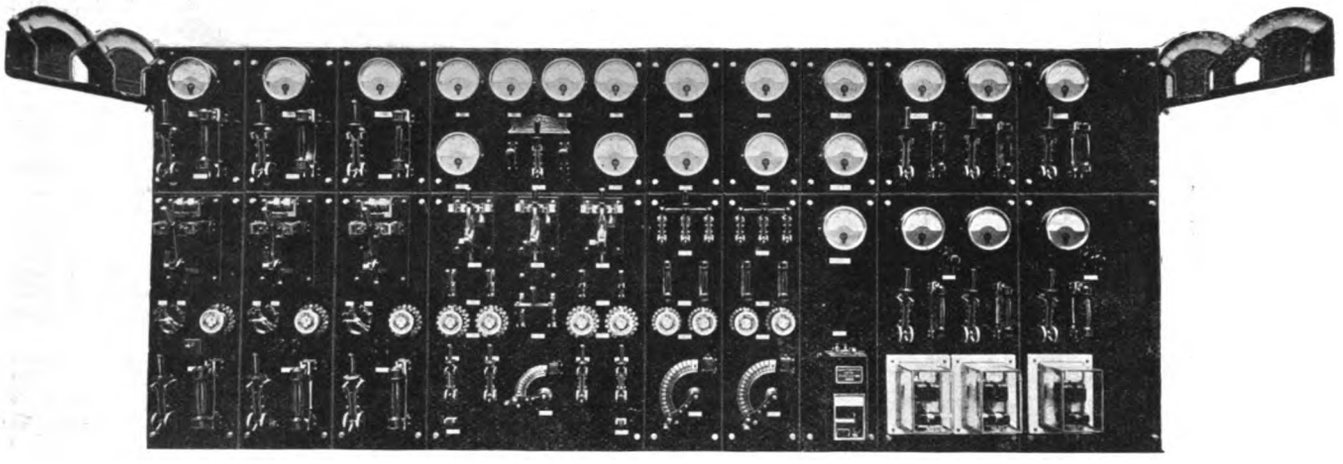

FIG. 7.—CONTINUOUS-CURRENT LIGHTING SWITCHBOARD, MADE BY MESSRS. JOHNSON AND PHILLIPS.

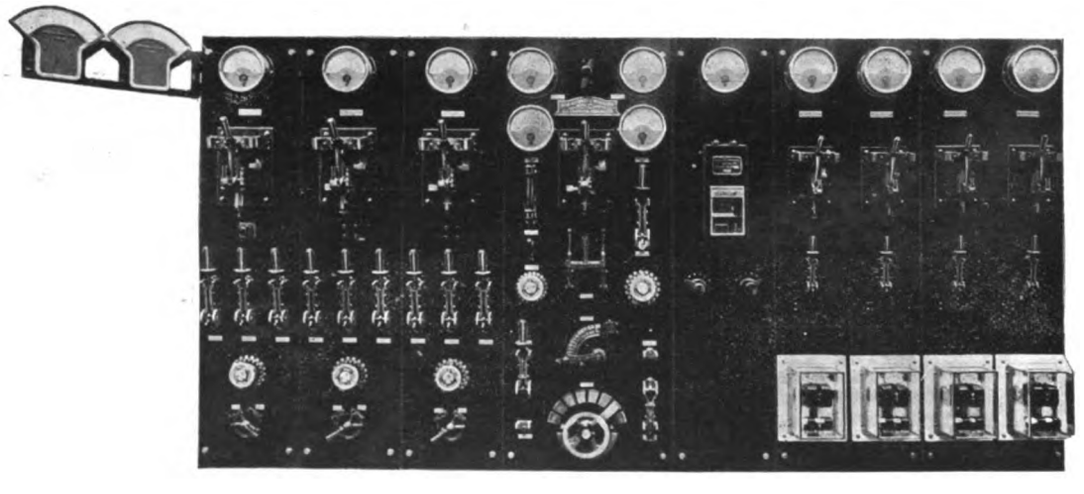

FIG. 8.—TRACTION SWITCHBOARD, MADE BY MESSRS. JOHNSON AND PHILLIPS.

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The traction board also starts with a generator voltmeter bracket and three generator panels to the left. The third switch is for the equalising connection; above the switches there is an excess-current cut-out, above this an ammeter, and at the bottom the shunt-field regulator and switch. The next panel to the right is for the reversible booster, and battery, containing all the instruments shown in the diagram Fig. 6. As seen in Fig. 8, there are two rheostats near the middle of the board. One of these is a 20-way switch for the shunt coil A, the other is a 30-way switch in series with the "potentiometer shunt" B. Below these comes the ordinary motor-starting switch, and at the bottom of the panel a rheostat which shunts a portion of the current in series winding C. This latter is regulated once for all, as also the shunt winding A, the ordinary regulation being by the 30-way switch in the potentiometer shunt circuit. The next panel is the Board of Trade panel, and on the right are two double-pole feeder panels. In connection with the Board of Trade panel, it may be mentioned that the negative main is not earthed directly at the station, but at the central tramway terminus seen in the map. Behind the switchboard, in a corrugated-iron covered way built against the wall of the building, are the resistances of the rheostats, the feeders from the network being also led through this passage.

The batteries have been placed in a special building on the new site, as already mentioned. The two batteries are of the same size, each consisting of 240 cells of the Chloride "R" type. Lead-lined teak boxes are employed, and each contains 39 plates, the positives measuring 9¼in. by 10⅝in. and the negatives 9¼in. by 10⅞in. The capacity of each battery is 675 ampere-hours at a nine-hour discharge rate, 600 ampere-hours at a six-hour discharge rate and 350 ampere-hours at a one-hour discharge rate. The battery house is in two storeys, one containing the lighting and the other the traction battery, but as the two batteries are exactly similar, they are interchangeable. If regulating cells had been required, it would, of course, have been impossible to place the battery house at a distance from the switchboard, on account of the length of connecting cable required; owing to the use of a reversible booster, however, only two cables are required to each battery.

(To be concluded.)

THE STEAM TURBINE AS APPLIED TO ELECTRICAL ENGINEERING.*

DISCUSSION.

(Concluded from p. 267).

Thursday, May 19th.

Mr. S. INSULL, president of the Chicago Edison Co., who said he was not an engineer, but a financier and operator of central station power supply, agreed with other speakers that Mr. Parsons, above any other man, was entitled to the credit of having brought the steam turbine to its present high state of efficieney as the result of his early experimental work. He had not had any experience in actually operating the Parsons turbine, largely on account of the fact that it had been almost impossible to get large size turbines of the Parsons manufacture in the United States until a very short time ago. His experience had been confined to the Curtis turbine, and that experience had only been during the past few months. A new station had been erected in Chicago where there were three Curtis turbines guaranteed to run at 6,000kw. each. During the past winter one of the machines had, on one occasion, been run at 7,800kw., and on another at 7,500kw. No efficiency tests had been made nor any actual load tests. The loads just referred to were occasioned by the winter peak load. Their experience in Chicago fully bore out that of Mr. Parsons and his associates so far as the economy of the turbine as compared with the reciprocating engine was concerned. In the old central station at Chicago there were reasonably economical reciprocating engines, but they had been unable to operate that station, which had a capacity of some 17,000kw. or 18,000kw., at within about 30 per cent. of the cost of operating the turbine station. He was not prepared to say that this reduction in the total station costs was owing entirely to the turbine; it was partly owing to the very much larger units that were installed in the turbine station and partly owing to the better design of the mechanical plant, but in his opinion it was mainly owing to the fact that the labour costs and miscellaneous expenses in a turbine station, if properly run, formed but a fraction of similar costs in a reciprocating engine station. As to cost of plant, his experience had been entirely with American prices, but he had found that the cost of, say, a 5,000kw. turbine plant was practically half that of a reciprocating engine plant. This reduction was affected to a small extent by the increased cost of the condensing plant, but they got a return on that cost from the increased value which was obtained from the condensing plant. Again, on the question of buildings, it was possible to get a given number of kilowatts in a very much smaller space, whether the turbines were of the vertical or horizontal type. The result was that the interest cost was very much lower, the capital investment very much lower, and therefore it was very much easier to advance the enterprise. If the experience over a period of years bore out the tests made upon the Parsons turbine up to date or the present Chicago experience, it seemed to him that the steam turbine would occupy a position in relation to the electric power business second only in importance to the original work done by the early inventors in the development of electric power and lighting.

Mr. H. W. DICKINSON said he had found very great difficulty in maintaining 27in. of vacuum. His condensers were put in with a very large cooling area, but it was found that the circulating water fouled the insides of the tubes very rapidly. Every tube had to be cleaned once a week, and yet the 27in. of vacuum could not be maintained. He had also experienced trouble with the oil from the exhaust, but by using oil separators he had practically got over that difficulty. As far as he was able to judge, the main advantage from the use of the steam turbine, which the central station engineer had to look to, was the saving in capital cost. Taking everything into consideration, he did not think there was much to be gained in the matter of steam economy at present. Later on it might be different. The total works costs at Leeds worked out at 0·89d. per unit, and the capital costs—*i.e.*, interest and sinking fund—worked out at 1·7d. per unit. Therefore, if they could reduce the capital cost, a considerable saving would result.

Mr. E. J. FOX considered the question of condensing a rather more important one in connection with steam turbines than was at present thought. On the one hand, the feeling was fairly prevalent among engineers that in many reciprocating engine stations condensing had been pushed too far, and that the cost of condensing very often balanced the benefits which it carried with it. On the other hand, with turbines, condensing was a *sine qud non*, and at the same time a good deal of extra power had to be expended in doing it. He did not think that, on the question of steam consumption alone, the turbine, except in the largest sizes, was coming up to the reciprocating engine at present. One of the leading condensing engineers was of the opinion that in many cases the cheapest way of maintaining these high vacua was not with surface condensers at all, but with a modified form of jet condenser, and the condenser which he had in mind was the counter-current jet condenser, arranged with the exhaust steam and condensing water travelling in opposite directions and fixed preferably on the top of a barometrical column about 30ft. high. With this type of condenser, the volume of water to shift would be a good deal less, but, on the other hand, the heat of the feed water was reduced by about 100deg. There were certain objections to having the condensers remote from the turbines, but with properly made joints, and with the exhaust arrangements large enough, there should not be very much difficulty in maintaining the vacuum on the turbine if it were 20ft. or 30ft. away. At an ironworks in the north of England a vacuum of 26½in. was maintained with a 6in. exhaust pipe 250yds. long, with only a drop of 1in. from one end of the pipe to the other. Regarding steam consumption, in justice to the makers of reciprocating engines, he ought to say that the figures given as being obtainable with the different sizes of turbines could also be obtained without difficulty by reciprocating engines of the larger sizes, say 1,500kw., while with the sizes from 100kw. to 1,000kw. the reciprocating engines gave considerably better results. Above 1,500kw. there was a difference in favour of the turbine. This was with the reciprocating engine working with moderate degrees of superheat under similar conditions to a turbine. But to get the best results from reciprocating engines, fairly high degrees of superheat should be employed, and the engines would gain more with increasing degrees of superheat than the turbines. Tests on a 200 H.P. engine had reduced the amount to 10lb. of highly-superheated steam per brake horse-power, which was equal to 14½lb. per kilowatt with 260deg. of superheat and a boiler pressure of 190lb. Therefore, as far as this one item was concerned, the reciprocating engine could certainly hold its own at present, especially if the makers of these engines only thought it worth their while to educate engineers up to the question of high degrees of superheat and high boiler pressure in the same way that they had been educated up to high vacua. He admitted that it was scarcely fair to discuss a single item in the way that he had done, and that other speakers to a lesser extent had also done.

Mr. C. H. MERZ said the question of cost had been criticised rather from the point of individual items than from total costs. If engineers would discuss costs on the basis of total costs in the true sense of the word then he unhesitatingly said they would find that the turbine was the thing to be adopted by engineers who were distributing power over large areas. He happened to have installed a 500kw. continuous-current Curtis turbo-generator in Cork recently, and with a vacuum of 27½in., a superheat of something over 100°F. and a steam pressure of 150lb., the steam consumption was 20·5lb. per kilowatt-hour. By bringing the vacuum up to 28½in., and increasing the superheat to 150°F., the steam consumption was something under 19lb. per kilowatt-hour. This he considered was a very good result, and it showed that the Curtis turbine could produce electricity at very much the same cost as a Parsons turbine. The correct type would depend to a large extent upon the cost of repairs, the cost of oil and such auxiliary items. He could not himself speak as to repairs, because the Curtis turbine at Cork had

* Paper by the Hon. Charles A. Parsons, F.R.S., G. Gerald Stoney and C. P. Martin at the Institution of Electrical Engineers. See *The Electrician* of May 27th, p. 221, and June 3rd, p. 265.

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not been working sufficiently long, but he could speak as to the Parsons turbine in this respect, and the matter had been referred to in his recent Paper. One or two of the speakers had referred to the difficulty of maintaining high vacua. This was, he thought, because they judged the matter from their experience with reciprocating engines. If they adopted turbines and put the condensers directly below them with only one joint, or, in the case of the Curtis turbine, combined the condenser with the turbine, there would be no difficulty in maintaining high vacua if proper cooling water was employed. With cooling towers not quite the same results could be obtained unless there was very large cooling area; but even in such cases he did not think there would be any difficulty in maintaining a vacuum of 28in. From the figures in the Paper with regard to the augmentor, he did not think the authors made a very great showing with this. When one went in for the complication and the extra expense which such an arrangement represented—if not in first cost, certainly in maintenance—one expected something better than the ordinary vacuum which could be obtained with a simple Edwards air pump. In Cork, the other day, although they had a bad vacuum on the turbine, they had an exceedingly good one on the condenser, for with an ordinary air pump they got to within ½in. of barometric pressure. Where there was not much objection to mixing the boiler feed with the condensing water, it would seem that if there was anything to be gained in capital cost by the use of jet condensers they should be used. Regarding continuous-current machines for turbines he thought that no continuous-current machine was worth having if it could not be operated with carbon brushes, and the authors had not stated how far they had succeeded in using these on large sizes. On the turbine at Cork carbon brushes were used with considerable success. During the time he was there making tests some oily waste accidentally got in between the brushes and the commutator and resulted in the commutator flashing over, but it cleared itself at once. For sizes up to 500kw., with speeds of about 1,800 revs. per min., it would seem that it was possible to design continuous-current machines using carbon brushes.

Mr. E. K. SCOTT suggested that a considerable system of unglazed porcelain pipes should be employed for keeping the condensing water cool.

Prof. W. E. AYRTON joined with the previous speakers in admiring Mr. Parsons' boldness—almost audacity—because it was not more than 15 or 18 years ago that he showed in one of the exhibitions at South Kensington the first turbine, and as he (Prof. Ayrton) was on the spot frequently he used to hear the comments that were made upon it: "Steam eater," "scientific toy," &c., &c. Nobody imagined, except perhaps Mr. Parsons himself, that that "steam eater" and "scientific toy" would ever be a competitor of the reciprocating engine. At the 1900 Paris Exhibition he was very interested to find that of all the engines in the British exhibit the Parsons turbine was the one taking the least amount of steam per kw.-hour. More recently he made inquiries from various people on the Continent and elsewhere and was extremely gratified to find that their opinions were that the low steam consumption at the beginning was maintained after some appreciable time of steady running. There was one advantage of the steam turbine over the reciprocating engine, and that was in the matter of getting up speed. The steam turbine could be started comparatively cold and in a very short time it was running efficiently at full-load. There was no warming up necessary, relatively, such as was required by the reciprocating engine. In addition to what Mr. Merz had said about the Curtis turbine, it was claimed that at a quarter-load the efficiency did not fall off as much as in the Parsons turbine. The scientific reason for this was the way in which the steam supply was cut off. In the Curtis turbine there were a number of separate nozzles through which the steam was introduced. They did not partially shut off the steam at any one particular nozzle, but the nozzle was entirely shut off, and the diminished result was obtained by simply having fewer nozzles fully turned on. The figure which he had obtained was 18½lb. of steam for a 500kw. machine running at 1,200 revs. per min. At Chicago the results were given as 17½lb. of water at full load, which was only increased to 19lb. at quarter-load. The Curtis turbine was also extremely frictionless. The lower shaft was in oil at a high pressure—400lb. to the square inch—and the result was, he knew as a fact, that one of these large turbines could be turned round with one finger; they were so beautifully balanced. But whether or no the Curtis turbine could compete with the Parsons turbine, it was, as several speakers had said, to Mr. Parsons that the whole world owed the development of a machine which would displace the old reciprocating engine.

Mr. LEON GASTER said that steam turbines were 30 per cent. cheaper than reciprocating engines and occupied about one quarter of the space for the same horse power. The lubrication was about 10 times less. At Mannheim the engineer had told him that compared with steam engines, on a 3,800 H.P. plant they would save £1,000 per year. The governing was also marvellous. In Switzerland some 400kw. plants were tested and in increasing the load from full load to 25 per cent. overload the speed varied only 0·3 per cent., at half-load the variation was 0·4 per cent., and when giving only 100 per cent. the variation was 0·8 per cent.

Mr. W. CRAMP thought there was a tendency to forget the difficulties which had been overcome with continuous-current dynamos, and he differed entirely with Mr. Merz. It was not a fair test to drop oily waste upon the commutator, and a very great debt of gratitude was owing to Mr. Parsons for developing the high-speed commutator with copper brushes. By substituting pure copper for carbon brushes, the efficiency of moderate-sized machines could be raised from 2 to 2½ per cent. If the loss in the extra windings mentioned in the Paper did not rise to this value a very great advantage was being gained, provided the initial cost was not very great. He would like to know what the loss in the extra windings was as compared with the loss in the carbon brushes.

Mr. W. H. PATCHELL said that the question of variable cut off of the expansion was as much likely to come up with the turbine as with the reciprocating engine. The Curtis people preferred to cut off some of the nozzles. One of the leading Continental engineers, however, wished to do the very opposite, and to get better results by wire drawing. The speakers, generally, had overlooked the most important point in the Paper. The self-centreing bearing was enough to stamp a man an engineer even if he had never constructed a turbine. With regard to cooling towers, several speakers had mentioned temperatures, and the authors had apologised for the figures of one test, because the cooling water was only 85°F. But if the best results were to be obtained from the turbine, such as the makers had provided, proper water must be used. It all depended on what this was. If they had to depend upon cooling towers, an all-round temperature was 80deg. It looked as if full efficiencies would not be got out of turbines until there were better rivers in England. He would like a few more particulars about the vacuum augmentor, because the few words in the Paper led one to think that it was one of the paradoxes which were sometimes met with.

Mr. W. M. MORDEY said that, in the course of the Institution visit to Italy last year, Signor Semenza, of Milan, told them in effect that, compared with the highest class of reciprocating engine—the Sulzer—his turbine plant took one quarter the space, practically the same steam consumption and a quarter the labour, and that the price was, on the whole, considerably lower than the reciprocating engine, without allowing for the buildings. With regard to Mr. Insull's remarks, it might be supposed that Mr. Insull was present as the representative of the Curtis turbine. But this was not so. Mr. Insull was the very enterprising president of the enormous Chicago Edison undertaking, and it was due to men like him, who had the courage to put in a 5,000 H.P. turbine and to order three more before even driving one, that the advances in electrical engineering took place. Mr. Insull would have said, had he had the opportunity, that if he could have got Parsons turbines when he wanted turbines he would have put them in in preference.

The Hon. C. A. PARSONS asked Mr. Stoney to make the main reply to the discussion, as he was more cognisant with the later details than himself. With regard to Mr. Hammond's remarks, he pointed out that in the accounts of electricity works, oil, waste, water and stores were all grouped under one heading. As a matter of fact, the oil consumption was one of the very smallest items in the stations with which he was acquainted. In the Newcastle and District Co.'s accounts, he believed station lamps were included in these costs. Mr. Barker had handed him a statement which showed that the yearly cost of oil at Cambridge was £40 per annum, or 0·003d. per unit. The oil cost was about one-tenth or one-twelfth that of an ordinary engine. Messrs. Brown, Boveri had gone very carefully into the cost of oil on the Continent and they made out that in the Sulzer engine the cost of the oil was 12½ per cent. of the value of the coal burned. With regard to condensers, at the Newcastle and District Co.'s station, there was a condenser which had been put in about eight years ago with a barometric head, and that had been working most successfully ever since. It was a jet condenser with a vacuum of 28½in. constantly maintained.

Mr. GERALD STONEY, replying first to Mr. Sayers' remarks as to the cutting of the blades by high-velocity steam, said there was nothing of this in the Parsons turbine, although in turbines of the single jet form there was cutting undoubtedly. Mr. Sayers had spoken about continuous-current dynamos, and one speaker had made the remark that no continuous-current dynamo was worth having unless it had carbon brushes. He differed from them. Although machines fitted with carbon brushes might run well for a time, sooner or later the high surface-speed of the commutator knocked them up. They had divided carbon brushes up into numerous parts, but none of them were as satisfactory as brass wire or gauze brushes. With regard to the compensating winding mentioned in the Paper, he would ask Mr. Sayers to note that it was stated "with improvements recently adopted." He was sorry they were unable at present to give the details of this winding, but it was a modification of what Prof. Forbes proposed some years ago. Mr. Sayers' remarks referring to Messrs. Jackson's experience were also interesting, and he might state that Messrs. Parsons had just put in some Sayers-wound dynamos for the St. Helens Company in Lancashire. The great difficulty with these special windings, and also with high-speed dynamos with compensated poles as proposed by Ryan, Deri, and others was that the position where sparkless commutation was obtained was too definite. At no load in an ordinary dynamo a considerable movement of the brushes could be obtained. Towards full load it was gradually diminished until a point was reached where no movement of the brushes was obtained. With the winding mentioned in the Paper they kept the same limit at no load, but at full load there was a much larger range than there was with any other form of compensated winding. With some forms of compensating winding sparkless commutation was obtained at no load and full load, but not at the intermediate points. He thought Mr. Hobart was the first to point out the great amount of induction in coils caused by the end windings, but it did not seem to matter, up to a certain degree, how much induction there was in the coils provided there was a suitable compensating winding employed. Damping coils were difficult to use in practice. With reference to the vacuum augmentor, he did not think the same results could be obtained with any form of air pump. The limit of what the air pump would take out was soon come to owing to the loss in the valves and so on. Mr. Hammond had mentioned the machines at the Hotel Cecil. These were made by the Parsons firm in 1894, and they were running still. In fact, these four old 75kw. non-condensing machines were able to keep the Charing Cross and Strand Co. out of the Hotel Cecil.* This plant turned out, a few years ago, as much current as the whole Newcastle and District electric lighting station, which lighted one-half of Newcastle. It showed the enormous advantage of a good load curve. At Neptune Bank about a

* [Mr. Patchell informs us that the Charing Cross Co.'s mains are taken into the Hotel Cecil as a standby.—ED. *E.*]

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year ago they saved £5 a week in oil by using the turbine. Mr. Hammond also doubted the possibility of maintaining a 27in. vacuum, but Mr. Barker, at Cambridge, had maintained a 29in. vacuum over a number of years. At Newcastle, they kept up 28in. and 29in. year after year, but it was a different thing with reciprocating engines. He was considerably surprised at Mr. Hammond's objection to metric measurements.

Mr. HAMMOND: My complaint was that you did not use the metric system in Table II.

Mr. STONEY said he agreed that this should be done. Continuing, he said that Prof. Dalby had given a thorough exposition of the advantages of good vacua, and had shown that there was not very much more to be gained by high steam pressures. His own opinion was that 150lb. or 200lb. pressure was enough, on account of the rapid increase in the difficulties with stop valves, and so on, with pressures beyond this. With regard to the pressures on the turbine, these agreed exactly with the theoretical curve. The pressures for turbines had been calculated and compared with results, and the two agreed as nearly as possible. Mr. Insull's account of the Chicago turbines was most satisfactory. With regard to floor space, he might mention that the area used by the Curtis and Parsons turbines, both for the larger and smaller sizes, was identically the same in square feet. With regard to the difficulty of vacuum spoken of by Mr. Dickinson, where there was bad water the cure was to use jet condensers. There was no objection to the condenser being at some little distance provided the exhaust pipes were large enough. They could be made perfectly air-tight and this state would be improved if they were exposed to coal dust and dirt. Mr. Merz's results at Cork exactly confirmed the figures which the Curtis Company were publishing, and as far as he was aware they were the first tests made on a Curtis turbine by an independent engineer. He could certify as to the great care and absolute accuracy of Mr. Merz's tests, as he had made the tests of the 1,500kw. set at Wallsend given in the Paper, and there every precaution was taken to secure absolute accuracy. Mr. Scott's remarks about cooling towers with porcelain pipes were very interesting, but he would like to see the idea carried out for a station with 10,000kw. in it. Mr. Gaster's description of Messrs. Brown, Boveri's work was also most interesting, and this firm was doing most magnificent work. They were the first to get a 3,000kw. set at work at Frankfort, and the 6,500kw. at Essen was the largest Parsons turbine being built.

Prof. AYRTON asked Mr. Stoney if he would express any opinion as to the comparatively small falling off of the efficiency of the Curtis turbine as the load was diminished. The case he had mentioned was 17½lb. of water per kilowatt-hour at full-load and 19lb. at quarter-load, which was an extremely small increase of steam per kilowatt-hour.

Mr. STONEY said he could only point out that the consumption of steam in a Parsons turbine of the size mentioned by Prof. Ayrton was considerably lower at full load than the figure given. The average results of the Frankfort machine given in the Paper were much lower than this. By utilising a cut-off instead of a throttling, a lower consumption would take place at light loads; but it would be, to a certain extent, at the expense of the consumption at full load, as would be seen by comparing the figures given by Prof. Ayrton with those of Messrs. Brown, Boveri at Frankfort. Such large sets as 6,000kw. were not expected to be operated at a quarter load. Smaller turbines should be installed—300kw. or less. Further reply to the whole of the discussion would be made in the *Journal*.

A hearty vote of thanks to the authors concluded the discussion.

DIFFERENT APPLICATIONS OF STEAM TURBINES.*

BY PROF. A. RATEAU.

Since 1894 the firm of Sautter-Harlé of Paris, with the assistance of the author, has been experimenting upon the construction of steam turbines. The first turbine constructed had only a single moving wheel, like the Laval turbines, and this wheel was formed with vanes in the form of a double arc similar to the buckets of a Pelton wheel, and these vanes were milled out of a solid block of steel. This type has since been copied in the Riedler-Stumpf type, built by the Allgemeine Elektricitäts Gesellschaft, but which was abandoned, as it did not offer any chance of obtaining the maximum efficiency. The most recent Rateau turbine is of the action type—that is to say, expansion of the steam is fully carried out in the distributor for each group consisting of a distributor and one moving wheel. The steam, therefore, acts by its velocity and not by its pressure. These turbines are, moreover, multicellular—that is to say, they consist of a certain number of elements, each element comprising one distributor and one moving wheel. A very interesting characteristic of the type of action turbines is the possibility which it allows of leaving very considerable play between the fixed parts and the moving parts, and this greatly facilitates construction and obviates the chances of dangerous friction if the bearings should become worn or the shaft somewhat bent. Besides this, the wheels revolve in a chamber where the pressure is uniform. There is for that reason an absence of longitudinal thrust upon the moving parts and no necessity for the use of dash-pots for the purpose of overcoming the effect of this thrust, although such dash-pots are necessary in reaction or drum turbines. Finally, in the action type partial injection of steam is possible—that is to say, the steam may be directed upon a limited portion of the circumference. The moving wheels are formed of discs of sheet steel more or less thin, and upon the periphery of these discs are riveted vanes of cylindrical form, Figs. 1 and 2. A steel band riveted to the periphery maintains the correct spacing of these vanes and ensures great rigidity to the construction. Wheels so constructed are extremely light, and remain in equilibrium at a velocity far higher than that to which they are subject in the turbine. These moving wheels turn between circular diaphragms provided with distributing vanes which enter circumferentially into grooves formed in the interior of the turbine case. Between two adjoining diaphragms is therefore produced a cell or very flat chamber in which the moving wheel revolves. The shaft passes through the diaphragms in collars of anti-friction metal with very slight friction. In the first diaphragm which the steam passes through the distributing vanes

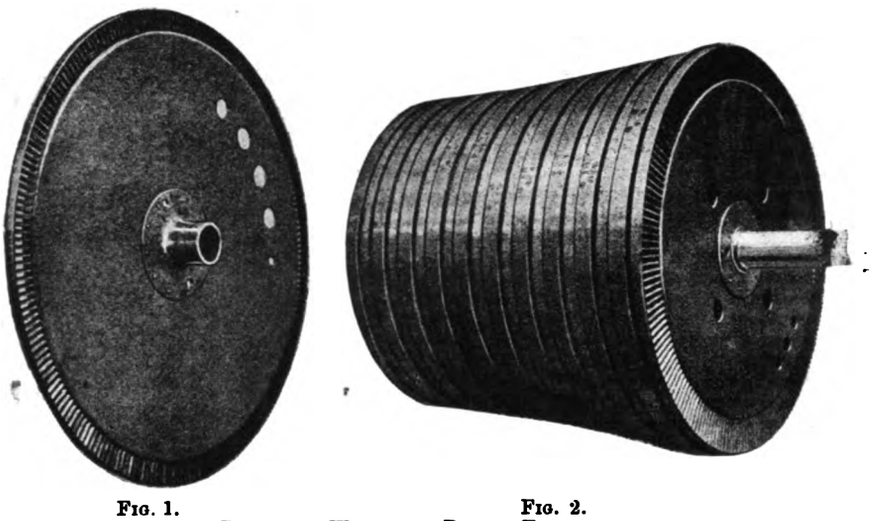

FIG. 1. FIG. 2.

REVOLVING WHEELS IN RATEAU TURBINE.

are placed only upon a part of the circumference. Partial injection of the steam is therefore obtained, and thus the velocity of the steam is better utilised. Moreover, to produce the same effect the useful part of each distributor is set with an angular advance on the preceding section; this angle of advance is calculated according to the speed of rotation, so that the steam leaving one moving wheel enters into the following distributor and never encounters a solid wall which would produce a shock and, therefore, a loss of kinetic energy. For the last wheels it is necessary to employ total injection—that is to say, the distributing vanes must be set upon the whole circumference of the diaphragm, and, moreover, owing to the expansion of the steam, the radius must be increased. The bearings of these turbines are external, and by means of a special system of spring packing they are kept perfectly tight No oil is carried by the exhaust steam to the condenser, and this has an important advantage, as the water of condensation can be used for feeding steam boilers direct without any necessity for the use of an oil separator. The speed of rotation is controlled by a centrifugal governor with a Denis compensator, which acts upon an obturator which controls the pressure of steam entering the turbine.

Mixed Turbines.—In the case of installations where exhaust steam must be used, it is often desirable to supply the turbines temporarily with steam at high pressure when the primary machine is stopped or is furnishing less steam, and the work done by the turbine must remain the same. In order to obtain economical working it is preferable not to expand this steam in order to lower it to the pressure for which the low pressure turbine is built. Therefore, the author has designed a turbine which may be described as of the mixed type, and this can be supplied either simultaneously or separately by steam at high pressure and by steam at low pressure without any lowering of the efficiency of the mechanism. In order to attain this result the turbine is constructed in two parts, one designed for high-pressure steam and the other for low-pressure steam. The steam at high pressure having done work in the first portion, will pass to the second portion, which may be fed either by steam coming from the accumulator or by the exhaust from the first portion. The admission of high-pressure steam into the first portion is automatically obtained by means of a special regulator which allows steam from

* Abstract of Paper read before the Chicago meeting of the Institution of Mechanical Engineers.

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the boilers to pass to the first portion as soon as the pressure in the accumulator falls below a given value. This arrangement, which has been adopted in all the new applications of the system to the use of exhaust steam, works very economically, and is particularly suitable to cases in which the primary machine works irregularly, and where, therefore, the demand for live steam is frequent and somewhat prolonged. In the small machines the two portions are usually joined together.

Efficiency of Turbines.—It is essential that the word "efficiency" should be clearly defined. The author uses the expression "Theoretical consumption of the perfect machine" to denote the maximum work which the steam is capable of supplying when starting from the saturated or superheated condition in which this steam is delivered to the engine and expanding adiabatically with no loss of admission pressure P to exhaust pressure p. By comparing the actual consumption of steam as measured during the tests of the machine with this theoretical consumption of the perfect machine for identical conditions of pressure and similar states of the steam, the net efficiency of the machine is obtained. After special study of the question, the author has been able to draw a curve of theoretical consumption and to derive from it the following empirical formula for use when the steam is saturated and dry at admission :—

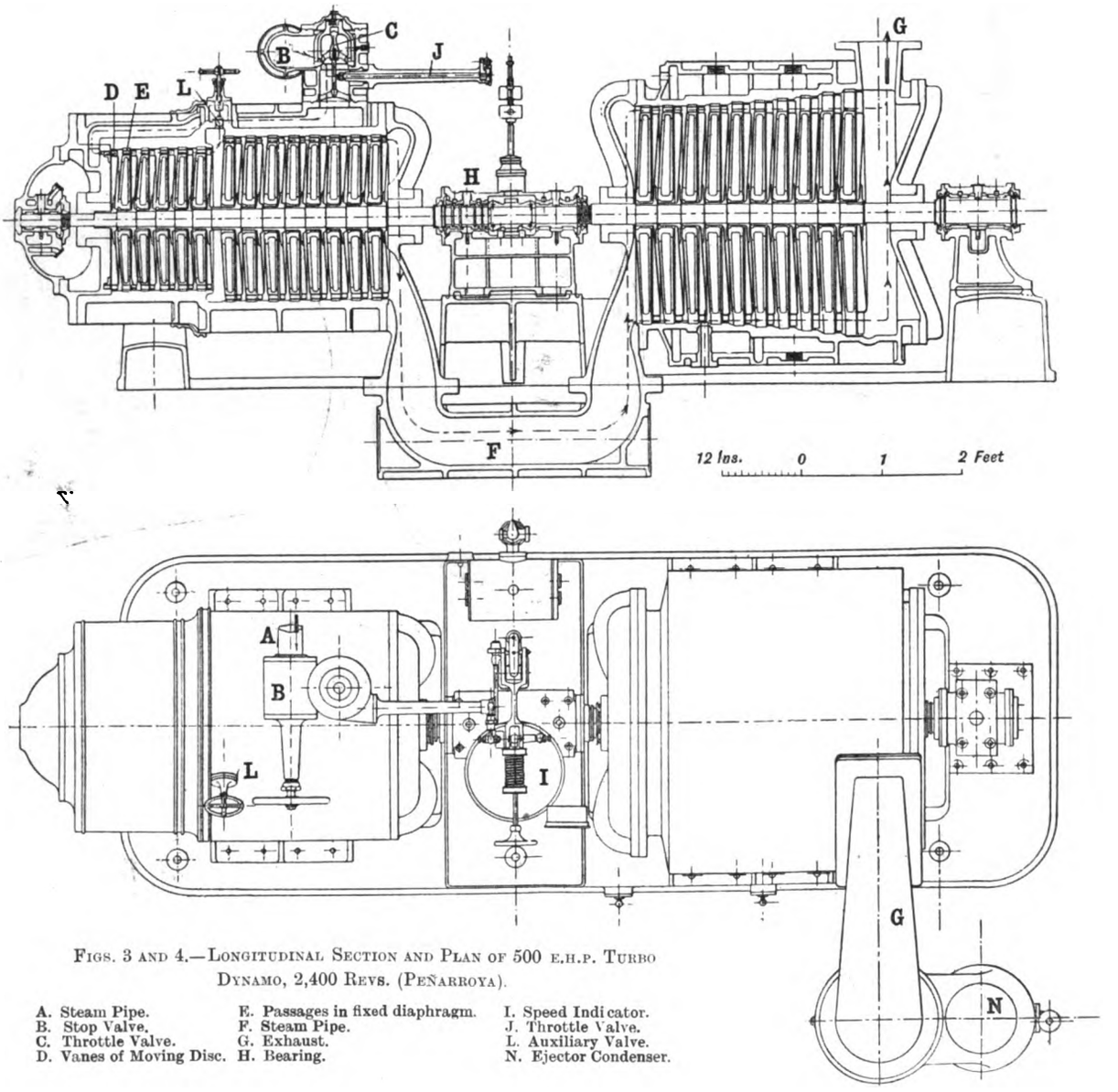
$$K = 0{\cdot}85 + \frac{6{\cdot}95 - 0{\cdot}92 \log P}{\log P - \log p}.$$

This formula gives the consumption K in kilogrammes per horse-power-hour of 75 kilogrammetres as a function of the absolute pressures P and p expressed in kilogrammes per square centimetre. In British measures this formula becomes

$$K = 2{\cdot}13 + \frac{16{\cdot}20 - 2{\cdot}05 \log P}{\log P - \log p}.$$

K in pounds per horse-power-hour, P and p in pounds per square inch.

Calculation of the Efficiency of Turbines.—The efficiency of a turbine may be calculated *à priori* when a preliminary study has been made of the practical coefficients which must be introduced into the theoretical formula. We calculate this efficiency with quite a remarkable degree of accuracy by dividing the losses of the machine under two headings: First, the internal losses which are produced by friction and eddying of the steam in the fixed and moving vanes; second, the external losses which correspond to the leakages of steam in the play between the fixed and moving parts, and to the friction of the wheels upon the steam and to the friction of the bearings. The first kind of losses gives rise to the *internal efficiency*, which may therefore be called the "hydraulic efficiency" by extending the use of the term employed for hydraulic turbines. This internal efficiency depends upon the more or less perfect form of the vanes, and also to the relation between the peripheral speed of the moving vanes and the speed of flow of the steam. It is possible to draw a curve show the efficiency as a function of the peripheral velocity, and therefore it is easy to at once assign the degree of efficiency which a given turbine will realise. Once having fixed the internal efficiency, then, in order to obtain the net efficiency, we must deduct the losses by leakage as well as the losses by friction of the wheels upon the steam, and also those in the bearings. Let us take, for example, a multicellular turbine of 1,500 B.H.P. upon the shaft with a speed of 1,500 revs. per min. By means of practical coefficients found by experience we can calculate that the internal efficiency of such a machine may easily rise to 69 per cent.; on the other hand, the losses by leakage and by friction in the bearings absorb 1·5 per cent. of the normal power, and the losses due to friction of the wheels upon the steam amount to 2·5 per cent., making a total for the external losses of 4 per cent. The net efficiency upon the shaft at the speed stated will then be 0·69 multiplied by 0·76 = 0·66. From this value of efficiency it is easy to calculate the consumption of steam per horse-power-hour,



FIGS. 3 AND 4.—LONGITUDINAL SECTION AND PLAN OF 500 E.H.P. TURBO DYNAMO, 2,400 REVS. (PEÑARROYA).

A. Steam Pipe.
B. Stop Valve.
C. Throttle Valve.
D. Vanes of Moving Disc.
E. Passages in fixed diaphragm.
F. Steam Pipe.
G. Exhaust.
H. Bearing.
I. Speed Indicator.
J. Throttle Valve.
L. Auxiliary Valve.
N. Ejector Condenser.

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which would be required by this turbine under conditions of pressure and of superheat of the steam already determined. All calculations for designs of turbines that we have made by this means have always proved correct within 1 to 2 per cent. of actual practice. Such accurate calculations are not possible in the case of reciprocating engines owing to the action of the cylinder walls, which makes calculations uncertain and often inaccurate, whilst in the turbine the continuity of flow of the steam allows practical calculations of a high degree of accuracy to be based upon theory, once having determined the fundamental coefficients which are employed in the formulæ.

Turbo-dynamos for Continuous Current.—The company of the mines of Peñarroya in Spain installed in their central electric lighting station a little more than a year ago three groups of turbo-dynamos developing 500 E.H.P. with continuous current at 240 volts. Each of these three generating sets comprises two turbines for high and low pressure and two dynamos for continuous current, the latter directly driven from the turbines upon the same shaft and upon the the same bed-plate, and the two dynamos supply a three-wire network with a potential of 480 volts between the outer wires. The speed is about 2,200 revs. per min., and the floor space occupied by the turbine with its two portions is only 12ft. by 5ft. 6in., with a height of 5ft. inclusive of a bedplate 1ft. high. The condensation of the steam is carried out by means of ejector condensers of a type designed by the author. Figs. 3 and 4 show a longitudinal section and a plan of the turbine, which has 24 moving wheels. The works tests of the first group were made in September, 1902, with the greatest care, and they have given the results which are shown in Table I. A surface condenser belonging to the works was employed for these tests, so that the water might be collected and measured. It will be seen that the vacuum at the condenser declined as the power increased. This result arises from the fact that the condenser was designed for machines of 250 H.P. only, and, therefore, was of insufficient size for the larger volumes of steam. A turbine developing 644 E.H.P. and working without appreciable superheat between an admission-pressure of 156lb. absolute and an exhaust-pressure of 1·8lb. (notably higher than the results given by good condensers in practice) required only 14·9lb. of steam per electrical horse-power at the terminals; the combined efficiency for the set being then 59 per cent. when compared with the energy contained in the steam for the same fall of pressure. With steam at 180lb. superheated 50deg. and a vacuum of 29in. of mercury, the consumption at 2,400 revs. per min. would decrease to 11·5lb. per electrical horse-power-hour. Fig. 5 gives the curves corresponding to the figures obtained at a speed of 2,400 revs. per min. The abscissæ denote the power of the machine in electrical horse-power at the terminals of the dynamos. The ordinates vary with the curves. For curve A the ordinates denote the absolute pressure of the steam on reaching the turbine in pounds per square inch. For curve B they show the absolute back pressure at the exhaust in pounds per square inch. For curve C they show the total consumption of steam in pounds per hour, and for curve D they show the consumption per electrical horse-power in pounds per hour, and, lastly, for curve E they show the combined efficiency. These curves show clearly the remarkable characteristic of very low relative consumption of steam at small loads. It will be seen that, in order to drive the machine at its normal speed with no load, but with the dynamo excited, the total consumption of steam is only 10 per cent. of that at full load. With reciprocating engines the result would be very different. Under similar conditions the consumption of steam at no load with the dynamos excited usually reaches from 20 to 25 per cent. of the consumption of steam at full load. It therefore follows that turbine sets are more advantageous than reciprocating engine sets when running at light loads, even admitting equality at heavy loads. Another valuable property of steam turbines is that they may be considerably overloaded. Thus, in the case of the machines at Peñarroya, which were designed for 500 H.P., they have been able to develop 650 E.H.P., and the output could have been raised even still higher had it not been for the overheating of the commutators of the dynamos. In our machines we are enabled to take an overload by supplying steam to a distributor more or less distant from the inlet in the series of successive distributors. The stop valves which regulate this supplementary admission can be moved by hand or controlled mechanically by the governor.

These sets of turbo dynamos for continuous current have proved somewhat unsatisfactory in practice, owing to the sparking of the brushes occasioned by the vibration of the armatures. In order to obtain sparkless running special arrangements must be made for absorbing the vibration, but it is very difficult to maintain in good equilibrium such heterogeneous bodies as the armatures of dynamos consisting of bars of copper which become slightly displaced under the action of centrifugal force owing to the compression of insulating material. Special arrangements for static equilibrium, and also for dynamic equilibrium have been designed, but the construction of the armatures is still always somewhat delicate, and it is only after several improvements that it has been possible to make them work well. At Peñarroya the vibrations were caused principally by want of level between the bearings, and this was brought about by settlement of the masonry supporting the machine. In order that bodies in rapid rotation upon very long shafts supported by several bearings may turn easily without vibration, it is indispensable that the principal axis of inertia of each part should coincide with the axis of rotation, and the bearings must be in correct alignment. In spite of these difficulties it has been possible to build good continuous-current dynamos for coupling directly to turbines, and when the voltage is high the problem is simpler. Owing to the high peripheral velocity of the commutator it is usually necessary to employ metallic brushes, but in certain cases, notably with turbines supplied by steam at low pressure when the angular velocity is lower it has been possible to use carbon brushes. Among other sets for continuous current built by Messrs. Sautter-Harlé may be mentioned one of 500 H.P. for Huta-Bankowa (Russian Poland), which is interesting from the fact that the two portions of the turbine and the two dynamos were built on two parallel shafts. This arrangement offers the advantage that one of the halves of the group can be used if the other is accidentally damaged.

(*To be concluded.*)

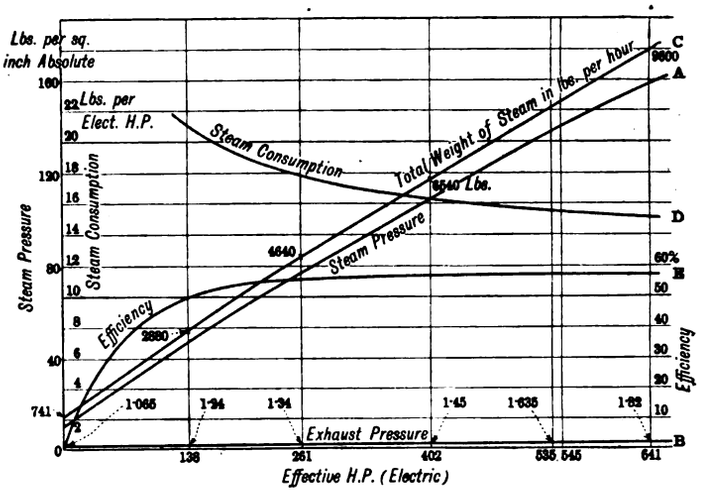

FIG. 5.—500 H.P. TURBINE DYNAMO (PEÑARROYA). Curves of Pressure, Consumption and Efficiency with Varying Power at Constant Speed of 2,400 revs. per minute.

Table I.

Data.	¼ Load.	½ Load.	Full load.	Over-load.	Overload at 2,400 revs.
Electrical H.P. at brushes.	135·0	259·0	525·0	627·0	641·0
Admission pressure, absolute, lbs. per sq. in....	46·21	76·6	136·0	156·0	156·0
Exhaust pressure, absolute, lbs. per sq. in. ..	1·24	1·38	1·63	1·82	1·82
Theoretical steam consumption of perfect engine per H.P. hour, lbs.	10·93	9·8	8·89	8·73	8·73
Actual steam consumption per E.H.P. hour at brushes, lbs.	21·3	18·0	15·8	15·39	14·90
Combined efficiency of the electrical generating set	0·513	0·540	0·560	0·569	0·580

Tramways in France.—According to *l'Electricien*, the French tramways aggregate 3,500 miles and are worked by 172 companies, who spent £32,200,000 on their construction. The average net income per mile is stated to amount to £130. 1s. In the Deparment of the Seine the length of the tramways is 231 miles. The initial cost of these is given as £9,450,000, and they are worked by 10 companies. During the first half-year of 1903 the total receipts are stated to have been £925,000, the net profit being £172,000. Three of these companies, however, are working at a loss, the losses in the second half-year of 1903 being, according to our contemporary, £6,680, £4,440 and £800 respectively.

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PHYSICAL SOCIETY.

At a meeting of the Physical Society held on May 27th, Mr. J. SWINBURNE, vice-president, in the chair, a Paper entitled

"The Law of Action between Magnets and its bearing on the Determination of the Horizontal Component of the Earth's Magnetic Field with Unifilar Magnetometers"

was read by Dr. C. CHREE. Starting with the general formula for the action between two magnets perpendicular to one another, in Lamont's first position, the Paper discusses how observations should be combined when the higher terms usually neglected in magnetometer reductions are taken into account. It considers the effect of errors in setting the deflecting magnet or in the values assigned to the graduations of the deflection bar, and of errors in the deflection angles, according as observations are made at one, at two or at three distances. Assuming a simple magnet to be replaceable by poles, and making use of formulæ due originally to Lamont and Börgen, calculations are made as to the size of the several coefficients P, Q, R in the deflection formula, for hypothetical values of the pole distance, in the magnets of the more usual English magnetometer types. These calculated values are compared with the mean values observed at Kew in past years in magnetometers of the several types; and conclusions are drawn as to the mean ratio of the pole distance to the total length of the magnets. The question of variation in the pole distance with time is discussed in connection with recorded mean annual values of the P coefficient for the observatory magnetometers at Kew, Batavia and Mauritius. The Paper concludes with the results of some experiments on the degree of uniformity in the pole distance of magnets of the same size and pattern. The method consisted essentially in employing two magnets alternately as deflector and deflected in the same magnetometer. Instrumental peculiarities are in this way largely eliminated.

Dr. W. WATSON said that the author had referred in the course of his remarks to a statement which he (Dr. Watson) had made at a former meeting of the Society to the effect that the limit of accuracy in the setting of the magnet carriage upon the deflection bar was 0·1mm. Although it might be possible, when working under favourable conditions at an observatory, to make the setting with greater precision, he thought that 0·1mm. was as much as could be expected or obtained in ordinary work in the field. He pointed out that the number of settings in a deflection experiment was a safeguard against inaccuracies in individual settings, and that it was probable that there was no source of constant error. He expressed his interest in the author's experiments on pole distances, and said that when the magnetometers were being designed for the Indian survey he had expressed the opinion that it might be advantageous to make the coefficient Q equal to zero by choosing suitable pole distances for the magnets. Probably Dr. Chree's experiments will enable us to settle whether it is sufficiently accurate to make Q as small as possible and work with a value of P only, determined in the ordinary way.

Dr. P. E. SHAW pointed out that brass, which is used for the deflection bar, has a specially large thermal expansion, and if 50cm. of it rises 3°C. the increase in length would be about 25 microns, which Dr. Chree stated to be the error in setting the magnet carriage on the scale. Possibly some alloy—*e.g.*, some form of invar—would be preferable to brass.

Prof. H. L. CALLENDAR said that some time ago he made some experiments upon the distance between the poles of magnets, and the conclusion he came to was that it was impossible to express the pole-distance as a definite fraction of the length of the magnet. He had found that, among other things, the pole distance depended upon the shape of the magnet, the intensity of magnetisation and the kind of steel of which the magnet was composed. There was also a variation of the pole distance with time.

Mr. SKINNER said it might be possible to fix the position of the poles by using magnets similar to those used by Mr. Searle in many of his experiments. These magnets consisted of long thin needles with steel balls at the ends, and it was found that the poles were very close indeed to the centre of the balls.

Dr. CHREE said that the limit of accuracy in the setting of the magnet carriage which he had mentioned (0·03mm.) was that which was obtainable when working under the most favourable conditions. With regard to the material of the deflection bar, he pointed out that a sufficiently accurate temperature correction was always employed to correct for thermal expansion. There was no invar which was sufficiently non-magnetic to be used in accurate work with a magnetometer.

A Paper on

"The Ascertained Absence of Effects of Motion through the Æther in relation to the Constitution of Matter on the FitzGerald-Lorentz Hypothesis,"

by Prof. J. LARMOR, was taken as read. In consequence of recent misapprehensions (*cf.* D. B. Brace, *Phil. Mag.*, March, 1904), the argument on this subject, as given in "Æther and Matter" (1900), is briefly restated. The absence of effect of convection, to the first order, was demonstrated by Lorentz. Absence of effect to the second order of the ratio of the velocity of convection to that of radiation has now been experimentally established, as regards optical interference with long path, by Michelson; as regards mechanical action on a charged electric condenser, by Trouton; as regards double-refraction, by Lord Rayleigh and by Prof. Brace. This suggests strongly a complete correspondence in detail between the material system connected with the earth's motion and the same system at rest in the æther, so that their internal relations are indistinguishable. Theoretically, such complete correspondence, up to the second order, exists, involving the FitzGerald-Lorentz shrinkage, provided a purely electrical constitution of matter (as regards its physical relations) is granted, but apparently not otherwise. Thus it is held that these phenomena point consistently in that direction.

A Paper on

"Coherence and Re-coherence,"

by Dr. P. E. SHAW and Mr. C. A. B. GARRETT, was read by Dr. Shaw. In a Paper in the *Phil. Mag.* (March, 1901) Dr. Shaw described a method of investigating coherence by measuring the forces required to sunder the cohered surfaces. It was there shown that forces of the order of 1 dyne were required for a copper-copper contact of two single wires. Further, there seemed to be evidence of a change of state at the place of coherence, possibly orientation of the particles at the contact. In the present Paper the authors follow the same method of investigation, adducing evidence that coherence can be explained, and only explained, by Lodge's original theory of fusion; and further establishing the after-effect, whether orientation or otherwise, mentioned in the former Paper.

When electrical radiation falls on a contact of two wires, under suitable conditions coherence occurs. On applying a small measured force the cohered surfaces separate. On bringing them into contact again at the same places coherence will often, but not always, occur without the incidence of electric radiation. This can be repeated two or three times, but the power to cohere spontaneously soon vanishes. This spontaneous coherence is called recoherence. Like coherence, its presence is indicated by the forces required to sunder the surfaces. Several tables of these results are given.

Allowing that coherence itself is due to fusion, for which the evidence is abundant, recoherence may be due (1) fusion, (2) molecular or intra-molecular change, brought about during coherence by the locally violent surgings at the contact.

As to fusion, Prof. J. J. Thomson has suggested that the opposed spikes formed when the surfaces are torn asunder may be so fine as to be fused together by the small circuit current when the surfaces meet again. Without such spikes it is obvious the surfaces would be normal, and no spontaneous coherence could occur. Against the spike theory it is pointed out that recoherence never recurs more than a few times, which indicates some unstable condition of the surfaces. The orientation seen in magnetism can be destroyed by reversals of decreasing currents, by mechanical shock, and by heating. On adopting these methods to destroy recoherence, the authors obtained no definite results.

Recoherence is therefore still unexplained. Two surfaces can be pressed together with small but measurable forces by two methods: (1) by a boom attached to a galvanometer suspension; a current in the galvanometer regulates the pressure between a wire on the boom and a fixed wire, these two forming the contact. (2) By a light balance of aluminium rendered only just stable; the pressure is regulated by a current in a solenoid, which acts on a magnet attached to one end of the balance. Both these methods are used by the authors to bring the surfaces into contact and to tear them apart again. The forces operating can easily be measured by a subsequent calibration.

Dr. W. WATSON, referring to the fact that when recoherence ceases to occur with a direct current it may be re-established by reversing the current, suggested that it might be due to the effect of the oscillations set up in the circuit at the make and break.

Dr. C. CHREE asked whether the authors could indicate approximately the relative number of cases in which re-coherence failed when the current was not reversed, but occurred when the current was reversed. He suggested that the fragmentary remains of the bridge which the authors described as existing during coherence might sometimes be so shaped as to make it easier for the current to pass in one direction than the other.

Prof. TROUTON asked if re-coherence would occur without a current running through the contact. He suggested that one side of the contact might be a point and the other side approximately plane, so that the current would flow more easily in one direction than the other.

Mr. R. S. WHIPPLE asked if the effect depended upon the materials. In the case of a Callendar recorder, with a boom contact, the contact-pieces being made of platinum, it was found that the sensitiveness of the instrument depended upon the direction of the current.

Dr. R. S. CLAY asked if the reversal of the currrent which established re-coherence took place when the substances were in contact.

Dr. P. E. SHAW, in reply to various questions, said that mere reversal of current would not produce the re-coherence phenomenon. It only occurs as a sub-permanent effect following coherence, and cannot therefore be attributed to sparking caused by rapid reversals. As to the action of platinum and other materials as contact-surfaces, he found platinum singularly apt at coherence, but re-coherence has not been looked for except in a copper-copper contact. Any explanation offered for re-coherence must take account of the observed effects—viz., that it is a sub-permanent effect following coherence, is unstable to various influences, and arises most often by reversal of current but sometimes without such reversal.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E FOURNIER D'ALBE.]

Cathode Spectra.—The blue line of lithium is broadened in the spectra of the regions near the negative element both in the arc and the spark spectra. H. Ramage, who discovered this effect, has now made some further observations of electric sparks in air at ordinary pressure. A quantity of lithium salt was fused at the end of a platinum wire forming the spark-gap of an induction coil. When the coil was started with this as the anode there were frequent bright red flashes. On reversing the spark, a bright red colour developed in the flame near the cathode. The broadened lines previously described were associated with a bright spot of white light observed on the salt where the spark touched it. The lithium vapour liberated from a hot anode appears to carry a positive charge and thus to convey part of the current to the cathode, but the lithium vapour liberated from the cathode does not appear to be charged. Magnesium, aluminium, zinc, tin and lead give bright spots on both electrodes, and there are differences between the spectra of these. The spectra of the anode spots on magnesium and aluminium contain the "oxide bands" of the metals, but these bands have not been observed in the cathode spots. An examination of the sparks in a revolving mirror shows that coloured flames actually shoot out from the cathode.

[H. RAMAGE, *Proceedings of the Cambridge Philosophical Society*, April 22, 1904.

N-rays from Nerves under Anæsthetics.—J. Becquerel and A. Broca have followed up their researches on the influence of anæsthetics on N-radiation from sulphide screens and sand by experiments on living animals. They used ether, chloroform and chloral, and found that each anæsthetic produced characteristic effects. During the period of excitement which precedes anæsthesia, the brain was observed to emit N-rays in enormous quantities. This was best seen by the weakening of the rays on passing the sensitive screen over a suture of the skull, when there was a decided diminution of brilliancy. On further application of the anæsthetic the emission of N-rays ceased, and shortly afterwards the N′-rays began to appear, shown by the screen increasing in brilliancy on passing a suture. In the case of ether, the latter rays only appear when the life of the animal is in danger. In the case of chloroform, the N′-rays appear during the whole duration of profound narcosis, even in cases where the animal awakes of itself. In the case of chloral, the N′-rays appear still earlier. As a general conclusion, the authors state that the total disappearance of radiation from the nerve centres during several minutes is a sure sign of death.

[BECQUEREL and BROCA, *Comptes Rendus*, May 24, 1904.]

Electrical Vibrations in Simple Circuits.—J. A. Pollock has compared the periods of electrical vibrations connected with narrow rectangular closed circuits with those of the oscillations associated with straight wires and with open and closed rings. The method adopted was to discharge a condenser in the neighbourhood of a narrow rectangular closed circuit. Oscillatory currents were thus set up in the rectangle, which, in turn, induced others in the third circuit of the required shape. Observations of the amplitudes of the disturbances in the circuits were made with Rutherford's magnetic detectors, while the dimensions of the circuits were adjusted, step by step, until finally all three were in tune. The length of a circuit of any shape could thus be found which had the same period of electrical vibration as that of a given rectangular narrow closed circuit. The author gives a number of tables and curves illustrating the relation between the rectangle and the straight line, arc of curve, or closed circle which is equivalent to it. The average ratio of perimeter of rectangle to length of straight wire was 2·4. The equivalent circular arc was a little larger, but in the case of the closed circle the perimeters were nearly equal. The author confirms Macdonald's conclusion that the wave-length of the free oscillation associated with open circuits is considerably greater than twice the length of the wire.

[J. A. POLLOCK, *Philosophical Magazine*, June, 1904.]

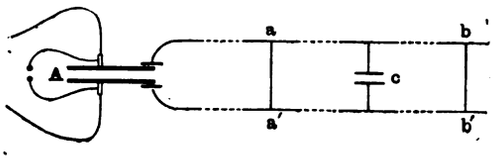
Condensation Nuclei.—If air containing condensation nuclei from any source whatever is introduced into a cylindrical condensation chamber over pure water, and if the cylinder is rotated on its axis more or less rapidly, without further interference with the air contained, the charge of moist air will soon be found free from nuclei. In view of the fact that the bubbling of air through water, so far from de-ionising air, actually ionises it, C. Barus and A. E. Watson have further investigated the above effect. Nuclei were produced in dust-free air by passing the X-rays through a cask of paraffined wood. The coronas were viewed through two diametrically opposite strips of plate glass. As a rule, the nuclei vanish in less than three minutes of moderately fast rotation, say two turns per second, the cask being 35cm. in diameter. But when the cylinder is rotating so rapidly that the water is held up as a smooth sheet against its sides, the time loss in nuclei is not much larger than when the cylinder is stationary. When, on the other hand, only part of the water is carried round by rotation, then the cleansing effect is very marked. The authors believe that nuclei are lost by the continued bubbling of air through the water.

[BARUS and WATSON, *American Journal of Science*, May, 1904.]

Ionisation of Air.—C. T. R. Wilson describes a new apparatus for the condensation method of demonstrating the ionisation of air under normal conditions. It is much larger than the apparatus previously described, and the cloud chamber is made of brass instead of glass. The expansion producing a rain-like condensation in dust-free air was found to be 1·247, or slightly less than the values previously found. When the expansion only slightly exceeds the critical value, a difference of potential of 160 volts entirely prevents the formation of drops. When the expansion is made larger, a few drops are seen even in the presence of the field. The drops increase in number as the expansion is increased. A difference of potential of 40 volts between the plates was found to reduce the number of drops formed on expansion to sensibly the same degree as 1,000 volts. Even a P.D. of 2 volts produced a noticeable diminution. Expansions capable of catching all the negative ions produced drops all of which had fallen to the lower plate in less than three seconds. The distance between the plates was 4·7cm. The rate of fall when negative ions alone came into action thus did not exceed 1·6cm. per second. Treating these data by Thomson's method, the number of negative ions present, in the absence of an electric field, comes out as less than 1,000 per cubic centimetre. This is in agreement with the values obtained from the leakage experiments.

[C. T. R. WILSON, *Philosophical Magazine*, June, 1904.]

Dielectric Constant of Water.—O. U. Vonwiller has made some experiments with a view of investigating the variation of the dielectric constant of water with temperature in the neighbourhood of its point of maximum density. The special object of the research was to verify Thwing's alleged maximum in the



dielectric constant at that point. The experiments, however, failed to reveal any such maximum. They were carried out with electrical oscillations having a frequency of about 25 million per second, produced in a Lecher wire system by the oscillatory discharge of a condenser. The arrangement of the apparatus is shown in the diagram. A is a condenser consisting of two parallel circular brass plates, 30cm. in diameter, connected to the ends of the secondary of an induction coil. Two brass plates are held 8mm. from the plates of A, and attached to them are brass wires 30cm. apart. Two bridges of copper *aa′* and *bb′* are placed across these brass wires, and the virtual length of the wires is increased by means of a condenser, C.

[O. U. VONWILLER, *Philosophical Magazine*, June, 1904.]

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THE COMING OF THE STEAM TURBINE.

Messrs. PARSONS, STONEY and MARTIN'S Paper and that of Prof. RATEAU, of which we commence an abstract in this issue, bring to a conclusion a sequence of important Papers giving the results of recent tests on various types of steam turbines. The interest taken in the use of steam turbines in central stations as shown by the discussion which took place in our columns last winter, has not been diminished by these recent contributions to the subject, and Prof. RATEAU'S Paper, as describing a less familiar type, will be read with interest. The Institution discussion brought out no points of great novelty; the figures published in the Paper go to confirm the good results formerly obtained with the Parsons turbine, and show that it goes on its way improving as it grows in size. The criticism was mainly directed against the large condensing plant required by a turbine as compared with a reciprocating engine, and to the increased steam consumption at light loads. Despite these objections, the discussion leaves the impression that the steam turbine's growing popularity is based on sure ground, for it was notable that the strongest supporters were those whose experience of turbines was most extended. To be valuable, any criticism on the use of steam turbines in central stations must take into account the steadily-changing conditions of modern practice. The growth of the power load has been such that it is rare to find a generating set running for many hours a day at a small fraction of its full load. For a variety of reasons, but principally on account of capital cost and working and management expenses, the day of small stations and small generating sets is almost past. The large stations which are now being built feed large areas, and to do this high-pressure transmission must be adopted; thus one factor which helped to decide the most suitable site for a station—namely, loss in mains—has become of minor importance. Choice of site then becomes less restricted, and is determined by such considerations as cheapness, nearness to a plentiful supply of water, and convenience of transport of coal. The increasing use of polyphase transmission emphasises the importance of even turning moment and steadiness of speed. Owing to the inherent high speeds of the turbine the designer is enabled to build a cheap and efficient alternator, and the troubles met with in the design of continuous-current machines do not appear to be insuperable, though there will doubtless be considerable modification of those present designs which are copies of slow-speed machines.

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Change from reciprocating engines to turbines necessarily alters the general proportions of a station design. The small floor space required by the generating sets leads to designs such as that of the Carville power station of the Newcastle Company or the Thornhill station of the Yorkshire Company; the space taken by the boilers even suggests a two-storey construction as most suitable for the boiler house in certain circumstances. What has not been so much emphasised is the fact that where steam turbines are used there is little advantage in extremely high boiler pressures and abnormal superheating. The possible efficiency of the turbine is high, the principal losses being due to skin friction and leakage; an adiabatic expansion of the steam being practically obtained the work available is proportional to log p_1/p_2, where p_1 and p_2 are the initial and final pressures. It will be seen, therefore, that a reduction of the boiler pressure is of small importance compared to a change in the pressure in the condenser; and moderate boiler pressures not only tend to the easy working of a station but to a reduction in the cost of boiler-house equipment.

The question of condensing plant is one of extreme importance, and here the cost of equipment will be increased over that required for reciprocating engines. The circulation of the large quantity of water which is requisite will often have to be performed against a considerable head, and an appreciable percentage of the output of the turbine will necessarily be absorbed. Owing to the impurity of the circulating water, the use of surface condensers is in many cases imperative, and, in present-day condensers, a rapid transfer of heat cannot take place unless the velocity of the water is increased so that eddying takes place. We may look, therefore, to some improvement in the design of condensers, but the greatest improvement is to be expected in the air-pump. The augmentor described in Messrs. PARSONS, STONEY and MARTIN'S Paper indicates that there are ways still open of increasing the effectiveness of this machine. With regard to jet condensers, steady advances have been made, and there seems no real reason why good results should not be obtained from the use of these. There is, then, hope that some improvements will be made in this direction, but the condensing plant must always remain an important part of the machine.

Owing to the fact that the steam consumption per unit generated decreases with an increase of load in all turbines, the question of overload capacity becomes of considerable importance, but the fact must not be overlooked that a turbine, unlike a reciprocating engine, has a poor starting torque, and if severely overloaded will come to rest, much as an induction motor does, and will not restart unless the load be reduced. Still it is evident from Mr. MERZ'S recent Paper that steam turbines may be relied upon to give loads considerably higher than their normal rating, so that, if the size of unit be carefully chosen, no turbine need be run at a light and inefficient load. It may be mentioned, however, that, in comparing the various types of turbines, the impulse type has a distinct advantage for light loads, as the steam consumption at light loads is increased by a smaller amount than with the other type.

Probably the most important consideration of all is that of cost. Not only is there an economy in the building, but for large units the turbines themselves are cheaper than reciprocating engines. The success of turbines constructed with large clearances, and without the need of fine workmanship, leads one to hope that the present price of turbines may be still further reduced. Modern tendencies in central station practice are towards a reduction in the capital cost of main and auxiliary plant. That the steam turbine does this is the strongest reason for its adoption.

HIGH-SPEED ELECTRIC RAILWAY EXPERIMENTS ON THE MARIENFELDE-ZOSSEN LINE.*

BY ALEXANDER SIEMENS.

On September 4, 1901, Mr. O. Lasche, of Berlin, read a Paper on "A High-speed Railway Car" before the Engineering Conference in Glasgow, which has been published in Vol. XXXI. of the *Journal* of this Institution. Since that time three sets of experimental runs have been made with high-speed cars on the military railway between Marienfelde and Zossen, near Berlin, which had been equipped electrically for the purpose, and last autumn speeds of over 200km. per hour were attained. Although further experiments are in contemplation, it may not be out of place to give a short history of the trials and of the preparation for them, as the main objects of the investigation have been accomplished.

The English patent 10,926/86, "Improvements in the application of Volta Inductors or Secondary Generators for distributing electrical energy and for regulating alternate-current motors, more particularly applicable to electric railways," communicated by Siemens and Halske, Berlin, forms a convenient starting point for such a narrative, as the Zossen experiments may be considered the latest link in the chain of development of the ideas enunciated in that patent. It is pointed out in the specification that "the use of Volta inductors or secondary generators for transmitting electrical energy offers the advantage of enabling a much higher tension to be employed than is possible with transmission by continuous currents, so that considerable energies can be transmitted through great distances by means of comparatively small conductors, while at the same time the regulation of the power of motion is capable of being effected much more easily." About the method of using the transformers in connection with electric railways, the specification suggests either to place them on the carriages or at certain distances apart along the line of rails. In the first case the primary coils are connected by rolling or sliding contacts to the conductor extending alongside the rails, which conveys alternate currents of high tension thereto; while in the second case the secondary coils of the transformers would supply low-tension currents to the working conductor and thence to the motors on the carriages. As motors, dynamo machines that can produce continuous currents are recommended, and various methods of regulating them are described. The results obtained with such motors at that time were, however, not very encouraging, chiefly on account of the high frequency of the currents employed, and no important practical steps were taken until the three-phase motors began to occupy the attention of electrical engineers.

In March, 1892, Mr. Wilhelm von Siemens gave instructions to have a short experimental line constructed at the works of Siemens and Halske in Charlottenburg, and try a 20 H.P. three-phase motor on it. The line was 360 metres long, with a curve of 40 metres radius and 70 metres long about the centre, the whole line being practically level. The current was supplied by a 50 H.P. three-phase machine, type R. 32/26, and between two tetminals of the same a difference of potential of 500 to 600 volts was kept constant. At the end of July the motor car was finished, and it was successfully tried on August 2nd, when loaded with 3,000kg. At starting the motor was connected triangle fashion, and afterwards star fashion, running 1,400 revs. per min. when the car was travelling at a speed of 22·5km. per hour. The movement was transferred from the motor to the wheels by worm gear at the rate of 11 to 1. Encouraged by the results, Messrs. Siemens and Halske formally applied, on October 29, 1892, to the Government for permission to equip from 40km. to 50km. of some imperial railway near Berlin, in order to investigate experimentally the possibility of working the ordinary railways by means of electricity. They proposed to place transformers along the line, from which a low-pressure current would be supplied to the cars, and they explained their desire for such a long line by their intention to run the cars at a speed of from 60km. to 70km. per hour. On November 12, 1892, the Government declared its readiness to take the proposal into serious consideration after the experimental line had been inspected by experts. Their visit took place on December 2nd, but on December 22nd the application was declined, as the experts had not been satisfied with the method of collecting the current from the conductor along the line. In the experimental line two overhead wires were used, the rails forming the third conductor, and the Government experts, as well as some of the engineers of Messrs. Siemens and Halske, considered such a system as inapplicable to full-sized railways. The consequence of this attiude was another long pause in the development, until five years later, when Mr. Wilh. von Siemens initiated further experiments, in which, however, high-tension currents were to be supplied to the car. His view was that, for great distances, the weight of the collectors had to be kept as low as possible, and that they would, for this reason, not be suitable to carry heavy currents; consequently, the tension had to be kept as high as circumstances

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would permit in order to allow sufficient energy being transmitted to the car.

A waste piece of land near Gross Lichterfelde was placed at the disposal of Messrs. Siemens and Halske by the parish, and they built a short line, about 1,800 metres long, of normal gauge, in 1898, equipping it with three overhead conductors for three-phase current of either 750 or 2,000 or 10,000 volts. At first the conductors were carried by insulators, each fastened to a movable wooden arm, and the current was collected by a horizontal bar, turning round a horizontal pivot and pressed by a spring from above against the conductor. When the speed of running was increased, these horizontal bars jumped at the insulators and caused so much sparking that this arrangement had to be abandoned. In rebuilding the line the three conductors were placed vertically one above the other, at a distance of 1 metre, and the insulators to which they were attached were supported by an elastic cord stretched between the two ends of a channel iron bent in the form of an ellipse and fastened to the poles. The collectors were also modified, each consisting of a horizontal arm, turning round a vertical pivot, and carrying a vertical bow sliding along the conductor, a spring pressing the arm against the conductor. This arrangement was eventually found satisfactory for the highest speeds attained. While it was possible to settle by the experiments on this short line a suitable form of collector and a reliable construction of the overhead conductors, it became obvious that for trials at greater speeds the assistance of the railway department of the Government was indispensable. In the course of negotiations to obtain this the scope of the proposed trials was widened in so far that the co-operation of other firms was secured by the formation of the "Studiengesellschaft fuer elektrische Schnellbahnen," on October 10, 1899. This syndicate consists of the Deutsche Bank, Delbrück Leo & Co., National Bank, Jacob S. H. Stern, A. Borsig, Phil. Holzmann, Frederich Krupp, v. d. Zypen and Charlier, Allgemeine Elektricitäts Gesellschaft, and Siemens and Halske. The War Office placed their single line between Zossen and Marienfelde at the disposal of the syndicate, and the president of the Imperial Railway Office became its chairman. Each year the syndicate has published a report of the trials of the preceding year, and all the data given in this Paper are taken from these official reports, unless another source of information is specially mentioned.

The permanent way of the military line consisted of rails weighing 33·4kg. per metre, placed on iron and partly on wooden sleepers, and its condition was such that no greater speed that 80km. per hour was allowed on it. In the first instance this was improved by relaying about 800 rails of 12 metres each, increasing the number of sleepers by 4,000 and adding broken stone ballast to the extent of 4,000 cubic metres. This work was finished and the line, 23km long, ready for the trials on September, 3, 1901, when the official inspection was satisfactory. At the same time electric contacts, to be actuated by the wheels, were placed at 500 metres distance from each other all along the line, and a registering apparatus at Mahlow station was connected to them, so that the speed of the cars could be verified there. The overhead conductors along the line were constructed by Siemens and Halske practically in the same way as the line at Gross Lichterfelde, with a device added to earth the line in case a conductor should break. At every insulator a metallic loop, about 30cm. in diameter, extending horizontally towards the pole, is connected to the conductor, and a vertical copper wire passes through the centre of the loops, the copper wire being efficiently connected to the running rails and through them to the zero point of the three-phase generators, the rails being, in addition, connected to metal earth plates at intervals of 1km. Any interruption of a conductor brings it, therefore, at once into contact with earth, and prevents any accident by shock from the falling conductor. The efficiency of this arrangement was tested, both intentionally and by an accident, when the conductor fell on an official, but in both cases the earthing served as an absolute protection. The line is fitted at every kilometre with means of adjusting the strain, kept at about 1,000kg., and with lightning dischargers of the horn pattern. At a distance of about 1km. from Marienfelde (8·5km.) the feeding line from the generating station Oberspree, 13km. distant, and built by the A.E.G., is joined to the line along the railway by a main switch.

Two carriages were built for the trials by v.d. Zypen and Charlier of Cologne, constructed and fitted as corridor carriages in accordance with the rules of the German Railway Union. One of these cars, called "A," was furnished with its electrical outfit by the Allgemeine Elektricitäts Gesellschaft, and has been described by Mr. Lasche as stated above, while the other was fitted out by Siemens and Halske, and has been described by Dr. Reichel (*Elektrotechnische Zeitschrift*, 1901, p. 671); in the reports the latter is called "S." Both cars carry the collectors, tested and approved of in the experiments of Siemens and Halske at Lichterfelde, with this modification, that in the "A" car each collector is carried by its own standard, while in the "S" car one standard carries all the three collectors. There are two groups of three collectors on each car. These cars were delivered on the experimental line in the beginning of September, 1901, and at first were drawn by locomotive so as to ascertain whether all their parts, especially the brakes and springs, were properly adjusted, and to study the mechanical behaviour of the collectors and conductors. Observations were also made as to the relative movements of the bogies and the carriages. A final inspection was made on October 1, and the permission to start running the cars by electricity was given on the following conditions:—

1. The trials may be commenced at a speed of 100km. per hour. This may afterwards be increased to 120, 140 and 150km. per hour, and subsequently at increments of 10km., provided that before increasing the speed an official inspection shows that the permanent way, the rolling stock, and all other apparatus have given no trouble at the last speed.

2. Level crossings are to be closed all along the line before runs at more than 100km. per hour are commenced, and proper catch-nets should be fitted under the conductors at the level crossings.

3. Experiments should at once be made to ascertain whether the electric instruments of the State railway and of the military railway are in any way affected by the working of the electric cars or by any breaking of the conductors.

4. The time table for the runs is to be agreed with the Direction of the State Railway, running alongside the military railway, and the station masters from Marienfelde to Zossen are to be advised on what days trials at speeds of more than 100km. per hour are to take place.

5. The conductors must not be charged with electricity, apart from the time table, except at times sanctioned and announced to the railway authorities by the syndicate with a view of trials on the shunting rails.

At the trials the following rules and regulations had to be observed:—

(*a*) By permanent-way officials:—

1. The trials and electric tests take place only between 8 a.m. and 11:30 a.m. Except during this time, the main switch at 8·5km. must be open.

It is to be kept under lock and key, which is in the custody of the representative of the syndicate.

2. Due notice of the time of the trials is to be given to all stations, Marienfelde to Zossen, and to all officials, including navvies, and no work is to be carried on during that time which might occasion contact with the conductors, nor is anybody allowed during that time to remain directly underneath the conductors or to lean against the posts.

3. As soon as the departure of a trial-car has been announced by gong signal, all gates at level crossings have to be closed, and the officials have to remain outside the gates until the trial-car has passed.

4. If a conductor breaks during a trial, nobody should touch the fallen ends until reliable advice has been received that the current has been cut off. Should the conductor break during the time the current is off, the ends should be placed out of the way of the ordinary traffic, and notice should be given to the inspector.

5. If any irregularity of the posts or of the conductors is noticed, the inspector should at once have this put right, or cause the syndicate to remedy the defect.

6. The permanent way between Marienfelde and Zossen is to be carefully inspected every day after the close of the trials, and any important irregularity is to be reported to the inspector, and no further trials must be run until the permanent way has been repaired.

7. To the stations, to the inspectors and to the guards of level crossings a copy of the pamphlet "First Aid for Accidents Caused by Electricity" is to be handed.

(*b*) For trial runs:—

8. When trials at a speed exceeding 100km. are to be run, the representatives of the military railway and of the State railway at Marienfelde have to be informed the day before.

9. On the days of the trials the main switch at 8·5km. may be closed after 8 a.m. The representative of the syndicate will permit the conductors to be charged when all work on the cars has been finished and all other preparations are complete. He then, with the consent of the engineer in charge of the respective electric company, will have the collectors brought into contact with the line, after a signal by a loud gong has been given in the shed.

10. As soon as the conductors are charged, nobody is allowed on the roof of the cars, and after the collectors are in contact with the line no further work must be done on the cars in connection with their electric fittings or with their bogies. Offenders against this rule to be removed from the shed, and will not be re-admitted.

11. Should it become necessary, after the conductors have been charged, to work at the bogies or at the electric apparatus of a car, the collectors are to be carefully removed from the conductors and locked in that position in such a manner that no unauthorised person can move them.

12. Due care must be taken that the line and the level crossings are properly guarded before a run at a speed exceeding 100km. per hour is commenced.

13. A commissary of the military railway, the representative and at least one other member of the syndicate, the engineer-in-charge and a fitter of the respective electric company, the driver on duty and the car inspector should be present during each trial run.

14. The apparatus for starting and stopping the car must only be handled by the engineer-in-charge or by the driver.

15. A portable telephone is to be carried, so that in case of accidents a communication with the adjacent stations can be established with the help of the two lowest wires of the military telegraphs.

16. Before the commencement of each run the representative of the syndicate and the engineer-in-charge will settle the speed and the brake trials of the run.

17. At each trial sand and water, for extinguishing fire, are to be carried, together with such tools as may be wanted for slight repairs.

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18. When the run is interrupted, owing to a defect observed on the car, the collectors have to be removed from the conductors before an investigation takes place.

19. During the run the driver should note any places where the car does not run smoothly, and should inform the representative accordingly.

20. Should a fuse melt at the generating station, Oberspree, it should at once be replaced, but if it blows again nothing further should be done until telephonic communication has been established.

21. After completing the trials for the day the car inspector should minutely inspect the car and remedy any defects. Particular attention should be paid to the state of the axles, the tyres, the bearings, the springs and all parts of the pneumatic and hand brakes. A similar inspection of the electrical apparatus is to be carried out by the engineer-in-charge of the respective electric company, and the conductors along the line are to be examined by an engineer of Siemens and Halske.

22. In the car a copy of the pamphlet "First Aid for Accidents Caused by Electricity" is to be exhibited, and all notices concerning the touching of apparatus, entering the cars, &c., are to be strictly followed.

On October 3 and 4, 1901, the conductors along the line were officially inspected and tested under pressure, and on October 7th the electric current was for the first time turned on to the cars. The technical committee of the syndicate had settled on September 24th that the trials should be undertaken in such a manner as to ascertain—(1) The highest safe speed on the line. (2) The proper construction of the permanent way. (3) The most advantageous construction of the car. (4) The most suitable electrical outfit. (5) The amount of energy at the various speeds. (6) The cost of working.

To obtain the necessary data, each car has been fitted with the following instruments:—(1) A speed indicator for the driver. (2) A speed-registering apparatus. (3) An acceleration indicator. (4) A voltmeter. (5) An ammeter. (6) A wattmeter. (7) A phase indicator. (8) A pyrometer. (9) Air-pressure indicators.

The speed indicator registers the kilometres per hour, and is checked by the speed-registering apparatus on the car and by the instrument at Mahlow station, where the position of the car is indicated every 500 metres by the wheel contacts along the line. Of the greatest importance are the observations in connection with the brakes, both as regards the time and the distance taken to bring the car to a standstill after it had attained certain speeds. At the generating station in Oberspree, suitable instruments for registering volts and amperes were connected to the feeder, so as to check the apparatus on the cars. Four sets of trials were to be run:—

(1) Starting and braking experiments up to a speed of 100km. per hour. The generating station to supply current at 25 periods and the motors to receive current only long enough to attain the prescribed speed, when the current is to be cut off and the brakes are to be applied. (2) Running at an equal speed, with current of 25 periods, first from station to station and afterwards along the whole line, with resistances in circuit so as not to exceed the prescribed speed. (3) Similar experiments as under (1) and (2), but with currents of higher periods for speeds from 100km. to 130km. per hour. (4) Running with currents of 45 periods at speeds exceeding 130km. per hour.

The two cars were to be used on alternate days, and no increase in speed was allowed unless everything had worked satisfactorily at the last speed.

On October 8, 1901, the "S" car made its first run between the car shed and 10·5km., but while the current was on the signalling apparatus of the State railway and of the military line were sufficiently affected to require the construction of metallic returns along the whole line. This was finished in time for the regular runs of both cars to commence on October 14th, and they were continued until November 30th, with the exception of 12 days, during which the permanent way had to undergo extensive repairs. During these trials the cars ran about 3,000km., of which 2,200km. were under current, and for 800km. the cars were pulled by locomotives before any current was used. The first two sets of experiments were carried out according to programme, and dealt with speeds up to 130km. per hour, and they were principally utilised to ascertain the rate of acceleration and the data of braking. During the third set the speed was gradually increased until the "S" car reached a speed of 160·2km. per hour on November 5th, while the railway officials made an inspection of the line in accordance with the regulations governing the trials. Even at a speed of 140km. the running of the cars became irregular owing to the condition of the permanent way, and at higher speeds the rails were bent and their level was so much disturbed that the speed of the subsequent runs had to be restricted to 130km. per hour. It was, however, possible to make valuable measurements of the energy required, and the working of the collectors and conductors could be observed with currents of 48 periods and 13,500 volts. About the behaviour of the various component parts the report of the syndicate enters into great detail, of which a short summary only is given. At the generating station the steam dynamo and transformers worked quite satisfactorily, and supplied current of 25 to 50 periods and 6,000 to 14,000 volts. The feeder consists of four conductors, each of 50 sq. mm. section, the fourth conductor connecting the running rails to the zero point of the two transformers. The conductors along the line, constructed as described above by Siemens and Halske, have given no trouble whatever, even in heavy rain or hoar frost. One of the most important problems—namely, to ascertain how large quantities of energy can be transferred from a standing conductor to a rapidly moving car—has been successfully solved by the construction of the conductors and of the collectors, both of which were the outcome of the experiment at Gross Lichterfielde. Both carriages, built by Van der Zypen and Charlier, ran in a very satisfactory manner, and ran steadier at a speed of 120km. to 130km. per hour than an ordinary corridor train carriage at 90km. per hour. At higher speeds the irregularities of the permanent way made the running dangerous. In the two articles mentioned above the electrical arrangements of the two cars are described in detail.

The report of the syndicate makes the following observations:—(*a*) It considers the switching arrangements of the "S" car more complicated than those of the "A" car, and suggests for both cars that it should be possible from either end to set both groups of collectors simultaneously. (*b*) The transformers in both cars are cooled by air, and have worked well during the trials. In car "S," after running 230km. in succession, necessitating 14 accelerations to a speed of 120km. per hour, the temperature of the transformers was only 25°C.; they were, therefore, considered sufficiently large to stand long runs, especially as they worked well with 12,000 to 13,000 volts. On the other car the transformers were much lighter, but they were never overheated, only on November 19th a primary coil was short-circuited by a current of 12,000 volts. After that date currents of no more than 8,000 volts were permitted, so that the point could not be settled whether the transformers on this car could be used for long periods with high voltages. (*c*) Each of the motors on both cars is designed for 250 H.P., the "A" car motors taking current at 435 volts, and the "S" car motors 1,150 volts, while the

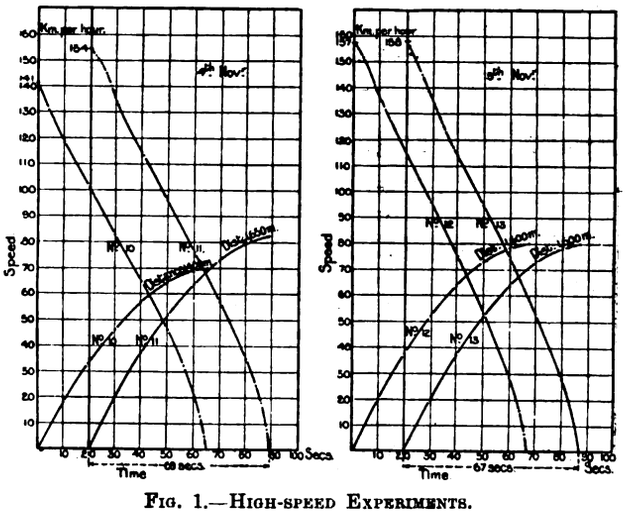

FIG. 1.—HIGH-SPEED EXPERIMENTS.

pressure in the secondary circuit is 650 volts when standing still and during acceleration. No difference in running was experienced, although the motors on the "S" car are rigidly fixed to the axles of the wheels, while the motors on the "A" car are carried by the bogie frame and drive by an arrangement of springs. The report prefers the latter arrangement, and suggests trying a third method—driving the wheels by connecting rods. (*d*) The switches and resistances present another feature in which the electrical arrangements of the two cars differ; on the "A" car liquid resistances were employed, regulated by pumps, while metallic resistances were carried on the "S" car. Both arrangements gave no trouble during these trials. The metallic resistance switches are more complicated than the others, but they work faster. Of great importance are the results obtained while accelerating and during the retardation of the cars. The acceleration varied with the demand on the generating station and the motors, as was to be expected. To obtain a speed of 100km. per hour the distances travelled varied from 2,000 to 3,200 metres, and the times from 138 to 220 seconds. These figures correspond to an average acceleration of 0·13 to 0·2 metre per second, and correspond to 700 H.P. to 1,000 H.P. As the motors are capable of exerting up to 3,000 H.P. during acceleration, this might have been increased correspondingly, but the generating set was not powerful enough to supply the necessary current. For trains intended to travel long distances without stops the rate of acceleration is, however, of less importance than the action of the brakes on which the safety of the service depends. Both cars were fitted with a Westinghouse quick-acting brake, hand-brakes and an electric brake acting by reversing the currents through the motors. The "A" car had, in addition, an accumulator battery, the current from which could be sent through the three-phase motors. A great many trials with these brakes are reported which are not important enough

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for recording in detail, as the brakes were not satisfactory, but a few curves are reproduced in Fig. 1, showing the results. In Fig. 2 the decrease of speed is shown when the "A" car was left to itself after attaining a speed of about 106km. per hour. The wind at the time was W.N.W. and had a speed of 11·4 metres per second; it offered, therefore, less resistance during the run from Marienfelde to Rangsdorf than in the opposite direction.

Very numerous observations were made about the consumption of energy both in the generating station and on the cars, especially during the last set of runs. For this purpose readings were taken at the switchboard in the generating station every 10 seconds of the volts, amperes and watts, and the periodicity of the current was checked by the number of revolutions of the generating set. On the cars amperes and volts were read at intervals of from 15 to 30 seconds. The measurements at the station were the most accurate, as the instruments there were not exposed to the vibrations unavoidable on the cars. After making the observations they had to be

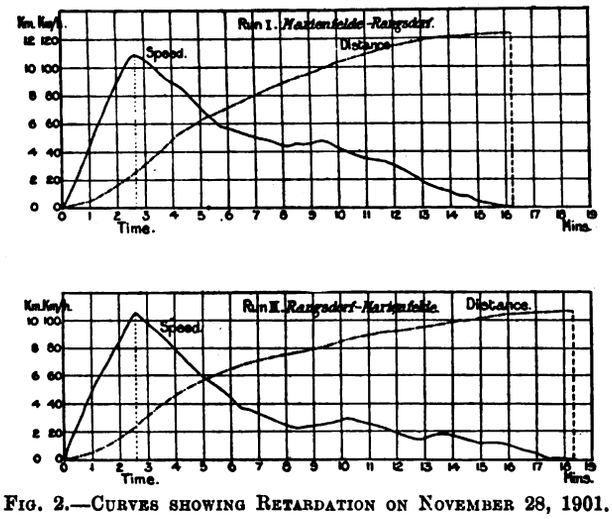

FIG. 2.—CURVES SHOWING RETARDATION ON NOVEMBER 28, 1901. CAR "A."

corrected, as the instruments were only correct at a certain periodicity. Numerous further measurements were taken, and the following table gives the average result of the power required at a constant speed :—

Car.	Speed.	B.H.P.			Efficiency of electrical outfit.		Consumption of steam.	
	Km. per hour.	Measured at feeding point.	Measured at car collector.	Calculated from speed.	Car by itself. %	Car and conductors. %	Kg. per B.H.P. per hour	
							At car wheels.	At flywheel of steam engine.
"A"	118	478	455	397	87	83	5·84	4·6
"S"	115	431	405	341	84	79	6·12	

The report does not consider these figures reliable enough for commercial deductions, partly because the instruments were not properly calibrated for the varying periodicity of the current, and partly because the motors in both cars were working very much below their rated output.

(To be continued.)

SOME PROPERTIES OF ALTERNATORS UNDER VARIOUS CONDITIONS OF LOAD.*

BY A. F. T. ATCHISON.

(*Continued from page 237.*)

ASYNCHRONOUS MACHINES.

There is an important type of generator which has recently received considerable attention, and which on account of many valuable properties may be expected to play an important part in alternating-current practice in the future. This type is the *asynchronous*, or, as sometimes called, the *induction* generator, which differs fundamentally from the synchronous machine in having a frequency not perfectly synchronous with the speed of rotation, but being (at constant speed) to a certain extent dependent on the load.

In its simplest form the asynchronous generator is an ordinary induction motor with the rotor mechanically driven above synchronous speed. Under these conditions it is well known that the machine acts as a generator and can supply electrical energy from the stator terminals.

The general equations for the induction machine giving the relation between torque, power and speed are of the form

$$T = \frac{E_1^2 R_2 S}{R_2^2 + S^2 x_2^2} \text{ and } P = \frac{E_1^2 R_2 S(1-S)}{R_2^2 + S^2 x_2^2}$$

where S is the "slip" expressed as a fraction of synchronous speed.

As in the case of the asynchronous motor the region of the curves with a greater slip than that corresponding to maximum torque represents a condition of instability—*i.e.*, the torque diminishes with an increase of slip—so that within the range of working conditions the properties of the machine are best studied as functions of the output rather than of the slip (Fig. 17).

Such a machine has properties altogether different from the ordinary synchronous generator. In the first place, to generate at constant frequency, the speed must increase slightly with the load just as in the case of the induction motor the speed decreases with the load, and, conversely, if driven at constant speed, the frequency will fall slightly with increased load owing to the necessity of a larger "slip" (which, of course, is negative in the asynchronous generator).

Further, the asynchronous machine has a definite power-factor for every load, and unless the power-factor of the external circuit is adjusted to this value, the induction generator cannot operate. Bearing in mind that in the case of the induction *motor* the current must lag behind the terminal P.D., and therefore lead in respect to the (counter) E.M.F., it will be seen that the induction generator can only operate on a circuit which takes leading current, and whose power-factor varies with the load to the exact extent required by the generator. If the value of the power-factor of the external circuit be too high (so that the leading current is insufficient for the generator at that load) the machine will not excite and cannot operate, whereas if the power-factor of the external

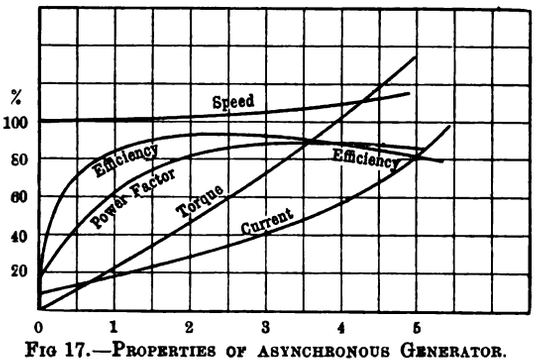

FIG 17.—PROPERTIES OF ASYNCHRONOUS GENERATOR.

circuit be lower than that required by the machine it will excite itself and raise its volage until by magnetic saturation (and therefore decreased permeability) the exciting current required is equal to the amount of wattless leading current in the external current.

The requisite conditions could not be realised in practice, and it is therefore necessary to have a synchronous machine connected to the stator terminals which can supply the necessary leading current to the induction generator, and secure the necessary stability of operation. The "exciter" may be a synchronous generator, in whic case the current it supplies will be lagging with respect to its own E.M.F., or a synchronous motor running lightly may be employed, in which case the induction generator E M.F. will rise until it is sufficiently below the counter E.M.F. of the synchronous motor to enable the latter to take the requisite leading current.

If the external circuit be inductive, the voltage of the generator will fall until the synchronous motor takes more leading current, so that the conditions of total power-factor required by the induction generator are satisfied; similarly, the voltage of the system may be maintained constant by regulating the excitation, and therefore the E.M.F. of the synchronous machine.

If the load is non-inductive, the amount of leading current required will be less than in the case of an inductive load, to give the same total power-factor for the generator to operate on. Similarly, if a load taking a leading current can be secured, the amount of current passing to the synchronous machine will be further reduced, until, when the power-factor of the load becomes exactly that required by the generator at that output, the synchronous machine could be dispensed with, except in so far as it is required to secure regulation of voltage and stability of operation.

It would be out of place in the present instance to go into the mathematical theory of the asynchronous generator, but a diagram showing the relation of the various quantities concerned will make the operation of the machine more clearly understood. It has been urged that the operation of asynchronous machines cannot be represented by vector diagrams, since the frequency of the rotor currents

* Abstract of a Paper read before the Birmingham Local Section of the Institution of Electrical Engineers on April 20th.

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and E.M.F.s is not the same as that of the stator or primary current, except at standstill; this objection, however, is not valid, because in their reaction upon the stator the rotor currents are of primary frequency whatever be the speed of rotation, since the sum of the "slip" frequency and actual speed of the rotor conductors is always equal to the primary frequency. It must be borne in mind, however, that the *relative* speed of the rotor conductors and magnetic flux determines the E.M.F. induced in the rotor, and also that the reactance of the rotor at any speed is its reactance at standstill multiplied by the (percentage) slip at that speed.

Taking a vector, OF (Fig. 18), to represent the flux common to both stator and rotor circuits, in quadrature and lagging behind this is the E.M.F. E_1 induced in the stator and E_2 (proportional to the slip and therefore of negative sign) the E.M.F. induced in the rotor winding.

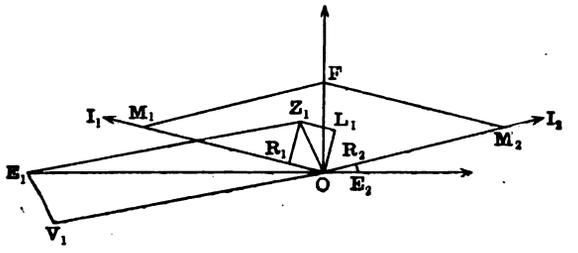

FIG. 18.—VECTOR DIAGRAM OF SIMPLE ASYNCHRONOUS GENERATOR.

The rotor current is given by the vector OI_2 lagging behind OE_2 by the angle $\tan - pL_2/R_2$ where pL_2 is the leakage reactance of the rotor winding at the speed considered. In phase with OI_2 is the magneto-motive force corresponding to it, and may therefore be represented by OM_2 (to a suitable scale of ampere-turns). The mutual flux OF is produced by the combined effect of rotor and stator ampere-turns, and, therefore, for the generator to operate it is clear that the stator current must have some such phase relation as OI_1, which is ahead of OE_1 in phase. The terminal voltage OV_1 is obtained by subtracting from OE_1, the vector of E.M.F. consumed by the stator impedance OZ, which is made up of its two components OR_1, the resistance drop in phase with OI, and the E.M.F. consumed by stator leakage reactance (of full frequency) OX_1 in quadrature behind OI.

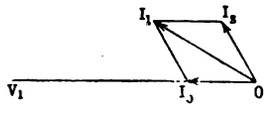

FIG. 19.

The angle V_1OI_1 then represents the phase difference which must exist between stator current and terminal voltage, and hence, if the load is such as to give a phase difference of less than this angle, it is necessary to employ, in addition, some apparatus which can furnish the requisite contribution of leading current which will combine with the external load current to give, as the vector sum, OI, the stator current. This additional source, as explained above, may be a synchronous generator or a synchronous motor connected to the stator terminals. Static condensers have been tried, to effect the same object; but as their power-factor is independent of the impressed voltage, such an arrangement is unstable and affords no means of voltage regulation.

The necessity of employing a synchronous machine in conjunction with an asynchronous generator is, in fact, a sufficient disadvantage

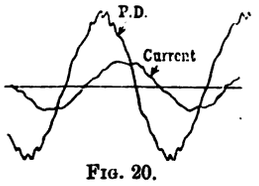

FIG. 20.

FIG. 21.

to prevent the commercial adoption of this form of generator; not because there is any inherent objection to such a combination in itself, but because the size of the synchronous machine (which may be looked upon as the "exciter" for the induction generator) may have to be considerable in comparison with that of the generator itself, although contributing no power to the external load, and, moreover, the synchronous machine itself requires the usual direct-current machine and accompanying plant for its own excitation. It is easy to see that even on a non-inductive external load, and more especially on an inductive one, that the magnitude of the leading current furnished by the synchronous exciter may be great in comparison with the external current; thus, considering the stator current of the induction generator and the terminal P.D. to be represented by the vectors OI_1 and OV_1 (Fig. 19), as before, then, if the external load is non-inductive, the vector of external current OI_0 will be along OV_1, and the current flowing in the synchronous machine will be given by the vector difference of these—*i.e.*, OI_s. ($\cos V_1OI_s$ is the power-factor of the synchronous machine, and therefore V_1OI_s can never exceed $\pi/2$.) If the external circuit is inductive the conditions are even more unfavourable. In fact, at light loads, when the power-factor ($\cos V_1OI_1$) of the induction generator would be small, the current in the synchronous exciter might considerably exceed that of the external load.

Figs. 20 to 28 are some oscillograms showing clearly these properties of the asynchronous generator.

Fig. 20 shows the conditions when there is no external load, and shows the almost wattless leading current taken by the three-phase synchronous motor (running light and acting as the "exciter"). On putting on a small non-inductive load on the external circuit the total current supplied by the generator takes the form shown in

FIG. 22.

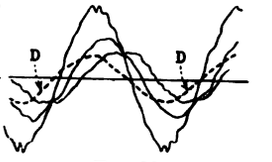

FIG. 23.

Fig. 21, increasing in magnitude and coming more nearly in phase with the P.D. On further increasing the non-inductive load the total current from the generator becomes still more nearly in phase with the P.D. (Fig. 22), owing to the increase of power-factor of the induction machine when loaded; but the generator still has to supply a leading current to its "exciter" similar to that shown in Fig. 20, only increasing also in magnitude. If we subtract this leading current from the total current coming from the generator

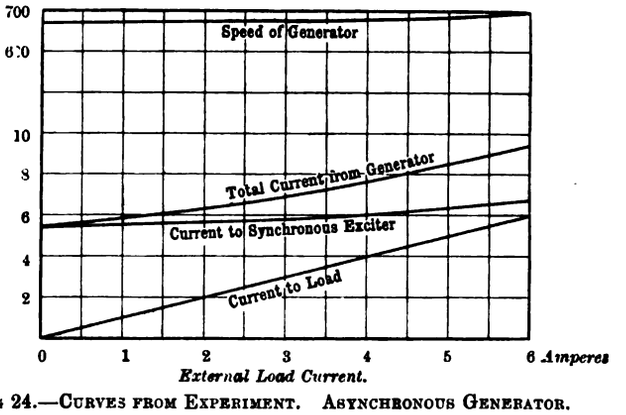

FIG 24.—CURVES FROM EXPERIMENT. ASYNCHRONOUS GENERATOR.

we get the current wave (curve D) in Fig. 23, which is the current in the external circuit and is practically in phase with the P.D.

The curves of Fig. 24 show how the total current in the generator, and that necessary to be supplied to the exciter, vary with the external load current; also the increase of speed necessary to maintain the frequency constant—the frequency is best determined by measuring the speed of the synchronous machine. A constant terminal voltage was maintained by slightly increasing the con-

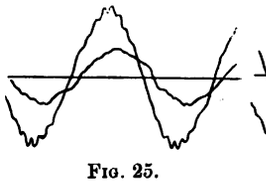

FIG. 25.

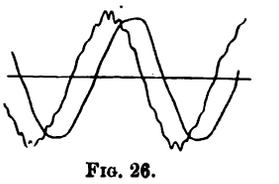

FIG. 26.

tinuous current of excitation of the synchronous machine. These curves show very clearly the great disadvantage of the induction generator—namely, the relatively large current in the synchronous exciter compared with that contributed to the load. That in the case of a highly inductive load this property is still further magnified is shown by Figs. 25 to 27, which show the current waves under these conditions. Fig. 25 is the total current from the generator, Fig. 26 the current taken by the synchronous machine, and, by subtraction, curve D in Fig. 27 gives the current in the highly inductive load.

Although a load of almost zero power-factor would never occur in practice, these curves are interesting as showing how the "exciting" current can considerably exceed the load current when the latter is

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inductive. (External load current, total generator current, and synchronous exciter currents being in this case 10·1, 6·0 and 14·5 amperes respectively.) The explanation of this has been given above in the vector diagrams of operation.

In spite of the disadvantage possessed by the simple asynchronous generator in being unable to supply the wattless component of current to an inductive load, such machines possess the very valuable property of being free from all troubles in connection with *hunting* when running in parallel. In the first place, they require no exact synchronising, and may, in fact, be switched into circuit when running considerably below normal speed; in this case the machine will merely take current from the 'bus bars and run as an ordinary asynchronous motor, and may be gradually speeded up until taking the desired share of the load. Exact governing of the prime movers is no longer of importance in the case of this class of generator, as the amount of load furnished by the machine depends simply upon its excess of speed above synchronism, and therefore is, to a certain extent, a self-governing arrangement.

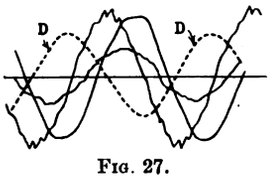

FIG. 27.

Any small change in speed does not give rise to the large fluctuations and "cross currents" which occur in the case of synchronous generators running in parallel, but merely alters the proportion of the load contributed by the machine without upsetting the stability of the combination. This inherent property of the asynchronous generator is of the utmost value for central station work, and if the objections pointed out above, in reference to the "excitation," could be overcome, such machines would present themselves as formidable rivals to the standard synchronous generators of to-day.

(To be continued.)

ROYAL COMMISSION ON LONDON TRAFFIC.

CONCLUSION OF THE EVIDENCE.

Friday, June 3.

Mr. EDGAR SPEYER was called, and said that he desired to deal with and reply to certain allegations made by the London County Council as to the capitalisation of the Yerkes group of tube railways (see *The Electrician*, Vol. LI., p. 629). The total share and loan capital granted during a period of 10 years—viz., 1893 to 1903—for the railways in question—*i.e.*, the Baker Street and Waterloo Railway, the Charing Cross, Euston and Hampstead Railway, the Great Northern, Piccadilly and Brompton Railway and the Edgware and Hampstead Railway—amounted to £16,193,000. This represented about £700,000 per mile (if the Edgware and Hampstead line, which was only partly a tube, were omitted), and he thought that this capitalsiation, so far from being excessive, as had been asserted in Mr. Haward's evidence, was reasonable. The capitalisation of the Central London Railway for 6½ miles of railway was about £650,000. In this connection he drew attention to the expensive connections with other railways, which necessitated a large expenditure owing to the high price of land. The Central London Company did not pay for the land at their great Bank station, and if they had, the cost of construction would have been increased by £90,000 per mile. Many other factors increased the present cost of construction of tube railways as compared with a few years ago. The equipment was considerably more expensive, largely owing to the great use of non-inflammable material. Labour cost more and construction work was 30 per cent. higher. Further, the raising of capital was more expensive. In giving the history of the Underground Company he pointed out that when Mr. Yerkes, in March, 1902, owing to the great expansion of the business of that company, went to Messrs. Speyer Bros., this firm, having convinced themselves that the project was a sound one, did all in their power to give it stability and the financial standing. They undertook to organise and provide £5,000,000 capital for the Underground Company, but stipulated that their firm should nominate the majority of the board of directors for a period of not less than 10 years, thus giving them continuous control and responsibility until the lines were all built and in operation for some years. For this, the three banking houses concerned received a commission of 5 per cent. on the capital. The public were sufficiently safeguarded by the individual Acts of Parliament relating to the separate railways, and the Underground Company had accepted the conditions attaching to these acts in good faith. As a proof of this, the bankers and their associates had already subscribed £12,000,000 towards the construction of the various railways in addition to the £5,000,000 referred to. In dealing with the probable traffic, he said he considered Mr. Harper's estimates too low. He had taken 200 journeys per head per annum of the population of London, which seemed small, for Berlin had 225 and New York 320. His own opinion was that if the population of greater London should reach 7,000,000 in 1905, which was very probable, the requirements for travelling would be 1,400,000,000, which seemed a moderate estimate. The tube railways referred to would be able to carry 327,000,000 per annum, and on the District Railway, 40,000,000 passengers more than at present. The suggestion as to the position of the public with regard to the enforcement of the statutory obligations of the separate companies by the Underground Company was entirely unfounded. All the railways in the undertaking were subject to the general laws applying to railways in this country. The existence of the limited liability company made it more easy to raise capital, and recent experience and developments in the money markets of the world had shown the wisdom of this policy. He handed in a complete statement of the relations between the Underground Company and its associated companies, and pointed out that the profits of the Underground Company were entirely contingent and dependent upon the success of the enterprise. One particular allegation of the London County Council he could not pass over without strong protest. It had been stated that the accounts would be so kept that it would be quite impossible to draw any useful conclusions therefrom. But obligations were placed on each railway to keep statutory accounts, and the Underground Company employed accountants of the highest standing in London.

Mr. J. CLIFTON ROBINSON, managing director and engineer to the London United Electric Tramways (Ltd.) dealt with Parliamentary procedure, and spoke very strongly against present methods, practically confirming the evidence given by Mr. Stephen Sellon and numerous other witnesses. He said that, looking at the Tramways Act of 1870 dispassionately it might be concluded that it never had in its purview the working of tramways by any local authority at all, and this view was emphasised by the remarks of Mr. Shaw-Lefevre when he moved for leave to bring in the Tramways Bill of 1870. Huddersfield was the first town in which the idea of municipalities operating their own tramways had been adopted, but in that case the Corporation only undertook it as a last resource, having had some uncompleted lines thrown upon its hands by a company. The fact was that at the beginning the only powers which the Corporation succeeded in obtaining consisted of a Board of Trade licence which expressly stated that the Corporation might themselves equip and work the lines only in the event of their failing to secure such terms as in the opinion of the Board of Trade would yield the Corporation an adequate rent. As a matter of fact, the Corporation themselves had to work the lines, and the total deficit up to 1897 was £60,000. Therefore it was the result of accident rather than of design that the precedent was established in this country for the entrance of a local authority upon a field of commercial enterprise which had previously been left in the hands of private companies. With regard to Standing Order 22, he said that it was understood at the time of the passing of the Tramways Act of 1870 that it was not intended to apply to the metropolis, but that the inclusion of London was due to the casting vote of the chairman of the Committee to which it was referred. However, he thought that the question was one in which Parliament should not be fettered by standing orders, and that all schemes should be considered on their merits, the local authority having a voice at the time. With regard to the demands of local authorities, he mentioned many instances in connection with the London United Tramways, which have been referred to in our columns from time to time. In respect of his own undertaking, he said that he did not suggest that all important tramway extensions were opposed solely because of the desire of the local bodies to get as much as they could out of the promoters. In the case of the London County Council and the Middlesex County Council, these bodies seemed to have been inspired more by a jealous wish to prevent the company laying any lines at all, so that the County Councils might strengthen their own position as tramway authorities. He regarded the latter attitude as a much more serious one than the former. With regard to local rates and wayleaves, he maintained that a tramway company was in a much worse position than the railway companies who complained of the unfair competition of tramways. The tramway companies did not run on roads for which they paid nothing. They had to repair and maintain the permanent way and pay rates on the roads so constructed and maintained. Further, their profits as tenants were fixed without any such rebate as that granted to a railway, which paid only a quarter of the district rate, and the whole of the tramway undertaking, including property, power house, depots and sub-stations paid local rates in full. As against all this the tramway company was not in permanent possession of its roadway as a saleable asset. Again, their portion of the road on which the tramway track was laid had to bear all the wear and tear of heavy traffic because of its good condition, and then as a final insult wayleaves had to be paid for the use of the road. These latter, in his opinion, should not be enforced. Dealing with the question of a new tribunal, he said he was distinctly in favour of such an authority. He would confer upon it the widest possible range of powers consistent with that supreme authority of the Imperial Parliament, which must needs be maintained. His own feeling was that any recommendation or proposal approved by a permanent body such as this would carry so much weight that even Parliament might hesitate to interfere with its suggestion. All vetoes should be abolished, and he objected entirely to any existing body claiming at the start an exclusive authority over an area that would tie the hands of the proposed tribunal. Such claims had already been advanced on behalf of the City Corporation, the London County Council and the Middlesex County Council. As to the question of obstruction in London owing to tramways, he said his view was that such obstruction was caused solely because the lines were not permitted to be laid through. A brief description was then given of the combination of the London United Tramways Co. with the District Railway Company and the various tube railway companies connected with it with regard to through bookings, &c. With regard to running powers, he suggested that it would be a very great advantage to the public if the representatives of the different tramway interests had power to run over one another's line. At present the London United Tramways

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Co. was not in a position to run their cars over any other system, but within a very short time the line from Hampton Court to Wimbledon would be completed, where it would join up to the London County Council line, and he then hoped to be able to negotiate with the Council as to running powers. It would be a great boon, for instance, for people to be carried from Blackfriars to Hampton Court. He saw no objection to a line being carried further into London than was the case at present, and, with a view to obviating congestion, suggested that when the narrower parts were reached the lines should dip underground and come up to the surface again beyond the congested area.

This concluded the hearing of evidence, but further private sittings of the Commission are to be held.

CORRESPONDENCE.

COMPLETION OF THE PRACTICAL SYSTEM OF ELECTRICAL UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Prof. Robertson's explanation (p. 240) of the value to be assigned to the permeability of air or vacuum is quite satisfactory. The following is, I think, the best way of dealing with this rather slippery subject. It is simplest to begin with the force exerted by a current on a magnet, because this, being independent of the medium, does not involve μ. Let A denote ampere-turns per unit length; then, if m is the numerical value of a pole in the ordinary and m' in the "rational" system, the force on a pole within a coil is $4\pi Am$, and is also Am'; hence $m' = 4\pi m$.

Next, if H and H' are the numerical values of a field-intensity, the force on a pole in a field is $Hm = H'm'$; hence $H'/H = m/m' = 1/4\pi$.

Again, the mutual force of two equal poles at distance r is

$$\frac{m^2}{\mu r^2} = \frac{m'^2}{\mu' 4\pi r^2} \qquad \therefore \quad \frac{\mu'}{\mu} = \frac{1}{4\pi}\left(\frac{m'}{m}\right)^2 = 4\pi;$$

hence the permeability of air is to be reckoned 4π times as great as in the old system.

Then, since B is μH, and B' is μ'H', we have B'=B.

As regards the name *kilogramme*, it is so well established that its total abolition and the substitution of something entirely different is out of the question. All we need is a convenient shortening. No great benefit would result from effacing its mark of derivation, and thus breaking historic connection. The name for our unit of time is similarly marked. In old books we find angles specified in degrees, minutes, seconds and thirds. The name *second*, whether for an angle or a time, was clearly intended to indicate the sixtieth of the sixtieth of a fundamental unit; but it answers our purpose very well, nevertheless.

I wish some practical men would tell us whether they are willing to employ in their calculations $4\pi \times 10^{-7}$ as the magnetic permeability of air, and $10^{-9}/36\pi$ as its specific inductive capacity. These seem to me to be the weakest points of the proposed system.—Yours, &c.,

J. D. EVERETT.

Ealing, W., June 4.

THE DESIGN OF ELECTRIC GENERATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On p. 275 Messrs. Parshall and Hobart do me the honour of referring to a passage in the new edition of my "Dynamo-Electric Machinery," in which I express a passing opinion favourable to the merits of one of five large generators described in their well-known work "Electric Generators." Of the five generators the designers are not mentioned, save in one case, and that the case of a distinctly inferior design. Messrs. Parshall and Hobart now declare their preference for another design different from that which I picked out for commendation. The designs which I selected for commendation and that which they now select are both open to criticism; for there are other criteria besides the one which they advocate, and which is beyond contest excellent as far as it goes. I cordially agree with them that blind copying by manufacturers of any design, irrespective of conditions of production, is to be deprecated. A design that is suitable for production in a country where labour is cheap and materials are dear must be modified before it can be equally good for production in a country where materials are cheap and labour dear. Their excellent rule about core-losses is framed upon considerations entirely other than those of the science of economics, which it is now the fashion to despise as a worn-out shibboleth. They have, however, avoided that burning topic—so will I. Electrical engineers owe so much to their labours that one must welcome any further suggestion of theirs for shortening calculations in design. Their curve on p. 275 is useful in such shortening of brain labour; and of its substantial agreement with the facts of standard continuous-current generators there can be no doubt. They have done well to draw fresh attention to it.—Yours, &c.,

London, E.C., June 7. SILVANUS P. THOMPSON.

TELEPHONE SYSTEMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to Mr. Poole's letter in your last week's issue, it may perhaps be of interest for me to recall that the relay and bell referred to by Mr. Poole were illustrated in my Paper "The Origin and Development of the Telephone Switchboard," read at a meeting of the Institution of Electrical Engineers on January 24, 1895, and published in Part 115, Vol. XXIV., of the *Journal*.

On reference to that number of the *Journal*, or to Vol. XXXIV., p. 397, of *The Electrician*, it will be seen that I remarked:—

This switchboard brings us one step forward in the inclusion of signalling apparatus in the connecting cords or bars at the central office. And I would invite particular attention to the way this was done, because I think it has been overlooked by some writers on telephone subjects. To each bar an indicator was connected in derivation, one end of the coil connected to the bar, and the other to earth. The specification [No. 4,903 of 1897] says: "The earth connection of the coupling-bar being through the coils of a magnet in no way interferes with the telephonic conversation"; which remark you will apply to the lines then prevalent with the electromagnet then used. The clearing-out indicator, as illustrated, was not mounted on the switchboard—there was a relay operating an audible signal; but a complete indicator is allowed for in the description.

—Yours, &c., J. E. KINGSBURY.

London, E.C, June 8.

RADIUM AND TERRESTRIAL MAGNETISM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As most suggestions and hypotheses are worth considering when they relate to scientific matters in their infancy, perhaps I might be permitted to suggest the association of terrestrial magnetism with a radio-active earth. The electric earth-currents producing the magnetic phenomena are the streams of electric matter or radiations derived from the disintegration of radio-active materials. These electric streams will occur in the earth itself and in its crust, and will be detectable in the surface layers and in the atmosphere. The intensity, or electric quantity measured per square metre, of the electric emanations that would be found in mines and in the free air would not be anything like so great as that of the deep-seated emanations, since absorption occurs in the earth. As the α-rays would be absorbed immediately after emission, the negatively-charged and more penetrative rays would probably be those giving rise to the magnetic phenomena.

The quantity of matter being greater near the equator may alone account for a magnetic equator near to the geographical equator, and rotation of the earth may augment the activity of the equatorial materials. A negatively-charged equatorial stream, with additional earth streams of less effect, would result in magnetic poles corresponding to those that exist.

Without further elaboration, I would suggest it would seem that when more is known of the radio active earth, and when enquiries have been made into the association of radio-activity and the magnetic elements, from a study of the survey maps, and into the effect of mechanical rotation on radio-active matter, and the absorptions of the emanations by sea-water, rocks, soils, &c., have been worked out, we may hope to get a glimpse of the earth's magnetic mechanism and lay bare another storehouse of phenomena.—Yours, &c.,

Herne Hill, S.E., June 2. ROBERT J. SOWTER.

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PARLIAMENTARY INTELLIGENCE.

LEYTON URBAN DISTRICT COUNCIL BILL.

REFUSAL OF THE "BERMONDSEY" CLAUSE.

The Police and Sanitary Committee (Section A) of the House of Commons, presided over by Mr. Heywood Johnstone, commenced consideration of this omnibus bill last week. Among the opposed portions are two which relate to tramways and electricity supply.

Mr. Baggallay, K.C., Mr. G. Fitzgerald and Mr. Hutchinson appeared for the promoters.

Mr. BAGGALLAY, K.C., in opening, described the district and gave figures as to rateable value, &c. Dealing with the tramways portion of the bill, he said that there were two tramway systems in the district—namely, that of the Lea Bridge, Leyton and Walthamstow Company and that of the North Metropolitan Tramways Co. Under the Tramways Act of 1870, the greater portion of these lines were about to fall into the hands of the District Council, but the portion belonging to the Lea Bridge Company running along the Leyton High-road would not fall in until 1910, and it was this line which the bill asked for power to purchase, negotiations with the company to that end having taken place. The two tramway systems in Leyton did not connect, and for that purpose certain new lines were proposed. Altogether, 36 new pieces of line were proposed, but most of them were merely junctions, doubling of existing lines, &c. It was proposed to work the tramways on the overhead system, and the total amount of money which the bill asked to borrow, including street widenings for tramway purposes, was £128,000. The bill also asked for power to run omnibuses in connection with the tramways. Another portion of the bill, he said, dealt with the electric supply undertaking of the District Council, power being asked for to supply energy in bulk to neighbouring corporations, the idea being that the authorities of Leyton, Walthamstow and West Ham would be able to assist each other when necessary. Among the opponents to the various sections of the bill, he continued, were the Lea Bridge Gas Co., the Great Eastern Railway, the London Omnibus Owners' Federation and the London General Omnibus Co. The Lea Bridge Gas Co. asked for special protection with regard to electrolysis in respect of the tramways and for the insertion of the "Bermondsey" clause in respect of the electric supply undertaking. The Great Eastern Railway opposed the tramway portion of the bill partly on account of competition, and the omnibus companies objected to the powers sought to run omnibuses. With regard to the latter point, he said the District Council did not propose to run omnibuses *ultra vires*, they only wished to run the 'buses along the tramway routes during the temporary period when the tramway system was dislocated owing to construction and reconstruction, and also over that part of the district where a tramway could not be laid. With regard to the Lea Bridge Gas Co.'s opposition, he contended that the bill gave that company all the protection it was entitled to.

Mr. R. VINCENT, clerk to the District Council, gave evidence in support of the bill, and was cross-examined by Mr. PADDON on behalf of the Lea Bridge Gas Co. He refused to give, at that moment, an undertaking that sec. 31 of the Tramways Act of 1870 would be applied to the reconstructed tramway as well as to the new lines. With regard to the electricity undertaking, he refused to agree to the insertion of the "Bermondsey" clause.

Mr. PADDON pointed out to the Committee that the object of his clients was to prevent the Council trading at a loss, for, as ratepayers, his clients, with whom the Council was competing, would be called upon to make good a portion of the deficit. Already at Leyton a loss had been incurred upon the electric light undertaking of £3,730.

Mr. VINCENT refused to accept this statement. The loss was not incurred by reason of bad management, but was accounted for because of the installation of gas engine plant, which had resulted in costly litigation. The clause asked for by the gas company was against all business experience. Whilst trade was bad it was the custom to reduce the price, and not to increase it.

The CHAIRMAN pointed out to Mr. Paddon that the line of his cross-examination was not exactly a new one.

Mr. PADDON replied that he was going to suggest that it was the settled practice of Parliament to insert the "Bermondsey" clause; he was not asking for a new thing.

Mr. J. E. WALLER, consulting engineer to the Council, said that he estimated that the tramways in Leyton would run 800,000 car-miles per year, and that the receipts would be 10d. per car-mile. At this rate the receipts would be £33,333 per year, and, allowing interest and sinking fund at 5½ per cent., this would amount to £6,160, and taking the working expenses at 6d. per car-mile, a total of 7·85 per car-mile would be reached, leaving a net profit of £7,173. His estimate of traffic was upon the basis of carrying the population of Leyton 58 times per year, which was a low estimate. In other districts round about Leyton the populations were being carried 150 and even 200 times a year. He placed no importance upon the objection of the Lea Bridge Gas Co. on the score of electrolysis seeing that the East London Waterworks Co. and the West Ham Gas Co., which were two much larger concerns interested in the district, did not seek similar protection.

Cross-examined by Mr. PADDON, he refused to give an assurance that the clauses of the Tramway Act of 1870 with regard to alteration of pipes, &c., should be extended to the reconstructed as well as the new lines.

Mr. BAGGALLAY, pointed out to the Committee that the intention of the Council was to use the existing tramways as they were, and he did not propose to give the Gas Company the right to call upon him to alter their mains, &c. He did not propose to give them any new rights except as regards new tramways.

Mr. WALLER, further cross-examined by Mr. PADDON, respecting the special protection asked for in respect of electrolysis, contended that the present regulations of the Board of Trade were sufficient, and no one had yet satisfied the Board that they were insufficient. Therefore, until the Gas Company could show that the rules were insufficient, they could not ask for special protection.

Ald. WILLIAM IVEY, of West Ham, gave evidence in support of the bill, as also did Mr. HOLMES, the surveyor of the Walthamstow District Council. Both witnesses agreed that a connection between the tramway systems of the three districts would be a great public advantage.

Lord ROBERT CECIL, K.C., then addressed the Committee on behalf of the omnibus companies, pointing out that as the bill stood at present, the Council had power to run omnibuses where they pleased. No evidence of any specific need for extra 'bus services had been produced, and the question to be decided was, how far were the omnibuses necessary for the development of the tramways?

The CHAIRMAN announced that the Committee had decided to strike out of the bill the power to run omnibuses in continuation of the tramway routes. The clause as so amended now gave the Council power to run omnibuses in connection with the tramways when the tramways were impracticable or when the lines were under alteration or repair. The exact wording of the clause, however, would be left until a later stage.

Mr. PADDON, addressing the Committee against the tramways portion of the bill, said that as all the roadway along practically the whole of the existing lines, as well as the new lines, would be altered for the purpose of electric traction, the company asked that the protective clauses as to alteration of existing pipes, &c., in the Tramways Act should be embodied in the bill. With regard to electrolysis, he held that the Board of Trade regulations which had been framed in 1893 did not now deal adequately with existing conditions, and Parliament had recognised this again and again in various bills.

The CHAIRMAN replied that, with regard to the first portion of Mr. Paddon's opposition, the Committee thought the bill sufficiently safeguarded him. As to the special clause giving protection against electrolytic damage, the Committee felt that until substantial evidence was produced that the Board of Trade regulations were insufficient they could not give him what he asked.

On Monday, Mr. PADDON addressed the Committee in respect of the insertion of the "Bermondsey" clause making the usual argument that the gas company, although large ratepayers, had no representation upon the Council, and that the money which they subscribed as ratepayers was used against them in the destruction of their business. The clause which he asked to have inserted was that the Council should so adjust their prices that, as far as reasonable, no loss should fall upon the rates.

After deliberation, the Committee refused to allow the clause.

[An application by the Swindon Gas Co. to secure the insertion of the Bermondsey clause in the Swindon Corporation Bill, which has been under consideration of Sec. B of the Police and Sanitary Committee, was also refused. A fuller report of this case will appear next week.]

TYNESIDE TRAMWAYS AND TRAMROADS BILL.

On Tuesday, a Committee of the House of Commons, of which the chairman is Sir Edward Strachey, commenced consideration of this bill. The measure has already been passed by the House of Lords (see *The Electrician* for March 25, p. 916). The only petition against the bill is that of the Newcastle-upon-Tyne Corporation in respect of the compulsory running powers over their tramway system granted in the other House.

Mr. BALFOUR BROWNE, K.C., who appeared for the company, with the Hon. J. D. Fitzgerald, K.C., Mr. Short and Mr. Macassey, said that the whole object of the bill was to secure through communication over the Newcastle Corporation lines and vice versa at the various points where the two systems met. There was no hostility to the Newcastle Corporation, because the company were not asking for anything without giving something in return. Clauses 15 and 16 provided for this intercommunication, and the terms and conditions upon which this through communication was to be arranged were to be sent to arbitration if not agreed upon. What the company proposed was that all the profits on the Newcastle lines should be taken by the Corporation, and all profits upon the company's lines should be taken by the company. Before the bill came before the House of Lords, a conference of representatives of the Corporation and company was held and certain suggestions were recommended by the Corporation Tramways committee, but they were defeated at a meeting of the Corporation. The chairman of the Tramways committee, whilst obviously not agreeing that negotiations with the company should be broken off, gave evidence, but so dissatisfied were the other members of the committee with this, that both he and the deputy-chairman of the Tramways committee resigned their positions. Therefore, there was this position: all the local authorities outside Newcastle wanted through communication, the late chairman of the Tramways committee, who was the only man in Newcastle who knew anything about the matter, was in favour of the through communication, and the company was also in favour of it; therefore, being unable to come to an agreement with the Corporation the company had been obliged to seek Parliamentary powers for the necessary running powers. In the petition of the Corporation it was pointed out that the streets of Newcastle were already too congested for any extra cars to be run, but it would not lead to congestion because it would only mean that a car of the Corporation running upon the company's lines would be replaced by a company's car upon the Corporation lines.

Mr. W. McLELLAN, engineer and manager to the Tyneside Tramways and Tramroads Co., described the company's system and gave details of the traffic receipts. He strongly favoured mutual running powers as a

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means of doing away with the congestion which now existed at the breaks between the two systems.

On Wednesday local evidence as to the need of through running was called, representatives from a large number of engineering works in Wallsend and the district speaking on behalf of their workmen, who mostly resided in Newcastle.

Mr. STEPHEN SELLON, consulting engineer to the British Electric Traction Co., who said his company had no connection with the promoters, gave it as his experience that through running such as was asked for in this case greatly enhanced the value of a line to the public, and also the paying value to the owners of the line.

Mr. W. MURPHY, chairman of the Dublin United Tramways Co., and Mr. J. GLEN, secretary of the Belfast Street Tramways Co., also agreed as to the desirability of the running powers asked for, because the more facilities there were the more people would travel.

This closed the promoters' case.

Mr. A. E. LE ROSSIGNOL, tramways manager to the Newcastle Corporation, compared the difference in size between the Corporation system and that of the Tyneside Company. He said that the company had only 3½ miles of double-track and 5½ miles of single-track, against 23 route miles owned by the Corporation. The capital of the two undertakings was in the proportion of 6 to 1 in favour of the Corporation, passengers 15 to 1, car-mileage 8 to 1, receipts 11 to 1, and expenses 7 to 1. Further, the company had only 22 cars in use and two building, against 170 cars in use and 20 building by the Corporation. He was against the running powers, because he foresaw all kinds of difficulties arising owing to the dual control. The company did not wish to change drivers and conductors when running over the Corporation lines, and through this it was quite possible that the fares taken in Newcastle would neither reach the Corporation nor the company. Again, the company's cars, as he had personally tested, were continually late, and if this state of things was allowed in Newcastle, the whole system would be disorganised. Out of every 10 passengers riding to the company's terminus only two changed on to the Corporation's cars.

Yesterday Mr. LE ROSSIGNOL continued his evidence and mentioned the electrification of the North-Eastern railway lines in the neighbourhood of Newcastle. His opinion was that the through traffic which the Tramways Company were seeking to create would be taken by the electric railway. Already the Corporation tramways had been affected by the opening of the electric railway to Gosforth. Taking the combined fares over the two tramway systems, there would be a little advantage in favour of the railway. The company were not offering a sufficient *quid pro quo* in this matter. All the cars upon the Corporation system would not be through cars, as the company only proposed three routes.

Cross-examined by Mr. J. D. FITZGERALD, he admitted that the Corporation had attempted to make some of the lines which were now in the hands of the company, and perhaps they would have been worked as a through service. But the Wallsend line was a single one, and the service was an eight-minute one as compared with a two-minute service upon the Corporation line into the centre of Newcastle. He admitted that the Corporation ran their line close to the Wallsend terminus of the company in order to get the traffic there, which was a paying traffic. It had always been the aim of the Corporation to run to the centre of Wallsend. In Liverpool, the South Lancashire Company changed conductors. In this case the conductors were not changed, and consequently a larger number of tickets had to be carried. Again, there was no guarantee that the company's officials would comply with the Corporation bye-laws and regulations whilst on the city lines. The Corporation was willing to run their cars into the centre of Wallsend over the company's lines, and this arrangement, on a cash basis, would be advantageous to the company, although the latter would have no running powers in Newcastle.

Re-examined, he said that the Tramways committee frequently changed their routes to meet the rush of traffic, and if these running powers were granted, any change of route affecting the company could not be made without consultation. This would be most inconvenient.

In answer to the CHAIRMAN, Witness expressed the opinion that the Corporation would neither lose nor gain money if the running powers were granted. But one of his principal objections was the friction and disagreement which was likely to arise.

Ald. ELLIS, of the Newcastle Corporation, said the Corporation was unanimous that the company should not have the compulsory running powers asked for.

Mr. J. M. McELROY, manager of the Manchester Corporation tramways, said that his reading of the bill was that the company wished to have a roving power all over the Corporation tramways of Newcastle, which was most unfair, having in view the small system which the company owned. He agreed that the break at Wallsend should be done away with, and the best way to do it was to allow the Corporation to work the line as far as Wallsend. The acquisition of compulsory running powers by a company under these circumstances gave them a much stronger position in any negotiations than they would have otherwise.

The CHAIRMAN intimated that it would hardly be necessary to call any more evidence of this character.

Mr. TALBOT pointed out that he had the managers of several large municipal tramway systems in the room, and the Corporation felt that their case had been much prejudiced in the House of Lords because the Chairman of the Committee also stated that one witness of that description was sufficient.

The CHAIRMAN said he would hear all the evidence which Mr. Talbot had, but it could be kept as short as possible.

Mr. J. YOUNG, manager of the Glasgow Corporation tramways, was then called, and said he agreed with the previous evidence. Glasgow had running powers into Paisley, but it had been put upon them by the Commissioners under the Scottish Procedure Act.

Mr. J. B. HAMILTON, manager of the Leeds Corporation tramways, also agreed with the previous evidence, and in cross-examination admitted that his Corporation had had negotiations with the Wakefield Tramways Co. and the Spen Valley Light Railway Co. with regard to running powers. Up to the present, however, nothing definite had been arranged.

Local evidence against the company's proposals was then heard and the Committee adjourned.

CARRIAGE OF GOODS BY MUNICIPALITIES.

MANCHESTER CORPORATION TRAMWAYS.

This bill came before a Committee of the House of Lords yesterday.

Mr. BALFOUR BROWNE, K.C., who appeared for the promoters with Mr. Lewis Coward, K.C., and Mr. Rhodes, said that the bill merely sought authority to make a few short lines in Manchester really as a means of connecting up the already authorised tramways. It also sought power to consolidate the other tramway acts which the Manchester Corporation had obtained in previous years. The only opposition came from the carriers and horse owners in Manchester on the ground that the bill gave the Corporation powers to undertake the carrying of goods and parcels by means of carrier vans, and to their locus he objected. The power which the Corporation was seeking under the present bill was actually contained in the previous ones, and nothing new was being asked for.

Mr. H. LLOYD, K.C., for the petitioners, said that the Manchester Corporation was seeking to carry municipal trading further than it had ever been taken before. They were endeavouring to get powers to carry and deliver goods, and this was opening up quite a new competition with the carriers and horse owners whom he represented. If the Corporation had had the powers which they now sought in previous acts, there was no reason to include them in this one. If, however, as he contended, they did not have the power, then, under the standing orders of the House, he had a locus, inasmuch as a new competition was being set up. If the Corporation would consent to a clause binding them to carry goods only on their electric tramways he would be content.

The Committee granted Mr. Lloyd a locus, and, after hearing evidence, adjourned.

THE GOVERNMENT AND THE NATIONAL TELEPHONE CO.

In the House of Commons on Monday, LORD STANLEY, in reply to Mr. Lough, said that the negotiations with the National Telephone Co. on the subject of the purchase of their system were not concluded, and while they were still in progress he could hardly be expected to make any declaration of the intentions of the Government as to terminating the company's licence by notice. If any arrangement were come to he had every intention of bringing it before Parliament for approval.

Mr. LOUGH: Must not the negotiations be concluded this month if the necessary notice is given?

Lord STANLEY: Yes, if it be given.

On Wednesday, in answer to Mr. Galloway, on the same subject, the POSTMASTER-GENERAL referred to the answer, adding that he could not say that any report would be made to Parliament this session.

TELEPHONIC COMMUNICATION IN IRELAND.

In the House of Commons on Monday Mr. CULLINAN asked the Postmaster-General whether, in the scheme decided on for telephonic connections with Tipperary and Clonmel, he would have Cahir, which was situated midway, included.

The POSTMASTER-GENERAL in a printed reply stated that Cahir was situated in the Clonmel exchange area. The National Telephone Co. had an exchange at Clonmel and he had been in correspondence with the company on the question of the connection of Clonmel with the telephonic trunk system and the establishment of an exchange at Cahir in communication with that system through Clonmel. The company had stated that they would open an exchange at Cahir provided sufficient support was forthcoming. The company further stated that they were now making inquiries on the subject.

On Wednesday, Mr. PATRICK JOSEPH O'BRIEN asked the Postmaster-General if it was proposed to include Nenagh in the scheme for affording telephonic accommodation in Tipperary County; and, if not, would he consider the advisability of making arrangements for accommodating this, an assize town and the capital of North Tipperary.

LORD STANLEY, in a printed reply, stated that the nearest exchange to Nenagh on the telephone trunk wire system was at Limerick. A trunk line between Limerick and Nenagh would be about 28 miles in length. It did not seem probable that enough support for a telephone exchange could be obtained at Nenagh to justify this costly extension, except under a guarantee of revenue at the usual annual rate of £5 per mile of the trunk line. If, however, the hon. member could furnish him with some definite information on this subject, he would be glad to make further inquiry.

OTHER ELECTRICAL BILLS.

In the House of Commons on Monday, the *London United Tramways Bill* and the *Middlesbrough, Stockton and Thornaby Tramways Bill* were a third time. On Tuesday the following Bills were read a second time:—*Barrow-in-Furness Corporation, Bournemouth Corporation Tramways, Holywood Tramways, North Wales Electric Power, and Portmadoc, Beddgelert and South Snowdon Railway.*

In the House of Lords on Tuesday the *Plymouth Corporation* Bill was read a second time.

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The *London County Council* (*Money*) Bill, which includes the borrowing of the necessary sum to enable the Marylebone Borough Council to purchase the portion of the Metropolitan Electric Supply Co.'s undertaking within their area, was passed by the Unopposed Committee of the House of Commons, and ordered to be reported for third reading.

The *Wolverhampton Corporation Bill*, which has already been passed by the Police and Sanitary Committee of the House of Commons (see *The Electrician*, Vol. LII., p. 959), was before a Committee of the House of Lords yesterday. The bill is now practically unopposed. The Great Western Railway Co. and the London and North-Western Railway Co. sought a clause by which, as regards any possible loss in respect of certain tramway lines outside the borough boundary, they should be placed in the same position as if the outside local authority itself had constructed the lines. By the Wolverhampton system of rating, the railway companies were placed in a worse position than they would be otherwise. To this the Corporation had agreed, but the House of Commons Committee refused to insert a clause to this effect. An appeal, therefore, was made to the House of Lords, and, upon the consideration of clauses, the Committee allowed this one. The bill was ordered to be reported to the House for third reading.

LEGAL INTELLIGENCE.

Poole and District Electric Traction Co. v. Bournemouth Corporation.

(*Continued from p. 281.*)

Monday, May 30.

Mr. JAMES MORE, civil engineer, of Edinburgh, and for 19 years chief engineer to Messrs. Dick, Kerr & Co., examined by Mr. HUTCHINSON, said he had made an inspection of the Poole undertaking upon March 24 and 25 last. He had also been familiar with Bournemouth since 1892, and it was an obvious fact that the district was a rapidly increasing one. The effect of the construction of the extensions to Poole Harbour and Parkstone would be to divert many passengers from the railway to the tramway. When the Christchurch lines were built they would act as important feeders, whilst the running powers over the Bournemouth lines would considerably increase the earning powers, as at present, on either side of the County Gates terminus there was a lost half mile as regards pick-up traffic. People would prefer to walk for that distance in order to get the car that would take them to their destination. With regard to a valuation of the undertaking which he had made, he had taken the sum of £7,600, which represented the profit for the full twelve-months of 1901, based upon the actual profit of £6,522 for the nine months as shown on the balance-sheet. He had capitalised that in perpetuity at 3½ per cent., which gave £217,143. The calculation of the profits he had assumed at a uniform increase of 2 per cent., or £150 per year. On a 28½ years' basis at 3½ per cent. this yielded £34,997. The increased profits due to the establishment of a through service would be £1,027 per year, owing to the extra pick-up traffic on the lost half mile already mentioned, and capitalised at 3½ per cent. this gave £29,340. The saving in working expenses due to this through running would be 14 per cent. or £1,124 per year, amounting to £32,137 if capitalised at 3½ per cent. This was based upon working expenses of 7d. per car-mile. The value of the extension to Poole Harbour taken at a 19·4 years' purchase of the net annual revenue at the same rate as the present line would be equal to £19,968. The value of the Parkstone loop he had estimated on the same revenue as the existing line, and the value at this rate would be £68,552, giving a total net value of £402,140. Having regard to the increased traffic upon the line in five years, it would be the most judicious course to double the Poole line throughout, and the cost of this would be £34,000, which, capitalised at 3½ per cent., would be £28,307. Therefore, the total value would be £373,513. With regard to the Christchurch line, he valued this at £85,022 upon an annual receipt of £6,930, making the total value of the company's undertaking £458,535. He had taken no account of the Canford Cliffs line.

Cross-examined by Mr. WILLIAMS: He was quite aware that in the Poole order there was a clause giving the Board of Trade power to reduce the fares every three years, but he had not taken this into account when valuing the undertaking. In fact, the lowering of fares was an advantage very often instead of a disadvantage. The Bournemouth lines did not at present work on Sundays, whereas the company did; but this would not affect his valuation, as the Corporation would very quickly change their policy in this matter. As to the increased frequency of service due to the opening of the Parkstone extension, he saw no difficulty in increasing the service to less than five minutes. At present it was between eight and 10 minutes. With regard to depreciation, his opinion was that £300 per annum for maintenance and renewals was sufficient. He considered that 96 miles per car per day was as much as the cars could run on the present route. With the exercise of the running powers in Bournemonth, he considered that 110 miles per car per day could be run. A tramway manager would be acting in the best way to arrange his service so that the gross receipts per car-mile were 11d. His opinion was that the Poole line was in an efficient state for working. There were certain bad patches which occurred on every tramway, but there were no structural defects.

Mr. ROBERT HAMMOND, examined by Mr. CRIPPS, said he had recently inspected the company's tramways at Bournemouth, and on arriving at his valuation had looked upon the nine months' profit shown in the 1901 balance-sheet as an agreed figure, and, proportioning this out for 12 months, a profit of £7,600 was arrived at, which he dealt with as the basis for the present line, the multiplier being 30. From this he deducted 1·09d. per car-mile for depreciation, which left a net profit of £6,250, and this was the figure he used for the valuation of future profits. In calculating the future increase of profits, he had estimated a 2 per cent. increase every year up to 1934, and this gave £29,812. Then, at the end of that period, the line had to be purchased as a going concern, and the present value of this he put at £33,401, making a total of £63,213. But deducting the expenditure during the whole period brought this figure down to £47,147. The next item was the Parkstone order, which, as regards traffic, he had placed on a par with the existing line. He had taken no account of feeding effect, nor had he added anything in respect of the value which would accrue in respect of running powers over the Bournemouth line. The earning power per mile he had placed at £3,125. The line was 1 mile 6 furlongs 9·7 chains in length, and worked out pro rata and discounted to the present value upon the basis of 25 years' purchase, the sum of £78,125 was arrived at. Deducting capital expenditure and adding for future profits, his total figure for the value of the Parkstone undertaking was £66,082. His figures for the other portions of the undertaking, although worked out independently of Mr. Sellon, came out almost identically the same. In working them out, however, he had accepted some of Mr. Sellon's figures as a basis.

Cross-examined by Mr. LLOYD: He had never constructed or designed a tramway, and was only professionally engaged in connection with these lines during the past month. He had had Mr. Sellon's views before him when he made his valuations. The reason why he selected 30 years was because this period was taken in connection with the water companies, which had a continuous tenure, and he considered the Poole Company was in practically the same position. It was a fact that Mr. Sellon had estimated a 2¼ per cent. compound increase of profits, whereas he had taken a 2 per cent. simple increase. But the two results came out to the same figures, because Mr. Sellon had taken a larger number of passengers at a lower receipt per passenger. He himself was content to say that the receipts per passenger would be the same with the same number of passengers. He had made allowance for certain capital expenditure already incurred, but had taken this from the balance-sheet and did not know to what it referred.

Monday, June 6.

Several minor corrections were made at the commencement, the most important being a reduction of Mr. Sellon's estimate of the ultimate traffic which would be carried upon the complete undertaking from 12,000,000 passengers per annum to 6,400,000 (see *The Electrician*, June 3, p. 281).

Mr. HAMMOND was then further cross-examined by Mr. LLOYD. He said that his total valuation of the undertaking amounted to £483,808. He agreed with Mr. More's evidence that 11d. per car-mile should be arranged for. The average working expenses would be, in his opinion, about 60 per cent., or 6·6d. The price of electricity at Bournemouth was 1⅛d. per unit. under a 30 years' agreement. He did not know what the price of current per car-mile worked out to at Bournemouth, but his estimate was that it should be 1½d. per car-mile. Assuming, however, that it was 2d., this would make Mr. More's figure of 7d. for working expenses correct. Deducting 1·09d. per car-mile for depreciation, this left 2·91d. net profit. The 1903 balance-sheet showed a net profit of 3·17d. per car-mile, with 338,500 car-miles run. The repairs in 1901 were 0·36d. per car-mile, and in 1903 1·16 per car-mile. The comparison of the profit of a tramway undertaking during the first three months and the remaining nine months was one-fifth, but he had taken it as a quarter in arriving at the total profit during 1901. The opinion of the manager of the Poole tramways was that one-third of the traffic only was due to visitors. His 2 per cent. estimated increase of traffic was based upon an increase of population. He considered that Mr. Sellon's estimate of the increase of traffic and profits were over moderate. He himself had taken 30 years as against Mr. Sellon's 15 years, as he considered this a fairer valuation. He admitted that, in order to make a true comparison of his own and Mr. Sellon's figures, depreciation would have to be added to his, as Mr. Sellon had not deducted for depreciation, and he had. With regard to the value of the running powers, he regarded every half-mile of the Poole tramway valuable for pick-up traffic with the exception of the half to the terminus. He did not know the exact character of the half-mile from County Gates towards Poole, but had based his 20 per cent. extra increase of traffic due to running powers upon general principles. He was not aware, therefore, that the south side of the half-mile in question consisted solely of Branksome Park with no cross roads and only seven houses, nor that on the north side the London and South-Western Railway ran parallel with the tramway to Branksome, and that there were no houses for the whole half-mile. It did not follow, however, that the property would remain of this character for all time. Dealing with the Christchurch lines, he admitted that he had taken credit for the whole of the profits for 10 years without taking the cost of construction into consideration. If he had taken the latter into account he would have asked for 25 years' purchase, as in the case of the Parkstone extension. He admitted also that this line would to some extent compete with the main line as far as through passengers were concerned, but in as much as he had added nothing to his estimates for feeding effects and running powers he considered he had made sufficient allowance for any competition that might take place. His estimates of capital expenditure had been made upon the figures in the 1901 balance-sheet, whereas Mr. Sellon had estimated upon the actual existing prices.

Mr. LLOYD: That shows that you can get a very much better result from your point of view by taking the 1901 balance-sheet than if you take facts?—Well, you can construct much more cheaply now.

Mr. C. T. MILES, an architect and surveyor of Bournemouth, described the property along the whole of the tramways and spoke as to the prospect there was of immediate development upon many large building estates.

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Mr. A. DICKINSON, late general manager of the City of Birmingham Tramways Co. and the South Staffordshire Tramways Co., said he had inspected the whole of the Poole and Bournemouth Tramways, and his valuation took everything into account with the exception of the Canford Cliffs line. The fair market value of the existing undertaking, as a going concern, he put at £217,171 on the basis of the 1901 balance-sheet, his multiplier being 28½ years, this sum being equal to an annuity in perpetuity at 3½ per cent. In respect of the prospective increase of profits, he had calculated a 2 per cent. cumulative increase for the same number of years, and this gave £34,648. For the running powers he estimated an increased profit per annum of £1,762, and this, capitalised as an annuity for 30 years on the 3½ per cent. table, gave a multiplier of 18¼, or a sum of £32,397. The increase of profits upon the projected Poole Harbour line on the same terms amounted to £6,179. The value of the Parkstone line, calculated on a 15 years' purchase and with an earning capacity of 60 per cent. of the existing line, he put at £40,650. The Christchurch lines, upon the same traffic, but eight years' purchase, would be £54,193. In the latter case he had taken no account of the cost of construction.

Cross-examined by Mr. WILLIAMS: When he made his inspection he was not accompanied by an official of the company, nor had he been guided in his valuation by Mr. Sellon's report. He had never read the latter. His allowance for depreciation was 16 per cent. instead of the 20 per cent. allowed by other witnesses. [Witness's detailed estimates were handed in.]

Mr. LLOYD called the attention of the Umpire to the statement by Mr. Sellon that a contract for the construction of the Christchurch lines had been entered into with the British Electric Traction Co. at a cost of £66,000 (*The Electrician*, June 3, p. 281). He had now a copy of the contract, but no mention of £66,000 was to be found in it. The work was to be done at cost price, with 4 per cent. for engineering and £12,000 profit.

Mr. BALFOUR BROWNE promised to look into the matter.

Mr. J. CONACHY, manager of the City of Birmingham Tramways Co., whose detailed estimates were also put in, gave the following résumé of his valuation:—Existing undertaking, 30 years' purchase with 2 per cent. annual increase, £228,000; prospective increased profits, £50,161; Parkstone line, £32,033; running powers, estimated at 1d. per car-mile upon 561,782 car-miles, £56,428; Christchurch rights, £50,185. From this total he deducted £43,053 for anticipated capital expenditure, leaving a net total value of £377,732, including the agreed items in the agreement of March 11, 1903.

Cross-examined: He considered 7d. per car-mile for working expenses too high a figure. On his own lines this was 6·26d. He estimated that the car-miles would be increased by 80 per cent. at the end of 30 years, and that therefore nearly 1,000,000 car-miles per annum would be run.

The proceedings were then adjourned until Saturday, June 18.

Bombay Tramway Co. (Ltd.) v. Bombay Municipal Corporation and Others.

The Judicial Committee of the Privy Council (Lords Macnaghten, Davey, Robertson and Lindley) delivered reserved judgment in this appeal (reported in our issue of May 27) on Friday last.

In delivering judgment, Lord LINDLEY said the questions raised arose out of the purchase by the Corporation of Bombay of the undertaking of the Bombay Tramway Co. It appeared that, although the Corporation had made arrangements with Mr. Bingham, by which he was to find the money for the purchase and to work the tramways when acquired by the Corporation, yet the Corporation were acting as principals and not as Bingham's agents. There was nothing in the Bombay Tramways Act, 1874, which expressly or impliedly prohibited such a transaction, nothing to show that if the Corporation exercised the power conferred on them by sec. 30 and acquired the tramways they were bound to keep them in their own hands and to work them themselves. The judgment appealed from was perfectly correct on this point. Another question was raised by the company, which was that the date to be fixed as the date of the purchase ought to be later than that set out in the judgment. If the date had to be determined by their Lordships unembarrassed by what took place in India, their Lordships would have thought that the proper date would have been that when the relation of vendor and purchaser was definitely created by the service of the notice to purchase (March 14, 1901). That was the view taken by the Judge of First Instance (Mr. Justice Fulton), but for some reason, which their Lordships did not appreciate, both parties appealed and contended before the Appellate Court for a different date. Their Lordships did not consider that either party could now, without the consent of the other, fairly insist that the above date ought to be adopted. Under these circumstances their Lordships saw no reason for disturbing the date fixed by the Appellate Court (date of award fixing the value of corporeal property of company). The company also contended that track rent payable to the Corporation ought to cease as from March 14, 1901, but that was disposed of by the fact that in March, 1901, it was expressly agreed between the company and the Corporation that the former would continue to work the tramways pending the ascertainment and payment of the purchase money. It was plain that so long as the company took the profits they must pay the ordinary expenses of working and the rent in question. Their Lordships would therefore humbly advise his Majesty to dismiss the appeal, with the costs of the Corporation.

Overcrowding of Tramcars.

At Leeds Police Court on Tuesday before the Stipendiary (Mr. C. M. Atkinson), a tram conductor (James Girvan) was summoned for allowing his car to be overcrowded on May 28.

The STIPENDIARY asked if the excess passengers had been summoned, and was answered in the negative.

The STIPENDIARY: If persons are allowed to commit a breach of the bye-law and are not prosecuted, I should hesitate before dealing with anyone for not preventing that breach. I should think that they themselves were the principals. To defendant: Have you got their names?—No.

The STIPENDIARY: I cannot undertake to convict unless the principal offenders are brought before the Court. It would be unjust to enforce a penalty against the secondary offender when the primary offender had not even had his name taken.

Deputy Chief Constable DALTON: I shall take care in future that those actually standing on the car shall be proceeded against.

The STIPENDIARY (to the defendant): You are liable, as conductor, if you allow any person in excess to be on the roof of the car. So far as the matter before me is concerned it must stand over.

Obstruction of Tramcars.

At Leeds Police Court on Saturday a carting agent, named Bartle, was summoned for committing a breach of the tramway bye-laws by impeding a Corporation tramcar.

For complainants, Mr. SAUNDERS stated that defendant was driving a light cart in front of a car, and refused to leave the lines to allow the car to pass.

The STIPENDIARY said that if the bye-law on which the prosecution relied meant that the tramways had an exclusive use of the road, he should hold that it was a bad bye-law. He must take the evidence most favourable to defendant. There was nothing to compel a man who was driving at a reasonably fast rate to turn his conveyance aside. The Corporation were claiming a right for tramcars to monopolise the road.

Mr. SAUNDERS: I submit there is evidence to show that defendant wilfully stayed on the track.

The STIPENDIARY: Why not?

DEFENDANT denied that he obstructed the car, and said he was driving ahead at the rate of 12 miles an hour.

After the Stipendiary had seen the horse, he said it was probable the horse was travelling at a speed less than that of the car, and at a speed which was safe for vehicles in a city like Leeds. There was no bye-law which could compel the driver of a vehicle to obey the behests of a tramcar driver, but there was one which made it an offence wilfully to impede a car. Other conveyances had as much right to travel on the tramlines as on any other part of the road. The only offence defendant had committed was that he had been highly offensive to those with whom he had come in contact on the occasion in question, and defendant had, it appeared, been previously fined for using abusive language on the same day. He would find that defendant had committed a breach of the bye-law, but of such a character that it could be dismissed, under sec. 16 of the Summary Jurisdiction Act, 1879.

Bruce's Assignee v. Scale.

In the Hastings County Court last week plaintiff sued for £19. 18s. for rent of electric light fittings, &c.

It appeared that plaintiff was assignee under an agreement for the wiring and fitting up of a house for the electric light. The agreement was entered into in 1899, but had been lost. There was a clause by which the consumer had the option to purchase the fittings at any time. Defendant paid the rent till July, 1901, but from that time till April last nothing had been paid.

Plaintiff sued defendant last November, but she successfully defended the action, and she now said she was desirous of purchasing the fittings, and contended that, as the agreement had been lost, she was not liable to pay. Judgment was given for plaintiff for £15. 1s. 11d. and costs.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Governing Body of Northampton Institute, London, E.C., require for 1904-5 session an instructor in mathematics (£100 per session) for the engineering department, and also a junior demonstrator, a junior technical assistant, and a junior lecture assistant for the electrical engineering department. Further particulars from the Principal (Dr. R. Mullineux Walmsley). Applications to be in by to-morrow, 11th inst. See also advertisement.

A lecturer in mathematics is required at Birmingham Municipal Technical School from Sept. 1 next. Commencing salary, £175 per annum. Applications by June 30. Particulars from the secretary (Mr. George Mellor), Suffolk-street, Birmingham. See also advertisement.

A junior lecturer in mathematics is required for University College, Nottingham. Salary £130, rising by £10 a year to £180. Applications (on forms supplied by the Registrar) by June 20. See also advertisement.

The Electricity committee of the City of York require a charge engineer. Salary £100 per annum. Applications to the city electrical engineer, Mr. C. A. Midgley, Foss Islands-road, York, by June 13. See advertisement.

A battery-room attendant and wireman is required for East Sussex County Asylum, Hellingley. Applications to the resident engineer. See advertisement.

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An assistant lecturer in mathematics, an assistant lecturer and demonstrator in physics and an assistant lecturer and demonstrator in chemistry are required at Birmingham University. Salary in each case £150 per annum. Applications by Aug. 1.

An assistant demonstrator in physics and chemistry and an assistant mathematics lecturer are required for the Northern Polytechnic Institute, Holloway, London, N. Applications by 28th inst.

St. Helens Education committee invite applications for the position of principal of the Municipal Technical School. Salary £200. Applications by 22nd inst.

Leeds Tramways committee require a permanent-way superintendent. Salary £300. Applications by 16th inst.

Mr. A. R. Bacon, chief assistant at the County of London Electric Supply Co.'s station, Wandsworth, has been appointed resident engineer at the company's City-road station.

Mr. A. G. H. Davis, of Wallsend-on-Tyne, has been appointed shift engineer at the new electricity station of Exeter Corporation.

Mr. G. Hosking, the baths engineer at Deptford, has been appointed clerk of works for the installation of the electric plant and fittings for the new Town Hall.

EDUCATIONAL NOTICES.

University College of North Wales.—In October next a systematic course of instruction in electrical measurement and practical electricity for students proposing to enter the profession of electrical engineer will be commenced. The physical laboratory at the college is well equipped The fee for the course is 14 guineas per session. Prospectuses, &c., from the secretary and registrar (Mr. J. Lloyd, M.A.). See also advertisement.

Merchant Venturers' Technical College.—On June 29, Sir William H. White, K.C.B., F.R.S., will open the new workshops, laboratories, &c., at the Merchant Venturers' Technical College, Bristol.

A research fellowship in pure or applied physics of the value of £125 is vacant at the Victoria University of Manchester (Owens College). Applications to registrar, from whom conditions may be obtained by June 13.

Prof. C. A. Carus-Wilson, M.A., M.I.E.E., commenced a special course of lectures to the senior students of the Electrical Standardising, Testing and Training Institution on 9th inst. upon "Direct-current Motor Construction."

Aberdeen.—The traffic receipts of the tramways department for the past year amounted to £62,794. 10s. 4d., compared with £50,008. 6s. 1d. in 1902, an increase of £12,791. 4s. 3d. The expenditure amounted to £26,530. 8s. 3d , against £15,120. 6s. 11d. The estimated income for the year was £63,700, and the total expenditure (including depreciation, interest, and sinking fund) £48,938, leaving a balance of £14,262.

Amalgamated Society of Engineers.—The result of the recent ballot for the general secretaryship of this society is that Mr. George N. Barnes has been re-elected by a large majority.

Aspull.—The Lancashire Electric Power Co. have submitted terms for the supply of electricity in bulk in the district.

Aston.—The Town Council were asked last week, in a petition signed by 75 burgesses, to convene a meeting of the Council to consider "a curious situation caused by the Electricity committee." The petition averred that—

(1) Meters were supplied to them stamped with a Board of Trade unit, which unit the committee unjustly, and they believed illegally, ignored. No explanation was given to any of them, and they had now been charged with four times the current recorded on their meters. (2) They were willing to pay a fair price for the current consumed by them, such price to be calculated only upon the units shown on their meters.

The petitioners also stated that they were solicited by the Corporation to use the electric light, and they felt a general sense of insecurity under the committee, as the contracts were inexplicit as to repairs. They, therefore, asked the mayor to intervene in order to prevent a long series of legal contests.

The Mayor moved that the petition be received, and referred to the Electricity committee for consideration and report. As the committee was a trading committee, it would be unwise for the Council to interfere between it and its customers unless the Council considered that circumstances had arisen to justify such intervention.

Mr. Godrich (chairman of the committee) protested strongly against statements made by the petitioners.

The petition was referred to the committee.

In the report of the Electricity committee reference was made to this dispute, and Mr. Godrich wished it to be perfectly understood that the committee did not desire to delude the public who had adopted electric lighting. If mistakes had been made they had done their best to rectify them. English-made meters were installed. They did not show direct reading, although the scale of the meter showed divisions, each of which represented four units. The mistake had been that certain consumers had counted each division for a single unit. The dial did not state that one division represented four units, and, unfortunately, owing to pressure of work, cards giving the information were not sent out to users. The fact remained, however, that current had been used to the amount charged, and the committee would, of course, ask for full payment. The report was approved.

The chairman of the Public Works committee (Ald. Evans) announced at the same meeting that the Aston-road tramway route would be ready for official inspection on Thursday (yesterday).

Asylum Lighting.—York Asylum Visiting committee recommend the erection of independent generating plant at the asylum, notwithstanding that the Electric Lighting committee of the Corporation have offered to supply current.

Bangor.—The Council have decided to increase the salary of the resident electrical engineer (Mr. Price F. White) by £40 per annum.

Barrow-in-Furness.—Application for sanction to borrow an additional £35,000 for electric lighting extensions has been made by the Council. The charge for electric current for private lighting has been fixed at 4½d. per unit.

Battersea.—The Borough Council will withdraw the petition against the Electric Lighting (London) Bill as soon as the agreement with the County of London Electric Supply Co. has been sealed.

Belfast.—The annual report of the city electrical engineer (Mr. Victor A. H. McCowen) for the year ended March 31 states that 2,255,579 units of electrical energy were sold, compared with 1,665,560 units for the previous year, an increase of 35 per cent. Of the year's output, 1,433,121 units were sold for lighting (32 per cent. increase) and 822,458 units for power (40 per cent. increase).

The total connections to the mains on March 31 were equivalent to 171,845 8 c.p. lamps, against 122,000 in 1903. The power connections (included in above) are equal to 2,055 H.P. in motors. There are now 260 premises or factories employing 388 motors supplied with power by the Corporation. The maximum load during the year was 2,180kw., which left just enough spare plant for safe working. The load-factor showed a slight improvement, being now 10·8 per cent., against 9·66. Owing to the reduction in the price of current last June, the average price paid was much lower than in the previous year, and now stands at 2·87d. per unit. The cost of production has again been reduced, though the price paid for coal was slightly higher than for the previous year. The total cost of production (exclusive of interest and sinking fund) now stands at 1·032d. per unit. The gross profit for the year was £17,558, equal to 7¾ per cent. on capital. After paying interest and sinking fund charges, the net profit amounts to £6,128. A further sum (£3,573) was recommended to be written off against depreciation of Chapel-lane station, and the balance carried to credit of renewals suspense account.

A Tramways committee has been formed for the purpose of arranging matters in connection with the purchase of the undertaking of the Belfast Street Tramway Co., and supervising the work of conversion to electric traction, &c.

Bermondsey (London).—The Council have passed an estimate of £260 for installing the electric light in the stairways and courtyards of the working-class dwellings now being erected.

Bombay.—The Brush Electrical Engineering Co. have applied for a licence under the Indian Electricity Act for the supply of electricity.

Bredbury and Romiley.—Stockport Council have informed the District Council that they can only take over the Bredbury electric lighting order upon a guarantee being given that within a reasonable time electricity supply in the district would pay.

Brighton.—Last week the yearly statement of accounts of the electric lighting undertaking were presented, and showed that, after paying interest and providing for sinking fund, the net profit was £6,959. 4s. 8d., which has been carried to reserve.

The Chairman of the Lighting committee (Councillor Broadbridge), in presenting the accounts, said the result of the year's working was most satisfactory. To date they had paid off about £85,000 of capital borrowed.

Ald. Botting said the revenue showed that there had been paid for the 7d. units £51,572, and the total cost of the whole expenses of the electricity undertaking was £46,594, which left, roughly, £5,000 to the good. He thought it unfair they should sell electricity at 1d. per unit which cost 1¾d. to generate while they charged 7d. per unit to those who used electricity for only a few hours.

Councillor Wilson said the committee should take steps for increasing their 1d. unit. If this were raised by ½d. it would give an extra £3,000 without counting the amount which would be paid for street lighting.

Councillor Tozer said the committee proposed to make a concession in connection with the lighting of the Municipal Technical School, and he asked that all consumers be treated alike.

Councillor Galliers said they were not giving the Technical School any advantage over private consumers. As to the question of applying some of the profits in relief of rates, they would be moving their generating station in the course of the year from North-road to Portslade, and the probability was that certain of their implements would have to be scrapped. It was thought best, therefore, to place the profit to reserve.

Ald. Buckwell said considering the town had to run the risk for any loss, and that if there was a loss in any year it could be thrown on the rates, the rates should benefit when there were profits. That was particularly desirable now when, owing to the extravagance of the Council, the rates were so high. It was unfair that a big reserve should be built up at

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the expense of the ratepayer of to-day for the benefit of the ratepayer 10 years hence. They were rapidly paying back their borrowed money, and they had been told over and over again by their engineer (Mr. Wright) that their cables, which were nearly paid for, were in as good condition to-day as when they were put down. That being so it was unnecessary to build up a big reserve.

Ald. CARDEN said they must put the finances of the undertaking on such a sound basis that they could be attacked by no one. In the past the ratepayers had received £13,000 or £14,000 in relief of rates from the electricity undertaking, but they ought never to have had a penny; the whole of the money ought to have gone to build up a substantial reserve. They had no claim to the money. While they had never provided a penny towards the capital of half a million, they had had £14,000 in relief of rates. They also got their street lighting at the extremely low price of 1½d. a unit compared with 5½d. charged in neighbouring Eastbourne. Having regard to the fact that the present would only be a transitory year, that next year they would have spent £200,000 at Southwick, and that they would have to provide a sinking fund in their next balance-sheet, it would be extremely detrimental to vote any sum to relief of rates this year. It would be a retrograde step to raise the price of current to consumers, as one member had suggested. Their engineers (Mr. Wright and Mr. Christie) strongly advised that the balance should be put to reserve.

Councillor HEUN said he had always believed that those great municipal undertakings should make no profit at all. Where income was greater than expenditure it should be used in one of three ways, to reduce the charge to the consumer, extinguish the debt on the undertaking, or be carried to reserve. It was absolutely necessary they should have a large reserve fund.

Councillor JARVIS was doubtful whether the profit of £6,959 actually existed. A capital of over half a million was involved, and yet when they looked at the amount allowed for depreciation they found it was about £4,000.

The report was adopted.

The Works committee recommend the Council to agree to a proposal to permit through cars to be run on Volk's Electric Railway and the projected Rottingdean tramroad, but to refuse a further proposal to waive the Council's right to acquire Volk's Electric Railway until the end of its lease.

Buenos Ayres.—The "Review of the River Plate" states that the first electrical section of the Metropolitan Tramway Co.'s line (from Constitucion to Recoleta) was recently opened for traffic.

The Municipal Council have decided to prohibit the use of trailers on the tramways in the city, as their use is said to have caused numerous accidents.

Through communication by electric tramway will shortly be available between Buenos Ayres and Quilmes. The Compañia Alemana Transatlantica will supply current for working the system.

It is said that German capitalists propose to establish a telephone company in Buenos Ayres.

Mr. John Oldham has been elected president and Messrs. J. T. Cornish and T. R. Wood vice-presidents of the Institution of Engineers of the River Plate for 1904-5.

Burton-on-Trent.—In consequence of the intention of the Midland Railway Co. to construct the Burton and Ashby light railway, the Corporation decided on Wednesday to apply for an extension of time for the completion of their tramways system, which will connect with the light railway at the borough boundary.

Bury (Lancs.)—The capital expenditure of the electricity department during the year ended March was £14,248. 18s. 1d, making £73,489. 6s. 10d. Loans outstanding are £45,829.

The income from sale of current was £7,604. 4s. 8d., including £599. 16s. 8d. from public lighting, £6,581. 14s. 3d. from private consumers and £422. 13s. 9d. from supply of current to the tramways. Rental of motors, meters, &c., and miscellaneous receipts made the total revenue £8,104. 16s. 6d.. Cost of generation was £1,787. 19s. 6d., repairs and maintenance of engines, accumulators, buildings, &c., £278. 8s. 4d., management £666. 17s. 3d., distribution £590. 8s. 3d., making, with miscellaneous items, £1,181. 11s. 2d., a gross profit of £3,495. 7s. 4d. Interest absorbed £1,464. 7s. 7d. and sinking fund £1,465. 3s. 3d., leaving net profit £565. 16s. 6d. 731,183 units of electrical energy were generated, of which 54,664 were supplied to public lamps, 67,630 to the tramways and 550,617 to private consumers. Generating costs were 1·30d. per unit sold, against 1·65d. in previous year, and the total costs were 2·62d, compared with 3·38d., the average price obtained being 2·82d., against 3·39d. There are 382 private consumers (with the equivalent of 38,095 8 c.p. lamps) connected, compared with 355 and 35,647 respectively last year. The total maximum supply demanded was 487·3kw., compared with 319·7kw., and the load-factor was 15·7, against 15·17. 48 motors, equivalent to 291 H.P., are let on hire, and the units sold for power and heating were 299,538, against 141,123. There are over 15 miles of street mains laid. After allotting one 250kw. generating set for tramway purposes, the works have a capacity equal to 22,000 8 c.p. lamps.

Canadian Railways.—Out of the 19,836 miles of railways in Canada at June 30 last 759 were operated by electricity and 19,077 by steam. The figures for electricity include those lines which come under the designation of "tramways" in this country.

Cannock.—Mr. F. Brown, of Walsall, has been appointed consulting electrical engineer to the Council.

Cheltenham.—On Monday, the Lighting committee reported that the time had arrived when the suggestion of the Finance committee that the president of the Institution of Civil Engineers should be invited to nominate an expert to investigate into and report upon the working of the electricity undertaking should be carried out.

The Local Government Board have sanctioned the borrowing of three sums (£4,132, £260 and £2,500) for electric lighting extensions.

In forwarding the sanction, the Board state that it would not accord with their practice to include in the loans any sums representing wages of the Council's ordinary staff of workmen. Therefore, they desired to be informed of the precise amounts included in each of the proposed loans on account of payments to such workmen. The Board also stated that they gathered from the report of their inspectors that the losses on the electricity undertaking had been due mainly to the adoption of an extensive system of street lighting and to insufficient charges for current. In view of the unfortunate position in which the undertaking was at present placed, the Board urged the Council to exercise in future more than usual caution in respect of further applications for electric light involving material extension of cables, &c., and, at least, always to secure guarantees under sec. 20 of the Electric Lighting Order. Extensions for public street lighting should also be cautiously proceeded with.

The chairman of the committee (Ald. Norman) moved the confirmation of the minutes, and explained that the proposed inquiry would be an impartial one.

After two amendments had been rejected, the minutes were confirmed.

Clewer.—The Windsor Electrical Installation Co. have notified the Parish Council of their intention to apply for a provisional order.

Colchester.—Last week the Council in committee resolved To entertain at Colchester the Council of the Institution of Electrical Engineers, donors of the Gilberd tercentenary painting, on the occasion of their visit for the formal unveiling of the painting; and further that, having regard to the exceptional interest and importance connected with the ceremony, the mayor be voted as additional remuneration such amount as shall be requisite for defraying the special expenditure in carrying out the proceedings decided upon by the executive committee.

In future the charge for electric current for power will be as under:—Up to 100 units per quarter, 4d. per unit; not exceeding 500 units per quarter, 2¾d.; exceeding 500 units 2½d.

Crewe.—The Electric Lighting committee report that, after paying all expenses, there was a profit of £1,116 on the electricity department for the past year. The charge for current for private lighting has been reduced from 4½d. to 4d. per unit.

Customs Duties.—Recent decisions have fixed the duty on imports of stranded copper wire into New Zealand (as electric appliances) at 10 per cent. ad val.

Dartford.—The Council have accepted the offer of J. G. White & Co. for constructing and leasing the tramways in the district. The company will take current from the Council at 2d. per unit up to 100,000 units per annum, 1¾d. from 100,000 to 150,000, and 1½d. for all in excess of this quantity.

Dawlish.—The Council have approved the amended agreement with Messrs. Crompton & Co. for the erection and maintenance of electricity supply works.

Devonport.—The Corporation have adopted the recommendation to reduce the charge for the supply of electric current to 4½d. per unit for the first 1,000 units, and 4d. beyond. Current for power is to be supplied at 2½d.

Dover.—The Electricity committee are preparing a scheme of "free" wiring, and application is to be made for sanction to a loan.

Dublin.—The Electric Lighting committee having found it impossible to obtain a supplemental loan of £50,000 for electric lighting at a less rate than 4 per cent. per annum, have decided to obtain a temporary loan from the Bank of Ireland.

Dundee.—A scheme for the erection of a new electricity generating station in the vicinity of the harbour for the supply of energy for lighting and power to the jute mills and various factories in the town will be discussed at an early meeting of the Council. The promoter (Mr. Geo. Balfour) will endeavour to obtain the consent of the various authorities to the promotion of a bill next session.

Ealing.—The report of the Electricity Supply committee for the year ended March 31 states that the gross profit was £12,142, and the net profit £3,838, after meeting all charges, including interest and sinking fund.

£2,000 has been placed to reserve. It has been decided to reduce the charge to the following rates after September:—*Flat rate*: All consumers except churches, 5d. per unit; churches, 4½d.; heating and power, 2½d. to 2d. *Maximum demand*: 7d. first 1½ hours and 2d. after in six winter months; 7d. first half-hour and 2d. after in summer. No alteration in present rate of 6d. to be made when current consumed through slot meters, but meter rent has been abolished in these cases.

East Ham.—Tenders are to be invited for wiring the new technical college. The General Purposes committee, having considered the question of withdrawing the compulsory minimum charge of 6d. per week made for the use of electric current supplied to tenants of the municipal working-class dwellings, recommend, as an experiment, that the use of the electric light be made optional for 12 months.

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Electric Driving in the Jewellery Trade.—The competition which the jewellery industry in this country has to meet from Germany and Switzerland is of the keenest kind. Much of the cheap, well-made jewellery that comes here from the Continent is only possible by the employment of the most up-to-date methods in manufacture. Pforzheim (Baden) has been long noted for the manufacture of jewellery, and there are now more than 700 factories in the city and over 20,000 workmen engaged. Jewellery to the value of £5,000,000 is manufactured annually, and two-thirds of this is exported. 400 out of the 700 factories are operated electrically, and in this way a great saving is effected. It is doubtful if the proportion of electrically-operated jewellery factories is as great in this country.

Electricity in Agriculture.—The National Electric Construction Co. have installed at Hafodybryn Farm, Llandedr, electrical plant for lighting and for operating farming implements.

Exeter.—By arrangement with the Corporation the National Telephone Co. have commenced the work of putting their wires underground.

The City Council on Wednesday decided to appoint a business manager of their electric light undertaking. In connection with the plant for the supply of energy to the tramways, it was decided to invite tenders for turbine and steam-driven plant.

Exhibitions.—Despatches have been received by the Foreign Office from H.M. Consul-General at Antwerp and H.M. Vice-Consul at Liège urging the desirability of British manufacturers participating on a considerable scale in the 1905 Liège Exhibition, and stating that France, Germany, Austria-Hungary and the United States will be largely represented, that 29,000 sq. yds. of space will be devoted to the machinery section alone, and that opportunity will be afforded for showing all kinds of machinery in motion.

A national exhibition will be opened at San Salvador (Republic of Salvador) on Aug. 1. British exhibits are invited. The Salvador Railway Co. will land exhibits free at the Port of Acajutla, and carry them free to the capital.

Exmouth.—A site has been acquired for the electricity works which are to be erected, equipped and maintained for a term of years by Messrs. Crompton & Co.

Farnborough.—The Board of Trade are again inquiring as to whether any steps have been taken to carry out the provisions of the Council's 1899 electric lighting order. No such steps have been taken.

Fatalities.—An inquest was held on Wednesday into the circumstances attending the death of a youth named Hartopp, which occurred in the underground workings at Exhall Colliery, Nuneaton, on Monday.

Deceased was a "clipper," whose duty was to fasten and unfasten tubs of coal from a wire running between a set of steel rails driven by an electric motor. While awaiting the coming of some tubs deceased caught hold of a steel girder above his head, placing his feet on the moving wire beneath. Three minutes later he fell, and when picked up was dead. It appeared that an electric cable passed over a girder and came in contact with that on which deceased was hanging, and two witnesses spoke to having seen electric flashes from wires in the vicinity.

Dr. Orton, who made the post-mortem examination, formed the opinion that death was due to electrocution.

Dr. Phillips attributed death to asphyxia, which might have been caused by electric shock.

Mr. L. W. de Grave, consulting engineer to the colliery company, said it would have been impossible for any electric current to have found its way into the girder from which deceased was hanging, or for him to have had a shock from the main cable.

Mr. Oliver Orton said he examined the cable directly after the accident, and found no leakage.

Eventually the jury found that death was due to electric shock.

The inquest into the circumstances of the death of the boy Edward Stanley Jones, aged 13, who was killed on Thursday last week on the Crossens section of electric railway of the Lancashire and Yorkshire Railway has resulted in a verdict of death by lectrocution, no blame being attached to any one.

Faversham.—The Council have fixed the price of electric current at 6d. for lighting and 3d. for power. The supply of current was commenced this week.

Felixstowe.—Sanction has been received by the Council to the borrowing of £14,160 (out of £17,160 applied for) for the purchase of the undertaking of the Suffolk Electricity Supply Co. and for extensions of plant, &c. The Local Government Board have reserved their decision as regards the balance (£3,000), payable when the company could show a profit of 6 per cent., until it becomes necessary for the Council to raise that sum.

Finchley.—The chairman of the Electricity committee (Councillor Todd) told the Council last week that applications for electric current for lighting were coming in at a brisk rate, and that the equivalent of over 11,000 8 c.p. lamps was connected. The committee had 40 contracts at present in hand for wiring premises in the district, and Messrs. Sayers, of East Finchley, propose to wire their houses, which would mean an addition of 2,000 lights. A further loan of £15,000 would be required to meet the growing demands of the department. An amendment to increase this amount to £17,000 was carried.

Folkestone.—An extension of time to construct their projected electric tramways has been applied for by the Corporation.

Glasgow.—The extension of the Corporation's electric tramways between St. George's Cross and Stobcross Ferry is now open.

Golborne.—Negotiations are proceeding between the Council and the Lancashire Electric Power Co. for the supply of electricity in the district.

Heavitree.—The Council are considering terms submitted by Exeter City Council for the supply of electricity in the district.

Hospital Lighting.—Burslem Council have instructed the borough electrical engineer (Mr. A. Bremner) to prepare estimates for wiring and fitting up the hospital for the electric light.

Hove.—The General Purposes committee recommend the Council to enter into a contract with Brighton Corporation for the supply of electricity in bulk for Aldrington.

Hull.—The Town Council have adopted the recommendation of the Electric Lighting committee to supply current to the North-Eastern Railway Co.'s docks and sidings in Hull at 1¾d. per unit for not less than 1,000,000 units per annum for three years for a 27 per cent. load-factor, and also to supply 500,000 units per annum for five years to Messrs. Reckitt & Sons at 1⅛d. per unit for a 33 per cent. load-factor. The present scale for general consumers for private lighting is 4½d. per unit, 2d. per unit for heating and cooking and for power when the units consumed per horse-power of the motors connected are less than 80.

Ilfracombe.—The Council have placed an order with the Ilfracombe Electric Light and Power Co. for lighting the exterior of the Pavilion by arc lamps.

Islington (London).—At the Council meeting last Friday the Lighting committee's recommendation as to the reorganisation and additions to the staff at Eden-grove electricity works, and as to the increase of salaries and wages, were approved by 32 votes to 17; but as a two-thirds majority is required the recommendations fell through.

Italy.—The cotton industry of Italy employs over 135,000 workers, distributed over 727 factories. Recent statistics show that rather more than half these factories are worked by steam, the remainder chiefly by hydraulic power and electricity. The total electrical horse-power employed in the cotton mills driven electrically is 4,539, and 933 H.P. is employed in flax, hemp and jute mills. Paper and wood pulp factories employ 1,075 H.P. of electric power, and the typographical industries 60 H.P. In the mining, metallurgical, mechanical and chemical industries the total of the electric driving is nearly 3,000 E.H.P.

Keighley.—Sanction to a loan of £11,500 for extensions of the electricity undertaking has been applied for.

Kensington (London).—The Borough Council on Tuesday voted 30 guineas to the borough engineer and surveyor for extra work in personally supervising the laying of conduits in connection with the electrification of the Metropolitan District Railway.

King's Lynn.—For the year ended March 31 the income of the electricity department was £5,685. 16s. 3d., and the total expenditure, including interest and sinking fund, £5,199. 8s. 1d., leaving net profit £486. 7s. 4d., compared with a deficiency of £47. 2s. 2d. on the previous year. The output for the year was 388,472 units, against 323,175. £2,783 was received from private consumers for lighting, £512 from power users and £1,991 for street lighting. Cost of generation was 1·29d. per unit. The number of consumers increased from 401 to 459, the number of motors from 25 to 37, and the total horse-power of motors from 109 to 474¼.

Leyton.—The Council have applied for sanction to a loan of £300 for wiring and fitting up Newport-road school for electric lighting.

Lewisham.—The borough engineer has been authorised to send in a claim for £759. 14s. 2d. for damage alleged to have been done to the roads and footpaths in the district by the Blackheath and Greenwich District Electric Light Co.

Lisbon.—In connection with a statement that the telephone line lately established between Lisbon and Orporto had been constructed for the Portuguese Government by the Anglo-Portuguese Telephone Co. (which works the telephone exchanges in these towns), we are desired by the Inspector-General of Telegraphs and the Electrical Industries of Portugal (Senhor P. B. Cabral) to state that the line in question is destined as a trunk connection between the telephone exchanges worked by the company, but that it has been constructed and will be maintained and worked exclusively at the expense of the State by the engineers and agents of Senhor Cabral's department and without any intervention by the company.

Maidstone.—The Electricity committee have decided to supply electrical energy to the Light Railways committee at 2d. per unit for the first 200,000 units per annum, 1¾d. for the second 200,000 units, and 1½d. per unit beyond.

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Marylebone (London).—At a meeting last evening the Borough Council agreed, on the recommendation of the Finance committee that,

Application be made to the London County Council for sanction to borrow £436,500 for the purchase of land and for the erection and construction of a station for generating electricity, under the powers of the St. Marylebone Electric Lighting Acts, 1901 to 1904, including buildings, machinery, &c., and the provision, laying, down and construction of mains and works for connecting the generating station with the existing mains, and the alteration and extension of mains and works. It is proposed to ask for the advance of £136,500 (part of the above-mentioned £436,500) during the Council's financial year ending March 31, 1905.

On the question of the principal loan for the payment of the amount awarded for the purchase of the Metropolitan Electric Supply Co.'s Electric lighting undertaking in Marylebone, the committee reported that,

Although the London County Council's Money Bill has passed the Committee of the House of Commons, and clause 6 of the bill authorises the County Council to lend to the Borough Council £1,415,000 for payment of the award, costs of the bill, judgment, &c., it is possible that the bill may not receive the Royal assent before the County Council rise for their recess at the end of July. In that event, the loan will not be forthcoming before the middle of October.

To meet these circumstances a recommendation was made by the Finance committee at last night's meeting that the committee be empowered to negotiate a temporary loan and to arrange for the payment of such amount as may be borrowed at the earliest possible date, the whole of the capital amount of the award being due to be paid to the Metropolitan Company by June 30. The proposals of the committee were adopted practically without discussion.

Middlesbrough.—In submitting his annual report the borough electrical engineer (Mr. H. M. Taylor) states that the revenue has increased by 100 per cent., with an increase in annual expenses of 50 per cent. The average price obtained per unit was 3·36d., which was low compared with other places. The net profit was £534, against a deficit of £485 in the previous year.

Middlesex.—The County Council have received an intimation from the Board of Trade that it was not intended to proceed with the Acton electric lighting provisional order, but that the Hampton Wick and District order had been granted. The question as to the liability of Messrs. J. G. White & Co. (contractors for No. 5 tramway) to make good portions of the track in Edgware-road which had subsided has been referred to arbitration.

Municipal Telephony.—The minutes of Glasgow Telephone committee submitted to the Corporation last week contained a reference to the termination of Mr. A. R. Bennett's service as general manager, and the committee expressed their appreciation of the able manner in which he had discharged the duties of his office.

The committee also reported that they had agreed to bear the cost of provisional protection of an improvement in telephone apparatus by the assistant general manager, on condition that the Corporation will, free of all charge for royalty, have its use for their telephone system.

Bournemouth Telephone committee have been informed by the manager of the National Telephone Co. (Mr. W. E. L. Gaine) that the company are unable to depart from the position taken up by them on the occasion of the recent interview. The Council have approved a draft circular drawn up by the town clerk setting out the proposals of the committee in regard to the equipment of a municipal telephone exchange, and it is to be printed and issued to ratepayers in the district. A canvasser has been appointed temporarily to make a canvass in the area.

Newport (Mon.)—The accounts of the first year's working of the municipal electric tramways show total receipts £23,653 and a gross profit of £8,119. 16s. 8d. After providing for interest and sinking fund (£7,719. 18s. 11d) the net profit was £399. 17s. 9d.

The revenue of the electric lighting department for the past year was £18,166 and the gross profit £9,370. Interest and sinking fund instalment required £9,595, leaving a deficiency of £225.

Newport, N.B.—The Council have decided not to entertain at present the question of the purchase of the works of the Tayside Electric and Gas Light Co.

Nottingham.—In submitting the accounts of the Electricity committee, which were abstracted in our last issue, the chairman of the committee (Ald. Sir John Turney) stated at the Council meeting on Monday that Dr. Kennedy, who had been called in to report upon the undertaking, had found that the plant, mains, &c., were in a most satisfactory condition. There were three items, however, that should be removed from the accounts—viz., the discount on issue of consolidated stock (£1,614), expenses of issue (£215) and preliminary expenses (£330). The simplest way would have been to do away with those items. It was gratifying to know that although they had spent a great deal of money upon the undertaking, there had not been much of it wasted. The accounts were approved, as were those of the tramways department.

Paris.—The company which supplies electricity in the areas on the left bank of the Seine, Paris, has decided to extend its generating station at Issy. Four alternators of 600kw. each are to be installed in place of the former units. Each generating set will consist of one Westinghouse single-phase alternator (3,000 volts 42 periods) direct-connected to one of the existing horizontal steam engines, which can give out 800 H.P. each. The exciting current for each unit will be furnished by a 25kw. exciter, at 125 volts. Each alternator will be fitted with a special flywheel weighing about 7·7 tons, which will about double its inertia. The spider will be cast in two pieces so that it may be mounted direct on to the shaft of the engine, without removing the bearings.

Patent Amendment.—The Mica Insulator Co. (Ltd.), Empire Works, Blackhorse-lane, Walthamstow, London, N.E. (late of Stanstead, Essex), seek leave to amend specification of Letters Patent No. 6,048 of 1895, granted to Carl Bolle, for "Improvements in the manufacture of flexible sheets for electrical insulation." Particulars of proposed amendment are set out in the "Illustrated Official Journal" (Patents, of June 1) and opposition must be given within one calendar month from that date.

Penge.—At last week's Council meeting a communication was received from the Blackheath and Greenwich District Electric Light Co. that they would arrange to commence supplying electric current in the district as soon as the Board of Trade had approved the transfer to the company of the Crystal Palace District Electric Supply Co.'s undertaking. This approval has since been given.

Presentations.—On April 29 the officials and workmen of Cape Town Corporation electricity works presented Mr. Walter F. Long, A.M.I.E.E., city electrical engineer, son of Mr. C. G. Long, J.P., of Maidstone, Kent, with a pianola on the occasion of his marriage with Miss Dora Rowlinson, daughter of Mr. R. Rowlinson, of Chorlton-cum-Hardy, which was celebrated the following day at St. George's Cathedral, Cape Town, in the presence of a large number of well-wishers.

At Ilford on Friday evening last week the staff of the electricity works presented the chief electrical engineer (Mr. Arthur H. Shaw) with a carved oak chiming clock on the occasion of his marriage, with Miss Hilda M. Cassidy, which took place at Ilford on the 1st inst. The presentation was made by Mr. Bond, who paid a high tribute to the esteem and regard in which Mr. Shaw was held by the staff. Mr. Shaw acknowledged the gift in suitable terms.

Provisional Electric Lighting Order.—The Board of Trade have issued an order under which Caerphilly District Council have to lay distributing mains within two years. The order limits the maximum price to be charged for electric energy to 11s. 8d. per quarter for 20 units or under and 7d. per unit for any quantity in excess of 20 units. The Council may enter into an agreement with the South Wales Electrical Power Distribution Co. for the supply of electricity in bulk.

Ravensthorpe.—The question of applying for a provisional electric lighting order is being considered by the Council.

Rochdale.—Application has been made for sanction to a loan of £42,405 for extension of the electricity undertaking, as follows:—

Buildings, foundations, &c., £4,500, three 200kw. turbo-alternators and one 200kw. motor alternator £5,800, 412kw. steam dynamo for direct-current supply £3,750, sub-station plant for lighting £2,500, three Lancashire boilers, with superheaters, valves, fittings and steam-pipe connections, £3,150, superheaters for existing boilers, extension steam pipes, expansion bends, valves, connections and coaling platform, &c., £2,750, condensing plant and exhaust pipework for above £2,650, feed pumps and pipes, tanks, &c., £500, switch gear and engine room connections £2,950, cables, meters, &c., £10,000; total £38,550; fees and contingencies 10 per cent., £3,855.

The question of giving a supply of electricity to Littleborough is under consideration.

Application has been made by the Council for sanction to a further loan of £42,405 for extensions of the electricity undertaking.

Rotherham.—The Council have been authorised to borrow the further sum of £14,670 for electric lighting extensions.

Runcorn.—The Council have applied for two years' extension to carry out the terms of their provisional electric lighting order.

St. Anne's-on-the-Sea.—In presenting the minutes of the Electricity committee at the last meeting of the Council,

Mr. IRVING said that the revenue for the past year was £5,992. 14s. 6d. (£2,179. 14s. 5d. from private lighting, £1,015. 12s. 4d. from public lighting, £2,670. 15s. 2d. from traction and £56. 12s. 7d. miscellaneous); the annual expenses were £2,621. 19s. 3d., gross profit £3,300. 15s. 3d. Interest and sinking fund required £1,718. 13s. 2d., leaving a net profit of £1,582. 2s. 1d., against £107 in 1903 and £12 in 1902 (the first year). The undertaking was in a most satisfactory condition; the works had been most economically managed and the committee had been able to reduce the cost of current for public lighting from 4d. to 2½d. per unit. Meter rentals had been abolished, and altogether their record was a creditable one for only three years' working. Their success was due to the energy and enterprise of their engineer (Mr. J. H. Clothier) who had proved himself a most capable manager.

Saffron Walden.—At a recent meeting the Council adopted a recommendation of the Electric Lighting committee to accept

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Messrs. Foote and Milne's proposals for equipping and maintaining electricity works. The capital cost is £9,150. Interest and sinking fund will be paid by the firm. Application has been made by the Council for sanction to borrow £10,150.

Shanghai.—It is reported that the Municipal Council are negotiating with American firms for the construction of electric tramways. The project comprises the construction of 23 miles of track on the overhead system, and the concessionaires are to be required to operate as well as to construct the system. A deposit of £5,000 is to be lodged with the Council on signing the contract, and the rental to be paid is £100 per mile of single and £150 per mile of double track.

Sheffield.—The electric lighting accounts were presented to the Corporation on Wednesday by the chairman of the Electric Light committee (Ald. Styring). He referred to the rapid increase in the demand for electrical energy for power, and announced that the new power house was rapidly approaching completion. The Council had not fully realised its duty to the electric lighting department, and he thought there should be a further extension of public lighting.

Sleaford.—There was a profit of about £200 on the past year's working of the electricity department.

Sunderland.—The Council on Wednesday adopted the report of the Electricity and Lighting committee, which recommended that opposition be offered to the Supply of Electricity Bill. The Tramway committee propose to appeal against the assessment of the tramway undertaking, which has been raised from £8,343 gross and £5,104 net last year to £20,150 gross and £14,129 net this year.

South Africa.—The "British and South African Export Gazette" states that Johannesburg Council have accepted tenders for engines and dynamos, at a cost of about £9,140, for temporary use pending the completion and equipment of their power station, and also for a pair of dynamos and an engine for Burghersdorp refuse destructor works. The purchase of switchboards, cables, &c., at a cost of £4,436, has also been authorised.

Bloemfontein Town Council will supply electrical energy for power at 9d. per unit.

Mr. Clement Hirzel has secured the concession for the supply of electricity at Nairobi (East Africa) within a 15-mile radius, and will promote a company in England to carry out the project. It is proposed to charge for current 1s. 4d. per 8 c.p. lamp per month, 1s. 8d. per 16 c.p., 2s. 8d. per 32 c.p., 4s. per 50 c.p., 6s. 8d. per 2½ ampere arc and 13s. 4d. per 5 ampere arc, and 2d. per unit for power.

An electricity generating station is to be erected on the new Natal central experimental farm.

A 14½ H.P. electric generator and a 25 H.P. engine have been installed at the Lourenço Marques electric laundry.

An electricity supply and tramways scheme for Zanzibar is under consideration.

The electric cableway which is to be used for conveyance of materials, &c., over Victoria Falls during the construction of a steel bridge across the Zambesi at that spot by the Cleveland Bridge and Engineering Co. was designed by Mr. R. Poole, and the steam engine and dynamo has been supplied by Ernest Scott and Mountain. The conveyor will carry a 10-ton load, and can deal with 800 tons per day.

Exports from the United States to British and Portuguese Africa during February included electrical machinery valued at £3,229, compared with £354 in February, 1903.

Recent shipments from New York for South Africa included 353 cases of electrical machinery and material.

Southwark.—The position of the borough electrical engineer (Mr. J. R. Blaikie) was again considered at the Borough Council meeting on Wednesday, when the Electrical committee recommended that Mr. Blaikie be given three month's notice to terminate his appointment. The matter was discussed a month ago, but was adjourned to give Mr. Blaikie an opportunity to resign.

The MAYOR now stated that he had received a letter from the engineer, but he advised that it should not be read.

Mr. CHELL: Surely it is only justice to a man, against whom grave charges are brought and whose professional future is at stake, that we should hear what he has to say.

The MAYOR: If the Council place confidence in me the letter will not be read. A communication attached to it is of a libellous character.

Mr. EDWARDS (late chairman of committee) said he wrote the communication referred to, and on the previous night gave Mr. Blaikie liberty to use it.

Ultimately it was decided by 35 votes to 11 to have neither communication read.

Mr. ATTENBOROUGH protested against the un-English mode of procedure adopted, and inquired if Mr. Blaikie had not offered to resign if the imputations against him were withdrawn

The MAYOR replied that, in view of the vote taken, he could not supply any information.

Mr. EDWARDS opposed the recommendation. There had been two inquiries into the condition of the undertaking. In the first case 12 meetings were held, with an average attendance of 12 members, and the recommendations contained no charge of maladministration or mismanagement. At the second inquiry there were five meetings with an average attendance of five. He was sorry that an arrangement had not been come to by which Mr. Blaikie would resign. He would have to go, for an officer at loggerheads with his committee found his position untenable. But he did not blame Mr. Blaikie for declining to commit professional suicide, for if he had resigned without conditions the terms, of the committee's resolution would have been held to be justified. Was it not strange, if the resident engineer was deserving of dismissal, that he should be supported by Mr. Newman (chairman of committee), himself (ex-chairman), Mr. Hawkins and Mr. Anton, two practical electrical engineers. A party meeting of the Progressives had been held to decide the matter on the previous night, but although he (Mr. Edwards) had been a member of that party for more years than he cared to remember, he was not summoned to attend because it was known he was upholding Mr. Blaikie.

Mr. WESTCOTT, in reply, said those supporting the recommendation were accused of lack of electrical knowledge. That might be true, but they had common-sense. They did not accuse Mr. Blaikie of maladministration, but of lack of interest in his work and general lack of supervision.

The Rev. Mr. PITT was convinced that Mr. Blaikie was being made a scapegoat, and Mr. NEWMAN said one of the members of the committee of inquiry went round canvassing for complaints against Mr. Blaike.

On a division, the recommendation was carried by 35 votes to 11.

Spain.—A decree has been issued authorising the substitution of electric for horse traction on the tramway between the Obelisco "Paseo" and Diego de Leon, Madrid.

Stepney.—The Parliamentary and Electric Lighting committee reported to the Borough Council on Wednesday that they agreed with the general principles of the Supply of Electricity Bill, 1904, subject to the following amendments:—(1) That the expression "company or person" in clause 3 (*a*) be amended so that is is made clear that it includes any authorised distributor, such as the Borough Council; and (2) that clause 6 be deleted.

Stockton Heath.—The Council have agreed to allow Warrington Corporation to supply electric current in the district, provided the charges are not in excess of those made at Warrington.

Stourbridge.—The borough electrical engineer (Mr. Clarke) has submitted alternative schemes of electricity supply—one to take electricity in bulk from the Midland Electric Corporation for Power Distribution and to distribute it to consumers through the Council's mains, the other to erect municipal electricity supply and refuse destructor works. The capital involved in the first scheme is £6,158, and in the second, £15,674. The manager of the company (Mr. J. H. McLean) intimated that his company would be willing to accept from the Council a notice of 6 or 12 months to discontinue supply. The Electric Powers committee recommended that the Council should take electricity in bulk for the compulsory area, and this has been agreed to by the Council.

The committee also recommended that further representation be made to the Board of Trade with the view of assuring the non-revocation of the Council's provisional electric lighting order of 1899.

Switzerland.—A new electrical mountain line of railway is to be constructed, 8½ miles in length, to connect the town of Weesen with the mountain Speer.

Tasmania.—The "Australian Mining Standard" recently announced that the electrical plant at the Mount Lyell Mines, &c., was to be increased from 280 H.P. to 1,000 H.P. capacity and that orders for about £9,000 worth of generating plant had been given to the Australian Metal Co., representing Brown, Boveri & Co. This plant will consist of two 400kw. steam turbo-alternators, to generate three-phase current at 500 volts, which will supply energy to motors for driving pumps, hoists, blowers, &c.

Victoria (Australia).—The local authority are disposed to accept a proposal of Messrs. Hunter, Buckley and Hunter to light the town of Bright by electricity, which they propose to generate by means of plant to be installed at their mines.

Mr. Henry Deane, Government Engineer-in-Chief for Railway and Tramway Construction, has started on a visit to Canada, the United States and Great Britain to obtain information on the subject of railway and tramway construction, the use of automobiles by railway administrations, the electrification of railways and the electrical working of lifts.

Walton-on-Thames.—Negotiations are proceeding for the lighting of the district by the Urban Electric Supply Co., who have erected experimental lamps.

Wanstead.—The clause in the Leyton omnibus bill relating to the supply of electricity in Wanstead has been struck out in the House of Lords.

Warrington.—Sanction to a further loan of £5,000 for electric lighting extensions has been obtained by the Council.

Workhouse, &c., Lighting.—Chelsea Guardians are considering an offer by the Chelsea Electricity Supply Co. to supply electricity

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at 4d. per unit for lighting the new offic es and buildings at King's-road.

York.—The accounts of the electricity department for the year ended March show total capital expenditure of £99,519. 11s. 1d., an increase of £25,462 during the year.

Receipts from sale of current were £8,685. 0s. 11d , including £7,522. 3s. from private consumers and £1,162 for public lighting. The total income was £9,112. 11s. 2d., working expenditure £4,962. 15s. 4d. Out of the balance (£4,149. 15s. 10d.), £3,799. 4s. 3d. is required to meet interest and sinking fund instalment, leaving a net profit of £350. 11s. 7d., which has been applied in wiping out the deficit of £351. 6s. at March, 1903. 924,263 units of current were generated and 811,027 sold.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Walthamstow Urban District Council invite tenders for the supply of three Westinghouse gas engines, starting appliances, piping and accessories, three continuous-current dynamos with spare armature of approved manufacture, with usual measuring instruments and switchboard. Specifications, &c., from the consulting engineer (Mr. J. Enright), 68, Lincoln's Inn-fields, W.C. Tenders to Mr. C. Sydney Watson, clerk and solicitor, Town Hall, Walthamstow, by 5 p m. June 23. Further particulars are given in an advertisement.

Wigan Corporation invite tenders for 12 bogie cars (single deck, two-motor equipments). Plans may be inspected and copies of general conditions, specifications, &c., obtained after 13th inst. from the borough electrical and tramways engineer (Mr. James Slevin), Bradford-place, Wigan. Tenders to town clerk (Mr. Harold Jevons) by noon of Tuesday 21st inst. See also advertisement.

The Council of the Metropolitan Borough of *Stepney* invite tenders for laying on an electric light wiring installation at the public baths in Whitehorse-street, Ratcliffe, E. Drawings may be seen and copies of specifications, &c., obtained from the borough engineer (Mr. W. M. Jameson), 15, Great Alie-street, Whitechapel, E., after June 20. Tenders to town clerk (Mr. George W. Clarke), by noon of Tuesday June 28. Further particulars are given in an advertisement.

Loughborough Gas and Electric Lighting committee invite tenders from manufacturers for the supply and erection of electric cables (including laying), switchboard, steam, feed, blow-off and other piping and feed pumps (including erection). Specifications from the consulting engineer (Mr. C. H. Gadsby), 20, Victoria-street, Westminster, S.W., after June 13. Tenders to the town clerk (Mr. Harry Perkins), Town Hall, Loughborough, by noon June 25. See also advertisement.

The directors of the *Isle of Thanet Electric Tramways and Lighting Co. (Ltd.)* are advertising for 12 months' supply of electricity meters. Specifications from the manager, power station, St. Peters, Kent.

Tenders are invited for the supply and erection of a complete telephone and fire alarm installation for the Angelton and Parc Gwyllt Asylum, *Bridgend.* Specifications, &c., from the clerk (Mr. W. E. R. Allen), Glamorgan County Offices, Cardiff. Tenders to Mr. Allen by June 18. See also advertisement.

The Lords Commissioners of the *Admiralty* are prepared to receive proposals from persons willing to submit for competitive trial range-finders, both large and small, for naval use. Conditions, &c., will be furnished to bona fide inventors or manufacturers of such instruments on application to the Director of Navy Contracts, Admiralty, London, S.W. Full descriptions of the range-finders proposed must be sent in by June 30.

Metropolitan Asylums Board invite tenders for builders', engineers', smiths', plumbers' gas fitters' and miscellaneous ironmongery, engineering stores and electric accessories. Forms of tender from the offices of the Board, the Embankment, London, E.C., and tenders by 10 a.m. June 15.

West Ham Education committee invite tenders for wiring and fittings required at West Ham Park elementary schools, Stratford. Tenders to Education Department, 95, The Grove, Stratford, E., by 5:30 p.m. June 20.

Lincoln Corporation invite tenders for eight electric tramcars. Tenders to Chairman and Members of Electricity committee, 5 and 6, Bank-street, Lincoln, by 10 a.m. June 13.

Wimbledon Urban District Council invite tenders for two water-tube boilers, economiser, feed pump and pipe work. Tenders to chairman of Electric Lighting committee by noon June 17.

London County Council invite tenders for two continuous coal and ash conveyors (gravity bucket type) at Greenwich electricity generating station and for maintenance of same for 12 months. Tenders to the clerk of the Council (Mr. G. L. Gomme) by 10 a.m. June 14.

Leigh Corporation invite tenders for one 300kw. steam-driven set and switchboards. Tenders to chairman Electricity committee by June 21.

Finchley District Council require tenders by 5 p.m. 20th inst. for a 350kw. high-speed combined engine and dynamo, with spare armature and spare parts.

Erith District Council invite tenders for tramway rails, fishplates and bolts and for permanent-way construction. Tenders by noon July 11.

Dublin Corporation invite tenders by 17th inst. for about 10,000 tons of coal for their electricity works.

Tenders are invited until Aug. 3 (16) by the municipal authorities of *Phillippopolis* (Bulgaria) for the concession for 50 years for the supply of electrical energy in the town and for the construction and working of an electric tramway. Specifications from the Mayor on payment of 20fr.

TENDERS RECEIVED AND ACCEPTED.

Middlesex County Council received the following tenders for the wiring and fittings necessary for the electric lighting of their new Napsbury Asylum :—

Wells, Rayner & Co. (*accepted*)	£5,343 0	Strode & Co.	£7,287 0
Hampton & Sons	11,955 0	D. Hulett & Co.	7,062 0
F. Suter & Co.	9,274 0	Wenham and Waters	6,549 0
Wippell Bros. and Row	8,000 0	W. J. Fryer & Co.	6,163 0
Allom Bros.	7,769 14	Belshaw & Co.	6,000 0
Comyn Ching & Co.	7,700 0	R. H. and J. Pearson	5,022 0
Simmonds Bros.	7,438 0	Thomas Potter & Sons	4,496 0
		Jones and Spence	3,200 0

On the recommendation of the Electricity and Lighting committee, Sunderland Corporation, on Wednesday, accepted the tender of the Electrical Co. for the supply of cables. The chairman of the committee (Ald. Bruce), in support of the recommendation to accept the tender, said it was the lowest of 16 tenders received. The second lowest came from Germany, while the third was from a Glasgow firm (who had not experience in making street cables), and the fourth was from an English firm.

The following contracts have been placed with Messrs. Belliss and Morcom (Ltd.), Ledsam-street Works, Birmingham :—

Two 180-190 H.P. engines (through Thomas Parker, Limited) for direct coupling to Parker dynamos for the Wolverhampton destructor. One 430-475 H.P. engine for direct coupling to a 300kw. generator at the Wolverhampton electricity works. One 100 H.P. engine (through W. C. Martin & Co.) for direct coupling to a Siemens dynamo for the Anchor liner "Caledonian." One engine for direct coupling to a 300kw. E.C.C. generator for Madras Tramways Co.

The D.P. Battery Co., 11, Victoria-street, London, S.W., have secured orders for a lighting battery for Walton-on-Thames, consisting of 260 17-plate cells of their Lumford station type in lead-lined wood boxes, and also for the renewal of the battery at Melton Mowbray electric lighting station for a battery of larger size, consisting of 260 15-plate Lumford station type cells in lead-lined wood boxes.

Johannesburg (Transvaal) Town Council have accepted the following tenders for temporary electricity generating plant :—

W. H. Allen, Son & Co., two direct-coupling engines at £1,980 (13 tenders received). Mather and Platt, motor-generators and a pair of dynamos for Burghersdorp refuse destructor at £834. W. H. Allen, Son & Co. are also supplying an engine for driving the latter.

Colchester Corporation have accepted the following tenders :—Reason Mfg. Co., fuse-boxes ; St. Helen's Cable Co., service cables ; Mather and Platt, 360kw. dynamo (at £840) ; Joslins Limited, wire netting for covering engine-room lights ; Poulton & Sons, boiler settings, &c.

Fulham (London) Guardians received 17 tenders for fire alarm systems for their infirmary and workhouse and a steam hooter. The lowest aggregate tender (that of Messrs. Clements, Booker & Co.) at £126. 15s. has been accepted.

For the supply and erection of two 100kw. direct-driven steam sets Mexborough Urban District Council have accepted the tender of Mavor and Coulson (with Willans engines), subject to satisfactory time of delivery. 36 firms submitted tenders.

The tender of the Hart Accumulator Co., Marshgate-lane, Stratford, London, E., has been accepted for the supply of a storage battery of 260 central-station type cells for the Council of Aliwal North, South Africa.

Ealing Town Council have accepted the tender of the British Electric Transformer Co. for the supply of transformers at £870, and that of Cowans Limited for extensions to the switchboard at £474. 10s.

Stretford Urban District Council have accepted the tender of the Lancashire Dynamo and Motor Co., Trafford Park, Manchester, for a 400kw. steam-driven generator, at £2,663.

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Bury Joint Hospital Board have accepted the tender of Mr. J. Downham for electric light wiring, telephones, &c., in their new diphtheria pavilion.

Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board have accepted the tender of Dick, Kerr & Co. for overhead equipment in the main car shed.

Battersea Borough Council have accepted the tender of Messrs. Graham, Morton & Co. for measuring boxes for the coal-handling and conveying plant at the generating station at £298.

Hastings Council have placed with the receivers and managers of Ferranti Limited an order for 20 10-ampere meters at £3. 5s., 20 25-ampere at £3. 10s. and 10 50-ampere at £3. 15s. each.

Canterbury Corporation received 13 tenders for the supply of 1,800yds of cable, varying from £902 to £1,137. 2s. and the lowest (that of the Western Electric Co.) was accepted.

Owing to the withdrawal of a tender for the extension of the electricity station buildings, Middlesbrough Town Council have accepted that of Mr. McNaughton at £3,370.

Shoreditch Borough Council have accepted the tender of the Electric Construction Co. for a motor balancer at £214.

BUSINESS NOTICES.

From 1st inst. the electrical branch of the Crypto Works Co. (Ltd.) will be transferred to the Crypto Electrical Co., 3, Tyer's-gateway, Bermondsey-street, London Bridge, S.E., to which address all communications relating to orders should be sent. Accounts due to or by the Crypto Works Co. (Ltd.) must be paid or rendered at their offices, 29, Clerkenwell-road, London, E.C.

Mr. E. T. Oubridge has retired from the business lately carried on by him in partnership with Messrs. F. W. R. May and E. G. K. Calder as the Southern Electrical Accessories Co., 4, Newington Causeway, London, S.E. Messrs. May and Calder continue under the old style.

The Electrical Trades Engineering Co. has removed to 22, Park-place, Baker-street, W.

Messrs. Spearing and Stark, electrical engineers and contractors, have removed to 109, Merton-road, Wimbledon.

LIQUIDATIONS, BANKRUPTCIES, &c.

In the failure of Messrs. Schischkar & Co. (Ltd.) the liquidator, Mr. J. E. Pritchard, 71, Colmore-row, Birmingham, announces a second and final dividend at the rate of 5s. in the £. The statement of affairs shows a total realisation of £4,232. 9s., out of which preferential creditors have received £75. 18s. 2d. and unsecured creditors £3,589. 15s. 2d. Other outpayments have consisted of £348. 12s. 8d., cost of carrying on the business, £115 paid to cancel a lease, and there is a small balance available to cover the cost of closing up the estate. The liquidation will have lasted about 15 months, and the unsecured creditors who usually derive so small a return from more promising liquidations, have, we think, reason to be well satisfied with the liquidator's work. It is due to Mr. Pritchard to call particular attention to the satisfactory division of 15s. in the £ which has resulted in this case.

An adjourned meeting of the creditors of the British Electric Car Co. (Ltd.) was held at Manchester on Wednesday, the liquidator (Mr. T. F. Wild) presiding.

It was agreed that, having heard the reports of the liquidator and the committee of creditors, the matter remain in the hands of the committee, with the request that they formulate a scheme for the purchase of the business, and ascertain the willingness or otherwise of the creditors to subscribe thereto. If sufficient support cannot be obtained, the scheme will be abandoned. Efforts had been made to sell the business as a going concern, but up to the present without success.

In the voluntary liquidation of O. Berend & Co. (Ltd.), a statement showing the position of affairs and the declaration of a first and final dividend, has just been made by Mr. A. Riley, the liquidator. From this it would appear that the estate realised £1,861. 10s., of which £1,530 was required to pay off the debenture-holder's claim. Unsecured creditors received a first and only dividend of 2¾d. in the £ on claims amounting to £5,176. 14s., the total amount so distributed being £58. 5s. 5d.

Claims against the Dover Electricity Supply Co. (Ltd.) (in consequence of the acquisition of its undertaking by the Corporation) by 24th inst. to the liquidators, Park-street, Dover.

The public examination of Alexander Scott Johnstone, sole partner in A. S. Johnstone & Co., electrical engineers, 57, Hope-street, Glasgow, took place on Monday. Bankrupt commenced business in Oct., 1901, with £200 capital. Liabilities £1,692. 17s. 2d., astets £232.

Winding-up Petitions.—A petition for winding-up the National Electric Traction Co. (Ltd.) will be heard in the High Court on 14th inst.

A petition, presented by the Voelker Incandescent Mantle (Ltd.), for the winding-up of the Electro-Voelker Synd. (Ltd.), will be heard on 28th inst. at the Croydon County Court.

A petition for the winding-up of Shippey Bros. (Ltd.), presented by Canadian Motors (Ltd.), will be heard at the High Court on the 21st inst.

Sale by Tender.—Pursuant to an order of the Chancery Division of the High Court, the property and assets of Electric Lighting Boards (Ltd.), in liquidation, comprising electric lamps, flexible electric cable, electric lighting boards and strip, machinery, furniture, patent rights, &c., are to be sold in six lots as set out in an advertisement elsewhere. The stock can be viewed on the premises, 80, York-street, King's Cross, London, N., any day up to June 29, and tenders must be delivered to the receiver and manager before 12 o'clock of the 30th inst. Particulars and conditions of sale may be had of the receiver and manager (Mr. Percy W. Straus, F.C.A.), 7, Great Winchester-street, E.C.; Messrs. Golding and Hargrove, 99, Cannon-street, E.C.; Lee, Davis and Lee, solicitors, 1, Gresham-buildings, Basinghall-street,; and Dolman and Pritchard, 9 and 10, King-street, Cheapside, E.C.

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (inclnding a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 30, Birley-street, Blackpool.

A complete secondhand electric lighting plant, suitable for an installation of 200 lamps (14 H.P. Crossley gas engine, 70-ampere dynamo, switchboard, &c.), is advertised in another column. Full particulars from Mr. W. P. Adams, M.I.E.E., 35, Queen Victoria-street, London, E.C.

Two electric lighting plants, consisting of two Armington-Sims engines and two Edison two-pole shunt-wound dynamos (350 amperes at 110 volts), and one Crompton compound-wound dynamo (150 amperes at 100 volts), coupled direct to a Willans engine, are advertised for sale by Messrs. R. H. Longbotham & Co., Wakefield.

A small electric lighting plant is advertised for sale in another column. Particulars of Messrs. King & Son (Ltd.), Horsham, Sussex.

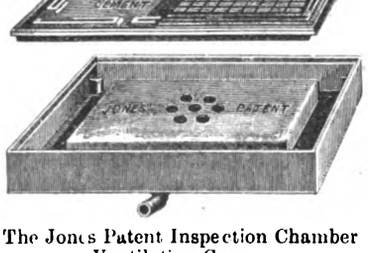
A battery of 55 E.P.S. cells, complete with trays, insulators, &c., is advertised for sale; two Campbell 12 H.P. gas engines are also offered.

Curtis Turbines for Japan.—The Tokyo Railway is constructing a tramway system in Tokyo which is to be operated by electricity, and is to be one of the most modern and efficient plants of its size in existence. It has been decided to use turbine-driven generating plant, and an order has been given for four 1,500kw. and two 500kw. Curtis turbine units, together with the necessary switch gear, and 800 G.E. 54 motors for the equipment of the tramcars.

Raworth's Traction Patents.—Orders have been received for one demi-car with regenerative control for the Glossop tramways, and for three new cars (full size) for the Scarborough tramways, thus increasing to 10 the number of tramway systems which have introduced regenerative control.

Catalogues, &c.—The Langdon-Davies Motor Co., 101, Southwark-street, London, S.E., finding that the number of single-phase alternating-current circuits having a periodicity of 60 is on the increase, have prepared and issued a special price list of motors suitable for this periodicity. The list can be carried in the waistcoat pocket.

Mr. John Jones, Carlyle Works, Church-street, Chelsea, London, S.W., has ready an excellent new list of cast-iron drainage fittings. The list is particularly strong in a variety of manhole covers, including those for heavy road traffic. The illustration shows a patented ventilating cover designed for pavement, roadway and other electric main inspection chambers. It will be seen that a wide channel is provided. This acts as a receiver for the condensation arising and returning from the underside of the inner arched cover, the channel having an outlet for the discharge of any liquid that may accumulate. The free ventilation of the inspection chamber is secured by the ventholes through the inner cover and through the slots and holes on the outside cover, these holes also forming an outlet for evaporation of moisture or the escape of any acccumulating gases. In the corner of each frame a bedding of lead is provided, protected by specially-formed angles, preventing jar and vibration by traffic. By this means it is claimed that perfect ventilation, free escape of condensed moisture and a dry interior to the chamber are secured.



The Jones Patent Inspection Chamber Ventilating Cover.

A new pamphlet of Nernst lamps for street lighting containing numerous testimonials from borough electrical engineers who have used these lamps for this purpose has been issued by the Electrical Co., 112-124, Charing Cross-road, London, W.C. The users include Mr. C. S. Davidson (Barnes), Mr. H. Goodyear (Colchester), Mr.

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A. J. C. Waterland (Dartford), Mr. C. F. McInnes (Gravesend), Mr. E. E. Hoadley (Maidstone), Mr. W. C. P. Tapper (Stepney), Mr. J. H. Clothier (St. Annes-on-the-Sea), Mr. H. W. Angus (Eccles), &c.

A very fully illustrated pamphlet on "Electric Power" has been issued by Messrs. Johnson and Phillips, Old Charlton, Kent, who, as our readers are aware, have made a speciality of the equipment of mining properties for electric working. The importance of this question from the financial aspect of mining work is shown clearly from the evidence of the authorities at the various mines where this plant has been installed, that mines which have experienced difficulty in making both ends meet have been able to turn the financial corner owing to the economies effected by electric working. Many of these plants have been worked under novel and apparently unsuitable conditions, but it is satisfactory to record that interruptions in working have been practically nil. The owners of extensive mining properties such as the Sheba, Burma Ruby, Rand and Rezende mines, are all highly satisfied with the results obtained by the introduction of electric plant, and what is good enough for the owners of these properties will be found in the long run indispensable in many other places. Copies of the pamphlet, which contains much interesting matter relating to the electric transmission of power, can be obtained gratis from Messrs. Johnson and Phillips.

A very complete catalogue of telephones, telephone parts, and the varied accessories which enter into the work of telephone installation has been issued by the General Electric Co., forming the 9th edition of the company's K section. The list comprises everything that goes to make up a complete collection of G.P.O. standard apparatus of British manufacture. It is particularly strong, too, in traction telephone equipment, and in this connection the company point out that apparatus of their manufacture is in use on practically every electric tramway system in this country, including the L.C.C. lines. Inter-communication sets, perhaps the most considerable development of telephone enterprise at the present time, are illustrated in numerous designs and to suit all requirements. In the G.P.O. standard apparatus described and illustrated is a secondary cell charging switchboard. This board allows of cells being charged from day to day and connected into the charging circuit without in any way interfering with the working of the line, an arrangement which overcomes the difficulty involved in maintaining the cells at a constant voltage, for by the movement of the lever which controls the "Barrel" switch, different sets of cells are brought into use periodically without stopping the line current for a single moment. The list is also complete in regard to fire-brigade alarms on the system in use in several towns and recently installed at Brighton. Special forms of telephones for naval and military use are shown, the latter offering special facilities for rifle-range work for communicating between the target and firing line. As is the case with all this company's publications, the illustrations are thoroughly up to date and are used to show even the smallest accessory described. Attention is called to the reduction in prices which have been recently made in these goods.

An amended price list of "Perfecta" resistance apparatus has been issued by Monté Callow & Co.

The Brush Electrical Engineering Co. have ready a neat illustrated pamphlet of electric locomotives, railway carriages, rail watering and cleaning electric cars, tramway cars (single and double deck), &c.

Imports.—The following are the values of imports to this country during May :—

Electrical machinery, £35,887 (a decrease of £1,579 compared with May, 1903) ; telegraph cables and apparatus, £4,286 (increase £3,307) ; other electrical goods and apparatus, £60,931 (decrease £6,651). The totals for the five months ended May 31 were respectively £214,811 (decrease £45,694), £14,813 (decrease £11,805) and £327,928 (increase £27,448).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from June 1 to 7, with the ports of destination:—

Aden, £17. *Africa*—Alexandria, £264; Durban, £1,385; East London, £753; Port Elizabeth, £82; Sekondi, £65; Suakim £110 (telegraph material). *Argentina*—Buenos Ayres, £2,325. *Australasia*—Adelaide, £115; Brisbane, £353; Fremantle, £1,159 (including £526 telegraph material); Hobart £41; Launceston, £270; Melbourne, £106; Oamaru, £108; Sydney, £2,822; Wellington, £411. *Brazil*—Bahia, £10,500 (telegraph material); Rio Janeiro, £1,922 (including £1,728 telegraph material). *Ceylon*—Colombo, £205. *Chili*—Iquique, £24. *Columbia*.—Santos, £30. *China*—Shanghai, £788 (including £52 telegraph material). *Denmark*—Copenhagen, £34. *Germany*.—Hamburg, £354. *Holland*—Amsterdam, £70; Flushing, £31; Rotterdam, £47. *Hong Kong*, £55. *India*—Bombay, £478; Calcutta £299; Madras, £52. *Japan*—Kobe, £387; Yokohama, £1,259. *Norway*—Bergen, £3,836 (telegraph cable). *Portugal*—Lisbon, £70. *Russia*—St. Petersburg, £432 ((including £100 telegraph material). *Siam*—Bangkok, £159. *Straits Settlements*—Singapore, £293. *Sweden*—Stockholm £110 (telegraph material). Total £31,621, against £16,648 in the corresponding week last year (June 3 to 9).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Radio-Activity: An Elementary Treatise from the Standpoint of the Disintegration Theory. By F. Soddy. (London: "The Electrician" Printing and Publishing Co.) 6s. 6d. net.

"Electric Lighting." By Percival Marshall. "Model Engineer." Series No. 22. (London: Percival Marshall & Co.) 6d.

"Jahrbuch der Elektrochemie" for 1902. Edited by Dr. Heinrich Danneel. (Halle: Wilhelm Knapp.) 24m.

"Electrotechnique Appliquée." By A. Mauduit. (Paris: Ch. Dunod.) 1904. 25fr.

"Modern Electric Practice." Vol. III. Edited by Magnus McLean. (London: Gresham Publishing Co.) 9s.

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

March 8, 1904.

5,620 F. MUIRHEAD. Junction boxes for electric wiring.
5,630 J. SOLARI. Exeter. Electrical fittings.
5,634 J. BONTHRONE. Liverpool. Switch point and "frog" for overhead equipment.
5,646 R. BÖHM. Electric and other lamps.
5,649 R. B. WHEATLEY. Plating aluminium or its alloys with a metal or metallic alloy by electrolysis.
5,663 H. HENNING. Annunciators for electric bells and the like.*
5,664 J. W. EWART. Wendover (Bucks). Base or wall blocks.
5,670 E. B. SKINNER. Holders for incandescent lamps.
5,678 S. G. BROWN. Electric conductors or cables.
5,688 J. Y. JOHNSON (Badische Anilin and Soda Fabrik, Germany). Apparatus for producing reactions in gases by electricity.
5,714 A. H. WHEELER (Frank Armonde Wheeler, Natal). Fittings of electroliers, wall brackets, &c.
5,731 F. W. HOWORTH (A.G. "Magneta" Eletrishe Uhren Ohne Batterie und Ohne Contacte, Switzerland). Electrical regulating of clocks.

March 9, 1904.

5,758 W. E. HITCH. Oxford. Electric cable conductors.
5,768 J. WOODWARD. Leeds. Automatic cutout for trolley wires and the like.
5,773 P. T. J. ESTLER. Plough or collector gears for conduit tramways.
5,786 B.T.-H. Co. and E. SCHATTNER. Luminous gas or vapour electric lamps.
5,799 H. LELARGE. Electrically separating coke from cinders, &c.*
5,803 and 5,926 MAVOR AND COULSON and H. A. MAVOR. Electric motors.
5,804 K. J. MCMULLEN. Electric firing for internal explosion engines.
5,824 H. LUTHI. Electric igniter for explosion motors.*
5,826 W. J. DAVY. Arc lamps.

March 10, 1904.

5,846 A. C. BROWN. Electric annunciator and relay.
5,860 H. HIRST and J. H. COLLINGS. Electric lampholder.
5,861 C. M. DORMAN and R. H. Smith. Salford. Insulating linings for covers or containers for electrical apparatus.*
5,879 H. R. WEBB. Nottingham. Electric fittings and the like.
5,892 C. O. BASTIAN. Electric vapour lamps.
5,914 S. KRAUS. Berlin. Electric pocket lamp, cigar, cigarettte and gas lighter combined.*
5,921 LA SOCIÉTÉ ANONYME L'INDUSTRIE VERRIÈRE ET SES DÉRIVÉS. Electric melting furnaces. (Date applied for March 21, 1903, date of application in Belgium,*
5,931 B.T.-H. Co. (G.E. Co., U.S.) Connectors for electric conductors.

March 11, 1904.

5,983 B. N. DADGE. Liverpool. Starting and controlling electro-motors.
5,996 H. W. C. COX and F. BUTT. Electric contact breakers for induction coils.
5,998 J. T. ARMSTRONG and A. ORLING. Electro-capillary relays.
6,006 B. C. WILLIAM-ELLIS. Thames Ditton. Electric motor starting and controlling gear.
6,009 G. L. HOGAN. Treatment of disease by electrolysis.
6,013 G. MELLER. Asynchronous motors.
6,030 G. E. PARKER and M. A. ADAM. Telephone systems.
6,035 F. TYERS. Clips for attaching pipes, cables, &c. to walls.
6,036 B.T.-H. Co. E. J. MURPHY and H. W. TURNER. Tubular electric resistances.
6,037 B.T.-H. Co. (G.E. Co. U.S.) Apparatus for producing high vacua.
6,038 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machine.
6,040, 6,041 and 6,042 H. C. LEVIS. (G.E. Co., U.S.) Arc lamps.

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March 12, 1904.

6,068 L. J. Aron. Birmingham. Controlling voltage under varying speeds and resistances.
6,076 A. Marr. Manchester. Telephone receivers also used as transmitters.
6,104 J. C. Fuller and G. Fuller. Contact breakers and tremblers.
6,110 C. E. Foster, E. R. Grote and M. V. Ely. Arc lamps.
6,117 Marcus Pulvermacher. Holder for fuse wires and their insulator.
6,126 H. L. Lynton. Byfleet. Variable speed dynamos.
6,132 H. Contal. Accumulators. (Date applied for, March 24, 1903, date of application in France.)*

March 14, 1904.

6,188 W. R. Pether and R. C. Gulliver. Electric apparatus for communicating between passengers and guard and similar purposes upon railways and the like.
6,201 R. Arno. Receiving apparatus for wireless telegraphy systems.
6,218 O. Imray (Deutsche Waffen and Munitions Fabriken, Germany). Automatic suspension device for arc lamps, &c.
6,230 B. Kalinowski. Electricity meters.
6,233 B.T.-H. Co. (G.E. Co., U.S.). Lamp fittings.
6,237 J. H. L. Bishop. Overhead electric conductors.

March 15, 1904.

6,251 W. A. Bristow. Ploughs for conduit and like traction.
6,266 R. J. Footner. Manchester. Apparatus for actuating or controlling points of tramway rails and wires from the vehicle.
6,269 E. Rigby. Warrington. Drums or bobbins for cable, wire, &c.
6,280 J. Robinson. Ryton-on-Tyne. Electrical time and cash check for registering billiards or similar games.
6,305 H. Beck. Arc lamps.*
6,319 J. A. Heany. Electric conductors.*
9,322 P. Dove. Terminals of storage batteries or accumulators.
6,333 General Contracts Co., E. S. Cook and W. H. Chipperfield. Strut piece for switches.*

March 16, 1904.

6,348 A. J. Beaumont. York. Service boxes with switch and earthing device.
6,382 H. G. Nicholson. Section insulators to be used with conductors of electric tramways or railways.
6,401 B.T.-H. Co. (G.E. Co., U.S.) Alternating-current motors.
6,402 B.T.-H. Co. (G.E. Co., U.S.) Insulating compounds.
6,403 B.T.-H. Co. (G.E. Co., U.S.) Insulated conductors.
6,411 H. Cooch. Brush holders for electric motors or generators.
6,425 O. T. Banks. Electrical candle fittings.
6,429 H. H. Lake (Luigi Risso, Italy). Elastic insulating clutches for dynamos and motors.
6,433 London Electric Supply Corp. and G. W. Partridge. Switches.
6,446 W. H. Scott. Switches.

March 17, 1904.

6,452 W. H. Jinks. Birmingham. Combination for tumbler switch.
6,470 J. W. Ferrier. Automatic circuit breaker.
6,496 A. N. Soden. Electric lamp and socket.*
6,523 C. P. Tolman. Electric lighting for road vehicles. (Date applied for, July 30, 1903, date of application in U.S.)*
6,556 W. J. Davy. Arc lamps.
6,558 P. Wessel and C. Herding. Electric signalling system for railways in case of accidents or stoppages.*
6,560 C. W. Atkinson. Automatic switches.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

28,701 Rugh. Telegraphy.
28,806 and 28,807 Bakeley and Schrage. Sockets for incandescent lamps.

1904.

306 Blake. Trembler for induction coils.
789 Pullen. Electric railways.
1,973 Adams-Randall. Telegraph systems.
2,274 Wise (Peirce). Telegraphic transmitters.
2,380 Rosen. Protecting a wire branch depending from overhead wire.
3,022 Hirsch. Connections or connecting pieces for electricity conductors.
3,913 Keijzer. Process of and apparatus for the generation of electric energy.
4,660 Cohen and Cohen. Contact-breakers or tremblers for ignition coils.
5,097 Cox. Electric meters. (Date applied for, March 2, 1903.)
5,098 Steinmetz. Electric lamps. (Date applied for, March 6, 1903.)
5,307 Roberts and Good. Electric fuse boxes.
5,824 Luthi. Electric igniter for explosion motors.
5,861 Dorman and Smith. Insulating linings for covers of electrical apparatus.
5,921 Soc. Anon l'Industrie Verrière et ses Dérivés. Electric melting furnaces. (Date applied for, March 21, 1903.)
6,305 Beck. Arc lamps.
6,679 Render. Fuses for electric blasting.
6,843 Sauses. Terminal attachment for the conducting wires of electrical machines and apparatus.

BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT CO. (LTD.)—The Board of Trade has approved the agreements for the purchase of the undertaking of the Crystal Palace District Electric Supply Co., and possession is to be given to the Blackheath Company in a few days. On 1st inst. there were 1,942 consumers representing an equivalent of 67,451 8 c.p. lamps connected, and 115 were awaiting connection. At the same date last year the equivalent of 18,094 8 c.p. lamps was connected.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 25$\frac{5}{16}$d. per oz. (June 9). Consols 90$\frac{3}{8}$—90$\frac{1}{2}$ for money, 90$\frac{1}{2}$—90$\frac{5}{8}$ for account; 2$\frac{1}{2}$ per cent. annuities 89$\frac{3}{4}$—90 (June 9). Consols Pay Day, July 1; Stocks and Shares Continuation Days, June 27 and July 2; Ticket Day, June 28; Pay Days, June 10 and 29; Mining Share Carry-over Days, June 25 and July 11.

BRITISH COLUMBIA ELECTRIC RAILWAY CO.—It has been decided to increase the capital to £850,000.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—The directors' report for 1904 states that the profit was £16,974. 13s. 3d., less managing director's remuneration, directors' fees, depreciation on properties and plant amounting to £7,998. 7s. 8d., leaving £8,976. 5s. 7d. Preference dividend and an interim dividend of 6 per cent. per annum on the ordinary shares absorbed £5,400, leaving £3,576. 5s. 7d., which, with balance from last year, made a total of £10,926. 10s. 9d. A further dividend on the ordinary shares of 12 per cent. per annum (less tax) for half-year ended March 31, making 9 per cent. per annum for the year will leave £7,326. 10s. 9d. to carry forward.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The transfer books and register of holders of the 5 per cent. first mortgage debenture stock will be closed from 16th to 30th inst. inclusive.

COMMERCIAL CABLE CO.—A quarterly dividend of 2 per cent. on the capital stock has been declared, payable July 1, out of the net earnings of the company. The transfer books will be closed at 2:30 p.m. on 28th inst., and re-opened on morning of July 5.

COMPANIA ALEMANA TRANSATLANTICA DE ELECTRICIDAD (BUENOS AYRES).—This company has declared a dividend of 6 per cent. for 1903.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The transfer books and register of holders of the first debenture stock of this company will be closed from 17th to 30th inst. inclusive, preparatory to payment of interest due July 1.

GENERAL ELECTRIC CO. (LTD.)—The transfer books of the 5 per cent. preference shares will be closed from 17th to 30th inst. inclusive.

GEORGE M. CALLENDER & CO.—For the year ended March 31 the directors propose a dividend on the ordinary shares of 8 per cent. (less tax), whereof 4 per cent was paid in November and 4 per cent. will be paid on 15th inst.

GERMAN-DUTCH SUBMARINE TELEGRAPH CABLE.—According to the "Frankfurter Zeitung" definite steps are being taken for the laying of the projected German-Dutch cable to connect the Dutch East Indies and the Pelew Islands (German) with Shanghai and the Commercial Pacific cable to the Philippines. It is said that a company is to be formed to work the line with a share capital of £350,000 and a 4 per cent. bond issue of £362,500. Large subsidies are said to be assured to the new company both by the German and Dutch Governments. Among the German group associated with the scheme may be mentioned the Disconto Gesellschaft, the Darmstadt Bank, Dresden Bank and the Schaffhausen Bank Verein, while the Dutch institutions comprise the Amsterdam Bank and the Netherlands Handels Maatschappij.

GREAT NORTHERN AND CITY RAILWAY.—An important addition is about to be made to the stations on this company's line by the opening of a station at Highbury.

JOHANNESBURG CITY AND SUBURBAN TRAMWAY CO.—At a meeting on 30th ult., the provisional agreement for the transfer of the undertaking to the Municipal Council was confirmed.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—Letters of allotment and regret have (it is stated in some of the financial papers) been posted in regard to the recent issue of 25,000 additional shares in this company.

MUNICIPAL ISSUES.—Belfast Corporation invite applications for £200,000 of 3$\frac{1}{2}$ per cent. stock at par to provide moneys for expenditure on electric light extensions and other works.

An issue of £390,000 4 per cent. stock to provide money for electric lighting and other works has just been made by the Port Elizabeth (South Africa) Corporation.

RAND CENTRAL ELECTRIC WORKS (LTD.)—The result of the working for May was 968,680 units generated, yielding gross revenue, £8,500, compared with 670,635 units and £6,006 for the corresponding month of 1903.

RHODES ELECTRICAL MFG. CO. (LTD.)—The directors have declared an interim dividend for the half-year ended May 31 at the rate of 6 per cent. per annum on the ordinary shares.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered a further issue of 20,000 6 per cent. cumulative preference £5 fully-paid shares and a further issue of £31,470 4$\frac{1}{2}$ per cent. redeemable first mortgage debenture stock of *Edmundson's Electricity Corporation (Ltd.)* to be quoted. The committee have been asked to appoint a special settling day in and grant a quotation to £350,000 4$\frac{1}{2}$ per cent. debenture stock of the *Metropolitan Electric Tramways (Ltd.)*.

WEST AFRICAN TELEGRAPH CO. (LTD.)—The report of the directors for the year ended Dec. 31 last announces that the revenue amounted to £62,514. 18s. 4d., from which are deducted £15,578. 4s. 4d. for ordinary expenses and £9,809. 0s. 7d. for expenditure relating to repairs of cables, leaving £37,127. 13s. 5d., added to £1,238. 5s. 11d. brought forward, making £38,365. 19s. 4d. £1,459. 1s. 3d. for income tax, £25,000 transferred to general reserve, and an interim dividend of 1 per cent., have absorbed £28,769. 19s. 3d., and the directors now recommend payment of a final dividend of 6s. per share (tax free), making 4 per cent. for the year, the balance (£2,663. 6s. 1d.) being carried forward.

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NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

EASTON LIFT CO. (LTD.) (81,115).—Reg. June 1, capital £25,000 in £1 shares, to adopt an agreement with W. P. J. Fawcus, and to carry on the business of manufacturers of and dealers in hydraulic, electric and steam elevators, lifts, steam appliances and other machinery, mechanical and electrical engineers, tool makers, &c. First directors, R. A. Smith, G. H. Ide, T. P. Wilson and S. V. Clirehugh. Reg. office, Broad Sanctuary chambers, Westminster, London.

NEALERON LIMITED. (81,056)—Reg. May 25, capital £3,005 in 2,005 A shares of £1 each and 4,000 B shares of 5s. each, to carry on business of manufacturers and importers of and dealers in electric accumulators, electric fuses and all appliances for electric blasting, portable electric lights, electric lamps, electric lamp regenerators, electric lighting appliances, electric motors, batteries, instruments and accessories, &c., and as electricians, suppliers of electric current, &c. The subscribers are G. F. Herron, electrical engineer, J. E. Neale, electrical engineer, N. Reynolds, I. Tofts, S. J. Passmore, E. Dubois and E. F. Smith. First directors, G. F. Herron and J. E. Neale.

PENMACHNO, CORWEN AND BETTWS-Y-COED LIGHT RAILWAY CO. (LTD.) (81,082)—Reg. May 27, capital £3,000 in £1 shares, to construct or acquire light railways and tramways in Carnarvon, Denbigh and Merioneth or elsewhere, to equip, maintain and work the same by electrical or other power, and to carry on the business of railway and tramway proprietors, electricians, mechanical engineers, suppliers of electricity, manufacturers of and dealers in electrical machinery, &c. First directors, H. Maconochie and J. L. Owen.

SCOTCH WATER POWER SYND. (LTD.) (81,034).—Reg. May 20. Capital £5,000 in £1 shares, to acquire the assets of Scotch Water Power Synd., to acquire easements in respect of roads, railways, tramways or canals, and to carry on the business of suppliers of water, electrical or other power, &c.

TELEPHOS (LTD.) (81,111).—Reg. May 31. Capital £10,000 in 8,000 shares of £1 eachand 40,000 ordinary shares of 1s. each, to adopt a certain agreement and to carry on the business of suppliers of electricity, electrical and mechanical engineers, manufacturers of and dealers in electrical, magnetic, telegraphic, telephonic and other apparatus and appliances, &c.

THOS. W. WARD (LTD.)—Reg. May 19, capital £350,000 in £1 shares (150,000 5 per cent. cumulative preference), to acquire the businesses now carried on by T. W. Ward and A. J. Ward at Sheffield under the styles of Thos. W. Ward and the Silent Machine and Engineering Co., and to carry on the business of electrical and mechanical engineers, metal workers, manufacturers and merchants of constructional steel, iron and metal work, manufacturers and merchants of plant, boilers, locomotive, stationary and portable engines, rails and railway accessories and plant, &c. First directors T. W. Ward and J. Ward (managing), A. J. Ward (assistant managing) and R. J. Wales.

STATUTORY RETURNS.

BROMPTON AND KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—In the return to March 24 the capital is £300,000 in 47,920 ordinary and 12,080 preference shares of £5 each, of which 27,920 ordinary and 12,080 preference shares have been taken up. £5 per share has been called up on 26,920 ordinary and 12,080 preference shares, and £195,000 has been received. £5,000 is considered as paid on 1,000 ordinary shares. Mortgages and charges, nil.

GENERAL ELECTRIC TRAMWAYS CO. (LTD).—The return to April 27 gives the capital as £18,500 in £1 shares, all of which have been taken up and paid for in full. Mortgages and charges, £15,000.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD)—In the return to April 12 the capital is £55,000 in 25,000 preference shares of £1 each and 6,000 ordinary shares of £5 each, of which 3,191 preference and 2,692 ordinary have been taken up. £1 per share has been called up on the preference and £5 per share on the ordinary shares. £16,651 has been received, in addition to £2 paid on two ordinary shares forfeited. Mortgages and charges, £21,000.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The return to May 18 gives the capital as £220,000 in 16,000 ordinary and 6,000 preference shares of £10 each, all of which have been taken up and paid for in full. Mortgages and charges, nil.

HARTLEPOOL ELECTRIC TRAMWAYS CO. (LTD.)—According to return to April 27 the capital is £100,000 in 5,000 ordinary and 5,000 preference shares of £10 each, all of which have been taken up. £10 per share has been called up on the ordinary and £9 per share on the preference, and £95,000 has been received. Mortgages and charges, nil.

POTTERIES ELECTRIC TRACTION CO. (LTD.)—The return to April 22 give the capital as £600,000 in 30,000 ordinary and 30,000 preference shares of £10 each, of which 24,499 ordinary and 24,500 preference shares have been taken up. £10 per share has been called up on 17,833 ordinary and 24,500 preference shares and £423,330 has been received. £66,660 is considered as paid on 6,666 ordinary shares. Mortgages and charges, £220,000.

WINCHESTER ELECTRIC LIGHT AND POWER CO. (LTD.)—According to return to April 5 the capital is £50,000 in 10,000 shares of £5 each, of which 7,396 have been taken up. £5 per share has been called up and £36,980 has been received. Mortgages and charges, £30,000.

MORTGAGES AND CHARGES.

BRITISH ELECTRIC CALIBRATED FUSE CO. (LTD.)—Issue on May 9 of £300 debentures, part of series created Dec. 4, 1903, to secure £3,000 charged on company's undertaking and property, present and future, including uncalled capital. Holder, J. Lang. No trustees. Previously issued of same series, £1,050.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	June 4	1,535	+ 289	1	1,535	+ 289
Airdrie	May 27	203	...	16	3,007	...
Ayr Corporation	...	...	...	...	...	...
Barnsley	,, 27	245	+ 53	21	3,446	- 125
Barrow	,, 27	214	+ 152	16	2,467	+ 1,518
Bexley District Council	...	...	...	...	...	...
Birkenhead	June 5	1,119	- 151	...	...	...
Birmingham Corporation	,, 4	249	...	20	6,210	...
Birmingham Tramways Co.	,, 4	5,582	- 628	22	116,446	+ 6,453
Blackburn Corporation	,, 3	968	- 320	10	9,881	+ 482
Blackpool Corporation	,, 2	1,668	- 54	9	7,948	+ 1,786
Blackpool and Fleetwood	,, 4	775	- 1,287	23	7,631	- 367
Blackp'l, St. Anne's & Lytham	,, 2	782	+ 217	31	6,920	+ 5,616
Bolton Corporation	,, 5	2,223	- 247	10	18,229	- 15
Bournemouth Corporation	,, 1	1,026	- 382	9	10,064	+ 459
Bradford Corporation	May 28	5,947	+ 2,094	9	42,326	+ 6,800
	June 4	4,596	+ 919			
Brighton Corporation	,, 5	890	- 1,244	9	8,648	- 126
Brisbane Tramways	April 20	2,119	+ 128	16	36,484	- 248
Bristol Trams & Carriage	June 3	5,172	- 2,836	2	11,374	- 2,527
Buenos Ayres & Belgrano	May 8	3,499	+ 287	3	10,197	+ 1,015
Burnley Corporation	June 4	1,093	+ 123	10	10,432	+ 2,892
Burton Corporation	,, 5	844	...	9	4,289	...
Calcutta Tramways Co.	,, 4	a3,3118	+ a959	23	a786,555	+ a99,348
Camborne-Redruth	,, 6	136	- 17	5	619	- 55
Cardiff Corporation	,, 4	2,166	- 568	9	19,031	+ 580
Carlisle Tramways Co.	,, 4	236	- 16	22	4,090	+ 264
Central London Railway	,, 4	6,726	- 601	23	158,406	- 2,684
Chatham & Dist. Lt. Rys.	,, 2	588	- 176	22	11,959	+ 1,782
City & South London Rly.	,, 5	2,859	+ 280	28	68,970	- 2,126
Cork Electric Trams Co.	,, 2	589	- 154	22	9,248	- 574
Darwen Corporation	,, 3	239	- 44	9	2,148	- 164
Devonport & Dist. Trams	May 27	600	+ 142	21	10,161	+ 1,552
Dover Corporation	June 4	200	- 71	10	1,978	- 138
Dublin & Lucan Railway	,, 5	162	- 20	23	2,461	+ 191
Dublin Southern District	,, 3	1,302	- 31	¶28	101,930	+ 1,953
Dublin United	,, 3	4,850	- 374			
Dudley—Stourbridge	May 27	1,490	+ 661	21	16,981	+ 1,362
Dundee Corporation	June 1	851	- 19	...	...	...
East Ham Council	,, 4	789	- 257	9	7,180	+ 655
Gateshead & Dist. Trams	May 27	1,039	+ 145	21	18,438	+ 1,091
Glasgow Corporation	June 4	16,040	+ 666	1	16,040	+ 666
Glossop	,, 4	109	...	23	2,243	...
Gravesend—Northfleet	May 27	397	+ 143	21	4,920	+ 776
Gt. Northern & City Rly.	June 4	907	...	16	14,866	...
Greenock & Port Glasgow	May 27	706	- 19	21	10,527	+ 652
Halifax Corporation	,, 25	2,141	+ 641	9	13,191	+ 499
	June 1	1,462	- 988			
Hartlepool Tramways	May 27	442	+ 167	21	5,564	+ 714
Huddersfield	...	...	...	...	...	...
Hull Corporation	June 4	2,165	+ 71	9	19,776	+ 1,850
Ilford District Council	,, 4	478	- 298	9	4,579	+ 397
Ilkeston Corporation	,, 1	184	- 201	...	...	...
Ipswich Corporation	,, 4	472	...	9	4,416	...
Isle of Thanet Co.	,, 4	538	- 478	...	...	...
Kidderminster & District	May 27	258	+ 119	21	2,325	+ 54
Kirkcaldy Corporation	June 1	221	- 48	23	4,659	...
Lanarkshire Trams Co.	,, 2	655	...	22	18,197	...
Leeds Corporation	,, 4	5,850	+ 1,888	11	57,794	+ 2,860
Leicester Corporation	,, 4	1,106	...	3	3,422	...
Liverpool Corporation	May 28	11,342	+ 481	22	215,550	+ 4,953
Liverpool Overhead Rly.	June 5	1,597	- 409	23	36,811	- 26
*London County Council	May 28	13,260	+ 2,181	§8	93,468	+ 16,063
Lowestoft	June 4	163	...	¶45	8,812	...
Manchester Corporation	,, 4	12,845	- 3,178	9	109,617	+ 681
Mersey Railway	,, 4	1,481	- 79	22	32,732	- 6,916
Merthyr	May 27	258	+ 51	21	4,182	+ 264
Middleton	,, 27	426	+ 9	21	5,877	+ 155
Nelson Corporation	June 4	134	+ 39	10	1,168	+ 52
Newcastle-on-Tyne Corp.	,, 4	3,704	- 133	22	77,829	+ 9,635
Newport (Mon.)	...	...	...	...	...	...
Oldham, Ashton & Hyde	May 27	640	- 5	21	10,980	- 587
Oldham Corporation	,, 22	1,152	...	12	13,690	...
	,, 29	1,315				
Perth (W. A.) Elec. Trams.	June 3	1,198	+ 62	22	29,755	+ 4,016
Peterborough	May 27	268	+ 115	21	2,795	- 62
Poole and District	,, 27	405	+ 98	21	5,588	+ 138
Portsmouth Corporation	June 4	1,904	+ 579	†10	17,717	+ 1,404
Potteries	May 27	1,967	+ 316	21	35,284	+ 2,962
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 27	188	+ 44	21	1,491	+ 51
Salford Corporation	June 6	4,118	- 1,490	10	39,506	+ 3,965
Sheerness	May 25	74	- 6	21	1,084	- 304
Sheffield Corporation	June 5	4,662	- 986	§10	47,796	+ 1,048
Southampton Corporation	,, 3	992	- 374	...	...	...
Southend Corporation	,, 1	309	- 178	9	2,728	+ 169
Southport Tramways	May 27	559	+ 246	21	5,987	+ 635
S. Staffordshire Trams.	,, 27	1 202	+ 239	21	16,452	+ 96
Stockport Corporation	June 3	823	+ 280	9	5,288	+ 2,166
Sunderland Corporation	,, 5	1,339	- 471	9	11,755	+ 251
Swansea Trams	May 27	942	+ 424	21	10,569	+ 896
Taunton Trams	,, 27	74	+ 18	21	1,068	- 60
Tynemouth and District	,, 27	499	+ 157	21	4,984	- 4
Tyneside Trams Co.	June 1	868	- 266	22	6,902	+ 770
Wallasey District Council	,, 4	786	- 186	§9	6,668	+ 185
Walsall	...	...	...	...	...	...
Warrington Corporation	,, 2	321	- 57	9	2,819	+ 17
West Ham Corporation	,, 2	1,055	...	14	8,748	...
Weston-super-Mare	May 25	286	+ 187	21	1,076	+ 108
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 27	782	+ 386	21	7,774	+ 92
Worcester	,, 27	468	+ 286	16	4,488	+ 1,975
Wrexham	,, 27	143	- 80	21	2,290	- 153
Yorkshire Woollen District	,, 27	826	+ 425	21	11,888	+ 5,290

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 8 days. ¶ Plus 8 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., June 8	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE.	BUSINESS, WEEK TO JUNE 8 High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	5 —5¼	4 15 3	April, Oct	5⅜	5⅛
St.	6%	Do. Permanent 6% Deb. Stock	131 —136	4 9 6	..	133½	132
t.	34/2	Auckland Elec. Trams 5% Deb. (red.)	98 —100	..	..	99½	99
10	10/0	Barcelona Tramways Ord.	6 —8	6 5 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	92 —97	4 14 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	96 —99	5 1 9	..	9¼	..
1	..	Bath Elec. Trams Pref. Ord.	⅛—13/16	..	..	..	..
1	..	Do. 5% Cum. Pref.	3/8—1	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	3¾—4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98 —103	4 9 1	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	18½—19½	4 2 1	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10⅜—10⅝	3 17 8	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107 —109	3 13 4	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100 —103	5 16 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	98 —101	4 19 0	..	99½	98¼
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10¾	5 11 7	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104⅞	4 6 7	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	9⅜—10¼	7 16 0	..	10⅜	9⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅜—11	5 9 1	Feb, Aug	10⅝	10 11/16
St.	5/0	Do. 5 per Cent. Perpetual Debs	116 —119	4 6 3	..	117⅛	116¼
5	3/0	Buenos Ayres and Belgrano Ord.	2⅜—2⅝	5 3 9	..	2⅜	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼—5½	5 4 4	..	5⅛	..
5	3/0	Do. "B"	5 —5½	5 9 1	..	..	..
St.	5%	Do. 5 per Cent. Debs.	106 —109	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	100 —103	4 19 0	..	..	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	96 —101	5 0 0	..	..	..
5	3/6	Calcutta Tramways	7 —7½	4 0 0	..	7 1/16	7⅛
100	4½%	Do. 4½% 1st Deb. Stock (red.)	107 —110	4 3 6	..	..	..
1	1/0	Cape Electric Tramways Shares	2 —2½	7 11 1	..	2⅜	2 3/16
St.	4%	Central London Ordinary Stock	92 —95	4 4 2	June, Dec	94½	93¼
St.	4%	Do. 4 per Cent. Pref. Stock	101 —104	3 17 8	..	103	102
St.	4%	Do. Deferred Stock	83 —86	4 13 0	..	84	..
100	4%	Do. 4 per Cent. Debs.	112 —115	3 10 6	..	114¼	113
5	2/6	City of Birmingham Trams.5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2%	City and South London Rly. Con. Ord.	50 —52	4 11 4	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —126	4 0 0	Feb, Aug	..	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 —109	3 13 5	May, Nov	108½	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	99 —102	4 18 3	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8⅓	Gt. Northern & City Rly. Prf. Ord. (4%)	5 —6	5 0 0	..	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	18 —19	5 5 3	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¼—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	1½	Liverpool Overhead Railway Ord	4¼—4½	3 1 1	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	4 0 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11 —11½	4 7 0	..	..	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	102 —104	3 18 0	..	..	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	3/4—1	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	3/4—1	5 0 0	..	..	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 —105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs.(1922)	105 —107	4 5 0	..	..	..
5	..	New Gen. Tract. 6 per Cent.Cum. Pref.	1 —2	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1st Mt.Db.Stk.	100—103	4 19 0	..	102½	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	89 —92	3 7 11	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 6	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	12/6	Anglo-American	48 —51	5 14 8	F,My,Ag,N	48	..
St.	25/0	Do. Preferred	92 —94	6 1 1	F,My,Ag,N	93	92¼
St.	2/0	Do. Deferred	7 —7½	1 7 6	F,My Ag,N	7 1/16	7
100	$2	Commercial Cable Capital Stock	175 —185	4 6 6	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93 —95	4 5 0	Jn Ap,Jy,O	95½	94
10	5/0	Cuba Submarine Ord.	7 —8	7 10 0	Feb, Aug	7⅛	7
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100⅞—103⅞	4 9 0	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10½	6 4 0	Ja,Ap,Jy,O	10½	10⅜
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	100 —103	4 9 0	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	126 —131	5 7 0	Ja,Ap,Jy,O	130½	127
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —90	3 17 9	Ja Ap,Jy,O	88	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 6	May, Nov	106½	106
10	6/6	Eastern Extension	11¾—12¼	5 14 0	Ja,Ap,Jy,O	12⅛	11⅞
St.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 15 0	Feb, Aug	105½	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	99 —102	3 19 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞—101⅞	3 19 3	May, Nov	..	..
10	20/0	Great Northern (of Copenhagen)	25 —26	5 15 6	Jan, July	25⅜	..
100	4½%	Halifax & Bermuda4½%1stMt.Db. (red.)	100 —103	4 9 0	June, Dec	..	..
25	37/6	Indo-European	42 —45	5 11 2	May, Nov	45	44½
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	2/0	West African Telegraph Shares	6 —7	2 17 2	..	..	..
2½	..	West Coast of America	1/16—1/8	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 10	Jan, July	..	..
10	..	West India and Panama	3/8—1/2	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	5⅛—6½	9 12 0	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 18 4	Jan, July	102½	102
10	3/0	Western Telegraph	12⅜—13½	5 6 6	Mr,Jn,O,D	13⅜	12⅝
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 17 9	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	100 —103	3 17 8	..	103	102
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
10	5/0	Globe Telegraph and Trust	8⅜—9½	5 19 0	Ja Ap Jy O	9⅛	8 13/16
10	3/0	Do. 6 per Cent. Pref.	13 —13½	4 8 11	Ja Ap,Jy,O	13⅛	13⅜
8	4/0	Reuter's	6¾—7½	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	117 —122	4 18 4	April, Oct	119¾	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed., June 8.	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE	BUSINESS WEEK TO JUNE 8. High-est.	Low-est.
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid,	4½—5½	5 14 3	August	..	..
St.	6%	National Co. Pref. Stock	104 —106	5 13 3	..	105½	104
St.	5%	Do. Def. Stock	84 —87	5 14 11	..	86¼	85
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 —13	4 12 4	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5¼	4 15 3	Feb, Aug	5 1/16	5 1/16
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —100	3 11 0	June, Dec	99⅛	99⅛
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 —105	3 17 0	..	103	..
..	..	Do. Do. Prov.Certs.70%tobepd.	29 —31	..	..	30½	30
1	0/6⅔	Oriental	1/8—1 1/8	6 6 3	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	6 4 6	..	1 1/16	..
5	3/0	United River Plate	5½—6	5 16 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¼—5½	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 - 106	4 15 10	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅞—1	..	..	..	..
1	0/8⅓	Do. 7% Cum. Pref.	1⅛—1⅜	5 1 9	..	1 3/32	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd.&con.)	120 —125	3 12 0	..	123¾	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	12¼	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
5	..	Bromley (Kent) El. Lt. & Power Shares	5½—6	..	..	..	..
..	..	Do. Do. 1st Debs	100 —103	4 7 5	..	..	..
St.	4½%	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 0	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	10⅝	..
5	4/0	Calcutta Electric Supply Ord.	7 —7½	4 13 4	..	7 1/16	7¼
St.	4%	Central Elec. Sup.Co.4%Guar.Db.Stock	105 —108	3 14 1	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7½—8	5 0 0	Feb, Aug	7⅝	7⅜
5	2/3	Do. 4½ per Cent. Pref.	5⅛—5⅜	4 3 6	Feb, Aug	5¼	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	..	5 1/16	..
5	1/7	Do. Do. (1903)	4¾—5	..	..	4 15/16	..
St.	4%	Do. 4% Deb. Stock (red.)	104 —106	3 16 6	..	105	104⅞
5	3/6	Chelsea Electric Supply Ord.	6 —6½	4 4 7	March	6⅜	6¼
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —110	4 3 0	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	10¾—11½	4 9 0	Feb, Aug	11¼	11
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	102½	101
10	4/0	County of London Elec. Supply Ord.	7⅜—8½	4 14 3	..	7⅝	7⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	11¼	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106 —109	4 2 11	..	108	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	99 —102	4 8 3	..	100⅜	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	90 —95	..	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅛—6	4 11 8	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 8 0	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
5	5/0	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
St.	4½%	I. of W. Elec Lt. & Power 4½% Db St (red.)	101 —103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	13/16—15/16	..	..	..	..
5	7/0	Kensingtn & Knghtsbdge Ord.	11½—12½	4 16 0	..	12¼	..
5	6%	Do. 6 per Cent. 1st Pref.	6¼—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	..	..
3	..	London Electric Supply Ord.	1½—1⅝	..	..	1⅜	..
5	3/0	Do. 6 per Cent Pref.	4½—5	6 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 —98	4 2 11	Mr,Jn,S,D	97	..
10	9 6	Metropolitan Electric Sup. Ord.	19½—20½	4 5 6	April, Oct	19⅞	19⅝
5	1/4½	Do. 4½ per Cent. Cum. Pref.	5⅝—5⅞	4 1 0	..	5 1/16	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 —100	3 11 0	..	99	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
10	6/0	Notting Hill Electric Ord.	12½—13½	4 8 11	March	12⅝	..
5	4/0	Oxford Electric Ord.	5½—6	5 8 4	March	5½	..
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 3	..	..	..
1	..	Rand Electric	13/16—15/16	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 —103	4 7 9	April, Oct	..	..
5	9 6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	14¾	..
..	..	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3 —3½	5 14 3	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	3/0	South London Electric Supply Ord.	3⅝—4¼	3 10 7	..	4	3⅞
5	2/6	Urban Electric Supply Ord.	4⅜—4⅝	5 2 6	..	..	..
5	2/6	Do. 5% Cum. Pref.	4⅝—4¾	5 2 6	..	..	..
5	7/0	Westminster Electric Supply Ord.	12½—13½	5 0 0	Mar, Sept	13⅜	12 13/16
5	2/6	Do. 5 per Cent. Cum. Pref.	6¼—6¾	3 14 0	..	..	..
		ELECTRIC MANUFACTURING &c.					
1	..	Aron Elec. Meter 6% Cum. Pref.	⅞—1	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5½—6	6 13 4	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¼—5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —105	4 7 0	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	3 —3½	8 11 5	..	3⅜	3 5/16
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	87 —90	4 10 9	..	..	..
2	..	Brush Electrical Engineering	¾—1	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1—1¼	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	73 —78	5 17 8	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord. xd & bonus	10 —11	5 13 8	Jan, July	10⅞	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 6 11	Jan, July	5¼	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	104 —108	4 3 3	Nov, May	..	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	⅞—1	6 17 2	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¾—2¼	6 13 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95 —98	5 4 6	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	8 —8½	..	..	8¼	..
5	3/0	Do. 6% Cum. Pref.	5 —5½	5 9 1	..	5 3/32	..
St.	4½%	Do. 4½% Deb. Stock	102—104	4 7 2	..	..	..
2	1/2½	Edison & Swan United("A"Sh.)(£3 pd.)	½—¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	½—1¼	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	74 —79	6 6 7	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5⅝—5¾	5 19 0	H'lf-yearly	5⅝	5⅝
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅝—5¾	5 2 6	..	5 1/16	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105 —108	4 4 6	..	107⅛	106½
2	1/2½	Electric Construction Co.	1⅜—1⅝	7 2 10	Jan, July	1½	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2¼—2¾	5 2 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—9⅝	5 2 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	11⅞	11½
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	19 —20	5 0 0	Feb, Aug	19½	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 —103	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	36/0	Telegraph Construction & Mainten'ce.	36 —39	6 3 0	Mar, July	38	37
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	102½	..
5	..	Willans and Robinson Ord.	2½—3½	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅜—4½	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	89 —94	4 5 1	May Nov	..	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. * Ex Dividend. † The London Stock Exchange Committee have refused to quote these.

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THE ELECTRICIAN:

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NOTES.

ELECTRICAL engineers will doubtless be keenly interested in the new arc lamp described by Mr. STEINMETZ on another page of this issue. A much greater efficiency is claimed for the lamp than is possessed by any of the present type of arc lamps, and it is well known that, at the present day, the electric arc lamp is the most efficient means of converting other forms of energy into light, excepting, perhaps, the mercury vapour lamp, which, however, produces a peculiar light unsuitable for most purposes. Unfortunately, however, Mr. STEINMETZ does not state definitely the efficiency of the new lamp, most likely because experiments in the direction of improving it are still going on; but that it must be very good, comparatively speaking, follows from his somewhat casual remark that electrodes of pure magnetite conduce to an efficiency of about twice that of an ordinary arc lamp. More definite figures on this point will be awaited with interest. Of hardly less practical importance is the fact that it appears to be possible to construct magnetite lamps for a useful life of several hundred hours, a length of time closely approximating to the life of incandescent lamps. A radical change from the present construction lies in the fact that the two electrodes are of dissimilar substances. Only the negative is of magnetite, the positive being a block of copper, so dimensioned as to conduct away any unnecessary heat. It might be thought that this block would show signs of burning after some time, but this appears not to be the case. A possible explanation is that the current does not impinge upon this copper terminal at a single point, but that the contact surface is much larger owing to the well-known fact that metal vapours are comparatively good conductors of electricity. Since the light emanates from the arc itself, and not from the crater of one of the electrodes, it would seem that the distribution of light is more uniform than in ordinary arc lamps. The invention certainly looks promising, and it is to be hoped that fuller information on the many points of detail which combine to make an arc lamp a commercial and technical success will soon be forthcoming.

IT is our painful duty to report two more third-rail fatalities this week, bringing up the total number of such accidents on the North-Eastern and Lancashire and Yorkshire Railways to four. Although the majority of individuals can bear with merely temporary inconvenience a shock from a 500-volt main, even when making good contact with the conductors, there is no doubt that in some cases such a shock may be attended with serious consequences. In each of the accidents that has occurred so far, however, the unfortunate victim has been guilty of wilful trespass, and consequently the railway companies may be exonerated from blame. In those situations, however, in which persons can trespass on the line without much difficulty, we recommend the adoption of guard-planks, which, although not making contact with the third-rail absolutely impossible, yet offer a considerable safeguard against either stepping or falling on to the live conductor. This expedient will, we believe, be widely adopted on the Metropolitan and Metropolitan-District lines when they have been equipped for electric traction.

AN excellent article on the electrolytic refining of iron appears elsewhere in our columns. The authors, Messrs. BURGESS and HAMBUECHEN, have realised fully that though

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the reduction of iron electrolytically is not a probable proceeding yet, there may be an opening for its purification. Rightly, they say that pure iron is a chemical curiosity; researches made on iron and its alloys are a little short of convincing, because the iron used has never been chemically pure; it is sufficient to recall that elaborate theories have been built on experiments with iron containing no less than 0·08 per cent. of carbon—a quantity colossal when the influence of that element is considered. But now, by the electrolysis of a sulphate solution, the authors claim to be able to produce at a cost for refining not exceeding one-half cent. per pound, iron approximately chemically pure, save for hydrogen, which is always present in electrolytic iron and can be easily expelled. Massive cathodes $\frac{5}{4}$in. thick can be produced, and it may be accepted that for the first time pure iron is a commercial commodity. Its utilisation must be effected electrically; clearly it is impossible to fuse such metal without contamination except by electrical means, and even this is difficult enough. Carbon electrodes would do very well if high-class steel and iron alloys containing carbon were to be made, but if carbon is to be excluded the matter is less simple. The authors, quite alive to this, propose to run a furnace of the inductor type. The whole Paper is sound, full of interest and well worth reading.

A DESCRIPTION of the large electric lighting installation at Wormwood Scrubbs prison appears on another page of this issue. The whole scheme has been well designed and thought out, and has been executed in a workmanlike manner. An iron-barrel system was naturally the most suitable for such a case, and the "Simplex" screwed conduit has been employed throughout. A special piece of work such as this naturally raises some debatable questions with regard to design, but we think that, taken as a whole, it would be difficult to improve on the system except in one particular point, to which we may briefly allude. For lighting the cells, the lamps themselves have been placed inside the cells and within reach of the prisoners. This constitutes rather a temptation to maliciously-minded prisoners, and we cannot but think a better plan would have been to place the lamp in a box outside the cell, allowing the light to penetrate into the cell by means of a thick glass window. To increase the amount of light which finds its way into the cell there could be a reflector behind the lamp, or the interior of the box could be painted with white enamel. We commend this suggestion to the approval of the prison authorities.

THE decision of the House of Commons Committee in confirming the view of the House of Lords that reciprocal running powers should be granted to the Tyneside Tramways and Tramroads Co. and to the Newcastle Corporation will probably be welcomed by all who have the welfare of the electric tramway industry at heart. We would not go so far as to say that wherever two tramway systems meet running powers are desirable, but in such instances as that at the Newcastle boundary, where practically no one from either direction wished to be deposited for the purpose of business, a very strong case existed. It was admitted by the Corporation that the bulk of the traffic was between the centre of Wallsend on the company's system and the centre of Newcastle on the Corporation system, yet a change of car was necessitated at the Newcastle boundary. We are inclined to think that the Corporation did not strengthen its case by offering to run the through service as far as Wallsend itself, and the conclusion is forced upon one that the opposition of the Corporation was not so much from any sincere opinion that the through running was unnecessary, but from a desire to exclude the company from the streets of Newcastle. The Corporation, however, are still fighting the matter, and Mr. W. R. PLUMMER, the Member for Newcastle-on-Tyne, intends to move the deletion of the running power clauses when the bill comes up for third reading in the House of Commons. A conference was also held in private on Wednesday, but according to the account given out to the Press nothing of a definite character was arrived at.

THE rejection, on the third reading in the House of Commons of the London County Council (Tramways and Improvements) Bill, of the line down Tottenham Court-road, should bring home to the minds of electric tramway engineers the unwisdom of promoting tramways in large cities where less than the Board of Trade limit of 9ft. 6in. between rail and kerb can be secured. It cannot be said that in such a street as Tottenham Court-road the limit is unreasonable, and the tramway, as originally proposed, would have had to pass through the portion where considerably less than this is the case. The truncated scheme, as passed by the Committee, obviated one difficulty only to introduce another, for a tramway 500yds. long from the junction of Euston-road and stopping half a mile before it reached Oxford-street would certainly have no *raison d'être.*

MR. MARCONI has a happy knack of hitting off public fancy, and his latest "feat," although it implies nothing novel either from the engineering or purely scientific standpoint, has been received with bursts of enthusiasm by the more emotional section of the daily Press and the more impressionable of its readers. The Marconi Company had announced long, long ago that their large power stations on both sides of the Atlantic could transmit messages from one side to the other, and over and over again the statement has been repeated that ships have been able to receive "wireless" messages thoughout their entire journey across the Atlantic, so that they were always in touch with one side or the other. A commercial application of this has now been made by the publication of a daily newspaper on the "Campania." Such applications as these are the field for wireless telegraphy, and we are glad to hear that the idea has proved so successful. We may reasonably assume that any attempt to compete with cables in the regular transmission of messages between England and America will now be deferred until this new branch of the wireless telegraph business has been more fully developed.

The Institution of Electrical Engineers' Conversazione.—The annual conversazione of the Institution of Electrical Engineers will be held on Tuesday, June 28th, at the Natural History Museum at 9 p.m.

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Junior Institution of Engineers.—On Saturday, June 25th, a party of members of the Junior Institution of Engineers will pay a visit to the Chelsea power station of the Underground Electric Railways Company of London.

Telephone Systems.—Mr. Kingsbury asks us to correct a typewriter's error which occurred in his letter on this subject, published in our last issue. The date of the early patent which he quotes should be 1879 and not 1897.

The Royal Society.—Among the Papers down for reading yesterday were the following:—"A Probable Cause of the Yearly Variation of Magnetic Storms and Auroræ," by Sir Norman Lockyer, F.R.S., and Dr. W. J. S. Lockyer. "On the Action of Radium Emanations on Diamond," by Sir William Crookes, F.R.S.

The Wright Maximum Demand Indicator.—The *London Gazette* for June 10th announces that the Board of Trade have approved the pattern and construction of Wright's Demand Indicator No. 93,644 and also the means provided for fixing same and connecting with the service lines as described in the specification and instructions deposited with the Board and numbered H 6,680.

New Electricity Works at Sheffield.—The opening of the new Neepsend generating station of the Sheffield Corporation will take place on Monday, June 27th. The new station will supplement the old works in Commercial-street, and is equipped with two-phase machinery. Arrangements have been made for an inspection of the works by the Incorporated Municipal Electrical Association on the following Friday when the Association visit Sheffield.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Dakar—Konakry	May 13, 1904 ..	—
Accra—Lagos	June 1, 1904 ...	—
Nagasaki—Fusan	June 7, 1904 ..	June 14, 1904

International Engineering Congress.—At the International Engineering Congress, to be held on October 3 to 8, 1904, at St. Louis, a number of engineers, by special invitation of the American Society of Civil Engineers, will lecture on the development of engineering practice in their respective countries during the past 10 years. Amongst the subjects the following are connected with electrical engineering:—

Underground Railways: William Barclay Parsons, M.Am.Soc.C.E., Chief Engineer, Rapid Transit Comm., New York City; Basil Mott, M.Inst.C.E., and David Hay, M.Inst.C.E., Central London and City and South London Railways, England; M. Biette, Ingénieur des Ponts et Chaussées, adjoint à l'Ingénieur en Chef du Chemin de fer Métropolitain de Paris, France.

The Substitution of Electricity for Steam as a Motive Power: James G. White, M.Am.Soc.C.E., New York City; Alexander Siemens, M.Inst.C.E., London, England.

Disposal of Municipal Refuse: Rudolph Hering, M.Am.Soc.C.E., New York City; M. Boreux, Inspecteur-Général des Ponts et Chaussées, Chef du Service de la Voie publique et de l'Eclairage de la Ville de Paris, France.

Steam Turbines: Francis Hodgkinson, M.Am.Soc.Mech.E., Pittsburg, Pa.; M. Rateau, Ingénieur des Mines, Professeur à l'Ecoles des Mines, France.

Electrical Power—Generating Stations and Transmission: L. B. Stillwell, M.Am.Soc.C.E., New York City.

Royal Meteorological Society.—At a meeting of this Society held on Wednesday, the Rev. C. F. Box gave an account of some curious "Effects of a Lightning Stroke at Earl's Fee, Bowers Gifford, Essex, April 13, 1904." A thunderstorm occurred during the early morning hours, and about 3 a.m. there was a blinding flash, lighting up the whole neighbourhood for miles around, followed immediately by a crashing explosion. One person stated that he saw what appeared to be a cylinder, and another person a ball of fire, descend and then explode, "casting darts" in all directions. On careful examination in daylight, it was found that in an oat field, which had recently been dredged, there were three distinct sets of holes ranging from 9in. down to about 1in. in diameter. The holes, which were perfectly circular, diminished in size as they went downwards, and remained so on to the perfected rounded ends at the bottom. Upon digging sectionally into the soil, which is stiff yellow clay, it was found that the holes were "as clean cut as though bored with an auger." An interesting discussion followed the reading of this Paper.

Conversazione of the Institution of Civil Engineers.—The annual conversazione of the Institution of Civil Engineers was held at the Institution buildings on Wednesday and Thursday, the guests being received by Sir Wm. and Lady White and the Council. The exhibit of engineering models and scientific apparatus excited, as usual, the keenest interest. Most of the exhibits related to shipbuilding and railway engineering, but there were also a number of electrical models and apparatus. Among the latter, several electric furnaces for laboratory use were exhibited by Mr. Bertram Blount. The furnace bodies, of cylindrical shape, are of fireclay covered with asbestos, and they retain the heat remarkably well; in fact, after half an hour's working with an internal temperature of about 1,000°C. the outside was not too hot to touch with the hand. Several types of resistances were shown. One, of German origin, consisted of a porcelain tube, upon which a spiral platinum band is wound. Another, of Mr. Blount's design, consisted of a porcelain rod within a porcelain tube, the annular space between the two being filled in with a mixture of carbon and other materials, such as carborundum. Temperatures up to about 1,500°C. can be attained by means of these furnaces. Among the other exhibits of electrical interest were: A conductometer, shown by Mr. R. Appleyard; a model of a sand-box for cable or electric tramcars, by Mr. G. L. Till; electric switches, by Mr. P. A. Spalding; and compensating potentiometers, by Mr. W. Clark Fisher. Considerable attention was attracted by the tattered remains of the clothes of a man struck by lightning, which were exhibited by Mr. Killingworth Hedges.

Second class Engineers in the General Post Office.—The *London Gazette* for June 10th contained the following announcement:—

The Civil Service Commissioners hereby give notice that the following regulations are published with the consent of the Lords Commissioners of His Majesty's Treasury, viz.:—

Regulations respecting open competitive examinations for the situation of second-class engineer in the engineer-in-chief's department of the General Post Office.

N.B.—These regulations are liable to alteration for future examinations.

I. The limits of age for this situation are 22 and 24. Candidates must be of the prescribed age on the first day of the examination.

II. Candidates will be required to show what technical education and practical training they have undergone to qualify themselves for a situation of this nature. They must satisfy the Civil Service Commissioners that they have had at least two years' training, either in a suitable workshop attached to a college or university or under a firm of electrical or mechanical engineers of good standing. Evidence on these points must be sent in at such times and in such manner as the Civil Service Commissioners may appoint. If it prove *primâ facie* satisfactory the candidate will be admitted to examination, subject to such further inquiry as may be necessary.

III. The examination will be in the following subjects:—

1. English composition.
2. Mathematics: (*a*) Arithmetic, algebra, plane and solid geometry, trigonometry; (*b*) differential and integral calculus.
3. Applied mechanics.
4. Electricity and magnetism.
5. Electrical engineering and electrical instruments.
6. Either steam and stationary steam engines or civil engineering (including designs of structures).
7. French or German or Italian (translation and composition).

*** Subjects numbered 5 and 6 will include drawing.

No candidate will be eligible who does not pass, to the satisfaction of the Civil Service Commissioners, in each of the subjects numbered 1, 2 (*a*), 3, 4, 5 and 6.

IV. A fee of £3 will be required from each candidate attending the examination.

V. Applications for permission to attend an examination must be made at such times and in such manner as the Civil Service Commissioners may appoint.

Students of the Institution of Electrical Engineers.—The report of the Students' committee for session 1903-4 states that there have been 11 meetings of the Students' Section during the past session, not including the annual general meeting, the average attendance being 36 and the highest being 56 recorded on January 20th. The following Papers were read:—"A German Workshop," by F. Neuhaus; "The Operation of Electric Lifts," by H. Church; "The Equipment of a Sub-station with Rotary Converters," by C. J. Davis; "The Equipment and Working of Small Private Generating Stations," by H. Purle; "The Testing of Alternate-current Machinery," by R. J. Kaula; "Automatic Railway Signalling,"

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by E. Fisher; "The Determination of the Correct Proportion of Condensing Plant in a Central Station," by P. Y. Hunter; "Notes on Commercial and Experimental Testing of Continuous-current Machinery," by L. A. Lewis; "Armature Reactions in Alternators," by H. W. Taylor; "Insulation and Insulators," by H. D. Symons; "Alternating-current Commutator Motors," by F. Creedy; "Some Notes on Steam Turbine Testing," by C. G. Seeley (read at the Annual General Meeting on May 18th).

The discussions were enthusiastically entered into, the average number of students taking part being seven. During the session well-attended visits have taken place to the following works :—

The County of London and Brush Co.'s City-road Supply Station, the Incandescent Electric Lamp Co., the India Rubber, Gutta-Percha and Telegraph Works Co., Tunnelling Works of the Baker Street and Waterloo Railway, the Post Office Central Telephone Exchange, the Central Electric Supply Co., Messrs. Thornycroft & Co., the Board of Trade Electrical Standards Laboratory, the Willesden Works of the Metropolitan Electric Supply Co., the Western Electric Co., the Electrical Power Storage Co., the Great Northern and City Railway.

During the Easter vacation a party of the Students' Section visited the Birmingham district. The number of students who took part was 42, of whom 23 were from London.

The party met at Rugby at mid-day on Monday, April 11th, and visited the works of Messrs. Willans and Robinson. Leaving Rugby the party reached Birmingham the same evening and visited the following works in and around Birmingham until Saturday, April 16th :—The General Electric Co. (Witton), the Midland Electric Power Co., the Electric Construction Co., the Wolverhampton Corporation Electricity Supply Station and the Lorain Surface-contact Tramway System, Messrs. W. and J. Player, the Lanchester Engine Co., Messrs. Chamberlain and Hookham, Messrs. Belliss and Morcom, the Birmingham Small Arms Co., Messrs. Stewarts and Lloyds, the Birmingham Electricity Works, the New Birmingham University Power Station, the Birmingham Municipal Technical School. The party was met on Monday, April 11th, at the Midland Hotel, Birmingham, by the Birmingham Local Section, when Mr. Vaudrey, the local chairman, and Dr. Sumpner, vice-chairman, gave an address of welcome to the party. On Friday evening, April 15th, those taking part in the visit dined together at the Midland Hotel, with Mr. H. D. Symons, chairman of the Students' committee, in the chair, and Mr. Vaudrey and Mr. J. K. Catterson-Smith, assistant hon. local sec., as guests.

The committee feel that the work of the session has been satisfactory, and trust that the same enthusiasm will be shown in the future.

Faraday Society.—At an ordinary meeting of the Faraday Society, held on June 9th, the President, Dr. J. W. Swan in the chair, M. Adolphe Minet presented the first part of a Paper on "The Electric Furnace: Its Origin, Transformations and Applications." The author discussed the growth of the furnace from the historical point of view, and then proposed a new classification worked out in minute detail in the form of a table. A full bibliography of the electric furnace completed the first section of the Paper. The discussion was postponed until the autumn, when the author will complete his study and fully illustrate his subject. Dr. F. M. Perkin then described a form of porous diaphragm that he had found convenient for laboratory use. It consisted of two perforated concentric porcelain cylinders packed in between with brown paper, asbestos, or other material, depending on the use to which the diaphragm was to be put. Mr. G. T. Beilby read a Paper on "The Hard and Soft States in Metals." The author considered that an exclusively crystalline theory of metal structure, even when stretched to its widest limits, was insufficient to explain fully these phenomena. But the crystalline was not the only form of solid aggregate; the movement of the molecules in the liquid state might be so suddenly arrested that they had no time to fall into the regular formation of the crystalline state, so that the solid which resulted was amorphous, not crystalline. A suddenly-congealed liquid might be likened to an instantaneous photograph of the rapidly-moving molecules of the liquid state. The author advanced the view that the hard and soft states were perfectly distinct phases. This was shown by the mechanical, electrical, optical and thermo-chemical properties as well as by the micro-structure. The soft phase C he called crystalline and the hard phase A amorphous. The transformation of A into C could be effected by heat, and took place at a definite transition temperature. On either side of the transition point the various properties were characteristic and distinct; for instance, an E.M.F. of 120 micro-volts might be developed in a thermo-junction of silver in the two phases. The E.M.F. fell to zero after the junction had been heated to 260deg. for a few seconds. The transformation from hard to soft was thermally irreversible, but was readily effected mechanically. This reverse transformation—soft to hard—took place when the metal was deformed by overstrain, however slight. It took place through an intermediate mobile phase in which the molecules had a freedom analagous to that in the liquid phase. This freedom was produced by motion directly imparted to the molecules during the slipping of one portion of the material over another, and the state of the mobile phase was somewhat analagous to that of an undercooked liquid. This transformation, C–M–A, while it occurred at every moving surface, did so, as a rule, in extremely thin layers. The layers of the hard phase which resulted supplied a rigid casing for the unaltered crystalline elements, and thereby gave a granular and cellular structure to metal which had been overstrained by having any kind of work done on it. The co-existence of the two phases in this way accounted for the variety of structure which might be developed in malleable and ductile metals.

Standardisation of Tramway Poles.—The conference of tramway pole makers, convened by the Engineering Standards Committee's Sub-committee on Electric Tramways, and referred to in our issue of May 13, p. 129, took place recently at the Institution of Civil Engineers. The following gentlemen were present :—

Mr. A. P. Trotter (chairman), Messrs. Forbes Higginson, J. H. Rider, H. M. Sayers, R. H. Scotter, A. M. Sillar, J. J. Steinitz, A. H. Walton, Frank Herbert (Messrs. Stewarts & Lloyds, Ltd.), W. James Higgs (Messrs. James Russell & Sons, Ltd.), L. L. Robbins (Messrs. the National Tube Co., Ltd.), T. Harris Spencer (Messrs. John Spencer, Ltd.), A. C. Williams (Messrs. the British Mannesmann Tube Co., Ltd.), Mr. Leslie S. Robertson (secretary) and Mr. C. le Maistre (electrical assistant secretary).

The Chairman in opening the proceedings drew the attention of those present to the position of affairs with regard to the proposed standardisation of three section tramway poles. He remarked that the sub-committee had commenced work upon this problem early last autumn, since which time a large amount of valuable and interesting information had been gathered by correspondence. In the first place, a circular dealing with tramway pole details had been drafted and forwarded to the manufacturers for their consideration. The replies had been collated in tabular form and the committee had held several meetings to consider this information carefully. As the result of their deliberations a further circular had been drafted, in which certain proposals were made for standardising three-section tramway poles, as far as possible, embodying the views of the committee and those of the manufacturers. This circular was forthwith issued to a large number of the tramway engineers in the kingdom. Some time necessarily elapsed before the replies could be all received and collated, but the résumé which was ultimately laid before the members evidenced the fact that a large majority of the users were in favour of the suggestions put forward. The sub-committee then proceeded to draft a standard specification for three-section tramway poles with the aid of the evidence and information which they had now gathered. Before, however, finally adopting this specification, it was thought advisable that the makers should have a further opportunity of considering the recommendations of the committee and of making any final criticisms they might desire. With this object in view the proposed specification was issued confidentially to the makers, and as the replies were not entirely in accord with the proposals this conference had been decided upon.

The classification and the overall length of poles, as well as the length of telescope joints which were proposed by the committee were agreed to by all present. A discussion took place with reference to the lengths of the sections proposed as standard, and some of the members were in favour of a slight alteration being made on the score of economy, suggesting that the two top sections should be made of equal length. The committee had proposed certain figures for the outside diameters of the poles, which were chosen with due regard to interchangeability and so forth. The witnesses were, however, not altogether in favour of the figures proposed, as, in their opinion, these would not represent the most economical pole which could be produced to stand the stipulated bending tests. A long discussion ensued, resulting in a definite proposal being made to increase the suggested diameters by an even amount. This important proposal, we are informed, is now receiving the consideration of the committee. The proposals as to standardising similar diameters and over-all lengths for both sectional and taper poles, and making the bases interchangeable, was carefully gone into. Questions relating to the proposed drop-test bending and permanent set tests, as well as many other practical details were also discussed at length.

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THE ELECTRIC LIGHTING OF WORMWOOD SCRUBBS PRISON.

The Prison Commissioners have recently introduced the electric light into some of the prisons, and we have had the privilege of inspecting the installation which has recently been completed in one of the wings of Wormwood Scrubbs prison. This huge edifice, consisting in the main of four wings as well as chapels, hospitals, &c., is supplied with current by the Hammersmith Borough Council. An extra high-pressure lead-covered paper-insulated main having a section of 0·1 sq. in. and made by Messrs. Callenders, is laid under the footway from the existing mains, about 1,500yds. distant, and is taken into a transformer pillar situated in the prison yard. This pillar is surmounted by a 5-ampere enclosed arc lamp of the Reason pattern which may be switched on by means of a key without opening the pillar. The transformer itself is situated in the base of the pillar and is of the British Electric Transformer Co.'s make; it has a capacity of 50kw. and a transformation ratio of 10 to 1, the primary voltage being 2,200 and the frequency 50 ∿ per second. Above the transformer are the primary and secondary 'bus bars, mounted on slate slabs. These are rendered accessible by means of two iron doors, one on each side of the pillar, and are entirely distinct in every way. There are two secondary panels, one for each wire, and fuse clips, together with fuses and handles, have been provided for all four wings of the building, although at present only wing B has been wired.

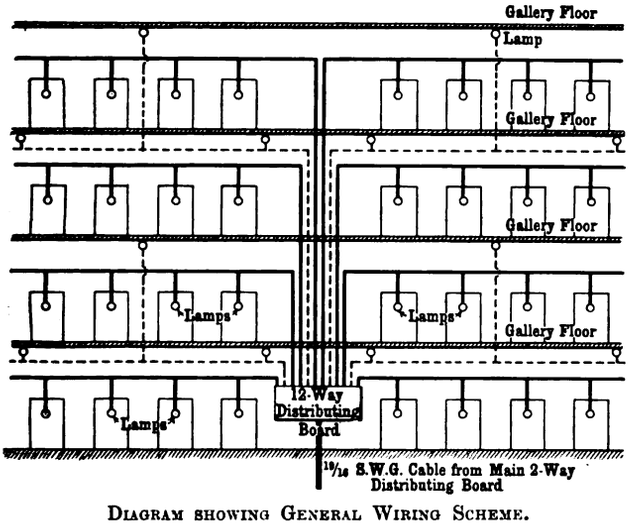

Diagram showing General Wiring Scheme.

The transformer pillar, as has been mentioned, is outside the buildings and from it to the main distribution board within wing B there is run a concentric lead-covered cable of 0·125 sq. in. in section laid solid in bitumen troughing. Immediately inside the building is the main distribution board, having two 'bus bars, on to which the main concentric cable is divided out after passing through a British Thomson-Houston meter. The board itself is of slate, and is enclosed within an iron box and covered by a glazed lock-up lid. From it are run two circuits of 19/16 S.W.G. cable, each conductor being tapped off the 'bus bars through double-pole switches and fuses. These two circuits are then carried in 1½in. Simplex steel tubing to two distribution boards situated half-way down the corridor, one being on each side. The sub-circuits which emerge from the corridor distribution boards are composed of 7/18 S.W.G. cable drawn into ⅞in. tubing, and each is controlled by a single-pole switch and fuse. Each distribution board has 12 ways, double-pole, eight of which supply the cell lamps and four those in the corridors. In wing B there are 352 cells fitted with electric light, and as these are distributed over four floors, the magnitude of the work can be easily gauged. On leaving the corridor distribution board, a sub-circuit of 7/18 S.W.G. is run along the wall above the cell doors, to the right hand, and a similar circuit to the left hand. By means of the "Simplex" T junction box the necessary switch and lamp leads are then tapped off at every individual cell, a hole made through the wall and the branch taken into the cell. Along with the 7/18 circuit for the cells, but in separate tubing, there is another 7/18 circuit for the corridor lights. This latter circuit supplies the lamps on the ground floor and also on the first floor, connections being teed off and taken through the floor of the gallery which runs round the building. Similar methods are adopted with reference to the third and fourth floors, and the system employed in connection with the distribution board on the other side of the corridor is also identical.

Each cell is provided with an 8 c.p. lamp, a single-pole switch, and fuse, the latter being fixed at about 6ft. from the floor, outside the cell. The lamp is fixed in a horizontal position just inside the cell over the door, so that not more than an inch of the lamp-holder projects beyond the wall face. Thus the lamp-holder is screwed directly on to the end of the conduit which passes through the wall. The maximum number of lights on any circuit of 7/18 is 23 8 c.p. lamps, which are in the cells. The corridor circuits are run close to the wall, on the face of the cast-iron brackets supporting the galleries, and a separate switch and fuse is provided as for the cell lighting, the lamp-holders also being screwed directly on to the conduit.

No joints have been made and the cable is of Messrs. Siemens' 2,500 megohm class. Inspection bends and draw boxes are inserted in the tubing at convenient distances, and all the work, except where it passes through walls, is on the surface. No single-strand wire whatever has been used, and in no case is there more than one lamp on a 3/22 lead.

Certain cells have been fitted with the lamp attached to a small bracket projecting from the wall above the table. This method of fixing the light is, however, entirely experimental.

On the installation as a whole nothing but favourable comment can be made. "Simplex" screwed steel conduit with brazed seam has been used throughout, and tests have revealed the fact that the electrical continuity is as near perfection as possible; connection to earth is made via the water pipes. After completion, the entire installation showed an insulation resistance to earth of 450,000 ohms. Messrs. R. H. and J. Pearson were the contractors.

For their courtesy in enabling us to view the installation, and in furnishing us with many particulars, we are indebted to H.M. Commissioners of Prisons, to Mr. J. Young, Clerk of Works to the Prison Commission, to Mr. G. G. Bell, borough electrical engineer of Hammersmith, and to Mr. F. Hill, chief assistant engineer at Hammersmith, under whom the Corporation's work was carried out.

FAVERSHAM ELECTRICITY WORKS.

The electric lighting station at Faversham, a small town of some 12,000 inhabitants, was officially opened by the mayor of the town, Mr. Frederick Austin, J.P., on Thursday last week. It is of special interest at the present time as being one of the few stations using gas engines for driving the generators, and they appear to offer considerable advantages for small stations such as the one in question.

In 1900 a private company was about to apply for a provisional order for supplying electricity within the Borough of Faversham, when the Corporation itself decided to undertake the supply of electricity. A provisional order was obtained in 1901, but, partly on account of strong opposition from certain quarters and partly due to protracted and futile negotiations with a private company, which offered to supply energy, work was not proceeded with until two years later. In March, 1903, a loan of £23,779 was sanctioned by the Local Government Board, and the work was then vigorously pushed forward and completed within 13 months from the time the first contract was let.

The station, of which Fig. 2 shows a plan, is a brick building consisting of an engine room, battery room, stores, office, and coal shed. One side of the engine room is of corrugated iron

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to facilitate future extensions. All the rooms are white-washed.

The Dowson gas-producer plant consists of one steam boiler, two producers, two hydraulic boxes, two sawdust and coke scrubbers, and a gasholder. They are all, with the exception of the gasholder, erected in the roomy coal shed. The gas producers are placed in a pit, so that their tops protrude a few feet above the level of the firing floor. The boiler is fired with coke, for which 18s. 6d. per ton is paid, while Welsh anthracite peas, at 26s. per ton, is used for the producers. When the producers are to be first started, the lid at the top is left open, so as to create a draught, and a wood fire is kindled. The anthracite is then gradually fed through the stokehole at the top until the depth of the fire is about 2ft. 6in., at which it is kept constant. When the fire is properly under way the lid at the top is closed, and the grate-hole at the bottom of the producer is filled in with fireclay. At the same time, steam and air are blown through the incandescent fuel, whereby gas is produced. A considerable amount of impurities pass along with the producer-gas, and a thorough cleansing is necessary. First, the gas is conducted through a hydraulic box, where it is cooled, and where the tar settles. From here it passes to the coke scrubbers. These are vertical iron cylinders filled with coke. Water (about 16 gallons an hour in this case) is led in at the top, and, in flowing down through the coke, effectively cools and purifies the producer gas, which is forced in an upward direction. Finally, the gas passes through the sawdust scrubber, the contents of which are replaced every three weeks or so, and then flows to the gas-holder, a few yards from the shed, where it is stored at a pressure of $1\frac{1}{2}$in. of water. Before entering the gasometer, however, the gas passes through a four-way distributing box. One way is not used at present, but the other three are connected to the producer, the gasometer and the gas engines respectively. By means of a single valve the producer is put in communication either with the gasometer or the engines. A small hand pump of the oscillating type is placed near the gasholder for draining the pipe system of condensation water. Twelve-inch gas mains are used for conducting the producer-gas to the engines. Before entering these, the gas has to pass a stop valve and a reduction valve, which reduces the pressure of the gas down to that of the atmosphere.

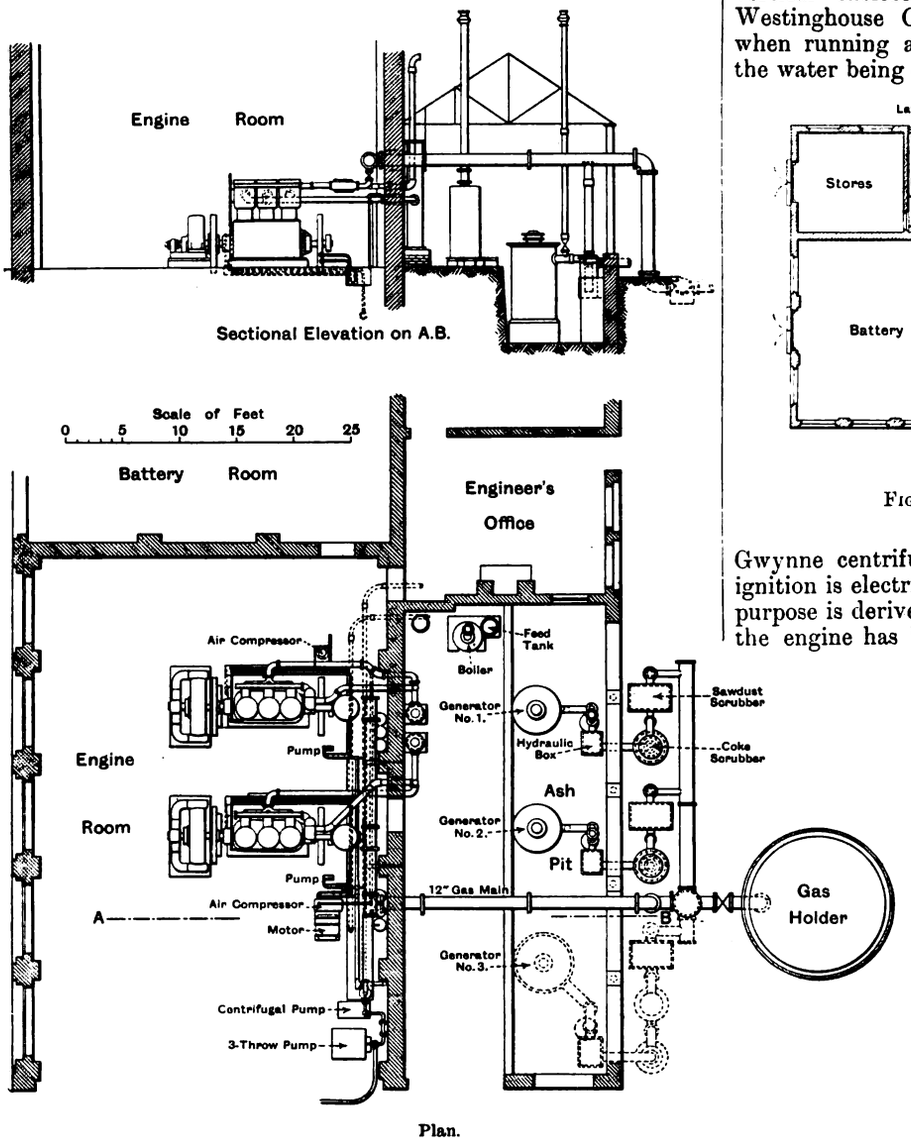

FIG. 1.—GENERAL ARRANGEMENT OF PLANT AT GENERATING STATION.

The gas engines (see Fig. 1), two in number, are of the vertical enclosed three-cylinder type built by the British Westinghouse Company. They are designed for 85 B.H.P. when running at 290 revs. per min., and are water-cooled, the water being circulated through the jackets by means of a Gwynne centrifugal pump belt-driven from the engine. The ignition is electric. At starting, the electric current for this purpose is derived from a 10-volt primary battery, but when the engine has been brought up to full speed the current is furnished by two small electric generators belt-driven from the engines. These generate the current at from 8 to 10 volts, and the change from the battery to these dynamos is effected by a suitable switch fixed to the wall near the engines. We understand, however, that in case of the extension of the existing plant, the igniting current is to be furnished by one dynamo only, driven by a separate electric motor fed from the 'bus bars. In this case the primary battery can be dispensed with. The gas engines are started by one of the three cylinders being supplied with compressed air, which is stored in four vertical cylindrical iron tanks at a pressure of about 200lb. to the square inch. These tanks are all interconnected, and the air is compressed by two independent sets. One set consists of a compressor belt-driven from the engine, while the other set comprisess a 5 H.P. slow-speed series motor directly connected to a water-cooled compressor. Cooling water is supplied from an overhead tank filled with water from a well near the station by two small pumps driven by 1 H.P. shunt motors; one of these pumps is of the centrifugal type, and the other is a Worthington three-throw pump actuated through gearing. These two small motors have their starting and controlling switches fixed near to them on the wall. Each is protected by a reverse-current cut-out. The overflow from the overhead tank flows by way of the rain-water mains to the cooling pond in the yard, which has a capacity of about 30,000 gallons.

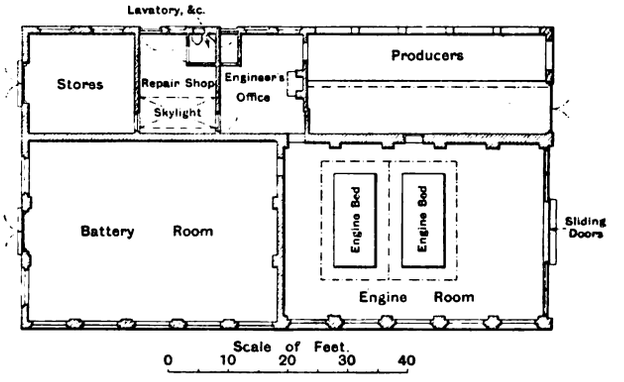

FIG. 2.—PLAN OF GENERATING STATION.

As already stated, the gas engines are started by compressed air, and for this purpose the gas inlet valves of the cylinders may be disconnected from the valve gear by moving a lever. This movement simultaneously puts into opera-

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ion the valve gear for the compressed air. It, now, the stop-valve for the compressed air be opened (after the piston has been moved just beyond the dead point), then the engine will start, receiving an impulse every revolution. After speed has been got up sufficiently, the compressed air is shut off and the lever referred to moved back. The engines are governed on the mixture, and not on the hit-and-miss principle. Exhaust pipes of from 4in. to 5in. in diameter are used. Directly connected to the engines are six-pole 58kw. 460-volt compound-wound dynamos, by the British Westinghouse Company.

All cables, from the main generators as well as from the balancers and boosters, are mounted on porcelain insulators and conducted to the switchboard through a cable trench closed at the top by iron plates. The boosters and balancers are mounted on one common bed-plate, the former having four poles, while the latter have six poles. A few of the principal particulars of the balancer-booster set, which was supplied by Messrs. Crompton & Co., are: Speed, 700 revs.; capacity of balancer, 180 amperes at from 220 to 240 volts; capacity of booster, 100 amperes at from 25 to 100 volts. The cables from the switchboard to each generator have a section of 0·12 sq. in., to the balancer 0·15 sq. in., to the booster 0·125 sq. in., and to the battery 0·15 sq. in.

Mr. Bertram Thomas supplied the switchboard, which is placed 4ft. from the wall dividing the engine room from the battery room. It consists of a number of panels of polished black slate and is equipped with the usual measuring, recording and safety devices. On the positive side of each generator is an overload and return-current release switch, the latter operating when the reverse current exceeds 5 per cent. of the normal. The negative side of the generators is connected to an ordinary switch. An overload switch is inserted in the balancer circuit, no fuse being used. Where fuses are used, they consist of copper wire wrapped in asbestos and mounted on substantial porcelain bodies with handles. In the centre of the board are two recording instruments for measuring the charge and discharge of the battery, and at the side there is a large 'bus bar voltmeter indicating up to 500 volts and a 500 0-500 paralleling voltmeter. There are also two other voltmeters by the aid of which the voltages between various points may be measured. Altogether there are 11 ammeters. All the regulating resistances are placed on top of the switch-board and are operated by means of bevel gearing and suitable shafting.

Three feeders emanate from the station. Each outer of these is protected by a fuse and is connected up to a Thomson wattmeter. Two wattmeters are also connected up to the generator circuits. In the battery room is an E.P.S. battery, consisting of 250 cells having a capacity of 500 ampere-hours. On each side are 23 regulating cells, which may be cut in or out by a regulating switch operated from the switchboard. The cells are supported on wooden beams, which themselves are well insulated from earth by glass insulators. Eight 1-ampere Nernst lamps and 14 16 c.p. incandescent lamps are distributed throughout the station, and arrangements are made so that these lamps may be thrown on the one or the other side of the three-wire system by a change-over switch. A number of wall plugs are fixed at various places. In the engine room is a 5-ton travelling crane, built by Messrs. James Spencer & Co., and worked by hand.

The feeders are insulated with vulcanised bitumen, and are laid solid in wooden troughs. They connect the station with a street pillar in the centre of the town, from whence distributing cables are laid in various directions. For domestic purposes three-core cable is used, tapering down from 7/15 to 7/18, while for street lighting vulcanised bitumen cable in wooden troughs is employed. All work connected with the cables was carried out by the Anchor Cable Co., who also supplied the cables. For consumers requiring more than 5kw. all three wires are brought into the premises, while for smaller consumers the current is taken from the middle wire and one of the outers. For street lighting there are 10 Brockie-Pell 10-ampere arc lamps, connected in two sets of five in series. An automatic device is provided, which inserts glow lamps in series should any one of the five arc lamps fail. The lamps are specified to burn 35 hours. They are of the open type, and are suspended from pillars of an artistic design supplied by Messrs. Rumney and Rumney. The total cost of the scheme approximates, we understand, £16,500.

Messrs. Talbot and Stevenson are the consulting engineers to the Corporation, and Mr. Gordon Sommerville is the borough electrical engineer. Our thanks are due to these gentlemen for providing us with information and conducting our representative over the station.

THE PORTSMOUTH TELEPHONE ACCOUNTS.

The accounts for the first complete year's working of the Portsmouth municipal telephone system, from March 31, 1903, to March 31, 1904, have now been published. The Portsmouth Corporation, it will be remembered, have built a telephone exchange system to compete with the National Telephone Co., having obtained a licence in 1901, which will expire on June 31, 1926. This involves, as our readers are aware, an extension of the National Telephone Co.'s licence so far as the Portsmouth area is concerned until the same date.

The capital account shows a total expenditure of £31,895. 3s. 9d., apportioned as follows:—

Underground construction	£11,296	3	11
Overhead construction and junction lines	8,174	15	9
Exchange	1,173	0	11
Instruments	5,102	11	5
Engineer's commission	1,300	10	9
Salaries and wages during construction	989	6	6
Building store room, &c.	247	1	3
Furniture and fittings	149	17	9
Printing, stationery and advertising	258	3	4
Tools, &c.	190	12	11
Miscellaneous	217	19	3
	29,100	3	9
Retention money	2,795	0	0
	£31,895	3	9

The total number of subscribers' lines connected up to March 31, 1904, was 1,384, and the telephones working were 1,659. This works out to a capital expenditure of £23. 1s. per subscriber's line, or £19. 5s. per telephone. The revenue account, giving particulars of the expenditure and income, is given below.

EXPENDITURE.

Line repairs	£314	1	10
Instrument and exchange repairs	465	10	5
Salaries	250	0	8
Wages, office	162	8	11
Wages, operators	522	0	6
Post Office royalty and commission—royalty of 10 per cent. on exchange rentals and local tolls	567	19	10
Terminal fees account—fees payable to National Telephone Co.	126	7	1
Printing and stationery	129	12	7
Rents, rates, taxes and insurance	348	18	2
Wayleaves	39	18	3
Contribution to borough accountant's department	30	0	0
Gas and electric lighting	57	13	9
Miscellaneous	185	0	0
Bad debts written off	43	1	6
Reserve for bad debts	60	0	0
	3,302	13	6
Trunk and telegram fees—fees payable to Postmaster-General	587	14	1
	3,890	7	7
Balance to net revenue account	2,680	4	10
	£6,570	12	5

INCOME.

Exchange Rentals	£5,154	1	4
Private rentals	89	11	3
Local tolls	608	8	0
Public telephones	18	17	4
Post Office commission account—amount receivable on collection of trunk fees	35	6	11
Terminal fees—amount receivable from National Telephone Co.	54	11	2
Extra insertions in directory	2	14	7
Shifts and sales	19	7	9
	5,982	18	4
Trunk and telegram fees—fees receivable from subscribers	587	14	1
	£6,570	12	5

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The repairs, it will be seen, have cost £779. 12s. 3d., which amounts to 2·4 per cent. of the capital expenditure. Out of the balance of the expenditure and revenue account £1,464. 8s. 3d. (4·6 per cent. of the total capital) has had to be set aside for interest and repayment of loans. No sum is allowed for depreciation.

The following statistics are appended to the accounts:—

—	1903.	1904.	Increase for 12 months.
Number of subscribers' lines ..	742	1,384	642
Extension and other lines.....	129	293	164
Exchanges	4	6	2
Underground cables	6	8	2
Ditto distributors	61	68	7
Mileage of metallic circuit wire, overhead	308 miles	566¼ miles	258¼ miles
Ditto, underground	1,207 do.	1,224 do.	17 do.

Employés.

—	1903.	1904.	Increase or decrease.
Engineer and manager	1	1	..
Assistant manager.....	1	..	-1
Chief clerk	..	1	+1
Clerks and canvassers	5	4	-1
Inside superintendent	1	1	..
Outside superintendent.....	1	1	..
Inspectors and operators	27	34	+7
Foremen	5	4	-1
Wiremen, labourers, &c. (not on permanent staff).....	29	20	-9
	70	66	-4

DERBY ELECTRICITY WORKS AND TRAMWAYS.

(Concluded from page 305.)

The mains at Derby are of many sorts and of many systems. Some Siemens jute-insulated armoured concentric cable, employed originally for the high-tension feeders, and laid direct in the ground, is still in use, the remainder of the high-tension mains being of B.I.W. cable, either drawn into iron pipes or laid "solid." A little of the vulcanised rubber low-tension distribution cable is also still in existence, but most of it has been replaced by lead-covered concentric cable (B.I.W., Glover's and other makes), partly laid solid in bitumen and partly in stoneware pipes. The old transformers are of Messrs. Siemens' make; the newer ones are of the "Berry" pattern.

The Callender Company have supplied all the mains for the extensions. The continuous-current three-wire distributing mains are chiefly of 0·8, 0·15 and 0·8 sq. in. section, and are insulated with vulcanised bitumen and laid solid in wood troughs. There are four feeders, 0·5, 0·25 and 0·5 sq. in. section, drawn into Doulton ducts. Cable made by the St. Helens Cable Co., insulated with a waterproof material and laid solid, has been employed for the arc lighting extensions. The feeders for the tramways are insulated with paper, which is impregnated with bitumen and lead-covered, these being drawn into Sykes ducts from the works to the tramway terminus (1,100yds.) Fig. 11 is from a photograph taken by The Callender Company during laying, and shows both the Sykes and the Doulton conduits.

The Sykes ducts are 12-way, but up to the present only four 0·2 sq. in. feeders and two 0·3in. return feeders (running only to the tramway terminus) are laid in them. Earthing the negative main is done in the switch-pillar at the tramway terminus. In order that the return feeders might be used to replace the positive feeders on emergency, they are insulated to the same thickness. From the tramway terminus onwards the cable is laid solid in wooden troughing, a telephone wire and pilot cables running alongside it in the same trough. Section pillars of the ordinary design are placed at ½-mile intervals, the telephone wire being connected to all of them.

Both the track and the overhead equipment were supplied by Messrs. J. G. White & Co., the Electric Tramway Equipment Co. being sub-contractors for the overhead material. In the trailing frogs the runners are carried so near each other that the wheel cannot get out of its path when travelling from the junction line on to the main. The same applies to the crossings, which are made in all cases to suit the exact angle of the wire at the crossing, the runners and crossing piece in the centre being co-incidental with the wires themselves. In all frogs and crossings there is a mechanical method of attachment to the ends of the runners which are sufficiently long, and are all arranged with strong anchor rings, so that the frogs when anchored are just as rigid as the other part of the line. The arrangement at the feeding points is shown in Fig. 10, the Board of Trade's recommendation having been adopted of having the stay wires in a vertical plane with the trolley wire so as not to form a trap for the trolley in the event of its coming off the wire.

The rails are of the girder type, weighing 95lb. per yard, and are 6½in. deep with a flange 7in. wide. On curves a slightly heavier rail, weighing 101lb. per yard has been adopted. The specification of the steel for the rails and fish-plates asked for 0·4 per cent. of carbon and 0·9 per cent. of manganese, the percentages of silicon, phosphorus and sulphur not to exceed 0·07, 0·08 and 0·07 respectively. A tensile strength of between 40 to 46 tons per square inch was required, with an elongation of 15 per cent. and a contraction of 20 per cent.; and a drop test (1 ton falling twice from a height of 14ft. upon a 5ft. length of rail 3ft. between supports) was also specified. The chief point of interest in the permanent way is the rail joint. It is a development of the sole-plate idea in the manner shown in Fig. 9, which is self-explanatory. The North-Eastern Steel Co. were sub-contractors for the rails; the contract had first been awarded to a Belgium firm, but on account of delay in delivery it was transferred to the North-Eastern Company.

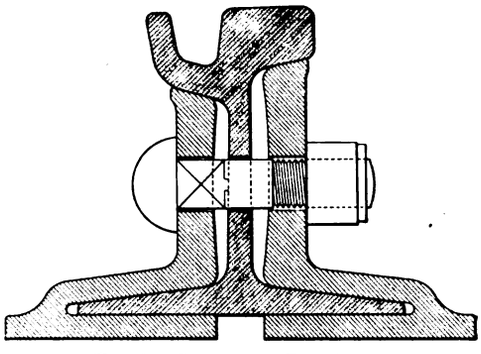

Fig. 9.—Section of Rail Joint.

The cars have Brush trucks and bodies, with B.T.-H. equipments. A semi-reversed stairway is employed, which, while possessing practically all the advantages of the reversed stairway type, does not obstruct the view of the driver. In deference to the Board of Trade suggestion also a wooden folding step has been fitted. Brush trigger life-guards are employed, the brakes are hand, slipper and electric emergency, and the wheels have steel tyres (Fig. 12). An ingenious device not much adopted hitherto in this country is the Wilson "trolley-pole catcher" (Fig. 13) supplied for the Derby cars by Messrs. R. W. Blackwell & Co. The end of the trolley rope is attached to this device, which pays it out or winds it up (by means of a clock spring) so long as the rope travels slowly owing to the usual slight variation in the position of the trolley wire relatively to the car. If, however, the trolley comes off the wire and the rope drum upon which the rope is wound moves rapidly, a centrifugal clutch flies out and stops the drum. This device has to be moved from one end of the car to the other when reversing the trolley, and a collar attached to the dasher just under the dash rail receives it.

As has already been indicated, no less than four systems of arc lighting are employed. Originally there were 80 Siemens arcs, run in two series of 40 off the old arc-lighters. Some 30 of these have been replaced by alternating-current arcs (by

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the Gilbert Arc Lamp Co.), run off the low-tension distributing mains through compensators, and the remaining 50 will be split up in series of 10 across the outers of the 2 x 230 volt continuous-current network. The last extensions consist of 30 continuous-current arcs connected in the same way in series of 10, and 30 arcs on the Gilbert series alternating system. These 60 arcs are suspended from the bracket arms of the tramway poles by means of the spring suspension (shown in Fig. 14) surmounted by a flat hook which will support the lamp on the bracket arm in the event of the spring pulling out. The spring is made so that its period of vibration is as far removed as possible from the period of the tram-pole, so that a swing is not set up. The series system employed by the Gilbert Company differs only in a few details from that put in at Eastbourne, and described fully in *The Electrician*, Vol. L., p. 854. It will be remembered that a transformer is employed whose primary is connected across the high-tension mains, and the secondary, which is connected to the series of 15 lamps, is free to slide up and down the primary winding and the core of the transformer. When all the lamps are in circuit, the secondary occupies a position over the primary coil, the frame being permanently tilted so that the repulsion between the coils when the normal current is flowing is balanced by gravity. When a lamp is cut out of the circuit, the currents in the primary and secondary momentarily increase, and the secondary is repelled further along the core

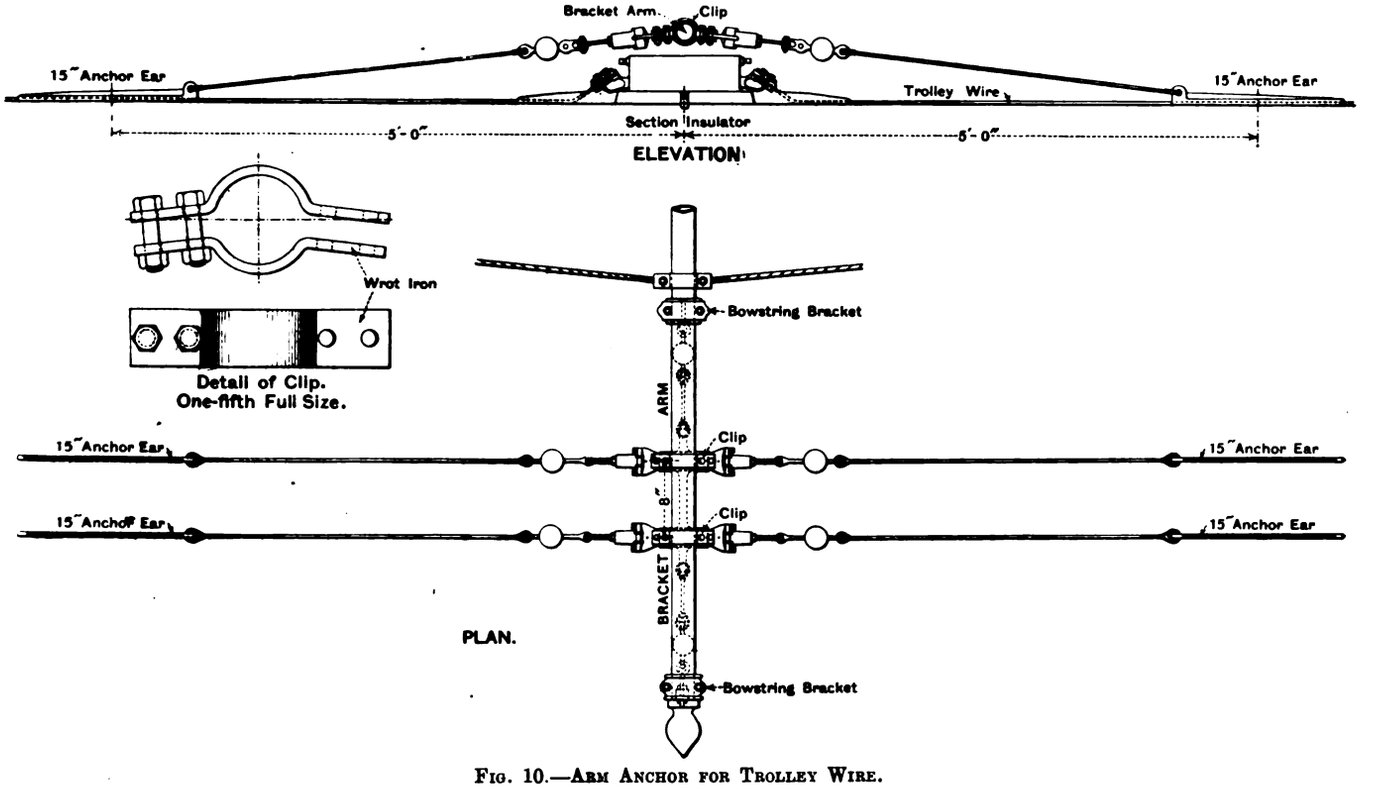

FIG. 10.—ARM ANCHOR FOR TROLLEY WIRE.

FIG. 11.—LAYING CALLENDER MAINS IN DOULTON AND SYKES DUCTS.

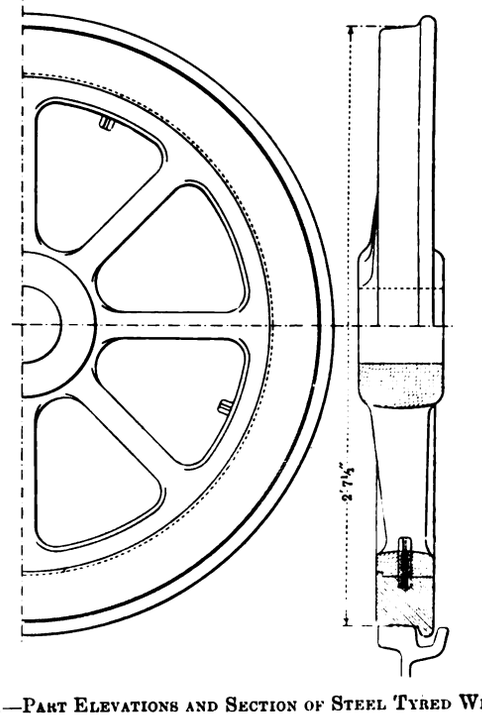

FIG. 12.—PART ELEVATIONS AND SECTION OF STEEL TYRED WHEEL.

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of the transformer until the current assumes its original value owing to the increased magnetic leakage between the coils. The regulation is quite automatic and instantaneous. Fig. 15 shows the cut-out employed on these circuits, the time-element device being particularly ingenious. The large coil A is shunted to the lamp. Should the lamp burn down so as to open the circuit, the coil is energised and sucks in the double U-shaped core BB. This pulls open the helical spring C below it, which, in its turn, gradually lifts the disc of the dash-pot D beneath. If the lamp circuit is open for more than a few seconds therefore, the lever E attached to the dash-pot is raised, and rotating about F pushes out the catch G, releasing the weighted arm H, which drops into the switch contacts K and short-circuits the lamp and coil. The lighting on the alternating circuits is excellent, the light being as well distributed as with an enclosed arc, but with a better colour. Some of the streets lighted with continuous and alternating current adjoin, and it is difficult to tell which are continuous and which alternating arcs. We believe, however, that the difference in first cost between the two systems is not inconsiderable, the series-alternating system being rather expensive, though less so than when the lamps are arranged in parallel each with its own compensator.

In all 8 miles of streets are lighted with arc lamps and about 3 miles with incandescent lamps. The latter include about 400 16 c.p. lamps and 60 32 c.p. Nernst lamps.

There are no less than 230 single-phase motors connected to the Derby mains, representing a total of about 1,300kw. All are induction motors. The largest of these are 40 H.P. Fuller-Wenström motors installed at Messrs. Roe's timber works. The primary or stator is wound in two phases with a displacement of 60deg. These two phases are connected in series when the motor is running on load, and then the current in the two

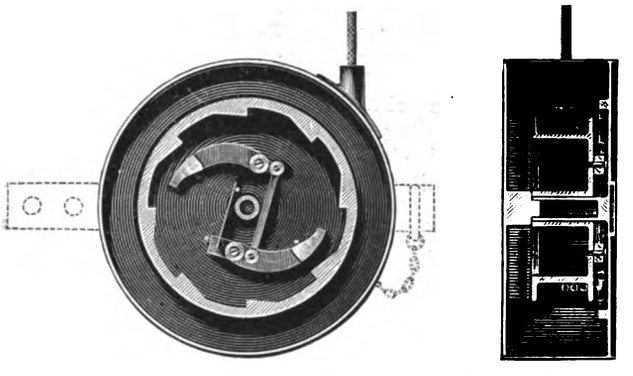

Fig. 13.—Wilson "Trolley-pole Catcher."

windings, of course, have the same phase. But when the motor is started the currents in the two windings are displaced 60deg., and the motor starts as a two-phase motor with a comparatively good torque. The phase-splitting device is a simple combination of one inductive and one non-inductive resistance. The motors will start on a loose pulley at a current of only 40 per cent. of full-load current. Full-load efficiency is 86 per cent., and the power-factor 88 per cent. The motor is guaranteed to stand a temporary over-load of 75 per cent., and an overload of 25 per cent. for half-an hour without overheating, the temperature rise after six hours' full-load test not exceeding 70°F. The speed is 760 revs. per min. A water-resistance is employed in the rotor circuit on starting, being connected to it by slip-rings in the ordinary manner. There are two of these motors and one 30 H.P. motor of the same make at Messrs. Roe's works, in addition to nine Langdon-Davies motors, ranging from 9 B.H.P. to 25 B.H.P. In the Langdon-Davies motors there is an inductive starting winding on the stator, no outside inductive resistance being employed, and, on starting, this winding is connected to the mains, and the ordinary running winding is connected to them through a resistance. On full speed being attained, the starting winding is switched off, and the resistance switched out of the running winding. No rotor starting-resistances are employed at present by the Langdon-Davies Co., the rotors being short-circuited permanently. The total brake-horse-power at Messrs. Roe's works is 256. At Messrs. Handyside's engineering works 258 B.H.P. of Langdon-Davies motors are in use, there being 46 motors varying in size from 1 B.H.P. to 25 B.H.P.

A large colour and varnish works (Messrs. Mason's) employs eight motors, aggregating 62 B.H.P. These drive heavy colour-grinding and mixing machines and a hoist. They are of the Heyland type, supplied by Messrs. Witting, Eborall & Co., and are geared directly to the machines they drive, being wound to start with full-load torque. The same firm has supplied the hoist motors and controlling gear in a large hosiery mill (Messrs. Davis & Sons), which is driven entirely by single-phase motors. The controllers for the two hoists in Messrs. Davis' mill are arranged so that the hoist can be rapidly started at full load and reversed in much the same way as a continuous-current motor, the whole device being, moreover, extremely compact. It may be added that the Corporation regulations for motors require that all motors over 2 B.H.P. shall be provided with a graduated starting switch while in the case of all motors over 4 B.H.P. an ammeter and a minimum cut-out must be provided.

It is worthy of mention that the number of units sold for power during last year reached no less than half a million, being about a third of the total units sold. The charge for

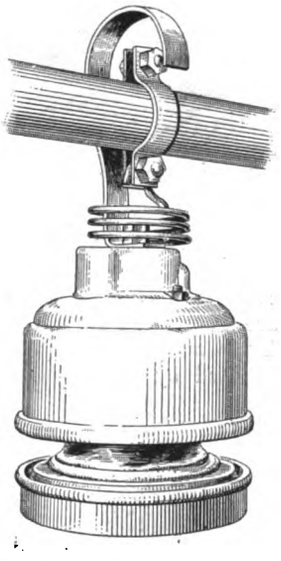

Fig. 14.—"Gilbert" Spring Suspension.

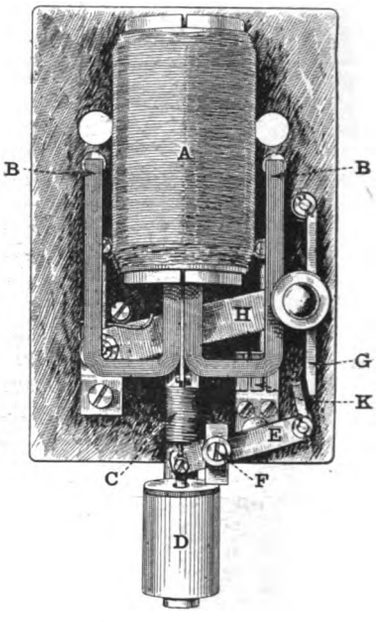

Fig. 15.—Alternating-Current Automatic Cut-out.

power is 3d. per unit for the first 12 hours of maximum demand per week, after which 2d. per unit for the next 18 hours and then 1d. per unit; or a flat rate of 1¼d. per unit if the use of the supply reaches 50 hours per week. The Derby Corporation let the motors on hire and keep them in repair, the inclusive charge made being equivalent to about 15 per cent. of the price of the motor. An excellent card system of indexing is employed, so that the present position and occupation of any motor, together with its age and history, may be looked up in a moment.

The price for lighting is 6d. and 3d. on the usual Wright maximum demand system, or from 5d. to 4d. on a sliding scale, according to the number of units employed. Street lighting is charged for at the rate of 1½d. per lamp-hour for the arcs and a corresponding rate for incandescents. The total number of lamps connected to the mains is equivalent to 105,000 8 c.p. lamps, and approximately 1⅓ millions of units were sold for all purposes during last year.

Mr. Alderman A. Butterworth has been chairman of the Electricity committee for a large number of years, and has supported Mr. T. P. Wilmshurst, the borough electrical engineer, in carrying out his progressive policy. Mr. Hugessen is mains superintendent and Mr. Pinn works assistant. We are greatly indebted to Mr. Wilmshurst for showing us all that was to be seen at Derby, and affording us every assistance in the preparation of this article.

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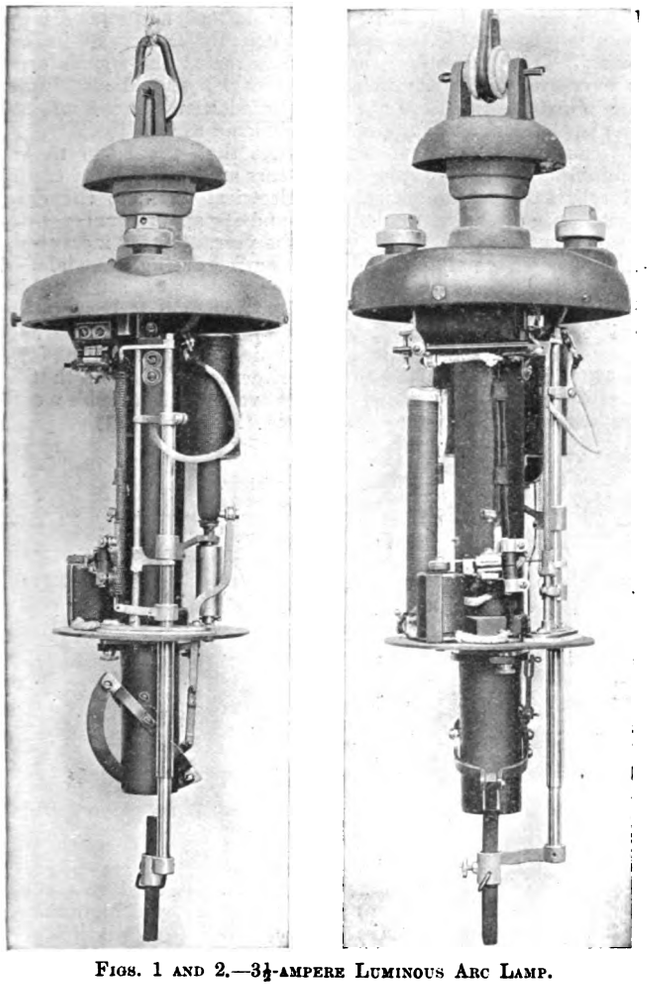
THE MAGNETITE ARC LAMP.*

BY CHARLES PROTEUS STEINMETZ.

The efficiencies of present methods of producing light from electric energy are extremely low, being only about 2 per cent. in the incandescent lamp, and perhaps 5 per cent. in the arc lamp. The reason thereof is to be found in the use of heat as an intermediary form of energy, which always leads to low efficiency. To study the methods of producing light from the point of view of developing more efficient methods, some years ago an electrochemical laboratory was established by the General Electric Company, and one of the results of the work of this laboratory is represented in the magnetite arc lamp.

Improvements in the efficiency of arc lamps have been made in the last years by adding metal salts, as calcium-fluoride, to the positive carbon, which evaporate in the arc, making it luminous and so increasing the efficiency; but since all such substances produce a smoke or dust, which has to be disposed of, the carbon



FIGS. 1 AND 2.—3½-AMPERE LUMINOUS ARC LAMP.

cannot be enclosed air-tight, and the flame carbons, therefore, give a short burning arc requiring frequent trimming. The condition of long life, with an open arc, excludes the use of carbon in the electrodes and some other carrier of the current in the arc flame must be found. The material which, in an arc lamp electrode, would constitute an essential advance in the art of illumination, must, therefore, fulfil the following conditions:—It must be a good conductor when solid and its vapours must be conductors of the arc; it must be incombustible so as to give a long burning arc; it must give a spectrum of high brilliancy—that is, an arc of high efficiency; the light must be distributed approximately uniformly over the whole spectrum—that is, it must give a white light.

In magnetite, or the black oxide of iron, one of the most common iron ores, a substance was found having the required characteristics. By very extensive investigations of the phenomena taking place in the electric arc with different materials as arc terminals, it was found that the material which carries the arc flame issues from the negative terminal as a high velocity blast which, when striking the positive, produces heat. If, therefore, the positive terminal cannot conduct this heat away, it may get hotter than the negative, and does so in the carbon arc. If the positive terminal is made large enough and a good conductor of heat, so as to carry away the heat, it does not wear away, but material from the negative terminal deposits on the positive, as drops of magnetite on the copper positive of the magnetite arc lamp if the latter is too large. By giving the positive terminal, therefore, a sufficient heat conductivity not to get too hot, but sufficiently hot to avoid the deposition of material on it, a non-consuming positive electrode is produced. This is the case in the magnetite arc lamp. In this only the negative or lower electrode consists of magnetite, and is consumed. The positive terminal is not replaced, but is a copper segment, which constitutes a permanent part of the lamp.

The metals of the iron group yield a brilliant arc flame of very high efficiency and white colour. The metals which are combustible are not well suited to give a long life, but a stable oxide of these metals must be used; that is, a compound which cannot burn any more. Amongst the conducting oxides, magnetite fulfils best the requirements of a carrier of the arc flame, since it is well conducting, stable at all temperatures, very plentiful in nature, and gives a white arc of high efficiency. Pure magnetite, however, is not quite satisfactory, since its efficiency is not very high, hardly twice as high as that of the ordinary carbon arc; and the arc tends to flicker and the rate of consumption of the electrode is as high as ⅛in. per hour. This, while very much lower than the rate of consumption of flame carbons, of 1in. to 2in. per hour, would still give only 50 to 60 hours' life with the standard size of electrode adopted for the magnetite arc lamp, of 8in. length. Therefore, with the magnetite as carrier of the arc flame are incorporated other substances in small quantities as arc-steadying compounds—titanium compounds for increasing the efficiency, &c. In the manufacture of these magnetite arc electrodes, by partially reducing the material to metal, a greater density is produced and so a greater amount of material with the same size of electrode, which

FIG. 3.—MAGNETITE ARC.

gives a longer life. Such partial reduction, however, has the disadvantage that, when not carried far enough, it leaves the electrode porous and possessed of relatively short life, while, when carried too far, the light tends to unsteadiness, turns faint and blue whenever the arc strikes metal, and in this case scintillating sparks are thrown off which may crack the outer lamp globe. A much better method of producing electrodes was found by not reducing the material, but adding a restrainer—that is, a substance which, added to the electrode material in small quantities, reduces the rate of consumption. By this means, without any loss of efficiency, rates of consumption of 20 to 30 hours per inch are produced, which give a life of 150 to 200 hours for the 8in. electrode. With very little sacrifice of efficiency a life of 500 to 600 hours is produced, and such an electrode has about the same life as an incandescent lamp—that is, the arc lamp requires trimming about as often as an incandescent lamp requires renewal.

A simple and satisfactory form is an electrode in which the material is compressed as impalpable powder in a thin iron tube, which is then sealed over by the arc. In the magnetite arc no light issues from the terminals, but all the light comes from the arc flame, and an arc length from ¾in. to 1⅛in. is, therefore, most efficient. Furthermore, to give a constant volume of light the arc lengths should be constant. This leads to a feeding mechanism differing from the "floating system" of the carbon arc lamp and much simpler—that is, a feeding device maintaining constant arc length. The operation of the magnetite arc lamp is, therefore, as follows:—When the power is put on the lamp, the arc is struck by separating the electrodes to a definite distance, say ¼in., and then the electrodes are locked in this position and remain fixed until after some hours or so, by the consumption of the negative electrode, the arc length, and thereby the arc voltage, has increased sufficiently to operate the feeding mechanism which resets the arc to its original length. Figs. 1 and 2 show the general arrangement of the lamp and Fig. 3 represents the luminous arc.

* From the *Electrical World* of New York. Slightly abridged.

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HIGH-SPEED ELECTRIC RAILWAY EXPERIMENTS ON THE MARIENFELDE-ZOSSEN LINE.*

BY ALEXANDER SIEMENS.

(Continued from p. 316.)

For the purpose of observing the air resistance at the various speeds openings were made in various parts of the car bodies and short brass tubes inserted. These tubes were connected by india-rubber tubes to a row of pressure indicators consisting of pairs of communicating glass tubes about 5mm. in diameter partly filled with water. An adjustable scale was fitted to each indicator divided into millimeters, so that the difference in the water level of the two tubes could be observed at the various speeds. Four such openings were made at each end of either car, two of which were near the centre and the other two at the sides, as indicated in the diagrams of Figs. 5 and 6. Preliminary trials proved that the position and the form of the opening of the brass tubes have no influence on the result, and this made it possible to compare the pressure all over the front of the car with the pressure in the centre, independent of the varying speed of the car. In addition, straight tubes, up to 8·4 metres long, were fitted to explore the pressure of the air in front of the car, and these observations showed that a cone of uniform pressure exists in front and at the back of the car, the apex of which was about 3 metres distant from the car. The "A" car, as the diagram shows, has well-rounded corners, while the "S" car has its ends in the shape of truncated cones. The pressure on these was very much smaller than in the centre, and sometimes

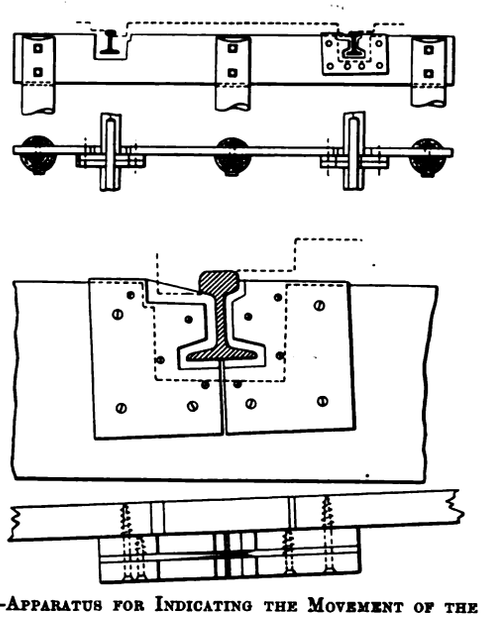

FIG. 3.—APPARATUS FOR INDICATING THE MOVEMENT OF THE RAILS.

even negative owing to the influence of the wind. Some openings were also made along the sides of the car and occasional observations showed that speed had very little influence on the pressure indicated, when the brass tubes ended flush with the sides of the car, and that the direction of the wind has much more effect. Figs. 5 and 6 show the results of observations made during several runs of both cars. Combining all the results the report considers that up to a speed of 150km. per hour the pressure may be calculated by the equation $p=0{\cdot}07v^2$, when v is the velocity in metres per second and p is the pressure on a surface of 1 sq. metre, at right angles to the direction of the motion. The number of observations were, however, insufficient to determine the best form for the end of the cars. Another set of observations was made to determine the extent of the movement of the rails, when the cars were passing at various speeds. For this purpose measuring apparatus were set up at various points of the lines, which are shown in Fig. 3. Each of these consists of three strong posts, about 1½ metres long, rammed into the ground, one in the centre and one on each side of the rails, to which a strong board is fastened with its upper edge a little below rail level and with suitable openings cut to permit the rails to pass through. Near each rail two short boards are bolted to the plank, between which a lead plate is supported. This is cut in two and fitted accurately against the rail, the edges touching the rail being sharpened. It is evident that any movement of the rail will bend these edges back and thus leave a permanent record of the greatest movement of the rail.

* Paper read before the Institution of Electrical Engineers on May 26th.

The result on one set of lead plates is shown in Fig. 4, and a summary of the principal observations is the following:—

Distance between sleepers. mm.	Material of sleepers.	Ballast. Motor cars.	Speed. Km. p. h.	Depression of rails in mm.
850	wood	sand	108	2·0—2·5
850	wood	sand	114	3·5—5·0
780	wood	stones	145	6·0—6·5
780	iron	sand	114	5·0—5·5
780	iron	sand	135	6·0—6·5
730	iron	sand	123	6·0—7·0
		Military trains.		
850	wood	sand	70–80	1·5—2·0
730	iron	sand	70–80	4·0—

From these experiences the conclusion was drawn that the permanent way had to be thoroughly reconstructed before speeds exceeding 120km. per hour could be safely investigated. As the military trains run only at considerable intervals, at a comparatively low speed, the existing signalling apparatus had to be supplemented by distant signals about 2km. from the stations, and some difficulty was also experienced in seeing sufficiently far ahead in rainy weather. It is, therefore, suggested to repeat the signals on the car by visual and by audible means, which should also indicate when the apparatus is out of order. In addition it is recommended to cut the current off in the sections which a car has just left.

In conclusion, the first report states that, thanks to the care exercised by the firms supplying the cars and outfit, to the cautious and reliable execution of all the electrical work, to the careful maintenance of the permanent way and its appurtenances, and to the conscientious observation of all the precautionary measures, no mishap or damage of any kind has occurred during the trials. No psychological effects on the drivers or passengers, attributable to the high speeds, have been noticed. Although it has not been possible to obtain reliable data for judging the economical aspect of this question, some valuable technical information has been gained. In the first place, the experiments have shown that it is possible to collect high-tension currents even in unfavourable weather from overhead conductors at double the speed of the present

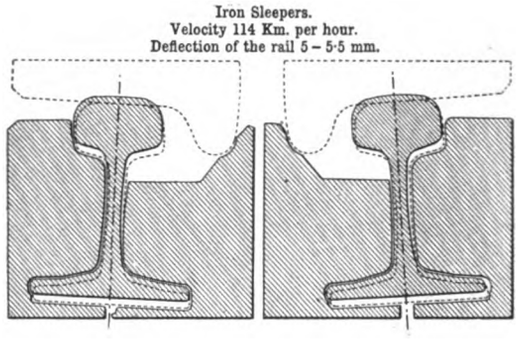

FIG. 4.—DIAGRAM OF THE DISPLACEMENT OF THE RAILS ON NOV. 30, 1901, AT 15·8 KM.

express trains. Both the conductors and the collectors have worked so satisfactorily up to the present that their efficiency at higher speeds may be safely assumed. Three-phase motors have shown themselves reliable, and their overheating has been prevented by suitable ventilation. It has, however, not been possible to decide whether it is preferable to fix the motor on the axle or support it wholly by springs; nor can it be safely said whether fluid or metallic resistances are the more suitable. The brakes have not been powerful enough for the high speeds. An alteration of the existing arrangements and the adoption of an efficient electric brake appears to be imperative. Generally speaking, the first year's trials have served principally to find out the best methods of making observations, and to determine which are the most suitable instruments for obtaining trustworthy information. Basing further experiments on the knowledge thus gained, it is certain that it can be ascertained whether the cars, their equipment, and all other outfit are suitable for regular traffic on main lines at a speed of 160km. per hour, and whether still higher speeds are practicable, especially from an economic standpoint. Originally it had been the intention to resume the experiments in 1902 on the lines laid down at the commencement, and to increase gradually the speed of the cars until a speed of 200km. per hour had been attained. It was, however, not possible to re-lay the permanent way in time, and in consequence of this the authorities would not allow a greater speed than 125km. per hour. The time was, therefore, utilised for determining more accurately the resistance of the cars at various speeds, the power required for propelling them and the losses of energy in the feeder and the conductors. In addition to this, further experiments were made with the brakes,

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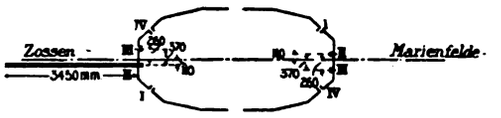
and alterations in the structure of the cars were considered, to ensure steady running at high speeds; the movement of the rails was also observed during the trials.



At first attempts were made to determine the resistance of the cars direct by pulling them at moderate speeds by a locomotive, to which they were attached by a dynamometer. It was found, however, that, owing to the great weight of the cars, and owing to the irregular pull of the locomotives, no steady curves could be obtained, nor was the success greater when the cars were attached to a goods train. Somewhat better results were achieved by the employment of a three-phase locomotive, but the curves were still too irregular to be accepted. Nothing remained but to revert to observing the

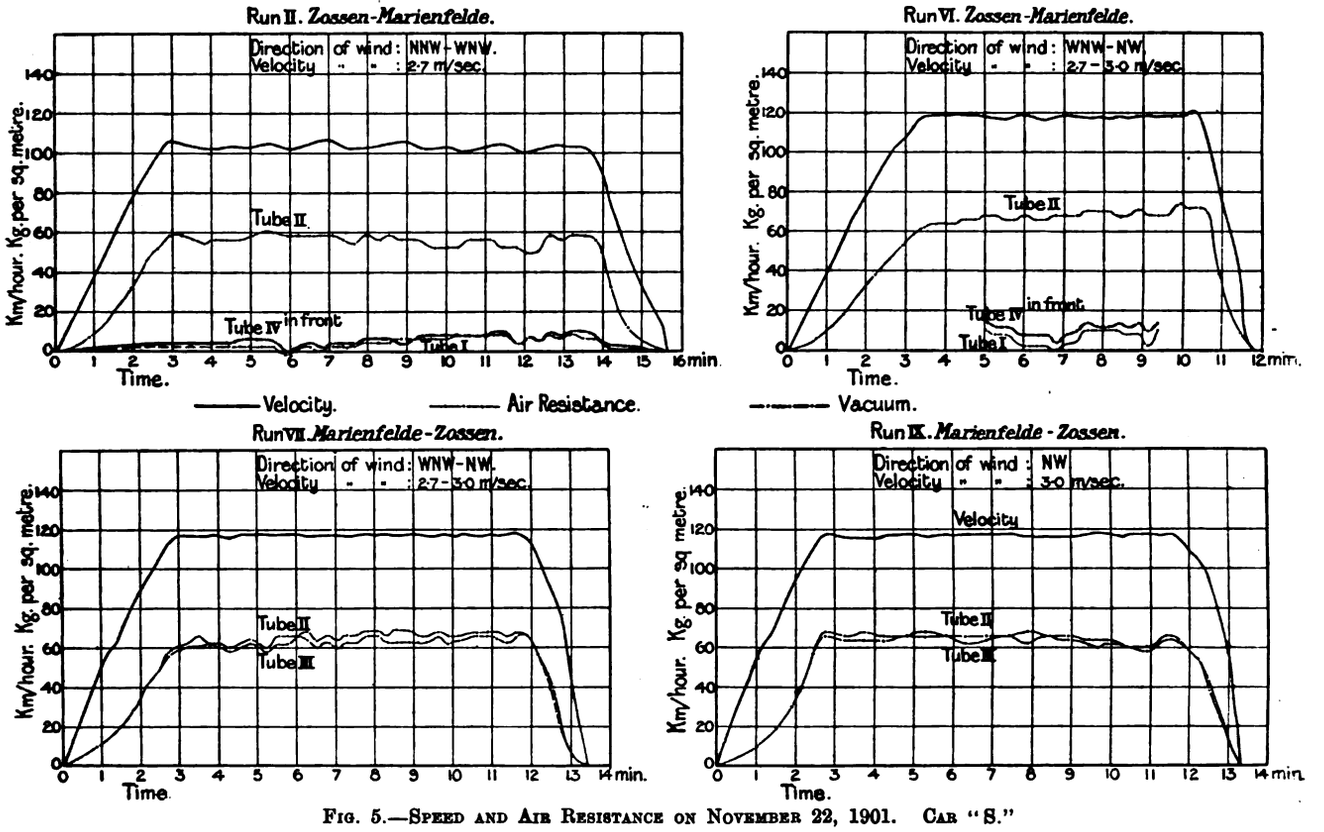
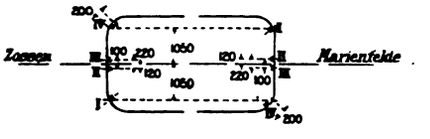


FIG. 5.—SPEED AND AIR RESISTANCE ON NOVEMBER 22, 1901. CAR "S."



time each car took to come to a standstill after attaining a certain speed, and the distance it covered during that time, due account being taken of all differences in level. The smallest curve on the line has a radius of 2,000 metres; it was therefore not necessary to

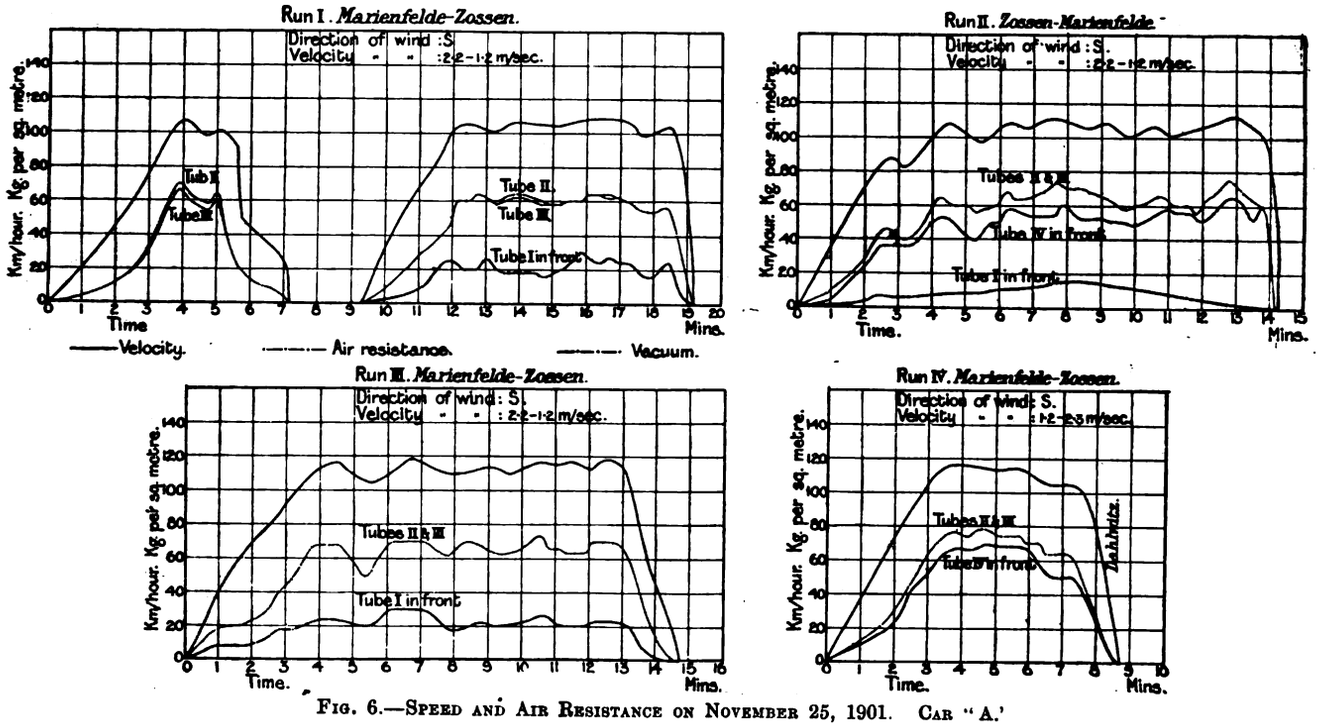


FIG. 6.—SPEED AND AIR RESISTANCE ON NOVEMBER 25, 1901. CAR "A."

The second report describes the experiments in great detail, and the following are the principal results ascertained by their help:— consider the curvature in the calculation; but very careful measurements of the air resistance were made by means of tubes projected

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from the cars in the way already described, and in the end a small correction was found necessary in the formula for air resistance, which was altered to $P=0{\cdot}0052V^2$, and the resistance of the cars was found to be equal to the resistance of 9 sq. metres. In Fig. 7 the final results of the traction resistance of the cars are represented by four curves showing the total resistance for a car weighing 83 tons, the air resistance of a surface of 9 sq. metres being the equivalent of the air resistance of a car, the horse-power required on the level with no wind, and, by the difference of the first and

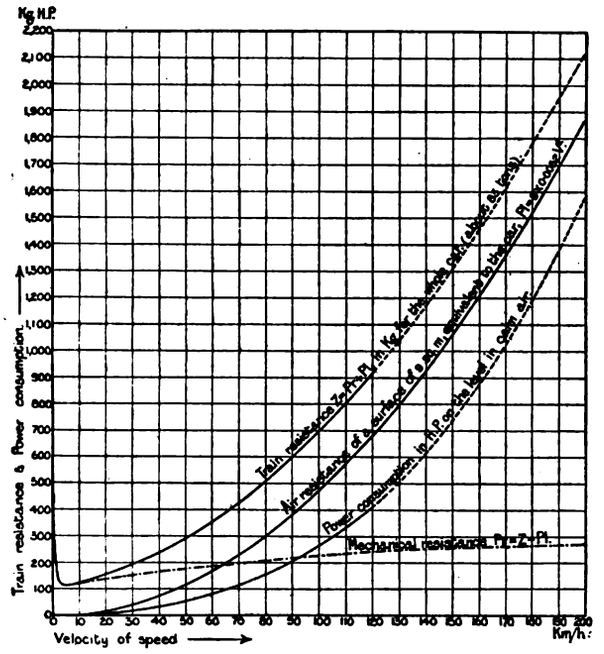

FIG. 7.—TRAIN RESISTANCE AND POWER CONSUMPTION OF THE HIGH-SPEED CARS.

second curves, the resistance due to mechanical friction. It is at once apparent, from this diagram, that at high speeds the air resistance is by far the most important factor, and that the proper shape of the car has to be very carefully determined.

(To be continued.)

ELECTROLYTIC IRON.*

BY C. F. BURGESS AND CARL HAMBUECHEN.

A great deal of attention has been devoted of late to the application of electrical energy to the metallurgy of iron, and some of the results attained seem to point to developments of industrial importance. Most of the attempts to apply electrical energy have been through its transformation into heat for use in various smelting and reduction processes. That the electrolytic as well as the electrothermal effect might be utilised industrially does not seem to have been considered seriously, as it has been commonly held that the difficulties inherent in the deposition of iron are such as to preclude its playing an important part in the industrial electrometallurgy of this element. It has, however, been shown, as a result of recent experimental work carried on in the laboratory of applied electrochemistry of the University of Wisconsin, that electrolytic iron can be produced in such quantities, and at such cost, as to make it a material of commercial as well as of scientific importance, should sufficient demand for it arise.

A survey of available literature on the subject of electrolytic iron leads naturally to the assumption that its deposition is difficult to accomplish and that there are few solutions from which it can be deposited. Moreover, it has been held that a satisfactory quality of deposit can be attained only by the use of very low current densities and an exceedingly slow rate of deposition. Practically, the only uses to which electrolytic iron has been put are in the so-called "steel facing" of dyes and electrotypes and as a material for investigating the properties of the pure metal. The hardness of electrolytic iron, which makes it especially suited to the facing of electrotypes, is due to the occluded hydrogen, which is practically the only impurity present. In fact, the very term "electrolytic iron" is commonly assumed to be synonymous with "pure iron." In just what manner the hydrogen is held by the metal is a matter of doubt, it being claimed by some that it is simply condensed and by others that it forms a definite hydride. Such iron may contain this gas in quantities equal to several hundred times the volume of the metal, and it can be almost entirely freed from it by heating. Certain investigators have found that electrolytic iron contains carbon in appreciable quantities, while others have found that carbon is absent.

Dr. John A. Mathews, "Alloy Steels, Mineral Industry for 1902," states that "pure iron may properly be classed among the 'rare metals'; thousands of tons of iron alloyed with impurities from a fraction of 1 per cent. upward are produced annually, but not a pound of iron in its pure elemental condition has ever been made under ordinary smelting conditions. By 'pure' we mean in a condition comparable with that in which the precious metals are produced or as pure as the best electrolytic copper and nickel. . . Just as pure iron is a chemical curiosity, so also is an alloy containing only iron and carbon. In practice, at least, four other solid elements occur fortuitously in all steels—viz., manganese, silicon, sulphur and phosphorous."

Something over two years ago the authors of this Paper undertook an experimental investigation of the conditions suitable for electrolytically depositing iron, and this work has proceeded almost without interruption since that time. The primary object of the investigation was to produce, if possible, pure iron in such quantities and at such cost as to make it an available material for further inquiry into its properties. Since our attention has been confined almost exclusively to this phase of the problem, the observations which have been made as to the physical and chemical properties of the product are by no means exhaustive and, indeed, are considered only as preliminary to a more extensive research which it is hoped to take up in the future.

The preliminary work consisted in testing the various electrolyte materials which had been suggested previously and from these the most promising were selected as the basis for further trials. It is needless to record here the many hundreds of tests which were made, for most of them were unsuccessful, nor is it necessary to recite the difficulties encountered. The investigation was necessarily a slow one, since many of the trials required days and even weeks of operation before conclusions could be drawn as to their success. A large number of iron salts were used, and the effects of variations of density of solutions, current densities, temperature, agitation of electrolyte and various other factors were noted. As a result of such observation ferrous sulphate with a certain percentage of ammonium sulphate was chosen as affording the most satisfactory results, and the process, as it is now being operated on a small experimental scale, may be briefly described as follows:—The electrolyte consists of ferrous and ammonium sulphates; the current density at the cathode is 6 to 10 amperes per square foot of cathode surface and at the anode slightly less; the E.M.F. for each cell is slightly under 1 volt; the temperature of electrolyte is about 30°C.; the anodes consist of ordinary grades of wrought iron and steel; the starting sheets for the cathodes are of thin sheet iron, previously cleaned of rust and steel.

One of the most serious difficulties encountered was in obtaining a thick deposit of iron. While it was proved that there is a considerable range of conditions under which iron can be deposited uniformly and densely for a few hours, or perhaps for a few days, it was almost always found that the surface would become so rough or pitted, or that such a rapid treeing would take place, or that the deposit would curl up to such a degree, that it was necessary to discontinue the experiment and start a new one under different condit ons. But improvements have been gradually effected until at the present time it is possible to continue the run four weeks without replacing the cathodes. At the end of such time the cathode reaches an average thicknes of about $\frac{3}{4}$in. and the surface is so rough and nodular that it is not considered advisable to carry the deposition further.

The current efficiency of deposition is very closely 100 per cent.; that is, there is a deposition of about 1 gramme per ampere-hour. The E.M.F. being 1 volt gives about 2·2lbs of iron per kilowatt-hour. Since all the factors which go to make up the cost of large scale production can not be accurately determined from a small scale experiment, it is impossible to state from our investigations what would be the cost of working on an industrial scale. For the past six months three tanks have been maintained in almost continuous operations, these tanks having the dimensions 8in. wide by 18in. long by 15in. deep and containing two anodes and one cathode. The finished cathodes from these tanks weigh about 20lbs., and constitute, perhaps, the largest pieces of electrolytic iron which have, up to the present time, been produced. The total amount of the material which has been produced from all of our experiments is about $\frac{1}{2}$ ton.

A run of two months' duration was made to determine the extent of the deterioration of the electrolyte, resulting in the conclusion that the solution can be kept in good working condition with little trouble or expense. It would appear, therefore, that the cost of refining, aside from fixed charges on plant, and with power at $30

* Paper read at the meeting of the American Electrochemical Society, Washington, April 9th.

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per kilowatt-year, would be under one-half cent. per pound of iron, thus placing it not greatly in excess of the cost of refining copper.

Even with these figures realised, whether or not electrolytic iron can be profitably produced depends upon the uses which can be made of the refined metal. These in turn depend upon its properties, the most striking of which is its purity. Although our work was directed toward the production of electrolytic iron in a dense and massive condition rather than in a high degree of purity, analyses which have been made show the purity to be in excess of 99·9 per cent. Not a trace of carbon was detected, and silicon, manganese and other impurities commonly found in iron appear to be absent. The only impurity which has been detected is hydrogen, which is present in appreciable quantities in the metal as taken from the electrolytic tanks. This gaseous element in its physical or chemical combination with iron influences, in a most striking manner, the physical properties of the metal. The hydrogen can be driven off almost completely, if not entirely, by heating to a white heat, the evolution commencing at a temperature below 100°C. and becoming rapid at a temperature below a red heat. Electrolytic iron heated in a Thomson welder, or even in a Bunsen burner, has been observed to give off hydrogen so rapidly that it ignites and continues to burn after removing the source of heat, presenting an appearance similar to that which would be produced by dipping the iron in alcohol and igniting it. The metal containing the hydrogen is so hard that it can be filed or sawed only with difficulty, and is so brittle that it is readily shattered by a sharp blow from a hammer. After the expulsion of the gas it becomes softer, and after having been raised to a welding temperature it assumes properties of malleability and toughness similar to those of Swedish iron.

The iron when heated in a forge fire can be readily welded and forged into any desired shape, and various test samples were made in this way. During such working, however, impurities are introduced, analysis invariably showing the presence of a very small percentage of carbon. The cathodes, ¾in. in thickness, have a surface so rough that they can not be rolled satisfactorily into sheets, though it is possible that improvements can yet be made in this respect which will enable smooth surfaces to be obtained. The deposit adheres so loosely to the starting sheets that it can be removed readily.

A considerable amount of work has been expended in the attempt to melt electrolytic iron without at the same time introducing impurities. The difficulties that lie in the way of doing this, however, are great, on account of the high temperatures necessary, and the affinity which the iron at such temperature has for many of the elements. The melting temperature of the pure iron seems to lie closely to that of platinum, though actual values have not as yet been determined from lack of suitable measuring instruments. Various forms of electric furnaces have been constructed for this purpose, a furnace of the inductor type appearing to be the most suitable for preventing the introduction of carbon. Results which have been somewhat satisfactory have been obtained by heating a molten electrolyte between graphite electrodes to a suitable temperature, and introducing the metal into such molten bath. The metal thus produced is tough and malleable, while it also has a fracture of coarse crystalline nature. The affinity which the iron has for carbon is shown by the fact that it can be readily melted in a graphite crucible, while a silica crucible heated to a considerably higher degree melts before the iron in it begins to flow. The absorption of the carbon in the former case produces a fusible alloy of iron.

Experiments have shown that the hysteresis, permeability and electrolytic resistance of electrolytic iron are greatly influenced by the amount of hydrogen in it. An iron ring was deposited in such form that a hysteresis and permeability loop could be determined by the Ewing method. It was found that by heating in boiling water the hysteresis was lowered several hundred per cent. By further heating in an oil bath to 200deg. the value was decreased still further, but to a smaller extent than in the first heating, and upon attempting to heat it to 500deg. the ring broke and the experiment was therefore interrupted. Certain samples of forged iron have shown permeability values equalling or even exceeding those of the highest permeability standard samples of Swedish iron. Other samples, prepared under apparently identical conditions, showed much poorer results, so that it is impossible as yet to draw definite conclusions as to the magnetic properties of electrolytic iron.

It having been shown that it is possible for electrolytic iron to be produced at a small cost, the question naturally arises as to what uses there may be for it. The first suggestion which naturally presents itself is that on account of its purity it would serve as a basis for investigating the properties of iron and its alloys. Investigations having for their object the determination of the influence of various elements alloyed with iron as regards its electrical properties, have been unsatisfactory on account of the presence of other impurities which modify or mask the effect of the element which it is desired to study. Starting with the pure iron, therefore, alloys of a predetermined and definite composition can be produced, thus making such investigations of greater simplicity. Unless the difficulties encountered in the working of electrolytic iron on account of its roughness offer too serious an objection, it should compete favourably with the purer grades of commercial iron which are used for various purposes and which sell for three cents and upward per pound.

Electrolytic iron naturally offers the means of manufacturing chemically pure iron compounds and for standardising solutions in the analytical chemical laboratory. The electrolytic iron, in addition to its purity, has an advantage for the purpose just mentioned of rapidly dissolving in an acid solution. A test which was made to determine the rate at which electrolytic iron and iren wire sold as chemically pure for standardising purposes dissolve, showed a ratio of 1 to 12 in favour of the former. By reason of the brittleness imparted by the occluded hydrogen, it can be readily broken up into grains of a desired size and even reduced to a fine powder.

Although the investigations referred to in this Paper have covered a considerable length of time, the work which has been done should, perhaps, be considered only as preliminary to a more extended investigation which it is hoped may be taken up in the future. Summing up the work thus far done, it shows that it is possible to obtain electrolytic iron in large quantities and at a reasonable cost, and that, therefore, iron should be added to the list of metals to which the process of electrolytic refining can be applied satisfactorily. It has been demonstrated, also, that such iron possesses a high degree of purity, though just how closely it approaches absolute purity can be shown only by spectroscopic analysis or by other methods which are more accurate than those which have been available.

DIFFERENT APPLICATIONS OF STEAM TURBINES.*

BY PROF. A. RATEAU.

(*Concluded from p. 309.*)

Turbines with Alternators.—The construction of 2-phase and 3-phase generators for direct driving by turbines offers much less difficulty than the design of continuous-current dynamos for the same purpose. The absence of the commutator renders possible higher angular velocities for alternators than for direct-current dynamos. Three types of alternators have been tried successively: The machine with the solid rotor, that with the rotating field magnet and that with the rotating armature. The first type would be, from a mechanical point of view, the ideal generator for coupling to a steam turbine. Unfortunately, from its design it is impossible to use speeds higher than 1,500 revs. per min. for a frequency of 50 ∿ per sec. On the other hand, this type of machine permits much greater magnetic leakage than the others, thus necessitating large dimensions and resulting in comparatively low efficiency. These circumstances are unfortunate, for the alternator with the solid rotor would permit of making the movable part of very solid construction which is easy to balance once for all and thus avoid any chance of mishap. A turbo-alternator, with revolving field-magnets, to develop 400 E.H.P. at 5,500 volts, is now working in the generating station of the Loire Electricity Co. The moving part of this machine makes 3,000 revs. per min. The results of tests have been as follows:—Pressure of steam, 170lb. absolute; back pressure of the exhaust, 2·85lb.; output at the terminals, 388 E.H.P.; consumption of steam per electrical horse-power, including excitation, 19·2lb.; combined efficiency, 48·7 per cent. The efficiency obtained could have been much improved by increasing to a slight extent the dimensions of the turbine, which had only 12 moving wheels; but even now it is comparable with turbine sets of the same power of other types. All these machines are fitted with ejector condensers. A machine of 2,000kw. at 1,500 revs. per min. would have a turbine efficiency of 68 per cent., which would enable the following guarantee to be given, assuming the use of superheated steam and the condenser giving a very good vacuum, which it is easy to obtain with steam turbines in which there is no entrance for the air:—Pressure of steam on admission to the turbine, 200lb.; vacuum in the condenser, 29in.; temperature of the steam, 350°C.; consumption of steam per horse-power-hour upon the shaft of the turbine, 8·5lb. This is a far better result, we believe, than can be given by reciprocating engines, and this can be obtained with steam turbines under the conditions specified.

Turbines for Low Pressure with Steam Accumulators.—One of the most interesting and promising applications of steam turbines is the employment of steam at low pressure, and particularly exhaust steam coming from engines working intermittently. The majority of such engines exhaust freely into the air, and the quantity of steam thus lost is considerable. The author has given special attention to

* Abstract of Paper read before the Chicago meeting of the Institution of Mechanical Engineers.

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Table II.—*Experiments with the Low-pressure Turbine and Dynamo of* 300 H.P. *for the Bruay Collieries. April 3, 1902.*

Revs. per min. n	Kilowatts at the terminals.	Absolute pressures. Steam to turbine. P. Lbs. per sq. in.	Absolute pressures. Condenser. p. Lbs. per sq. in.	Temperature of steam. $t°$. Cent.	Temperature of steam. $t°$. Fahr.	Flow of steam measured. I. Cub. ft. per hour.	Consumption of steam per horse-power-hour. Measured. K. Lbs.	Consumption of steam per horse-power-hour. Theoretical. K. Lbs.	Efficiency. ρ.*
1,337	169·5	12·02	2·13	132·0	269·6		45·2	21·9	0·485
1,500	176·5	12·02	2·22	132·0	269·6		42·8	22·2	0·518
1,610	186·0	12·02	2·22	132·0	269·6	165	40·6	22·2	0·547
1,690	190·5	12·02	2·22	132·0	269·6		39·7	22·2	0·559
1,840	198·0	12·02	2·22	133·0	271·4		38·1	22·2	0·581
1,510	225·0	14·37	2·49	135·0	275·0		41·0	21·2	0·516
1,605	232·5	14·37	2·52	135·0	275·0	201	39·8	21·3	0·534
1,700	240·5	14·37	2·57	135·0	275·0		38·5	21·5	0·559
1,800	247·0	14·37	2·62	135·0	275·0		37·4	21·7	0·580
April 5, 1902: Experiments made by Messrs. Sauvage and Picou.									
1,589	70·3	5·42	1·25	111·0	231·8	79	51·1	25·1	0·492
1,600	140·9	9·37	1·82	135·0	275·0	130	42·1	22·3	0·530
1,591	202·0	12·83	2·32	137·0	278·6	177	39·7	21·1	0·531
1,598	232·5	14·70	2·79	147·0	296·6	203	39·5	21·9	0·556

* The efficiency is the relation between the electric power measured at the terminals of the dynamo, and the theoretical energy contained in the current of steam utilised for such conditions of pressure; this yield is therefore stated after the deduction of all losses in the turbine and in the dynamo.

the problem of the employment of such waste steam, and has obtained satisfactory results by means of his regenerative accumulator combined with low-pressure turbines, which are themselves

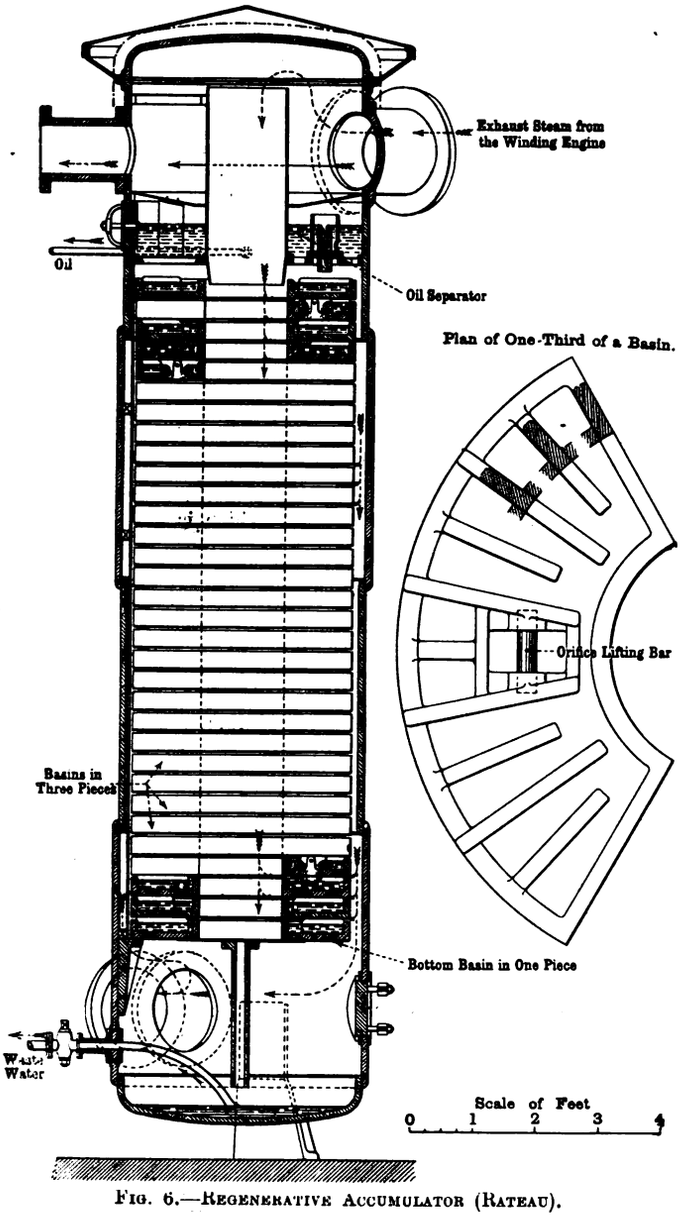

FIG. 6.—REGENERATIVE ACCUMULATOR (RATEAU).

coupled directly to dynamos, centrifugal pumps, or fans. The regenerative accumulator is intended to regulate the intermittent flow of steam before it passes to the turbine, and it consists essentially of a vessel containing solid and liquid materials which play the part of a flywheel for heat. The steam collects and is condensed as it arrives in large quantities in the apparatus, and is again vaporised during the time when the exhaust from the principal engine diminishes or ceases. The necessary variations for condensation and regeneration of the steam correspond to fluctuations in pressure in the accumulator, this pressure increasing when the apparatus is being filled and decreasing when it is discharging into the turbine. Water which has a very high calorific capacity has been used as a heat flywheel, but in order to communicate rapidly to a liquid mass a considerable quantity of heat corresponding to the latent heat of steam to be condensed, it becomes necessary, owing to the poor conductivity of water, either to arrange it in thin layers or to cause a rapid circulation in order to increase the surface of contact between the steam and the water itself. The first solution of the problem gave rise to the accumulator with flat cast-iron trays in which water is contained in shallow vessels arranged one above the other (Fig. 6). The second solution of the problem gave rise to the accumulator with water only, in which a rapid circulation was produced by the injection of steam into the body of the liquid itself (Fig. 7). The low-pressure turbine, fed by the regular flow which comes from the accumulator, and working, for example, between an admission pressure of 15lb. per square inch and a vacuum at the condenser of 27in. of mercury (back pressure of 1·6lb.), can furnish an electric horse power for about 31lb. of steam per hour. In a moderate-sized pit, consuming 13,000lb. of steam per hour, it is therefore possible to economise under these conditions about 350 E.H.P. In steel works, where reversible steam rolls are employed, consuming about 45,000lb. of steam per hour, it will be easy to develop, by means of accumulators and turbines, an extra output of over 1,100 E.H.P. It is desirable to mention that the prime movers are in no way injuriously affected in their working by the presence of the accumulator and turbines. This method was applied for the first time at Bruay, and the installation has worked most satisfactorily since August, 1902, when it was first put into use. The exhaust steam from a winding engine is first of all treated by an accumulator with cast-iron trays, and then passes to a low-pressure turbine of 300 H.P., which itself drives two dynamos keyed upon the same shaft. A particular feature of this type of installation is the "automatic expander," which comes into use when the winding engine is not giving sufficient steam, and also when this engine is not working. This apparatus then permits the admission to the turbine of live steam, which is passed from the boilers through reducing valves; the expander can be adjusted by means of a spring, and comes into use as soon as the pressure falls below a predetermined point.

Table II. gives the results of tests made upon this set in April, 1902, and January, 1903. Numerous similar tests have been made at different times since the apparatus was first started, and Fig. 8 enables a comparison to be made between the efficiencies which were calculated from the results obtained in April, 1902, January, 1903, and November, 1903.

It will be noted from Table II. that although the tests of November, 1903, were made with an output much lower than the normal output of the turbine and for a part of the curve in which the efficiency varies rapidly, the mean point which these tests graphically represent is very distinctly higher than the curve of 1902. The combined efficiency of the turbo-electric group has, therefore, been maintained at an excellent value since the set was first put into use. When, as at Bruay, the low-pressure turbine is fed with expanded live steam during the time when the

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prime mover is at rest, the consumption of steam is obviously higher than that of an engine working at the full pressure of the boilers. If the demand for live steam is only made during a relatively short period the slightly higher consumption during these periods will have scarcely any influence upon the total economy. If this is not the case, and, on the contrary, such periods are of considerable length as compared to that during which exhaust steam is used, as, for example, when the prime mover is only working during the day, and it is desired to have a regular service day and night from the secondary set, then it would be best to add to the low-pressure turbine a high-pressure turbine, which, during the time that the prime mover is not working, would receive live steam at boiler pressure. The steam passing out of this high-pressure

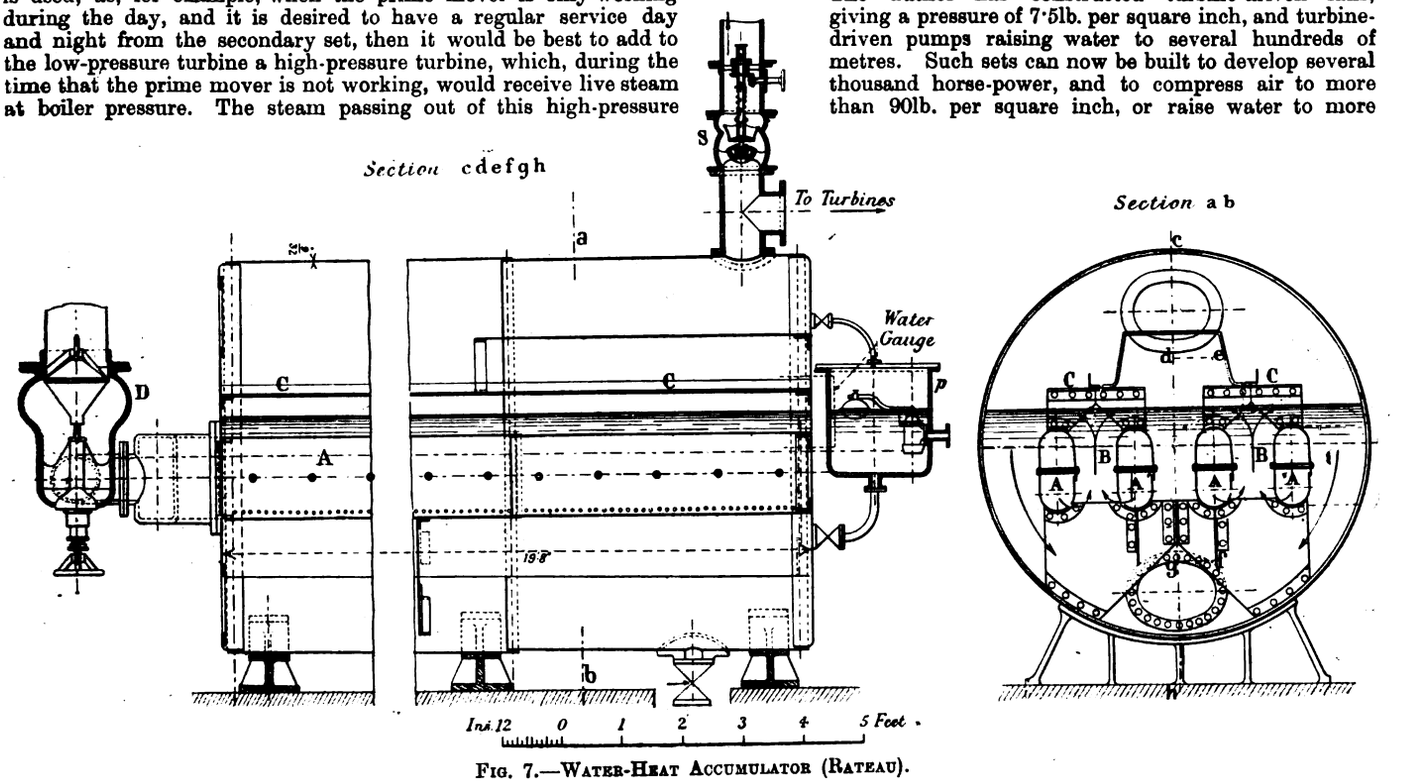

FIG. 7.—WATER-HEAT ACCUMULATOR (RATEAU).

turbine would pass to the low-pressure turbine, which would use equally well either the steam coming from the accumulator or the exhaust from the first portion of the turbine. The admission of live steam at high pressure is, moreover, automatically obtained by a suitable system of obturators controlled by a speed regulator on the one hand and by the pressure in the accumulator on the other hand. Such a group works under all conditions with the maximum possible economy with an ordinary vacuum, and working at full

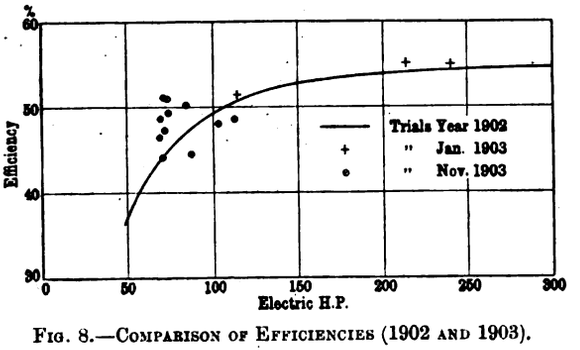

FIG. 8.—COMPARISON OF EFFICIENCIES (1902 AND 1903).

load it would consume only 18lb. of steam per electric horse-power-hour if supplied with steam at 110lb. pressure, and it would consume 26lb. to 36lb. of steam when it was fed by exhaust steam at atmospheric pressure.

Conclusion.—Besides the constant value of the turning effort, the chief advantages which can be claimed for steam turbines may be thus summarised: Very low consumption of steam, particularly at small loads; small floor space and absence of expensive foundation work; cost of oil very low, particularly for Rateau turbines, which have oil reservoirs and ring lubrication to all the bearings; the oil in the reservoirs need be changed only once in two months, and it is not thrown out by the rotating parts, so that the machinery always remains clean; momentary or even permanent overloads are very easy to deal with, it being possible to have overloads of more than 50 per cent. higher than the normal load; regulation of speed carried out in a more perfect manner than is possible with piston engines, due, on the one hand, to the absolute constancy of the turning effort, and, on the other part, to the great kinetic energy accumulated in the revolving parts. This last characteristic makes the machines very insensible to variations in load. The full load may be taken off and put on again without causing a variation in speed of more than 2 to 3 per cent. When coupled to dynamos, fans or centrifugal pumps, steam turbines render it possible to obtain surprising results owing to their capability of giving great power at very high speeds.

The author has constructed turbine-driven fans, giving a pressure of 7·5lb. per square inch, and turbine-driven pumps raising water to several hundreds of metres. Such sets can now be built to develop several thousand horse-power, and to compress air to more than 90lb. per square inch, or raise water to more than 2,000ft. high. Turbines are able to use to perfect advantage steam at low pressure, for they have an efficiency rising in value as the pressure of the steam becomes lower.

HIGH-VOLTAGE OIL SWITCHES.

The oil switches shown in the accompanying illustrations, made by the Stanley Electric Mfg. Co. of America, are so designed that the circuit is broken simultaneously at several points, thus distributing the resulting disturbance over a considerable area. Moreover, for potentials above 6,600 volts the various contacts are arranged in the same horizontal plane, so that the disturbances resulting from the rupturing of the arc are distributed, rather than concentrated, as is the case where the contacts are one below the other. Another advantage of opening the contacts in a horizontal plane is that the arc tends to flare upwards, increasing its length and thereby securing a longer break than in the vertical type, with the same separation of contacts. The contacts are located comparatively near the surface of the oil, so that the gases resulting from the explosion are readily dissipated, and, by using large tanks and long breaks, the switch may be opened and closed many times before the oil is carbonised appreciably.

The principles of construction are embodied in a 300-ampere 60,000-volt switch of which Fig. 1 gives an idea of the general construction. Each pole consists of a cast-iron top or mounting plate, on which are mounted the two terminal contact insulators, a bearing of liberal length for the driving shaft, a combined gas vent and automatic oil level indicator, and a suitably insulated tank filled with oil in which are immersed the contacts. The insulators are of porcelain in the form of corrugated cylinders. The centre insulator carrying the contact blades is entirely immersed in oil, while the two terminal insulators are partly filled with and have their lower ends immersed in oil. These two insulators are held in position by means of hollow clamp rings which are fastened to the insulators with set screws and cement. The contact blades are fastened to the central insulator in a similar fashion.

Fig. 2 shows a contact in detail. The contact arms are of hard-drawn flat copper strips. Each fixed contact is forced downwards by three coiled springs which are carried on the studs on which the fixed contacts slide, and which are screwed on the bottom of the

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insulator. These fixed contacts, as well as the blades, have ground surfaces. On closing the switch each contact blade slides under the corresponding fixed contact, and, owing to the arrangement of the springs, a perfect self-aligned contact results.

The shape and position of the shunt or arc-rupturing contacts are such as to prevent any possibility of the arc being taken by the main contacts. These auxiliary contacts are readily replaceable.

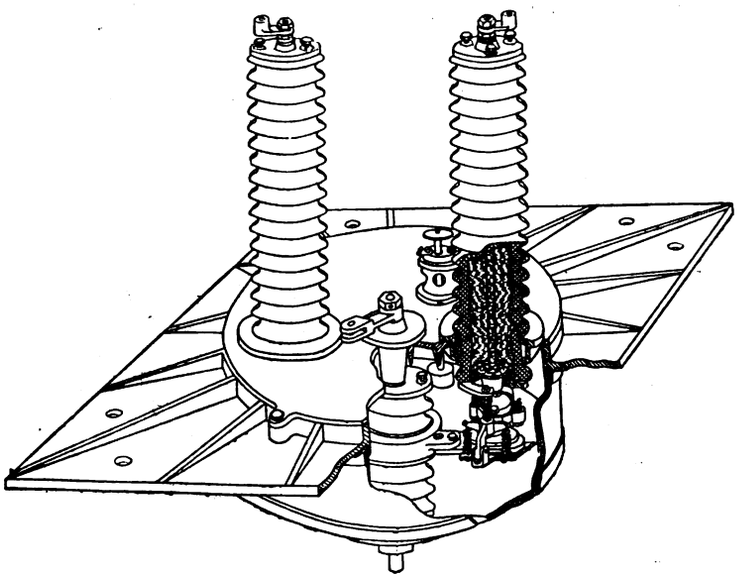

FIG. 1.—DETAILS OF 300 AMPERE 60,000 VOLT OIL SWITCH.

Should the oil leak out or, for any other reason, recede below a safe level, the indicator closes the pilot circuit and warns the attendant by ringing a bell or lighting a lamp, as may be desired. Each switch is tested at 120,000 volts, and, in installing, the iron top and tanks are grounded, making it perfectly safe for the operator to handle the controlling device. The three-pole switch is made up of three of the units described above, connected by rods, and the cranks on each operating shaft to either a motor, magnet or hand-operated controlling device, and the operation of either of these devices may be controlled by plain overload, time delay overload or reversed current relays. Each pole of the switch may be mounted in either soapstone or brick compartment or upon iron framework.

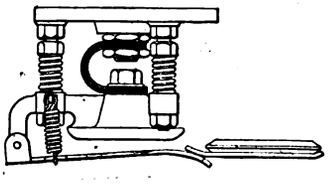

FIG. 2.—DETAILS OF A CONTACT.

APPLICATION OF ELECTRICITY IN THE CHINA CLAY INDUSTRY.

An interesting installation has recently been completed for conveying china clay, in liquid form, from Parson's Park, in the Parish of St. Neot (Cornwall), a wild moorland district, to Moorswater, where it is dried and from whence it is conveyed to all parts by rail. The length of the pipes between the two places is 9¼ miles, and the transmission of the liquid clay takes place at a speed of nearly 3 miles an hour. Parson's Park is situated at an altitude of about 800ft. above sea level and possesses abundant beds of good quality china clay. The laying of the pipe system was commenced in the summer of 1901, and necessitated the boring of an adit, 300yds. in length, near Redgate. There are two trestle bridges, 250ft. and 335ft. in length respectively, and also a wooden launder, 180ft. in length.

Water is kept flowing over the slopes of the clay pit as the material is loosened and broken by a hand instrument suitable for the purpose and known as a "dubber." As the clay contains many impurities, such as sand, the pit is divided into two parts, and the sand is given ample time to settle. At intervals this sand is removed by trucks running on rails down into the pit. These trucks are hauled in and out by electrical means. In order to facilitate their handling, a turntable and short sidings have been laid on the clay at the bottom of the pit. From the pit the liquefied clay runs through a launder into a shaft some 70ft. deep by 7ft. square. From here the solution is pumped into wooden refining beds. There are nine of these, each 30ft. long. The first is sub-divided into four beds, each 2ft. wide and placed side by side. In the second and succeeding beds the sub-division is greater. As the clay solution passes from one bed to the next most impurities are extracted by suitable traps, while the finest impurities are held back by sieves of very fine copper gauze placed at the end of the last section of the refining beds. From here the solution runs through launders to one of the 12 granite settling pits. The bottom of these slope towards the centre. All superfluous water is here drained off and returned to the pit first mentioned. If the iron plug in the centre of the settling pit is removed, the clay runs into a small cistern, from whence it flows past a perforated iron plate into the transmission pipes.

Electricity is extensively used for lighting and power purposes, the contractors for the electrical equipment being the British Thomson-Houston Co. In the power station at Little Hammett, about 1¼ miles distant from the clay pit, current is generated at 500 to 550 volts by a 65kw. B.T.-H. compound-wound dynamo, belt-driven from a water turbine running at 650 revs. per min. The turbine is of the vortex type and develops 106 H.P. with 500 cubic ft. of water per minute under a head of 150ft. The water is taken from the St. Neot river about a mile above the station, and is returned to the river again by a race at a spot approximately 1¼ miles below the power station. The generator switchboard has one enamelled slate panel, 48in. by 16in. by 2in., with a sub-base, 28in. by 16in. by 2in. It is mounted on vertical angle-irons, and is equipped with one 300-ampere circuit-breaker, one 300 to 600-volt voltmeter, one 10 to 200-ampere ammeter, one field-breaking switch and one double-pole single-throw quick-break 200-ampere switch. The transmission line is overhead, the copper wire (No. 4/0) being supported by some 60 poles at a height of 22ft. above the ground. At one place only does it cross a public road, and here the wire is suspended from an auxiliary iron wire. The lighting at Parson's Park is effected by four 1,000 c.p. arc lamps and 12 250-volt incandescent lamps, two being connected in series across the supply. For haulage purposes there has been installed a 25 H.P. 500-volt compound-wound motor, running at 630 revs. per min. This drives the winding gear, which was supplied by Messrs. Ransomes and Rapier. Two cast-iron drums run loosely on the drum shaft, and the arrangement is such that either or both may wind the rope. The pump motor develops 30 H.P. when running at 580 revs. per min. It is compound wound and fitted with a pulley 12in. in diameter and with a face 10in. wide. The pump itself runs at a very low speed—*i.e.*, eight to 10 strokes per minute—and delivers at every stroke about 70 gallons of liquid.

At Moorswater, the solution is first run into large settling pits, and when the clay has settled sufficiently it is removed by small trucks to the kiln. This is 250ft. long, and the wet clay is deposited at any required place by trucks running on wires stretched over the kiln. The latter is heated by 12 flues, and after the clay has been thoroughly dried it is ready for despatch to various destinations.

Wireless Telegraphy.—In our issue for June 3rd (p.286) a statement was published, on the authority of Reuter's Agency, that the Marconi wireless telegraph stations at Bari (Italy) and Antivari (Montenegro) had then been erected a month and were in regular working order. A correspondent informs us that, so far from this being the case, the month of July will not see the Antivari plant finished. He informs us that the Bari station is ready, but at Antivari only two towers and a hut are yet to be seen, and that all the electrical material and staff engaged to carry out the work are still in Italy. With regard to the further statement, also due to Reuter's Agency, that the station at Coltano (Pisa) will be ready in August or September, our correspondent is very dubious.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Use of Nickel in the Magnetic Detector.—Marconi's magnetic detector consists of a core or rod of thin iron wires on which are wound one or two layers of thin insulated copper wire. Over this winding insulating material is placed, and over this, again, another longer winding of thin copper wire contained in a narrow bobbin. One terminal of the inside winding is connected to earth, the other to an insulated conductor. The ends of the outside winding are connected to a telephone. A horseshoe magnet, suitably placed, is moved by clockwork so as to cause a continuous change or successive reversals of the magnetism of the iron core. The transmission of the signals is due to the fact that electric oscillations reduce the effects of magnetic hysteresis. Marconi noticed that the signals in the telephone are weakest when the poles of the rotating magnet have just passed the core and are increasing their distance from it, whilst they are strongest when the magnet poles are approaching the core. To obtain more definite results on this point, A. L. Foley has used a ballistic galvanometer instead of a telephone. Since nickel is more susceptible than iron in weak magnetic fields, and less susceptible in strong fields, it occurred to him that a more uniform sensibility for varying distances between the moving magnet and the core might be obtained by making the core of nickel. He found that the sensitiveness of a detector with a nickel core was not very different from the sensitiveness when an iron core was used. Contrary to expectations, however, the sensitiveness with a nickel core appeared to be the greater in stronger fields, and with the iron core in weak fields. With a mixed core of iron and nickel wires the deflections of the galvanometer increased as the magnet approached the core, even up to the point of contact. A mixed core, consisting of annealed piano-wire and hard-drawn nickel wire, produced a more sensitive detector than was obtained by using a core of piano wire only.

[A. L. FOLEY, *Physical Review*, May, 1904.]

New Method of Colour Photography.—Auguste and Louis Lumière describe a new method of photographing in the colours of Nature, somewhat similar to Joly's method, except that coloured starch grains are substituted for tinted gelatine lines. From the starch of potatoes, the grains having a diameter of 15 to 20 microns are separated out. They are divided into three lots, which are coloured orange-red, green and violet respectively. After thorough drying, the coloured powders thus obtained are evenly spread on a glass plate covered with a layer of isinglass. With care, one succeeds in spreading a very uniform layer only 1 grain in thickness. Then any interstices are closed up by means of a black powder, such as powdered wood charcoal. One thus obtains a colour screen in which every square millimetre contains 2,000 or 3,000 elementary screens of the primary colours. The surface is then covered with a layer of thin transparent varnish having an index of refraction equal to that of the grains of starch, and, lastly, an isochromatic film of gelatino-bromide of silver is applied. The sensitive plate thus obtained is exposed in a camera in the ordinary way, except that exposure is made through the glass side. A pure red surface produces a blackening of the film behind every red particle, leaving it unaffected behind the others. On developing and fixing, such a plate will, therefore, show the complementary colour of the original. To obtain the correct colour, the authors dissolve away the reduced silver and develop the unexposed chloride. They thus obtain a transparency in the natural colour without much more trouble than that of taking an ordinary photograph.

[A. and L. LUMIÈRE, *Comptes Rendus*, May 30, 1904.]

New Vacuum Regulator.—Bunsen studied the absorption of gases by glass surfaces, and pointed out that the action could be greatly increased by employing thin glass fibres. This has suggested to M. Krouchkoll the employment of glass wool for the regulation of the exhaustion of vacuum tubes. A piece of "glass cotton" is placed in a side tube communicating with the main tube, and when the latter becomes hard it suffices to slightly heat the side tube, and the gas thus disengaged reduces the vacuum. This regulator offers the advantage of a very simple and easy construction. The regulation is, moreover, automatic. When the anti-cathode is heated up, the heat developed in the tube suffices to extract some gas from the glass cotton, and the tube remains for a long time in good working condition.

[KROUCHKOLL, *Comptes Rendus*, May 16, 1904.]

Emission of N-rays after Death.—A. Charpentier has preserved some dead frogs in a dried state in order to test them for the continuance of N-ray emission after death. He found that the emission of N-rays continues for several months after death, chiefly from the nerve centres. The faradisation of the central end of the sciatic nerve made the radiation more perceptible. A month after death, the brain appeared to emit more rays under the influence of electric excitation. After two months, there was still a cerebral emission, with a maximum between the eyes. The brain and spinal marrow, removed and dried on a plate of glass, emit N-rays for about a month and a half. The difficulty in these experiments is to avoid the formation of radiating moulds on the objects.

[A. CHARPENTIER, *Comptes Rendus*, May 30, 1904.]

Rotation of a Dielectric in a Magnetic Field.—A brilliant confirmation of Maxwell's electromagnetic theory as developed by Lorentz and Larmor has been obtained by H. A. Wilson in the case of the E.M.F. induced in a dielectric when it moves in a magnetic field. The method employed was to rotate a hollow cylinder of ebonite in a magnetic field parallel to the axis of the cylinder. The inside and outside surfaces of the cylinder were provided with metal coatings with which electrical contact was made with sliding brushes. The inside coating was connectedto earth, and the outside coating to one pair of the quadrants of a sensitive quadrant electrometer, the other pair of quadrants being connected to earth. The magnetic field was then reversed, so reversing the induced E.M.F. in the ebonite. The resulting electric displacement was measured by means of the electrometer, the quantity of electricity required to produce a given deflection being determined by means of a small parallel plate guard ring condenser. As a result, the author found that a radial electric displacement is produced in a dielectric, such as ebonite, when it is rotated in a magnetic field parallel to the axis of revolution. The direction of the displacement is the same as is produced in a conductor. The displacement is proportional to the magnetic field and to the rate of revolution. The amount of the displacement agrees with that calculated on the assumption that the induced E.M.F. in the dielectric is equal to that in a conductor multiplied by $1 - K^{-1}$, where K is the specific inductive capacity of the dielectric, as required by the theories of Lorentz and Larmor.

[H. A. WILSON, *Proceedings of the Royal Society*, June 2, 1904.]

Magnetic Change of Length.—Shelford Bidwell publishes a confirmation of the remarkable curve for the magnetic change of length in cast annealed cobalt, obtained by the Japanese physicists Honda and Shimizu. The curve is a straight line from the origin downward, indicating a steady shortening of the rod with increasing magnetic field strength, amounting to eight millionths in a field of 1,400 units. All other forms of cobalt show the usual curve, indicating a shortening up to about 1,000 units and a lengthening in stronger fields. This is, of course, the reverse of the behaviour of iron, which is lengthened in weak fields and shortened in strong fields. Nickel, again, shows a uniform shortening, which, however, rapidly tends towards a maximum. As a consequence of the reciprocal relation between the changes of length produced by magnetisation, and the changes of magnetisation attending mechanical strain, the author infers that there will be no Villari reversal in well-annealed iron, nor in annealed cast cobalt. In rolled cobalt, however, it might be expected that the effect would be considerably increased by annealing.

[S. BIDWELL, *Proceedings of the Royal Society*, June 2, 1904.]

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THE BOARD OF TRADE AND MINISTRY OF COMMERCE.

It is no exaggeration to say that the Board of Trade is the most useful and the worst organised of all our Government departments. Originally created in 1786 "for the consideration of all matters relating to Trade and Foreign Plantations," it has become a sort of general utility man for the Government. The burden imposed by the "foreign plantations" may not be heavy, but "all matters relating to trade" covers a wide field, and any duties, however diverse their nature, which do not come precisely within the province of other Government departments, are trustfully and hopefully thrown over to the Board of Trade to deal with as it thinks fit. Our readers are chiefly concerned with the Railways department, which has to deal with railways and tramways, and the "Fisheries and Harbours" department, to which for some obscure reason all matters under the Electric Lighting Acts are referred. Others may know also that the Patent Office is subject to the control of the Board of Trade, and some less fortunate may have made the acquaintance of the Board in Bankruptcy proceedings. The regulation and control of our mercantile navy is also placed in the hands of the Board of Trade; there is a "Commercial, Labour and Statistical Department," a department concerned with the maintenance of standard weights and measures, and, finally, the Gas Referees. It would not be unreasonable to expect that this great Government Department should be controlled by a Board of able men with wide experience in commercial and engineering matters, that the various departments should be under leading men picked from the various professions and branches of business with which they have to deal, and that the whole organisation should be of an intensely practical character. Turning to the actual facts, we find that the Board of Trade is first placed under a political head, a Minister who usually enjoys Cabinet rank. He is the President, and the "Board" is supposed to consist of the following:—The Archbishop of Canterbury, the First Lord of the Treasury, the First Lord of the Admiralty, the Principal Secretaries of State, the Chancellor of the Exchequer and the Speaker of the House of Commons, together with such Privy Councillors as hold any of the following offices—viz.: The Chancellor of the Duchy of Lancaster, the

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Treasurer of the Navy, the Master of the Mint, and, in addition, the Speaker of the Irish House of Commons, such holders of office in Ireland as are Privy Councillors in England, and last, but not least, a "Parliamentary Secretary." Originally there was a Vice-president, in place of the Parliamentary Secretary, and also 10 other members who were specified by name. This "Board" is practically a fictitious one, however. It never meets, and all affairs are controlled by the permanent officials. Although many of these officials are capable civil servants who have risen to their present posts through their own undeniable abilities, and although there are two or three technical officials with a wide and thorough knowledge of the professions which they represent, the large majority of the servants of the department, from the permanent secretaries down to the assistant clerks, have no business or commercial experience whatsoever. Those who may think that the Board of Trade is a body for the protection and extension of the commerce of the country are woefully ignorant of the true condition of affairs. Yet it is this heterogeneous department, taken as it is, without reconstruction or reorganisation, that it is proposed should become our Ministry of Commerce.

This is the recommendation made by a Committee appointed by the Treasury to inquire into the matter. The "reference" to the Committee was wide, and the members of it (the Earl of JERSEY, Sir JAMES MACKAY, Sir CHARLES RYAN, Sir GEORGE RYDER, and Mr. ALFRED EMMOTT, M.P.) have been afforded an admirable opportunity of reforming, bringing up-to-date and making effective the whole organisation of the Board of Trade and the Local Government Board. The reference to the Committee was as follows:—"To consider the position and duties of the Board of Trade and the Local Government Board, and to report whether any, and if so what, alterations should be made in the constitution and status of those offices; also, whether, in the interests of administrative efficiency, any rearrangement of duties between those and other Government Departments is desirable," and after more than a year's deliberation the Committee have simply recommended that the salaries of the President of the Board of Trade, the Parliamentary Secretary and Permanent Secretary should be raised, that the President should receive the new title "Minister of Commerce," and that increases should also be made in the salaries of the President, Parliamentary Secretary and Permanent Secretary of the Local Government Board.

Fortunately, the electrical industry has suffered almost the least of any by the inadequate organisation of the Board of Trade. The electrical adviser is a broad-minded man, who is an experienced electrical engineer himself and has the interests of his profession at heart, and the clerk in charge of the work under the Electric Lighting Acts is a courteous official, ever ready to assist those who have to find their way through the mazes of officialdom to obtain the result which they seek. With the Local Government Board we are less fortunate. The delays in acceding to requests by local authorities for Local Government Board inquiries into applications for loans under the Electric Lighting Acts is notorious. In the direction of assisting to extend the development of the industry generally, the present Board of Trade can, of course, do nothing, and the mere changing of its name to Ministry of Commerce will not be of any assistance. A Government Department of Commerce is urgently needed, to assist us to hold our own against the enormous industrial and commercial development in other countries where effective aid is actually afforded to the commercial community and private enterprise is strenuously encouraged. We want the appointment of a Minister of Commerce who is not merely a president of the "Board of Trade": a man with truly commercial ideas who will not fear to trample on the worn-out traditions of more than a century ago; one who will not merely acquiesce in the organisation of a Department to control and regulate our industrial undertakings so far as may be necessary to safeguard the interests of the general public, but will broaden the basis of our industries and commerce so that we may retain our position as the leading commercial country of the world.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Conduction of Electricity through Gases. By J. J. THOMSON, D.Sc., LL.D., Ph.D., F.R.S., Fellow of Trinity College, Cambridge, Cavendish Professor of Experimental Physics, Cambridge. (Cambridge: The University Press.) 1903. 16s.

This large volume, brought out by the Cambridge University Press, is an expanded and advanced edition of the small book under the same title which appeared some years ago, and which still remains in print, as published by Constable, and available for the use of more elementary students. The present treatise, however, is a fitting sequel to the same author's "Recent Researches in Electricity and Magnetism," and represents a mass of experimental and theoretical work—work conducted not only in these islands, but on the continents of Europe and America—and brought up to date by supplementary notes with references, bringing the information down to the middle of last year, and to the beginning even of Blondlot's marvellous statements respecting N-rays.

Although, therefore, it is a very convenient work of reference and summary of what has been done by many experimenters, it is not to be regarded as a mere summary: each account is usually accompanied by critical remarks, and in some cases by a recalculation of results, for instance, in the important case of Kaufmann's epoch-making experiments made in the light of Mr. Heaviside's theory. The important work of Wien also is admirably treated, and the subject of ionisation in gases, which is rather specially the branch associated with the Cavendish Laboratory, is of course summarised with considerable fullness and in a most satisfactory manner, the whole being welded together by the unifying influence of the working hypothesis of electrons or corpuscles and of conductivity by ions.

The author says in his Preface that he has

"endeavoured in this work to develop the view that the conduction of electricity through gases is due to the presence in the gas of small particles charged with electricity, called ions, which under the influence of electric forces move from one part of the gas to another. My object has been to show how the various phenomena exhibited when electricity passes through gases can be co-ordinated by this conception rather than to attempt to give a complete account of the very numerous investigations which have been made on the electrical properties of gases; I have, therefore, confined myself for the most part to those phenomena which furnish results sufficiently precise to serve as a test of the truth of this theory. The book contains the subject matter of lectures given at the Cavendish Laboratory, where a good deal of attention has been paid to the subject and where a considerable number of physicists are working at it."

And he goes on to say that

"with the discovery and study of cathode rays, Röntgen rays and radio-activity, a new era has begun in physics, in which the electrical properties of gases have played and will play a most important part; the bearing of these discoveries on the problems of the Constitution of Matter and the Nature of Electricity, is in most intimate connection with the view we take of the processes which go on when electricity passes through a gas."

Thus the prediction of Clerk Maxwell that it would be by investigations into the passage of electricity through gases that most light would be thrown upon the nature of electricity has been abundantly justified.

The book must be regarded rather as a compendium of information for the student than as a philosophic treatise or a work for the general public. It represents a great amount of industry, but somewhat plainly shows the form of lecture notes and of working progress during the compilation of the book. It consists, therefore, rather of the nascent material for a future treatise than of that treatise itself, but as such it is

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very appropriate to a rapidly advancing and constantly growing region of physical science. It is a book for constant reference on the part of workers in the most immediately promising parts of pure physics. OLIVER LODGE.

Electromagnetic Phenomena and the Deviations of the Compass. By Commander T. A. LYONS, U.S. Navy. Vols. I. and II. 1903. (New York: Wiley & Sons.) 25s. 6d. net each vol.

Completeness is the distinguishing mark of this great work. There are few matters having even an indirect bearing upon "the soul of the ship" which are not dealt with in one of the volumes. The first is a compendium of all those branches of the science of electricity and magnetism which are capable of throwing light on magnetic phenomena, and although the phrase "electricity is probably a stressed displacement movement of the ether" (Vol. I., p. 513) is beginning to sound a little antiquated, it will probably be many years before Commander Lyons' work ceases to be a sure guide to the naval cadet. The second volume is by far the more valuable of the two. It contains, besides an interesting historical sketch, a full theoretical and practical exposition of the methods of determining the magnetic coefficients and of "swinging ship," and an admirable treatise on the sources and determination of the heeling error To represent the direction and amount of the force acting on the compass, the author uses the force-and-angle diagram, or dynamo-goniogram, or "dygogram," as it has been abbreviated, since it "appeals more strongly to the understanding, and presents the conditions and forces in action more clearly to view than formulas." The author displays a commendable anxiety to make his meaning absolutely clear, and thus give a sound theoretical preparation for a class of work which is of paramount importance to modern navigation with steel hulls.

Elementary Telegraphy and Telephony. By ARTHUR CRUTCH. (London: E. and F. N. Spon.) 1903. 4s. 6d. net.

In these days of specialisation and short cuts to knowledge, students who desire to enter a particular branch of electrical engineering may begrudge the time that would be spent in learning thoroughly the elements of electricity and magnetism, preferring, if they can, to confine their studies to what will be absolutely essential to them in the future. To beginners with these limited aspirations we may commend Mr. Crutch's book. Without pretending to be a text-book of electricity and magnetism, it explains the elementary principles which the telegraph and telephone electrician must know, and it describes the simpler applications without intruding on the ground covered by the technical works on these subjects. Students aspiring to reach the top of their profession, however, should possess a wider knowledge of elementary electricity and magnetism than can be acquired from the present volume.

American Meter Practice. By LYMAN C. REED. (New York: McGraw Publishing Co.) $2. (9s. post free, U.K.)

The existing literature on electricity meters is by no mean profuse, at any rate in England, but the author of the work before us confines himself entirely to American practice. Some of the terms employed, such as "quarter-phase" for two-phase, are rather confusing to the English reader, and there are also occasional errors or misprints. Some exceedingly useful diagrams of connections are given, and the author's discussion of the points which should be possessed by a good meter are worthy of careful notice. Detailed descriptions of meters most commonly in use in America occupy several pages. The last chapter, which is on the elements of photometry, appears scarcely necessary in a book on meters.

Radium and All About It. By S. R. BOTTONE. (London: Whittaker & Co.) 1904. 1s.

Notwithstanding its presumptuous title and its cover designed to catch shillings at bookstalls, this little book shows fair scientific accuracy, so far as it goes. The account given of the history of the discovery of radium and of the remarkable physical properties of the element is very readable, though marred somewhat by the confused usage of the term "emanation." Of course, the description of the physiological actions of radium is sensational, but the chemical is the weakest side of the book, some of the views expressed being, shall we say, rather original. A good feature is the collection of long quotations from the published writings of authorities on radium.

THE GILBERD TERCENTENARY.

In our issue of December 11, 1903, we gave a report of the proceedings at the Institution of Electrical Engineers on the occasion of the presentation to the Colchester Corporation of the Gilberd picture, a painting by Mr. A. Ackland Hunt. A reproduction of the picture was also given on p. 288 of the same issue, together with many historical notes concerning Dr. William Gilberd of Colchester.

On Saturday last the Council of the Institution of Electrical Engineers paid a visit to Colchester in order to be present at the unveiling of the picture at the Moot Hall, by invitation of the Corporation. Among those who were present were Mr. R. K. Gray (President), Prof. Silvanus P. Thompson, F.R.S., Prof. W. E. Ayrton, F.R.S., Mr. Conrad W. Cooke, Capt., E. W. Creak, F.R.S., Prof. J. D. Everett, F.R.S., Prof. John Fergusson, Mr. J. J. Fahie, Mr. J. Gavey, Mr. Hugh E. Harrison, Mr. R. Hammond, Rev. W. C. Howell, Mr. J. E. Kingsbury, Mr. G. E. Lloyd (Secretary), Dr. Joseph Larmor, F.R.S., Mr. W. M. Mordey, Dr. A. Muirhead, F.R.S., Prof. J. Perry, F.R.S., Mr. W. H. Patchell, Mr. J. H. Rider, Mr. C. E. Spagnoletti and Dr. R. Mullineux Walmsley.

The train by which the party travelled left Liverpool-street at 10 o'clock, and on arrival at Colchester, the guests were met by carriages and driven to the Town Hall, where they were welcomed by the Mayor (Ald. E. H. Barritt). Before the ceremony of unveiling the Gilberd Memorial picture was undertaken a number of visits were paid to places of interest in Colchester, including the house where Gilberd was born, and the church where he was buried. The Corporation electricity supply works were also visited. At 1 p.m. a luncheon was served in the Moot Hall, at the conclusion of which a silent toast was drunk to the memory of the Father of Electrical Science, Dr. William Gilberd.

The MAYOR then alluded in feeling terms to the gift, saying that the act of the Institution of Electrical Engineers in presenting to Gilberd's native town a valuable and historic painting depicting a realistic scene in Gilberd's life, was one which stirred the feelings of all Colcestrians. He would, therefore, submit a further toast—viz., "The Donors of the Gilberd Tercentenary Commemoration Picture," coupling with it the name of the President of the Institution of Electrical Engineers, Mr. R. Kaye Gray.

Mr. R. KAYE GRAY, in responding, thanked the Corporation for the magnificent way in which they had received their guests.

Prof. J. PERRY, F.R.S., in a humorous speech, said that in some people's minds municipalities were doing badly what companies could do very much better, but no company could do what the Colchester Corporation was doing that day in honour of Dr. William Gilberd. Colchester was very proud of its natives, which were of two varieties, the oyster kind and the Gilberd kind.

Further speeches having been delivered, the proceedings terminated.

Several further visist were then made, and after a reception by the Mayor and Mayoress in the Mayor's parlour, the company passed into the Moot Hall at 5:30 p.m., where the Gilberd picture was hung beneath the gallery, and where the ceremony of unveiling took place. The Mayor having referred to the circumstances under which the picture had come into the hands of the Colchester Corporation, the Mayoress performed the ceremony of unveiling the picture, which now bears the following inscription:—

WILLIAM GILBERD, M.D.
1544—1603.

Dr. Gilberd of Colchester, author of the famous book, "De Magnete," founder of the science of electricity and the discoverer of terrestrial magnetism, was President of the Royal College of Physicians, and Court Physician to Queen Elizabeth. He is here depicted demonstrating his experiments before Her Majesty and her Court.

This picture was presented by the Institution of Electrical Engineers to the Corporation of Colchester on December 10th, 1903, the Tercentenary of the death of Dr. Gilberd.

Mr. R. Kaye Gray then presented the Mayoress with a handsome gold neck chain as a memento of the occasion, and Mr. Ackland Hunt, the artist, asked her to accept a framed photograph of the picture.

Prof. SILVANUS P. THOMPSON, F.R.S., referring to the inquiries which he had conducted concerning Gilberd's discoveries, covered much of the ground dealt with on the occasion of the presentation of the picture in London last December. He said he had carried back the

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pedigree of Gilberd to something like 200 years earlier than before, and he felt certain that if the records of Colchester Castle were carefully searched, further facts concerning Gilberd and his family would be discovered. As to the method of spelling his name, he thought Colchester was justified in spelling it with a final "d." He promised to present Colchester with a permanent photograph of a letter written by Gilberd in 1599.

Dr. E. L. FENN asked the Mayor to accept an important document concerning Gilberd, which contained the great scientist's signature, and paid a tribute to the splendid efforts of Prof. S. P. Thompson in perpetuating the memory of Gilberd.

The DEPUTY MAYOR thanked Dr. Fenn for his gift.

Rev. W. C. HOWELL and Prof. JOHN FERGUSSON al o spoke.

A vote of thanks was then passed to the Mayor and the party returned to town.

"THE TIMES" AND WIRELESS TELEGRAPHY.

The following is an extract, reprinted by special permission of *The Times*, from a private letter received by mail from their wireless telegraphy operator at Wei-hai-Wei :—

De Forest Wireless Station, Wei-hai-Wei,
North China, April 10, 1904.

I have delayed writing until I could give definite statement about the work. Owing to the movements of the boat we did not have an opportunity to get a good test out until last night. Before saying more I will relieve your mind. 150 miles both ways in calm weather and 125 at other times will be good enough, don't you think? That was the result of the test last night, first test, and I am sure it will stand good. In rough weather the boat rolls, shakes and jars so badly that Brown can't hear me beyond 125 miles. The troubles and snags I've been up against on other jobs fade to a mere shade compared to this. Placed as we are, in an out-of-the-way corner, where it is well-nigh impossible to get anything done, it doesn't take much to put you in a bad hole in this work. A few more jobs like this and I'd begin to sprout grey hairs . . . that's no dream. Perhaps the importance of our mission and the fact that all eyes were upon us, as it were, spurred us on. The country is full of wireless, and we are showing 'em a thing or two. I can't begin to tell you all the trouble we had. Anyway, it would make poor reading, and I don't know that I care to rehearse it either.

The topmasts fitted on the boat at Shanghai went down the first night out. On our arrival here there were a few old junk masts lying on the ground, no houses for us, nothing even started. It took several weeks to raise a mass of rotten wood about 170ft. high. The country hereabout, by the way, is almost devoid of timber, and it is very hard to get any kind of poles. Several of our cases were badly damaged on the trip, mostly the Secor stuff, and that gave us a lot of trouble. The engine houses fared worst, and small parts on engine were broken and bent in bad shape. The bright gentleman who packed the engine oil put the tins in a box and drove nails through them. About half the oil, rather, nearly all in some cans, had leaked out when we unpacked. That damaged engine gave me the time of my life, but I finally mastered it, and now it is doing its part all right. While the "Haimun" was coaling in Japan another topmast was fitted up, but only one, so that we can only run wires straight up and not across from mast to mast. They didn't seem to want to go to the trouble of two topmasts, so we get along with one. Owing to the peculiar circumstances in erecting the pole, the shacks were not built until the pole was up, and, of course, with Chinese to build the shacks, that in itself was a big job. A Chinaman works half an hour, and then sits down and smokes for a quarter of an hour. If there are 20 on a job five will be working and the others squat around smoking and looking on. At the time the shacks were built it was the Chinese New Year, which lasts from one to three weeks. It was very difficult to get any of them to work, and those who did went their own gait or not at all.

Although the putting up of the poles and the houses took several weeks, the correspondents seemed to have an idea our part would take no time at all, and as soon as their part was finished were in a great hurry. You said in your memo., "Stations must be working within three weeks." Including nearly, or the best part of, three and a half-days' work on engine and generator, we equipped the shore station in six days, and equipped the boat in one day completely. We didn't twiddle our thumbs much that week. Nine days after we began to work the pole blew down and another week was required to repair it. During that week I strung up two wires about 80ft. high, and we worked that 60 miles losing no time on our work. There is an almost continuous succession of high winds here, and my antennæ have been carried away three or four times.

On the boat we were grounded to the hull, and have a four-wire antenna a little less than 100ft. high. With the repaired pole on the shore station we have a scant 150ft. of antenna. The site is on the top of a cliff, about 150ft. above the sea, with a rocky hill sloping sharply up to one side, rising higher than the pole. I forgot to mention that we are on an island 1½ by 2 miles in area, a mass of rocky hills rising several hundred feet above sea level. The site we have is the best procurable on the island, Liukungtao, and there is no suitable site on the mainland within 4 or 5 miles of the office. I am going to have several photos taken, and will forward them within two weeks.

As I said before, the country is full of wireless, and we have any amount of competition, not in Press work, however. All the British warships, from the third-class cruisers up, are equipped with Marconi, about 24 in all; nearly all the Japs have wireless equipment; the Russian ships are equipped, and several German vessels. One or another of them can be heard any time, day or night. The Japs are particularly numerous, and we are at it all the time. We laugh at them, for we have struck some good points in tuning, which settle them very nicely. On the boat when receiving our stuff, two of the four wires are grounded directly, which gives best results. Any resistance between those wires and the ground weakens the signals. If we want to hear the Japs call, disconnecting ground wire entirely from syntoniser of the receiver brings them in strong; while with the ground wire on, as in receiving our stuff, the Japs come very faintly. On the shore station it is different. Three wires are best in receiving up to 100 miles, with the other two wires free, at which time the Japs come in weakest. By grounding the other two wires the Japs come in very strong and our stuff weakest. Above 100 miles our stuff comes best with two wires grounded directly. That, of course, allows others to come in, but they are not strong enough to prevent my reading through. So far, that tuning is best, and certainly gives very satisfactory results. There are always one or more British warships lying here, and we have them all wondering. The lieutenants of two torpedo boats have told me they do not depend on more than 40 or 45 miles regularly, and another says he can depend on 60 miles. The last one has 160ft. of wire to do his 60 miles, while our boat has a scant 100ft. of wire, and easily covers more than double the distance. Our speed is a source of wonder and admiration to these British officers. I saw some of their tape after we got through with it, and couldn't read a word.

CORRESPONDENCE.

POWER STATION DESIGN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reading your report of the discussion on the above Paper, I note Mr. Merz has supplemented his reply to my criticisms by a few additional remarks, all of which, however, are more or less wide of the points at issue. In doing so, I am sorry to find he has not discovered his recommendation of concrete as suitable material for the screen walls of a station, for, on referring to his Paper, I find, on p. 52 of *The Electrician* of April 29th, a suggestion that "the screen can be of brick, concrete or corrugated iron." Can there be any possible misunderstanding regarding the meaning of these words?

When discussing the arrangement of roofs, I made no allusion whatever to the comparative merits of large and small spans, but merely stated that the arrangement adopted at Carville was a bad one from an architectural standpoint on account of the large number of valleys, and this I still maintain to be the case. The spans as scaled from the diagrams are about 20ft. wide, and with such I contend that a "lean-to" roof would have been better and more economical, as the trusses in this case might have been attached to the framing of the bunkers, thus reducing the number of valleys from five to one, and dispensing with an undesirable and expensive feature of roof construction without in any way weakening the structure or increasing the superficial area of roofing material.

Referring to the chimney arrangement at the Neptune Bank Station, I still think the design far from "a correct one," because in a station with a single row of boilers aggregating 2,800 H.P., and where extensions must certainly have been contemplated at the outset, it would have been cheaper and more in accordance with the principles of correct practice and economic design to have built one chimney of adequate capacity for eight or more boilers, than to have erected two smaller ones of 130ft. high, and by adopting the former course have rendered further extension possible on the 70ft. of land between the end of existing building and retaining wall. In designing chimneys for generating stations as well as iron and steel works plants, I have always found the single chimney to be the cheapest and best arrangement where one row of boilers was being installed.

Allowing that due consideration should be given to possible changes in the type of prime mover does not alter the fact that the first installation at Neptune Bank comprised three different types, the turbine set being installed much later. At the very commencement the course pursued was one which the authors condemned in other stations, where the original designer probably had nothing whatever to do with any extensions of the plant, the alteration in the type of prime mover

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being due to changes in the personnel of the staff or financial considerations. I certainly favour the maintenance of a symmetrical arrangement as far as possible.—Yours, &c.,

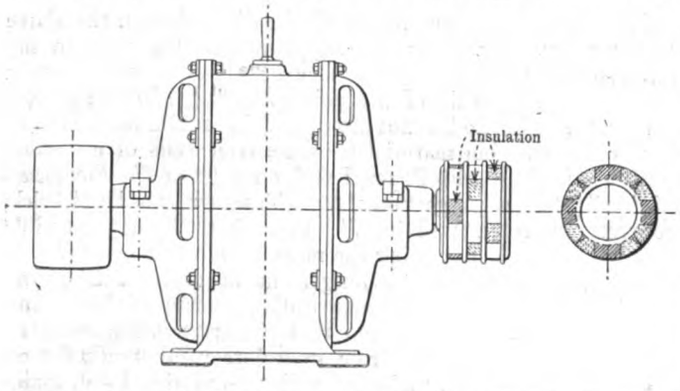
Westminster, S.W., June 14. A. VENNING.

A NEW SINGLE-PHASE MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

On p. 152 of your issue of May 13th, you reprint the complete specification of the British patent No. 3,705, November 7th, 1903, referring to an "Improvement in Single-phase Alternate-current Motors," and taken out by Rudolf Goldschmidt and Crompton & Co. It is claimed that by the arrangement covered by this patent a better starting torque is obtained than in the case of a commutator-motor, with the advantage that no commutator is used, but only a "collector with a small number of parts, and which must of necessity give sparkless collection." To obtain this result, the well-known "repulsion" principle is used, but, instead of a continuous motor-winding, an open-coil winding is adopted, and the circuit of the different coils is alternatively opened and closed by the "collector." The idea is that the circuit of every coil would be broken as soon as the plane of the coil lies parallel to the lines of magnetic force, and that no current would flow in the coil at that moment. This is, however, not the case.

The same mistake was made by the writer about six years ago (German Patent, No. 105,940, October 1, 1898, by Lahmeyer Electrical Co., Fig. 4 of which is enclosed herewith).



An experimental motor was built with three coils in the rotor, two of which were always short-circuited by the brushes, whilst the third was opened. It was found that this motor would work fairly sparkless if rotating very slowly, but would spark very badly when approaching full speed. The reason for this is that, besides the E.M.F. due to "transformer" action, a second E.M.F. is induced in the rotor coils (when rotating), as they are cutting magnetic lines; as the latter E.M.F. attains its maximum just when the coil is parallel to the lines of magnetic force, it is clear that there is no sparkless position for the brushes.

It is, furthermore, clear that by the use of a small number of rotor coils the motor can develop its full starting torque only in certain positions of the rotor. A more uniform starting torque can only be obtained by increasing the number of rotor coils and commutator segments. It seems, therefore, that the usual commutator is in every respect superior to the arrangement proposed by Mr. Rudolf Goldschmidt.—Yours, &c,

St. Louis, June 1. L. SCHÜLER.

FAULT TESTS FOR SUBMARINE CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I shall feel much obliged to any of your readers who can give me the following information:—

1. When and where was the Blavier fault test first applied and described? Who was M. Blavier?

2. When and where was the Cromwell "Varley Loop" fault test first applied and described?

3. Where can I find a description of McGill's fault test?

4. When and where was the "False Zero" method of balancing the resistance of a cable traversed by earth currents first applied and described?

I remember trying the "False Zero" method on the Western and Brazilian Company's cables in the end of 1874, but I cannot find any description of it in any of the 37 "B.A. Reports on Electrical Standards, 1862-67," reprinted in 1873 by E. and F. Spon, or in Culley's "Handbook of Practical Telegraphy," 1874 edition, or in Latimer Clark and Robert Sabine's "Electrical Tables and Formulæ" of 1871, or in any other book prior to any of these dates! I am anxious to record the dates and the origin of "Submarine Cable Fault Tests" in the next or 17th edition of Munro and Jamieson's "Pocket-Book of Electrical Rules and Tables." I have just re-read the late Prof. Fleeming Jenkin's Cantor Lectures on "Submarine Telegraphy," delivered before the Royal Society of Arts on January 29, 1866. Both Blavier's formula and Varley's loop test are described there, as well as Murray's loop. Mr. John Murray, of Glasgow, first tried his test on board the "Niagara" during the first (or 1857) Atlantic Cable Expedition.—Yours, &c.,

Kelvinside, Glasgow, June 10. ANDREW JAMIESON.

PARLIAMENTARY INTELLIGENCE.

SURFACE-CONTACT TRAMWAYS AT TORQUAY.

A committee of the House of Lords, of which Lord Hawkesbury is chairman, commenced the consideration of the Torquay Tramways Bill on Friday last week. It has already been passed by a committee of the House of Commons (see *The Electrician*, March 18, p. 869), but a difficulty has arisen since then owing to the Chairman of Committees of the House of Lords having struck out of the bill a special clause giving extra protection to the Corporation and the Torquay Gas Co. in respect of electrolysis, both of which were allowed in the Lower House.

The Hon. J. D. FITZGERALD, K.C., who appeared for the bill, with Mr. Vesey Knox, explained the circumstances under which the bill now appeared before this Committee. After having gone over much the same ground that he covered in opening the bill in the other House, he said, the only opposition in the House of Commons, was by the Torquay Gas Co., who asked for special protection in respect of electrolysis, and in view of the fact that the promoters had already agreed to give special protection to the Corporation as regards its gas and water pipes, the House of Commons decided that the gas company should be similarly treated. When, however, the bill, having passed the House of Commons, came before the lord chairman in the House of Lords, he decided to strike out this special clause both as regards the Corporation and the company, which was to the advantage of the promoters. But the promoters felt that they were honourably bound to the Corporation in this matter, and he would ask, as strongly as he could, that the clause should be re-inserted. This action of the lord chairman had had the curious effect of bringing about opposition from a number of ratepayers in Torquay, who did not oppose in the House of Commons. In reading through the petition, however, it was evident that many of the signatories did not reside upon any of the proposed tramway routes, and it was unnecessary for him to point out that unless they were frontagers they did not have a locus to oppose the bill.

Mr. J. TAYLOR, Mayor of Torquay, said the Corporation now approved of the bill as it stood.

Cross-examined by Lord ROBERT CECIL, on behalf of the frontagers, he said that at one time he was quite against tramways, and even now he would rather be without them, but in carrying out his official duties he did not allow his private opinions to outweigh his duty to the Council. The Town Council was strongly in favour of the tramways as a means of affording a better communication in the town than had hitherto existed. They were satisfied that the financial position of the Dolter Company was such as to warrant the Council not insisting upon any guarantees in this respect. An expenditure of £42,000 was being incurred upon the electricity works, but only about £10,000 of this was in consequence of the introduction of tramways. His opinion was that the Dolter system was more simple than that which was installed at Wolverhampton. Over a large portion of the 7 miles of tramway proposed he agreed that the lines came within the statutory distance of 9ft. 6in. from the curb, but he saw no objection to this. There were tramways in much narrower streets than those in Torquay.

Re-examined: The promoters had deposited £5,000, which was not to be returned until certain of the lines were constructed.

Several members of the Torquay Town Council also gave evidence in support of the bill.

On Monday, further local evidence in favour of the lines having been heard,

Mr. F. S. HEX, town clerk to the Torquay Corporation, gave evidence as to the financial position of the Corporation, and said that the water-works was responsible for a considerable portion of the existing debt of the Corporation. Under various acts, however, the Corporation was empowered to borrow to the extent of some £200,000.

Mr. H. LUBBOCK, chairman of the Dolter Electric Traction Co., said that the capital of the company was £100,000. £90,000 had been issued at the date of the last balance.

Cross-examined by Lord ROBERT CECIL, he stated that fully-paid shares to the extent of £50,000 had been issued. £26,000 uncalled capital

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remained as well as £10,000 unissued shares. £14,000 had been raised in addition, and deducting general expenses there was now £3,000 in the bank. No decision had yet been come to as to whether or not the Dolter Company would construct the lines in Torquay or whether a subsidiary company would be formed. Whatever was done, however, there would be no difficulty in obtaining the necessary capital, as promises to take £50,000 in shares had already been received. The total cost of equipping the lines would probably be £136,000

Mr. W. C. C. HAWTAYNE, consulting engineer to the Dolter Electric Traction Co., said the total length of track was about 9 route miles. The gauge was 3ft. 6in., sharpest curve 40ft. radius and the steepest gradient 1 in 10 for about 66ft. He then explained the details of the Dolter system, which have already been given in our columns. He did not think any street in Torquay upon which it was proposed to lay tramways was too narrow for a tramway. In Dean-street, Norwich, the width was only 13ft 3in., and yet there was a double line of tramway there. In fact, the cars overhung the pavement.

Cross-examined by Lord ROBERT CECIL, he maintained that all necessary precautions had been taken to render the system safe, and all the possible conditions of danger which counsel cited he could not conceive happening. It was not a fact that at some points in Torquay the proposed tramways would come within 1ft. and 2ft. of the curb. It would be absurd to put a tramway with only 1ft. between it and the curb, as the Board of Trade would not pass it. He admitted, however, that upon about one-half of the system the lines would come within the statutory limit of 9ft. 6in. between the rails and the curb. In making his estimates of the traffic, he had taken 6·03d. per car-mile (his usual figure) as working expenses. Carrying the population of Torquay 100 times over during the year, it would only need a revenue of 8·35d. per car-mile in order to pay 5 per cent. dividend. But he anticipated a much larger receipt than 8·35d. per car-mile.

Mr. J. E. WALLER said that he had reported to the Corporation of Torquay that the tramway system was one which should be in the hands of the Corporation, but the ratepayers evidently thought otherwise. However, the routes of the lines now proposed followed very closely those of the routes which he laid down in his report. He approved the estimates of the construction of the lines, but had not checked the promoters' figures as to detailed costs of working.

This closed the promoters' case.

For the opponents, a large number of local witnesses were called, whose evidence was largely to the effect that the motor omnibus service now running in Torquay was sufficient for the present needs. Many witnesses also resented the idea of making Torquay the place wherein to experiment with a new and untried system of electric traction. Objection was also taken to spending £11,000 upon enlarging the generating station. One witness stated that tramways were dangerous under any conditions, whilst others admitted that they were shareholders in the Motor 'Bus Co. in Torquay. Others stated that they were not resident upon any of the routes.

On Tuesday further evidence was called against the bill.

Mr. W. E. THOMAS, secretary to the Torquay Motor Omnibus Co., stated that the capital of that concern was £10,000 in £5 shares. The revenue per car-mile amounted to 11·36d., and the company proposed to add more cars, but were waiting to see the result of this bill before actually extending their business. Their minimum fare was 2d. He contended that the omnibuses fully met the requirements of Torquay, and that tramways were entirely unnecessary.

Lord ROBERT CECIL then addressed the Committee on behalf of the opposition, and questioned very much the financial position of the promoters. He believed it was their intention to make a profit out of the venture by selling it to a subsidiary company. He considered that a Committee had never had before it a case in which the financial record of the promoters was weaker than the present one. It was exceedingly unlikely that the scheme could be carried out with a smaller capital than £150,000, and the only resources to meet it were £3,000. Further than that, he contended that tramways injured the amenities of a town, and were an evil in themselves. He also pointed out that the Dolter system was an untried one, as far as this country was concerned, and the undertaking was nothing more nor less than a speculation. If the system failed it would throw a large expense upon the ratepayers of Torquay. He submitted that no substantial public case had been put forward by the promoters.

The Hon. J. D. FITZGERALD, on behalf of the promoters, said that Lord Robert Cecil had spoken as if the only persons to enjoy beautiful scenery such as was to be found at Torquay were those who could afford to keep carriages. The Dolter system had been at work in Paris for two years, and had, therefore, passed out of an experimental stage; but should it not be successful, the only people who would suffer by it would be those who had put their money into the Dolter Company. As to the financial position of the Dolter Company, he said that he should have thought the name of Lubbock would have been sufficient guarantee on this point. He appealed to the Committee to pass the bill on the ground that it would be in the interest of the borough of Torquay.

After a short consulation,

The CHAIRMAN said that the Committee had decided to allow the bill to proceed.

Mr. BAGGALLAY, K.C., for the Torquay Gas Co., referring to the question of the electrolysis clause, asked the Committee to allow the clause to remain in as agreed with the promoters. He did not wish the clause to form a precedent, but asked for it merely because the system proposed in this bill had not come within the consideration of Lord Cross's Committee when it reported some years ago.

Mr. C. C. HUTCHINSON supported the appeal on behalf of the promoters.

The CHAIRMAN said the Committee would grant the clause and would report to Lord Morley to this effect.

RUNNING POWERS GRANTED OVER NEWCASTLE CORPORATION TRAMWAYS.

TYNESIDE TRAMWAYS AND TRAMROADS BILL.

Sir Edward Strachey's Committee of the House of Commons concluded consideration of this bill on Friday last week.

Mr. H. LLOYD, K.C., in addressing the Committee on behalf of the Newcastle Corporation, pointed out that it was utterly inconceivable that upon a tramway system a through route could be given from every point to every point. But further than this he would ask the Committee to take into account the smallness of the company's system as compared with that of the Corporation. He would not be going too far in regarding it as a branch line and the Corporation system as the main line, and it could not be possible that every branch railway line should have through running powers over the main line. There must be a break in every system, whether tramways or railways, somewhere. The company admitted that they had no complaints as to the inconvenience of the break at the Wallsend boundary, but what there had been complaints about was the 1d. fare charged from the boundary of Wallsend to the centre of the town, which was only ½ mile, and the company argued that they could not, as a commercial company, reduce this unless they had through running into Newcastle. The bill asked for running powers over three routes, and traffic facilities—*i.e.*, through booking—over all other routes. But such a proposal was manifestly ill considered when the complication of the Newcastle tramway system was taken into account. But it had been admitted by the engineer to the company that the bulk of their traffic was from the centre of Wallsend to Newcastle, and to obviate the inconvenience at the Wallsend boundary, if inconvenience there be, the Newcastle Corporation were willing to run their cars into the centre of Wallsend. The company were making this application in order to enhance the value of their own undertaking and with no wish to seek the confidence of the public.

Mr. BALFOUR BROWNE, K.C., in replying for the company, after mentioning that both the Corporation and the company were agreed that running powers were necessary, asked what logic there was in the contention of the Corporation that they should be allowed to run into Wallsend, but that the company should not be allowed to run into Newcastle. Their arguments as to the difficulties of dual control were defeated by their own offer to run over the company's system. When the company first sought powers for the Wallsend line, the Corporation also did the same, but Parliament preferred the company, but this so-called offer of the Corporation was an endeavour to secure the control of the very lines which Parliament had refused them.

The Committee having deliberated in private for some time,

The CHAIRMAN announced that the Committee were unanimous in finding the preamble of the bill proved so far as running powers over the three specified routes were concerned. Clause 17, having regard to traffic facilities over other lines, would be struck out.

CARRIAGE OF GOODS BY MUNICIPALITIES.

MANCHESTER CORPORATION TRAMWAYS BILL.

The House of Lords Committee presided over by Lord Hawkesbury continued consideration of this Bill on Friday last week.

For the carriers in Manchester a large amount of evidence was called as to the very elaborate system of parcels delivery there was, and as to the probable ruin of the existing firms owing to the rate-aided competition of the Corporation. A suggestion was put forward on their behalf that the Corporation should be restricted to carrying goods on their electric tramways.

Mr. LEWIS COWARD, in a brief reply for the Corporation, argued that the Corporation already had the powers asked for in this bill, and that the only object of the measure was to consolidate these powers in one act.

After a very short deliberation, the Committee decided in favour of the Corporation.

Upon the consideration of clauses the Midland Railway Co. sought to have the power to carry animals and minerals eliminated from the bill, but this was refused, the Chairman holding that if this were done he would be going back upon previous legislation.

LONDON COUNTY COUNCIL (TRAMWAYS AND IMPROVEMENTS) BILL.

Upon the order for consideration of this bill, as amended, in the House of Commons on Thursday last week,

Mr. COCHRANE moved that the following clause be added to the bill:—"Whereas it has been arranged between the Council and the Commissioner of Police that on and after Jan. 1, 1905, the Council shall not run any car on that portion of the tramway in Westminster Bridge-road which lies to the west of its junction with York-road on such days and at such hours as the Commissioner of Police may from time to time direct. Such arrangement is hereby confirmed. Provided always that if any question shall arise between the Council and the Commissioner as to whether any such direction is reasonable, such question shall be determined by the Secretary of State for the Home Department."

Dr. MACNAMARA and Capt. JESSEL expressed surprise that the London County Council had accepted this clause without protest. The effect of it would be to prolong the walk which now had to be made from the tramway terminus over Westminster Bridge.

Mr. BURNS explained that the House had already denied the Council the opportunity of removing the congestion on the south side of Westminster Bridge by refusing to sanction the continuation of the line over the bridge and along the Embankment. The Home Office had proposed

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this clause in order to alleviate the congestion at the Westminster terminus, and the London County Council had felt reluctantly compelled to accept it.

The clause was then read a second time and added to the bill.

Mr. REMNANT then moved the omission of the tramway which was passed by the House of Commons Committee from the Hampstead-road and half-way down Tottenham Court-road (see *The Electrician*, April 29 and May 6). He contended that such a line as this served no useful purpose and would be an inconvenience at such a spot as Francis-street.

Mr. BULL said that some system was necessary whereby tramway termini should be situated in side streets, and he hoped the Traffic Commission would give some attention to the matter.

Mr. COMPTON RICKETT, who was Chairman of the Committee which passed the line in question, pointed out that there were many similar tramway termini in London to the one proposed, and the congestion of traffic was no worse in Tottenham Court-road than in Moorgate-street, Aldersgate-street, Gray's Inn-road, Aldgate and Whitechapel. The Committee had come to the conclusion that there was a good and sufficient case for the line, even if it were never taken to Oxford-street, as originally contemplated.

Capt. JESSEL hoped that the House would not prejudge the important question of linking up the north and south of London by sanctioning such small extensions as this, especially as the Royal Commission on London Traffic had been considering this question.

Mr. BURNS supported the decision of the Committee as a means of providing further facilities for rapid transit. He pointed out that when tramways were discussed in the House, tubes were always suggested as an alternative, but his opinion was that in 10 years Mr. Yerkes and Mr. Perks would be handing over their tubes to the London County Council as relief sewers because people would no longer ride in them.

After some further discussion, the House divided, with the result that the motion was carried by a majority of 29.

The bill was then ordered for third reading, which took place on Monday.

On Tuesday, Dr. MACNAMARA asked the Home Secretary whether, in view of the clause introduced by the Home Office above referred to, he would consider the desirability of requiring the halfpenny omnibuses over Westminster Bridge to start from York-road instead of the present terminus.

Mr. AKERS DOUGLAS said he was not in a position to make any statement on this subject at present, but when the matter came up for consideration all care would be taken to consult the public safety and convenience.

REFUSAL OF THE "BERMONDSEY" CLAUSE.

Swindon Corporation Bill.

As briefly mentioned in our last issue, the Swindon Corporation bill has been under consideration by the Police and Sanitary Committee of the House of Commons. The bill is of an omnibus character, but two sections deal with electricity supply and tramways respectively. Mr. G. A. Fitzgerald, the Hon. F. N. Thesiger and Mr. H. H. Gaine, appeared for the promoters.

Mr. FITZGERALD, in opening Part III. of the bill, said that clauses 23 and 27 related to the supply of electricity outside the borough boundary and the supply of electrical fittings, and in respect of both these clauses the Swindon Gas Co. was opposing. The point of the opposition as regards clause 23 was that unfair competition would be set up outside the borough, and that if this were allowed the "Bermondsey" clause should be made applicable. The object of the Corporation, continued counsel, was to make the electric light boundary co-extensive with that of the Corporation water undertaking, and the proposal contained in the bill did not involve the erection of a new generating station. The gas company had a monopoly of these outside districts, and charged the inhabitants 6d. per 1,000 cubic ft. of gas more than they charged inside Swindon. The gas company further opposed the electrical fittings clause on the ground of competition. The object of the clause was to enable the Corporation to introduce electric light into small dwellings, and so make the electricity undertaking more successful.

Mr. J. G. GRIFFIN, electrical engineer to the Swindon Corporation, said that although there was a large demand for electrical energy in the outside districts, none of them were large enough to support an undertaking of their own. The Corporation were willing to undertake to give a supply, and it would only need a small extension of plant and no extension of buildings. The effect of the clause which the gas company asked for would be to choke off consumers.

Under cross-examination Witness stated that the burden upon the rates so far in respect of the electric light undertaking was £781, which he did not think could be regarded as a loss.

This concluded the case of the promotors on these two clauses.

The CHAIRMAN, after consultation with the Committee, said that the Committee did not think any case had been made out for the extension of the area as far as electricity supply was concerned, not on account of the opposition of the gas company, but because of the fact that no necessity had been proved. They would not grant the "Bermondsey" clause, therefore, but would allow clause 27 with regard to the supply of fittings.

After some discussion the form of this clause was ordered to be verbatim as the "Willesden" clause (see *The Electrician*, Vol. LI., p. 255).

The tramways portion of the bill was then dealt with.

The Hon. F. N. THESIGER said that some electric tramways which the Corporation had constructed would be opened in September, and the bill asked for powers to construct extensions and also to run motor omnibuses. The object of the latter was to test whether a particular route would bear the construction of a tramway, and also to use them as feeders to the tramways.

Mr. J. HINTON, Mayor of Swindon, said that the proposal was to run motor omnibuses as a convenience to workmen beyond the line of route of the tramways, as at present two-thirds of the workmen residing in the villages round about had to combine together to hire vehicles to get to their work. The cost of the omnibuses would be £800 each, and there would be seven of them put on the streets at first. The bill asked for powers to borrow any such sum as would be necessary for this purpose, subject to the consent of the Local Government Board.

Mr. J. G. GRIFFIN, said that £11,000 would be required for the tramway extensions, but that the cost of the motor omnibuses was not included in this. It was proposed to run the omnibuses every hour during the day up to 5 p.m., and a more frequent service between 5 p.m. and 10 p.m.

After consultation with the Committee,

The Chairman said that the Committee was of opinion that they could not grant the powers in connection with the motor omnibuses, owing to the fact that the Swindon Corporation had so many matters still in hand and undeveloped. In previous cases where powers to run motor omnibuses had been granted by Parliament, the tramway systems in the towns in question had been thoroughly developed. The Committee would, however, give the Corporation the tramway extension powers asked for, and an extension of two years for the construction of the already authorised lines.

On the consideration of clauses the Committee refused to grant the Corporation an extension of time for the commencement of payment of sinking fund upon the tramways loans already authorised.

The bill was then ordered for a third reading in the House.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

Confirmation Bill No. 3.

Applications by Gas Companies for the "Bermondsey" Clause.

A Committee of the House of Lords, of which His Grace the Duke of Northumberland is chairman, commenced consideration of this bill yesterday. The bill seeks to confirm a number of electric lighting provisional orders granted by the Board of Trade, there being a considerable amount of opposition on the part of the various gas companies, who desire the insertion of the "Bermondsey" clause in respect of extensions of area asked for by a number of local authorities.

Mr. BALFOUR BROWNE, K.C., on behalf of the County of Durham Electric Power Distribution Co., first made an application concerning the order granted to this company with reference to certain districts adjacent to Sunderland but not affecting the Sunderland Corporation. The Corporation, however, he said, who did not oppose before the Board of Trade, had now entered a petition against the bill, and in consequence the promoters had been compelled to bring up a number of witnesses at great expense only to find that no appearance was made on behalf of the Corporation. Otherwise the bill was unopposed, and he would ask, under the circumstances, that taxed costs should be ordered against the Corporation, in accordance with the Standing Orders of the House, on the ground that the opposition was unreasonable and vexatious. The reason for the opposition was that perhaps at some future date the borough boundaries would be extended to include the districts included in the present order. He asked for costs because no notice had been given of non-appearance.

The Committee unanimously decided that the Sunderland Corporation should be charged with costs.

The CHAIRMAN then suggested that as the opposition in respect of the other orders was all on the same point, it would be most convenient to hear all the cases before coming to a decision.

Mr. BALFOUR BROWNE, addressing the Committee in respect of the Maidenhead order, said that it authorised certain extensions of the already authorised area supplied by the Corporation of Maidenhead. As a matter of fact the area scheduled in the order was larger than the Corporation had asked for, but the Board of Trade had decided that the larger area should be included. On this point there was opposition from the Great Western Railway Co., as large ratepayers in Maidenhead, and he was bound to say that the Corporation did not want the extra area in question, and that if this were cut out the opposition of the railway company would be met. The other opposition was by the gas company, which asked that, so far as the area included in this order was concerned, the "Bermondsey" clause should be made applicable. He contended, however, that the principle of this clause was entirely wrong, and he would ask the Committee to support the policy of the Board of Trade which was to refuse to insert it. Naturally, the Maidenhead Corporation would not supply these outside districts unless they saw their way to make a profit, and the districts which were proposed, adjacent to the existing area, were very good ones, a large demand for electrical energy existing. It was quite true that it was through himself that the clause in question had been inserted on behalf of the South Metropolitan Gas Co. for the first time in the Bermondsey Electric Lighting Order, and although he was now repentent, he felt bound to point out that at that time there was considerable suspicion as to whether a corporation ought to carry on this form of municipal trading. But Parliament had now decided that local authorities should carry on this work. One of the main evils of the clause was to prevent a Corporation from doing the very thing which the gas companies asked—viz., that the undertaking should be carried on upon business lines. No man in his senses would say that the "Bermondsey" clause conduced to this. No one who was doing badly would ever think of raising his price. Counsel then went on to quote the various precedents both ways which have been reported in our columns from time to time, and argued that, practically speaking, we were at the parting of the ways, and the Committee was called upon to decide a very important principle. He did not ask that the "Bermondsey" clause should be modified in any way,

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but that a decision should be given whether any such clause was desirable. The object of the clause was not to protect the gas company's interests in any way, but to put a spoke in the wheel of all municipal enterprise in relation to electricity supply, and, therefore, it was of extreme importance that the point should be decided once for all. One great difficulty which the clause introduced was that it precluded the Corporation from entering into contracts for long periods, because a price could not be quoted which would hold good for more than a year. No such restriction was placed upon the gas companies. It was quite true that the Huddersfield Corporation, whose extension order was in this Confirmation Bill, had agreed to put in the clause to avoid opposition, but it did not matter in the slightest to Huddersfield, because their undertaking was a thoroughly established one.

Mr. E. MOON, K.C., on behalf of the Great Western Railway Co., asked the Committee to strike out the parishes of Hitcham and Burnham, the portions referred to above, so that his opposition would be met.

Mr. VESEY KNOX, for the Maidenhead Corporation, supported the application.

The CHAIRMAN said the Committee were agreed that this should be done.

The MAYOR OF MAIDENHEAD was then called, and gave evidence as to the progress of the existing electricity works.

Mr. PADDON, for the Maidenhead Gas Co., subjected Witness to a lengthy cross-examination as to the method of making out the Corporation accounts, the Mayor contending that everything had been carried out in good order as provided by the Board of Trade, despite nothing having been set aside for interest and sinking fund. Counsel said that if the accounts were kept as they should have been, a loss would have been shown of £2,000 instead of the £460 shown in the accounts. Mr. Paddon referred to the method of making out the accounts as an insult to the commercial susceptibilities of anyone who read them. On the general question of rate-aided competition, Witness refused to assent to anything put to him by counsel.

Mr. H. BURSTALL, of Messrs. Burstall and Monkhouse, consulting engineer to the Maidenhead Corporation, said that a large number of applications had been received from the outside districts. As to the effect of the "Bermondsey" clause, his opinion was that, during the early years of an undertaking, it would be absolutely fatal.

Mr. C. O. MILTON, electrical engineer to the Maidenhead Corporation, also gave evidence.

Mr. PADDON then addressed the Committee on behalf of the Maidenhead Gas Co., and made the usual arguments as to the unfairness of rate-aided competition, and pointed out that as only 10 per cent. of the population in Maidenhead took electrical energy, any loss had to be borne by the remaining 90 per cent. Further than this, the Maidenhead Corporation could not raise a penny in rates in the outside districts, and, therefore, if any extra loss was incurred it would have to be borne by the ratepayers inside the borough. With regard to the question of the effect upon contracts, he was willing to make it clear that the clause should not interfere with entering into contracts, as was the case in the Marylebone Act.

The Committee adjourned.

LEITH CORPORATION TRAMWAYS ORDER CONFIRMATION BILL.

In the House of Commons on Wednesday,

Mr. KERR moved, under sec. 9 of the Private Legislation Procedure (Scotland) Act, that the above bill should be referred to a Joint Committee of the Houses of Lords and Commons.

Sir L. McIVER pointed out that the object of the motion was to allow the Edinburgh Tramways Co. a *locus* to be heard before the Joint Committee as to their release from being compelled by statute to run a line of omnibuses, which would now be in competition with the Leith tramways as authorised by the order. The company, which had been refused a *locus* at the local inquiry, felt it unfair to be compelled to run a service of omnibuses in competition with up-to-date electric tramways.

Mr. Parker Smith, Sir Robert Reid, Mr. Worsley Taylor and Mr. Dalziel spoke against the proposal.

Mr. GRAHAM MURRAY said he thought the *locus* in this case was wrongly refused by the Commission.

On a division the motion was carried by a majority of 15.

OTHER ELECTRICAL BILLS.

All opposition to the *Bristol Tramways (Extensions) Bill* having been withdrawn, it has been referred to the Unopposed Committee of the House of Lords.

The *Holywood Tramways Bill*, which has passed the House of Lords (*The Electrician*, May 6, p. 110), is also now unopposed.

In the House of Lords on Thursday last week, the *Belfast Corporation (Tramways) Bill* was read a third time and passed. On Friday the *Lothians Electric Power* and the *Acton Improvement Bills* were read a third time. On Monday the *Trafford Park Bill* was read a third time and passed.

In the House of Commons on Thursday, the *North-Western Electricity and Power Gas Bill* was read a third time. The *Dundee, Broughty Ferry and District Tramways Order Confirmation Bill* and the *Leith Corporation Tramways Order Confirmation Bill* were read a second time. On Monday the London County Council (Money) Bill and the London County Council (Tramways and Improvements) Bill were read a third time.

The *Preston, Chorley and Horwich Tramways Bill* came before a Committee of the House of Commons, of which Sir Edward Strachey was chairman, on Monday. The bill, which has already passed the House of Lords (*The Electrician*, March 18, p. 873), asked for an extension of time for the construction of lines authorised in 1903, and the only opposition was by the Lancashire and Yorkshire Railway Co. in respect of the construction of a bridge over the Bamber Bridge level crossing at Walton-le-Dale. The House of Lords decision left it to the parties to come to some agreement, but this had been found impossible owing to the opposition of the local authority, and the Committee now gave the tramway company an alternative route, and found the preamble of the bill proved.

A Committee of the House of Lords, of which Lord Hawkesbury is chairman, considered the *Charing Cross, Euston and Hampstead Railway Bill* on Wednesday. The proposals of the bill, which has passed through the Lower House, are to make certain extensions beyond the limits of deviation as laid down in previous acts, to enlarge the tunnels in the neighbourhood of the Cobden statue, Camden Town for the purpose of a station and to acquire a small portion of Messrs. Reid's brewery property at the junction of Oxford-street and Tottenham Court-road. The only opposition is in respect of the latter, Messrs. Reid objecting to the cellars in question being taken by the railway company. The proceedings in the House of Commons were given in our issue of March 25. On Wednesday, evidence for the police authorities against the proposal was heard, but the Committee passed the preamble of the bill.

The *Baker Street and Waterloo Railway Bill* was before the House of Lords Committee of which Lord Hawkesbury is chairman on Wednesday. The measure has already passed the House of Commons, and was reported in our issue of March 18th last. Mr. Balfour Browne, K.C., described the proposals of the bill, which are to acquire some land in the Westminster Bridge-road and in Regent's Park, for the enlargement of the tunnels already authorised, under the Westminster Bridge-road and the Edgware-road, and to raise further capital of £288,000 with borrowing powers of £96,000. The London County Council opposed the bill so far as the further capital was concerned on the ground that the already authorised capital was sufficient. Mr. Galbraith and Sir Benjamin Baker, joint engineers to the company, described the works to be carried out, and allocated the new capital as follows:—Land, £168,000; extra equipment £176,000; sundry works, £40,000, these latter consisting chiefly of extra precations against fire. The secretary of the company stated that £1,522,000 had been expended, and that a further £1,486,510 would be required to complete the construction. Mr. Talbot, for the London County Council, submitted that the Committee should be satisfied that the capital powers of the company already authorised had been exhausted. It was not satisfactory that the company should merely say that their undertaking had been handed over to the Underground Electric Railways Co. of London. After consideration, the Committee found the preamble of the bill proved.

The *Bridlington Corporation Bill* came before the Unopposed Committee of the House of Lords last week. The bill is of an omnibus character, and provides for the extension of the existing electric lighting area, the letting on hire of electric motors, apparatus, &c.

The *Plymouth Corporation Bill*, which has already passed the House of Commons (*The Electrician*, April 29), was passed last week by the Unopposed Committee of the House of Lords.

The *Harrow Road and Paddington Tramways*, which has also passed through the House of Commons, came before the Unopposed Committee of the House of Lords on Tuesday, but was put back for further consideration. A report of the proceedings before the House of Commons Committee was given in our issue for April 1.

The *South Western and Isle of Wight Junction Railway Bill* has been passed by the Unopposed Committee of the House of Lords. The objects of the bill were set forth in our issue of March 11, when the measure was before a Committee of the House of Commons.

A Committee of the House of Commons, of which Sir Edward Strachey was chairman, considered the *Preston and Blackburn Tramways Bill* on Tuesday. The objects of the bill were set out in our issue of March 18, when the bill was before the House of Lords Committee, which passed the bill. The only opposition again was at the instance of the Lancashire and Yorkshire Railway, for whom Sir Ralph Littler, K.C., argued that, in view of the large sums of money which the company had spent upon improving the lines in the locality of Preston and Blackburn, to sanction a competitive tramway between those two points would be most unfair. The promoters, he said, admitted that the whole of the capital required under the bill would be found in London, so that there were no local people interested in the concern.

The Committee eventually rejected the bill.

THE POST OFFICE AND WAY-LEAVES.

In the House of Commons on Wednesday,

Col. DENNY asked the Postmaster-General whether there had been a number of interruptions on the telephone circuit erected for life-saving purposes between Padstow and Hawker's Cove, and, if so, whether steps could be taken to improve the service.

Lord STANLEY, in reply, stated that the telephone line in question was regarded by the Admiralty as a very necessary one, but the owner of the land over which the line passed had recently insisted upon the removal of the wires on account of the injury which they caused to his partridge shooting. The interruptions referred to had been caused in consequence of a temporary cable having had to be laid. In spite of an offer to pay a reasonable rent for any injury to the shooting, the owner of the land maintained his objection, and it would be necessary to re-erect the line on another route at a heavy cost to the public funds. Fortunately, such extreme unreasonableness was rare, but difficulties were so frequently put in the way of the Post Office in this manner that he was bringing in a bill which would give the Postmaster-General authority to deal with certain cases in which the present state of the law gave facilities for unreasonable obstruction.

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TELEPHONE RATES.

In a printed reply to Mr. O'Brien in the House of Commons on Wednesday, Lord STANLEY said that the ordinary rate of subscription for an unlimited local service on a Post Office provincial exchange was £7. 10s. a year. On the message rate system the subscription was £3 a year with a fee of 1d. for each local call originated by the subscriber. The *minimum* payment on account of the calls was £1. 10s. a year. The number of subscribers required to justify an extension of the telephone trunks system to Nenagh must depend chiefly upon the cost of constructing and maintaining the line between Limerick and Nenagh. He was obtaining estimates for this work, and will inform the hon. member of the number required as soon as possible. An extension of the telephone trunk system to Nenagh could be carried out at any time under a guarantee of about £145 a year for seven years.

TELEGRAPH CONSTRUCTION BILL.

In the House of Commons on Wednesday, Lord STANLEY introduced a bill to amend the Telegraph Acts, 1863 to 1904, with respect to the construction and maintenance of telegraphic lines.

The bill was read a first time.

GOVERNMENT PURCHASE OF THE TELEPHONES.

In the House of Commons yesterday,

Mr. LOUGH asked the Postmaster-General whether, having regard to the shortness of time now available, he could state whether he had come to any decision as to buying out the National Telephone Co. under the clause which permits of doing so this year by compulsory arbitration after six months' notice.

Lord STANLEY: After careful consideration I have arrived at the conclusion that it would not be in the public interest to exercise the compulsory powers of purchase reserved to the Postmaster-General by clause 17 of the National Telephone Co.'s licence. I shall, therefore, not give notice to the company under that clause, and I am unable to say at present whether the negotiations now in progress with a view to a voluntary sale will lead to a satisfactory result.

Mr. GIBSON BOWLES: Is it intended or not to continue the competition between the Post Office and the National Telephone Co., or do you propose to go on with the old arrangement?

Lord STANLEY: There is plenty of work to be done by the Telephone Department without actually entering into direct competition with the company. If these negotiations fall through—and I cannot now say whether they will or not—the circumstances will be entirely changed, and then I shall have to consider what action we shall take as regards competition.

FATALITIES ON ELECTRIC RAILWAYS.

In the course of a discussion on the Board of Trade vote,

Mr. SOARES said with regard to accidents on railways in course of electrification, the President of the Board of Trade recently stated that there had been two fatal and two non-fatal accidents, but that in all cases the sufferers were trespassers. He submitted that nobody had a right to kill a man for trespassing. The setting of man-traps was illegal, rnd he regarded these "live rails" as nothing more nor less than man traps of the most dangerous description, and that a man who by any mischance trespassed on a railway should be liable to be electrocuted was a dreadful thing. He believed the Board of Trade had power to protect the public, and he hoped the right hon. gentleman would see that all proper and necessary steps for that purpose were taken.

Mr. GERALD BALFOUR said that an inquiry had been ordered into the cause of that accident, but until he had received the report of the inquiry he could make no further statement.

LEGAL INTELLIGENCE.

Norwich Corporation v. Norwich Electric Tramways Co.

At Norwich Assizes on Tuesday and Wednesday Mr. Justice Phillimore heard an action to recover money paid by Norwich Corporation for the repair of roads alleged to have been injured by defendant company.

Mr. MACMORRAN, K.C., for plaintiffs, said the dispute was one that would have to be decided upon the construction of section 57 of the Norwich Electric Tramways Act, 1897. By sec. 28 of the Tramways Act, 1870, when tramways were laid down the tramway company were liable to keep in repair so much of the roadway as lay between the rails and 18in. outside the outer rails. If the company failed to do so the Corporation might, he contended, themselves at any time, after seven days' notice to the company, do the necessary repairs, &c., and expense reasonably incurred in so doing should be repaid to them by the company with 5 per cent. interest. The dispute turned upon the meaning of the fifth subsection of the section 57 of the act (dealing with the junction of the paving laid and maintained by the company with the surface laid and maintained by the Corporation) and involved a sum of £700 a year, or more. It was well known that where granite setts were laid on a macadam road there was a great tendency, which began at a very early period and went on increasing, for the road to wear close to the setts, so that in time, sometimes in a very short time, the setts stood up above the level of the macadam. That must inevitably happen, because the life of the setts was much longer than that of macadam.

The JUDGE: If it were all macadam and no tramway, it would all wear evenly?

Mr. MACMORRAN: Yes; and the Corporation maintained that the company were bound to see that a uniform surface existed—that was to say, a continuous surface from the setts to the macadam, and from the macadam to the setts.

The JUDGE: What would happen in the case of wood, if the whole street were paved with wood?

Mr. MACMORRAN: In that case the surface is continuous, and the tramway company repairs only 18in. beyond the outer rail. Wood wears uniformly. If the Corporation were bound to keep the macadam at the side of the tramway setts up to the level of the tramway, then there would be no additional burden placed by the 1870 Act upon the company beyond that which fell upon it under the general law. They must give some meaning to sub-sec. 5, and he submitted that that meaning was that the company should maintain the level of the road near to the lines.

The JUDGE inquired if the provision claimed by the Corporation was special to Norwich, or was it common to other towns.

Mr. LOW, K.C. (for defendants): I am informed it is unique.

Mr. MACMORRAN: I do not know that it is in any other act. There was no dispute as to the actual facts. It would be suggested by defendants that the real cause of the trouble was the failure on the part of the Corporation to keep their macadam up to the level of the setts. But there never was an obligation on the part of a road authority to keep their road to any particular level. They must repair the road in order to avoid its becoming dangerous. Doubtless if the Corporation fail to maintain the roadway there is a remedy against them.

Mr. A. E. COLLINS, M.Inst.C.E., the city engineer, said 2in. was the maximum drop. From the first moment of use they were wearing down the macadam at five times the speed of the granite setts, and it was only a question of time before a perceptible step was formed at the junction, and once that step was formed there was rapid destruction. In addition, the rut when formed would hold water, and would further tend to disintegrate the road. In consequence of the company refusing to have the work of repair carried out, the Corporation had done it. The line of contact between the company's and the Corporation's paving was (1) toothed, as between the company's granite and Corporation macadam; (2) straight, as between the company's wood with granite edging and Corporation macadam; (3) straight, as between the company's granite and Corporation wood; (4) toothed, as between company's granite and Corporation wood; (5) toothed, as between company's wood and Corporation wood; (6) toothed, as between company's granite and Corporation granite.

Mr. J. W. Cockrill, M.Inst.C.E., borough surveyor of Great Yarmouth, and Mr. E. J. Silcock, M.Inst.C.E., Leeds, corroborated Mr. Collins' evidence.

For the defendants, Mr. LOW submitted that on the true construction of the section in question there was no case against the defendants.

Mr. B. B. MORGAN, F.I.S., surveyor and assessor to Norwich Guardians, said he had inspected the roads, examining the conditions of the setts and of the macadam. Generally, the macadam had sunk by the edge of the granite setts. The sinking was from ¼in. to 2½in. In most of the places the road was very much worn. The whole roadway had sunk. In every case the depression was below the level of the rest of the macadam. That depression was in consequence of the greater wear on it, and the greater wear, he had no doubt, was in consequence of the presence of the tramway setts.

The JUDGE thought neither side need follow up that matter now. If the Court should find that that was a burden that ought to fall on the company, he had no doubt that very strict care would be taken that the Corporation did not allow their macadam to go too long, and thus be a burden on the company. But for the purposes of that case it was enough that there were cases in which the macadam was good enough, and where, therefore, nothing need have been done but for the depression complained of.

Mr. A. N. BANNISTER, manager of the company, said the Corporation roads where the steps occurred were generally bad.

Mr. I. E. WINSLOW, consulting engineer to the New General Traction Co., said clause 57 of the 1897 Act was an agreed clause between the parties.

Mr. STEPHEN SELLON, M.Inst.C.E., consulting engineer, said he had never known a clause such as 57, which he thought was meaningless.

Mr. LOW said on the general question no one would suggest that where one had in juxtaposition such materials as macadam and granite setts that the wear would be equal. It would suit the purposes of this Corporation very well no doubt if they had been able to get an enactment in which the company would be compelled to repair part of their road.

The JUDGE: You are so compelled in one instance where the road is very narrow.

Mr. LOW: But this is an attempt to get the same thing in by implication. The question was whether the Parliamentary contract that had been entered into between the parties would bear a construction which would compel the company to keep in repair a part of the roadway which the wording of the very sub-section said had to be laid and maintained by the Corporation. As to the meaning of the word "junction." It was not the junction "between," but the junction "of," the paving laid and maintained by the company with the surface laid and maintained by the Corporation. Junction was not a thing at all—it was a position; that was, the section contemplated the tramway and the roadway as a complete entity. The sub-section contemplated that as being constructed at a proper level. The Corporation could not be compelled to maintain the surface of their road in the position in which it was, but before the Corporation could complain they must maintain that which they had to

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maintain, for the company could not get a junction with nothing. The company, in fact, had no right to touch the road outside their 18in.

The JUDGE: Unless it is implied in preserving the union.

Mr. LOW said the "junction" referred to was simply the point of contact of the union between this macadam.

The JUDGE: But you do not keep in good condition a point or place. The Act of Parliament tells you to keep in good condition the juncture; you cannot keep a point in good condition.

Mr. LOW said he knew what a junction between a granite sett and a piece of macadam was—that was where the two met. But if they were to make that a shifting point, and to run about all over the road, in accordance with the softness of the material used or the negligence with which the road was made up, no company would ever risk such a liability.

Mr. MACMORRAN, in reply, argued that the word "junction" was one to which a variety of meanings could be given, and in the section of the act in question it meant the macadam next to the setts of the company.

The JUDGE ultimately said he would take time to consider the matter, and would give judgment in London.

J. H. Holmes & Co. v. John White & Co.

On Friday last in the Commercial Court, King's Bench Division, Mr. Justice Channell and a special jury heard a claim for £300 odd for goods sold and delivered and work done in connection with the installation of the electric light on the s.s. "Frascati," which was later lost at sea. The defence was that by the contract plaintiffs agreed to complete the installation and let it run in full working order for five consecutive hours and that until that was done the installation should remain the property of plaintiffs. Defendants urged that that clause had not been fulfilled.

A number of affidavits were read in which plaintiffs' witnesses declared that the installation was completed and those for the defence insisted that a number of defects had not been remedied and that the work had not been properly finished at the time that the steamer was lost.

His LORDSHIP thought that trial on affidavits in such a case was very unsatisfactory and upon the materials before him there was really no answer to the claim. If the ship had not been lost defendants might have established a counterclaim or obtained a reduction on the ground that some of the lights were not supplied, but that did not go to non-payment, but merely as to the amount.

Mr. ROBSON, K.C., for defendants, contended that there was no evidence whatever of the full completion of the installation and that unless that could be shown plaintiffs were not entitled to a verdict.

The jury found that a satisfactory test had been made and that defendants accepted and used the lights.

Judgment for plaintiffs, with costs.

Davis v. J. G. White & Co. (Ltd.)

In the City of London Court on Friday, the plaintiff, Mrs. Davis (wife of a Cricklewood fruiterer), sued defendants for £50 damages for injuries caused by being poisoned by coal gas. It appeared that Middlesex County Council were last year laying a light railway through High-street, Cricklewood, where plaintiff helped her husband in his shop. Willesden Council decided to have the roadway repaved, and defendants were given both contracts. Plaintiff contended that defendants' men punctured a number of gas pipes, and gas escaped, and she swallowed so much gas that she became unconscious. She was ill for a long time, and now demanded compensation.

Defendants denied their men were careless, and said the repairs were done as quickly as possible. The gas mains were so undulating that it was impossible to tell their exact position. Gas escaping in the open air could not (they urged) have caused plaintiff's injuries.

Mr. FOULGER, chief engineer of the Gas Light and Coke Co., said that the gas mains throughout London were necessarily zig-zag, or they would soon fill with condensation and London would be without gas light.

The jury found for plaintiff for £15 and costs on the higher scale, "in view of the public importance of the case."

Are Illuminated Signs Structures?

At Worship-street (London) Police Court last week London County Council summoned the proprietor of some baths in Brick-lane, Spitalfields, for putting up "a structure" or an "erection," without their consent. It appeared that a box with glass sides and front had been attached to a front wall, the box being illuminated at night from within by electric light. The box was supported by brackets, and had above iron braces hooked into eyes let into the wall. It was suggested that those braces, being removable, took the construction out of the character of a "structure in the nature of a building." The Council had taken out two summonses under secs. 73 and 22, because they could not decide whether the construction was an erection or a structure. Counsel pointed out, in the case of "Hull *v.* London County Council," which had raised a somewhat similar point, the County Council's contention had been over-ruled.

In giving his decision the magistrate (Mr. Haden Corser) said that, had he been left to his own judgment in the matter, he should have come to the conclusion that the construction was neither an erection nor a structure. But the decision of the High Court in "Hull *v.* London County Council" precluded his forming any judgment at all. That case and one against the London Illuminated Advertisements Co., virtually decided both points, and so the Council failed. In dismissing both summonses, he thought the County Council should not have taken the proceedings, and that it was a waste of public money. Defendant was entitled to his costs, and he awarded him £5. 5s.

Electro-Neurotone Co. (Ltd.) v. Dubois and Williams.

On Friday last this action came before Mr. Justice Grantham and a special jury in the High Court, and was for the recovery from defendants (a firm of solicitors) of damages for alleged misrepresentation and breach of contract. Defendants denied both the breach and the alleged misrepresentations.

Mr. LUSH, K.C., said the action was brought to recover damages for not making good an undertaking which defendants gave to plaintiffs. Plaintiffs were owners of some patent rights in an electrical apparatus in the nature of an electrical battery. The company was formed with a small capital for carrying on business in the sale of these articles. There were four directors, Messrs. Bailey, Hedges, F. G. Lloyd and Hodgkinson. Another person named Thomas, who was a company promoter, was desirous in 1902-3 of buying the business and goodwill of the company and selling it to a new company with a larger capital. Negotiations proceeded, and Thomas' scheme involved a reconstruction. Thomas wanted to buy all the shares except the seven "subscribed" shares. Thomas instructed defendants to act as his solicitors in the matter, and they did so act. The scheme went to the length that the shareholders of the company executed transfers of their shares in favour of Thomas, but inasmuch as it was not certain that the scheme would go through, Thomas executed re-transfers. The actual arrangement sued under was entered into in August, 1902.

The defence was that defendants simply acted as solicitors for clients throughout, and not personally.

Mr. LUSH said the company went into liquidation, and in liquidation it had remained. Defendants had never registered the company.

His LORDSHIP said he had no doubt that Mr. Williams had made himself personally liable to pay the money to register the company, and he would have to put the company back in its old position.

Mr. W. A. E. WILLIAMS, one of the defendants, denied that he gave any personal undertaking on behalf of his firm to the company. His firm had no interest in the matter except as solicitors for Thomas and the company. The cost of restoring the company to its original position would be about £160.

The jury found for plaintiff company, and assessed the damages at £100. Judgment was entered accordingly, stay of execution being refused.

Nicklin v. Bertwistle.

At Burnley County Court recently William Nicklin, electrician, sought to recover £80. 0s. 6d. as damages from James Bertwistle, master joiner and builder, for injuries received through his alleged negligence.

It appeared that in November last plaintiff was employed by Messrs. Simpson Bros, Hapton, to put up electric fittings in a house. Other work was being done at the place, and defendant, who had the carpentering contract, had erected a temporary staircase. After plaintiff had worked at the house a fortnight the stairs suddenly collapsed as he was going up, and he was precipitated to the ground, sustaining injuries to his wrist, his thigh and his eye. It was argued that defendant had put up the steps negligently, and was liable for plaintiff's injuries. There was no remedy against his employers (Messrs. Simpson) either under the Workmen's Compensation Act or at common law, and his only remedy was, therefore, against defendant, whom, it was contended, as a contractor working in the house, occupied the same position as the owner of the house. It was further contended that there was an implied invitation to the workmen to use this stairway.

For the defence it was submitted that defendant was not liable. The contract for the building of the house was originally let by the architect to a Mr. Duxbury, who let the sub-contracts, and the electrical contract was let by the owner himself. There was no privity of contract between the parties, and counsel contended there was no duty and no responsibility on defendant. Plaintiff never asked per mission to go up the stairs and none was given. Even if the stairs were not safe, defendant was not liable.

His Honour held there was no evidence against defendant. There was no invitation to use the stairs; the mere allowing a person to enter the premises was not enough. Judgment was then entered for defendant.

Re British Aluminium Co. (Ltd.)

In the Chancery Division on Tuesday Mr. Justice Buckley sanctioned the petition of this company for the reduction of its capital from £400,000 to £310,000.

National Electric Traction Co. (Ltd.)

A petition of the Consolidated London Properties (Ltd.) was before Mr. Justice Buckley on Tuesday, but the petitioners' debt having been satisfied, as well as that of another creditor supporting the petition, it was dismissed.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"The Management of Electric Tramways and Light Railways." By W. R. Bowker. (London: E. and F. N. Spon.) 9s.

"Journal of the Institution of Electrical Engineers." Vol. XXXIII. Part 3. May, 1904. (London: E. and F. N. Spon.) 5s.

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MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Council of the University of Birmingham, who have created a Chair of Electrical Engineering, are inviting applications for the professorship at £1,000 per annum, with liberty to undertake certain consulting work. Particulars from the secretary, to whom applications by Aug. 1.

A lecturer in mathematics is required at Birmingham Municipal Technical School from Sept. 1 next. Commencing salary, £175 per annum. Applications by June 30. Particulars from the secretary (Mr. George Mellor), Suffolk-street, Birmingham. See also advertisement.

Finchley Local committee for Technical Instruction require a teacher for electric lighting and wiring for evening classes at Christ's College, Finchley, during 1904-5 session. Applications to Mr. John Cogdale, Bowes-road Council School, New Southgate. See also advertisement.

An assistant demonstrator in physics and chemistry departments (at a salary of £150 per annum) and an assistant mathematics lecturer for two evenings per week (at £12 per session per evening) are required at the Northern Polytechnic Institute, Holloway, London, N. Applications to the clerk to the Governors, Mr. W. M. Macbeth, by 28th inst. See also advertisement.

A teacher is wanted in the electrical laboratory at the Great Eastern Railway Institute, Stratford, E., for evening classes in electrical engineering and magnetism and electricity. Applications to Mr. A. J. Hill, G.E.R. Locomotive Works, Stratford, E., by June 23. See advertisement.

Enfield Committee for Technical Instruction require a teacher for an electric lighting class to be held at Ponder's End on Wednesday evenings during session 1904-5. Applications to Mr. E. K. Andrews, 23, Essex-road, Enfield. See advertisement.

A junior lecturer in mathematics is required for University College, Nottingham. Salary £130, rising by £10 a year to £180. Applications (on forms supplied by the Registrar) by June 20.

A fully-qualified engineer is wanted as car-shed foreman by Rochdale Corporation for their tramway department. Wages £3. Applications by noon 22nd inst.

Stockport Tramways committee require a car-shed foreman. Applications to chairman by noon of June 20.

Mr. John Wilson, B.Sc., has been appointed junior assistant in the physics department of Merchant Venturers' Technical College, Bristol, in place of Mr. Margetson, promoted to an assistant lectureship in the engineering department. Mr. Wilson gained the Pemberton scholarship at the Durham College of Science in 1900, and a special exhibition in 1901. In 1902 he took the degree of B.Sc., with distinction in physics. He also passed the intermediate examination for the B.Sc. (London) in 1903, with first-class honours in physics and second-class honours in mathematics.

Mr. Alex. Gow, principal of Warrington Technical School, has been appointed, out of 93 applicants, principal of Blackburn Technical School at £500 per annum.

Motherwell Town Council have appointed Mr. S. Williams, mains superintendent, to the position of burgh electrical engineer, in succession to Mr. S. E. Britton.

Wakefield Electric Lighting committee have selected Mr. A. Neville, of Southampton, for the position of first assistant engineer at £150 per annum.

Mr. J. T. Boothman of Nottingham has been appointed clerk of works at Loughborough Corporation electricity works at £2. 12s. 6d. per week.

Acton.—An inquiry will be held this (Friday) afternoon into the application of the District Council to borrow £54,091 for electricity supply.

Ameraham.—The Uxbridge and District Electric Supply Co. have notified the Council of intention to lay elecric lighting mains in the district.

Ashton-under-Lyne.—£400 is to be expended in alterations of the main switchboard and switchboard gallery, and an additional Weir pump is to be purchased. The charges for current to private consumers are to be considered at an early meeting of the Electricity committee.

Barnsley.—The Council have applied for a loan of £800 for further standards and arc lamps for street lighting.

Basingstoke.—The Town Council have decided upon the Town-yard site for an electricity generating station.

Bedlington.—The Northern Counties Electricity Supply Co. notifies the Council that the laying of electric lighting mains in the Cambois district is to be shortly commenced.

Birmingham.—The Tramways committee has reported to a special meeting of the Council that the mileage of tramways in Birmingham is less than in other large towns, and that the narrow and congested streets are a serious obstacle to connecting up the existing tramways. To facilitate traffic it is proposed to construct a series of loops instead of "dead-end" termini. They recommend the promotion of a bill authorising the construction of new lines to serve Nechells, Saltley, Washwood Heath, Bordesley Green Deritend, Digbeth, Carr's-lane, Small Heath, Sparkbrook, Balsall Heath, Moseley, Harborne, Ladywood and All Saints. The scheme comprises the construction of 39¼ miles of single track, and is estimated to cost, if the overhead trolley system is adopted, £295,000. Consideration of the report has been postponed until July 5.

The Council approved proposals to borrow £32,000 for relaying and converting to electric traction the Small Heath tramway, and £7,610 for the extension of the Coventry-road tramway.

Birmingham Tramways committee and Aston Corporation have come to terms as to running powers, and cars now run through between Steelhouse-lane and Aston Cross.

Blackburn.—The annual report of the borough electrical engineer (Mr. Alfred S. Giles) on the working of the Corporation electricity deparment for the past year states that the total receipts were £28,549. 16s. 6d., and the working expenses £13,892. 16s. 7d., leaving gross profit £14,656. 19s. 11d.

After paying interest (£6,195. 10s. 1d.), sinking fund instalment (£7,028. 5s.) and interest on temporary loans (£201. 4s. 2d.) there was a net profit of £1,634. 9s. During the year 2,895,181 units were sold, an increase of 15 per cent. over last year. The number of consumers on March 25 was 990, an increase of 100, and the total connections were equivalent to 138,485 8 c.p. lamps, against 106,866. The works cost was 0·65d. per unit, compared with 0·79d. in 1903, the total cost (including management and distribution) being 1·05d., against 1·2d. Various extensions were completed during the year. The new switchboard has been erected, and the work of changing over the connecting cables of the generators and the numerous feeders supplying the town will be completed during the next few months to be in readiness for next winter. The surplus of £976. 9s. 6d. (after paying the adverse balance of £657. 19s. 2d. from previous years) has been carried to reserve. The total capital expended is £220,466. 12s. 1d., an increase of £45,776. 12s. 9d. for the year. There are 205 arc and 432 incandescent lamps for public lighting, and the total maximum supply demanded was 1,778kw. In order to increase the demand for current for lighting and power, the Corporation have decided, on the recommendation of Mr. Giles, to reduce the charges for current. The equivalent of about 820 H.P. in electric motors is connected. The reduced charges were given in our issue of June 3.

The Council have adopted a system of bonuses to tramway motormen for economy in consumption of electric energy. Hitherto the energy consumed per car per mile has varied as much as 30 per cent.

Camberwell (London).—The Council have asked London County Council to obtain powers to construct a tramway from the authorised line at Camberwell Green to Forest Hill and on to the Crystal Palace.

Carnarvon.—The Town Council have received sanction to a loan of £17,000 for electricity supply.

Chester.—The Council have increased the pay of motormen from from 5d. to 5½d., and that of conductors from 4d. to 4½d. per hour.

Coventry.—There was a net profit of £775 on the past year's working of the electricity undertaking.

Croydon.—Alterations and extensions of mains estimated to cost over £2,600 were authorised at the last meeting of the Corporation. A proposal to apply for sanction to a further loan of £20,000 for future extensions of mains, &c., was deferred. Application has been made for sanction to borrow £10,000 for tramways, including £7,164 for 10 new bogie cars.

Customs Decisions.—Auto-transformers (not being static transformers) imported into the Australian Commonwealth are liable to a duty of 12½ per cent. ad val., and conduit of indurated fibre, for electrical uses, to a duty of 20 per cent. ad val.

Devonport.—The Council have increased the salary of the borough electrical engineer (Mr. J. W. Spark) from £250 to £275, and that of the assistant engineer (Mr. W. J. Stamp) from £130 to £140.

Dudley.—Mr. Reginald P. Wilson has been retained by the Council as consulting electrical engineer for another year. The appointment of a borough electrical engineer has, it is stated, been deferred until arrangements with the tramways company are completed.

Ealing.—During the year ended March 31, 753,910 units of electric energy were supplied to private consumers, producing £17,564. 10s. 9d., less £110. 4s. 6d. for discounts, &c.

Meter rentals produced £609. 5s. 7d., public lighting (307,400 units) £3,332. 15s. 5d., repairs and maintenance of lamps £252. 2s. 6d., and with incidental charges, &c., total receipts were £21,797. 5s. 8d. Generation expenses came to £6,698. 1s. 2d., cost of distribution £286. 6s. 7d., management expenses £1,300. 13s. 11d., rent, rates and taxes £1,037. 1s. 8d., &c. Gross profit was £9,654. 5s. 10d. Interest required £4,324. 19s. 10d., sinking fund instalments £3,904. 5s. 6d., bad and

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doubtful debts £75, leaving net profit £3,838. 11s. 6d. The total capital expended to March was £158,072. 16s. 5d., an increase of £20,524. 2s. 1d. for the year.

Edinburgh.—The Council have approved the following increases of salary to the undermentioned officials of the electricity department:—

Chief assistant engineer, from £350 to £375 per annum; station engineers (5), from £160 to £200; second assistant to superintendent of mains, from £120 to £160; superintendent of meters, from £250 to £275; clerical assistant to engineer, from £200 to £220; assistant clerk, from £110 to £120 per annum.

It has been decided to entertain Councillor Mackenzie, who has retired from the position of chairman of the Electric Light committee, at a dinner on July 12, when he will be presented with an illuminated address in recognition of his public services to the city.

Egypt.—The proprietors of the "Egyptian Gazette," 36, New Broad-street, London, E.C., inform us that, should any of our readers desire to have information concerning trade with Egypt, such information can be obtained at the above address. We gather from the letter to hand that the "Gazette," which is published daily, and was established in 1880, represents the British Chamber of Commerce of Egypt in this country.

Electricity in Wool Sorting.—Wool sorters run great risk of contracting anthrax, by inhaling germs with the dust from the wool. Under the old system the dust is drawn by a current of air into a large room where the greater part of it settles on the floor, but the finer dust escapes through an opening provided to emit the air. This arrangement is open to the objections that the settling chamber occupies too much space, that the fine dust may carry the infection into the open air, and that the subsequent removal of the settled dust is more dangerous than the sorting itself. Messrs. Matthews and Yates have recently put on view at the exhibition now being held at Bradford apparatus which draws the dust by means of fans from the sorting boards, separates the dust from the air by centrifugal force, and deposits it in a sack or in the boiler furnace, the air escaping dust-free and much valuable space being saved.

Electric Smelting of Ores.—Dr. Hannel, superintendent of mines for Canada, who was sent by the Canadian Government to Europe, in company with other commissioners, to ascertain the economic possibilities of electric smelting of ores, has made a preliminary report to the Minister of the Interior in which he pronounces the process both economical and easy, and urges its adoption in the Dominion.

Exeter.—A discussion took place at last week's Council meeting on the proposal to open a showroom for the display of electric light fittings, motors, &c. Exception was taken on the ground that the Council were embarking in unfair trading with some of their own ratepayers. It was eventually decided to open the rooms, but not to undertake the sale of fittings and apparatus.

Exhibition.—The Second International Colliery Exhibition will be opened at the Agricultural Hall, London, on June 25. As on previous occasions, the promoter is Mr. H. Greville Montgomery.

Fatalities.—Two accidents occurred on the electrical portion of the North-Eastern Railway on Monday. At Manors station, near Newcastle, a porter named Inness was crossing the line at noon, when he tripped and fell on to the live wire. A shunter who was near pulled him off the rail. A doctor who was sent for found Inness was dead.

At the inquest on Tuesday, the jury found that deceased had died from shock as the result of coming in contact with the live rail, and added a rider to the effect that all electric lines should be protected where traffic was likely to take place.

Later in the day another accident happened at Wallsend station, where a man came in contact with a live wire and received injuries.

An inquest was held at Formby, Lancs., on Saturday concerning the death of Patrick Flood, a labourer, who was killed on Thursday last at Formby, on the electrical portion of the Lancashire and Yorkshire Railway. It was stated that in order to get on to the line Flood must have climbed over a 6ft. hurdle fence.

The Resident Engineer (Mr. H. E. O'Brien) at the Altcar generating station gave evidence and stated that wherever the public had a right to be on the line the live rail was protected.

The Coroner said that, despite all the provisions that scientific men were continually making for the protection of life, fatalities were still occurring. They could not provide for every contingency. In the present case, notwithstanding the notice boards warning people not to go near the live rail, Flood and a companion named Matthews had gone where they had no right to be—in fact, were trespassing. The former was killed and the latter received a severe shock.

Mr. Parmiter, for the railway company, said that they were not, in a case of that kind, bound to get the approval of the Board of Trade, but for their own satisfaction and that of the public, Col. Yorke, chief inspecting officer and Mr. A. P. Trotter, the electrical adviser to the Board, inspected the line, with the object of seeing whether they approved of what the company had done for protecting the public.

The jury returned a verdict of accidental death.

Folkestone.—The Earl of Radnor (the lord of the manor) was recently asked by a deputation from the Council to withdraw his objection to the overhead system of traction. This he declined to do, and it is probable that the "G.B." surface-contact system will be adopted.

Hampstead (London).—The Finance committee have been considering the proportion of "general establishment expenses" to be borne by the electricity undertaking, and recommend that the amount to be debited for the year ended March 31 be £14,000. In future a pro rata charge is to be made according to the number of consumers at the end of each financial year.

Hessle.—The Council will apply for a provisional electric lighting order.

Hove.—The Council have given notice to Brighton Corporation of intention to exercise their powers under sec. 16 of the Electric Lighting Clauses Act, 1899, to themselves lay the cable in Hove from Southwick power station in connection with the bulk supply which is to be taken from Brighton.

Ilfracombe.—The Council have made arrangements with the local electric light company for supply of current for lighting the popular Victoria Pavilion at the foot of the Capstone with coloured electric lamps.

Johannesburg.—"South African Mines, Commerce, and Industry" says the town engineer has been instructed to invite tenders for the steel work of Twist-street bridge, and car sheds and workshops in connection with the municipal electric tramway project. The estimated total cost of the car sheds is £22,500, and the cost of the workshops is included in the £74,520 provided for generating station and other buildings. It is intended to invite tenders from local contractors for the steel work, allowing time for the material to be obtained from Europe.

Kidwelly.—A committee has been formed to collect information as to electricity supply.

Kirkcaldy.—The receipts on the Corporation tramways for the year to May 15 were £9,934. 8s. 7d., and the undertaking already pays its way without assistance from the rates. 301,779 car-miles were run, and 2,770,936 passengers carried at an average fare of 0·87d. 395,071 units of electric energy (at 1¾d. per unit) were consumed during the year. A profit is also shown on the working of the electricity supply undertaking.

Leamington.—The Council will raise no objection to the Leamington and Warwick Electric Co.'s application for an extension of 12 months to construct their electric tramways.

Leeds.—The Tramways committee held a special meeting on Monday to consider the objections of the tramway employés to the committee's arrangements for split turns on the tramways.

The committee have had detailed statistics prepared, which show that the average "spread" of duty is 66 hours 48min. per week to earn pay for about 60 hours, and each man has to work 27 Sundays in the year against 26 under the old conditions. No resolution has yet been passed as to a reply to the men, and another meeting will be held shortly to consider the matter, probably on Monday next.

Leeward Islands.—Among the public improvements carried out during 1903 in Dominica was the establishment of telephonic communication between Roseau and Portsmouth. There are now 36 subscribers and 96 miles of wire. The system has proved of great value.

There is no telegraphic communication between the island of Montserrat or the Virgin Islands in this group.

The telephone is established in the Presidencies of Antigua and St. Kitts as well as in that of Dominica. In 1903 there were 145 subscribers and 260 miles of wire in the former island and 79 subscribers and 251 miles of wire in the latter.

Light Railway.—The Board of Trade have, after modification, confirmed the order transferring to Lowestoft Corporation the powers conferred by the East Anglian Light Railways Order, 1902.

Lincoln.—The accounts of the electricity undertaking for the year ended March 31 show total receipts £6,201. 1s. 9d., including £5,186. 13s. 3d. from sale of current for private lighting and £277. 6s. 4d. from power consumers.

The profit on sale of lamps, &c., was £60. 8s. 10d. Expenditure was £2,700. 10s. 4d., including £1,672. 15s. cost of generation, £136. 3s. 1d. for distribution, management expenses £576. 17s. 8d. Gross profit was £3,500. 11s. 5d., compared with £2,978 in the previous year. After providing for interest and sinking fund (£2,735), the net profit was £766, compared with £339. The accumulated deficiency at the beginning of the year was £1,665, and the profit has been devoted to writing down this amount. Total capital expenditure was £47,052, an increase of £1,540 during the year. In the report of the city accountant (Mr. J. H. Burgess), which accompanies the accounts, it is recommended that, in order to provide for possible risks arising from obsolescence of machinery, any balance of profit which may be available at the end of the current year be applied towards depreciation. The total maximum supply demanded during the year was 372kw. There are 396 consumers, representing 28,365 8 c.p. lamps connected. The average number of lamps per consumer is 71·63.

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London County Council.—At Tuesday's meeting it was agreed to loan £10,634 to Hammersmith for electric light installation and meters.

St. Marylebone Electric Lighting.—The Finance committee reported again upon the question of the application of Marylebone to borrow £1,881,444 for the acquisition of the undertaking of the Metropolitan Electric Supply Corp. within the borough and the erection of further works. Marylebone asked the Council to advance £1,365,000 of this immediately, and the County Council made provision for it in their money bill. Now, owing to orders made by the Court, the Borough Council require an additional £50,000, and the committee recommended that £1,415,000 be lent instead of the £1,365,000, as first agreed, the loan to be advanced on or before Oct. 31.—Agreed.

London County Council Tramways.—The Streatham tramways, which have been completed by the contractors, Messrs. J. G. White & Co. two weeks ahead of their contract, will be opened for traffic on Sunday.

London United Tramways.—Middlesex County Council offer to consent to the widening of Hayes and Southall canal bridges by the company (to permit of a double line of tramways) provided the company will agree to make the bridges 50ft. in width.

Louth.—The Council decided on Wednesday to discontinue negotiations with the National Electric Construction Co. as to electricity supply and to establish municipal works.

Lowestoft.—The tramway manager is reporting on the question of adopting a parcels delivery system in connection with the tramways department.

Metropolitan Asylums.—On Saturday the Board accepted the following offers to supply electric current:—

From Hackney Borough Council for Eastern Hospital, 4d. per unit for lighting, subject to 10 per cent. discount if account paid within 21 days; 2d. net per unit for power. From Fulham Borough Council for Western Hospital, 5d. per unit for an average consumption of 12 units per 8 c.p. lamp per annum; 4d. for an average of 12 to 24 units; 2d. for all units over an average of 24 units.

Telephone installations are to be provided at both hospitals at a cost of £280 for the Eastern and £300 for the Western Hospital.

Motherwell.—During the past year 118 new consumers were connected, compared with 74 in the previous year, bringing the total to 282. The total connections are equal to 35,056 8 c.p. lamps, an increase of 11,847.

The number of units sold was 724,279, compared with 291,247. Works costs were £2,649. 7s. 10½d., equal to 0·88d. per unit, compared with 291,247 units for previous year at £1,548. 12s. 5d. (1·28d. per unit). During the year 111 additional public lamps were erected, bringing these to 603. The expenditure on the year was £3,033. 7s. 8d. The total income was £6,735. 8s., against £4,335. 5s. 5d., an increase of 55 per cent. The gross profit was £3,702. 0s. 4d. Interest was £1,738. 9s. 11d., sinking fund £1,800, leaving a net profit of £163. 10s. 5d., which has been carried to credit of "free" wiring account.

On the motion of the convener (Bailie Wilson) the Electricity committee have unanimously recorded the regret of the committee at Mr. Britton's resignation, and their cordial appreciation of his services during the 3½ years he has acted as burgh electrical engineer. A testimonial to this effect is to be presented to Mr. Britton.

Municipal Telephony.—It is stated that the accounts of Brighton municipal telephone department for the year ended March 31 show a deficit of £1,878 after charging £1,430 general expenses to capital account and without allowing for depreciation. The full accounts have not reached us.

At Swansea on Monday the chairman of the Telephone committee (Mr. D. Davies) said that the question of telephonic intercommunication between the Corporation and the National services was still under consideration, and that counsel's opinion was being obtained on the question of applying for a mandamus.

Newport (Mon.)—The past year's working of the electricity undertaking showed a deficiency of £225. 0s. 4d , and of the tramways a profit of £399. 17s. 9d. Next year, with all the tramway routes working, the Corporation anticipate a fair profit all round. During the year 4,473,011 passengers had been carried.

Northfleet.—The Council will oppose the application of Gravesend for a provisional electric lighting order for Rosherville.

Obituary.—Mr. A. Le Neve Foster, for many years connected with the Silvertown Company, and of late years with Messrs. Davis and Timmins, passed away on June 7, aged 61.

Paisley.—The new electric tramway service was inaugurated on Monday.

Personal.—The "London Gazette" for June 14 contains an announcement of the appointment of Mr. Gilbert Scott Ram electrical inspector in the factory department of the Home Office.

Porto Rico.—Considerable trade developments are taking place at Porto Rico under the ægis of its new owners, the United States. Exports and imports are increasing, and up-to-date methods of handling these goods are being introduced. The sugar-cane cars are now being discharged by means of electric cranes, which have proved very successful in this special class of work. The American Railroad Co. owns a large number of these cars. The company has also an extensive electrical plant for supplying power to its workshops and factory and to eight irrigation stations, where electrically-driven Root centrifugal pumps are employed.

The Ponce Electric Railway and Lighting Co. owns a successful overhead trolley tramway, and has completed its electric lighting station. There is another local electricity supply company which has previously been working successfully, but is likely to succumb to the competition of its aggressive rival.

At Arecibo the municipal electric lighting service for public and private supply has been successfully inaugurated.

Portsmouth.—It was reported at a meeting of the Tramways committee last week, that the points in various parts of the borough were pretty nearly worn out. They were given a life of two years, but have been in use three years. The committee decided that they should be replaced with long points, which would prevent cars jumping and would obviate the necessity of employing point boys, as the motorman would be enabled to manipulate them with an iron bar without leaving his post.

On the recommendation of the Tramways committee the Town Council have increased the salary of the general manager of the tramways (Mr. W. R. Spaven) to £400 per annum, with an ultimate increase to £500 by two annual increments of £50 each.

Portugal.—The electric tramway which was inaugurated a short time ago from Cintra to Collares is to be extended to the sea coast. Electric tramways are becoming very popular in Portugal, and also in the Portuguese colonies.

The principal thoroughfares of Lisbon, and, in fact, all the principal towns in Portugal, are now lighted electrically, and it is stated that activity prevails in this branch of industry in that country.

Amongst the alterations proposed in the existing customs tariff, it is suggested that the duty on imported steam engines should be according to weight instead of, as at present, horse-power.

Presentations.—At the Brompton and Kensington electricity works on Friday last Mr. W. J. Allbright, who is leaving to take up the position of resident engineer to the Crystal Palace District Electric Supply Co. (recently acquired by the Blackheath and Greenwich District Electric Light Co.), was presented with an illuminated testimonial, signed by about 60 of the staff and employés, and a gold watch. Mr. H. W. Bowden, manager and chief engineer of the Brompton and Kensington Company, in making the presentation, referred in eulogistic terms to Mr. Allbright's ability and the regret which his departure caused in all departments.

Mr. W. J. S. Jones (late of Queensland), engineer to the works department of the County of Durham Electric Power Supply Co., was married last week to Miss Sallie, second daughter of Mrs. and the late Mr. R. H. McBryde, of Newcastle-on-Tyne. On 1st inst. Mr. Jones was entertained by his colleagues at the Gateshead power station to a luncheon, and was presented with a case of cutlery and a silver fruit dish. The chair was taken by Mr. W. J. Charlton, secretary to the County of Durham Electrical Power Distribution Co., the vice-chairman being Mr. A. S. Esslemont, managing engineer. The presentation was made by Councillor J. W. Laws.

Radcliffe (Lancs.)—The electricity works are approaching completion and current will be available in a few days.

Reduced Telegraph Rates.—The Eastern Telegraph Co. notify the following reduced rates per word on telegrams "via Eastern" on and after 1st prox.:—

To Spain, Portugal and Gibraltar, 3d.; Malta and Tangier, 4½d.; Greece and the Island of Crete, 6d.; Tripoli (North Africa), 7d.; Cyprus, 1s. 5d.; Egypt (Alexandria and all stations in First Region), 1s. 5d.; Egpyt (all stations in Second Region), 1s. 10d.; Egypt (all stations in Third Region), 2s.; Suakim, 2s.; Hedjaz (Jeddah and other stations via Jeddah), 3s. 3d. To West Africa: Sierra Leone and Conakry, 3s. 6d.; Grand Bassam, 4s. 6d.; Accra and Sekondi, 4s. 8d.; Lagos, Brass, Bonny and Kotonou, 5s.; French Congo (Gaboon, &c.), 5s. 5d.; British Borneo (Labuan), 3s. 6d.; British Borneo (other places), 3s. 9d.; Siam, via Moulmein, 3s. 3d.

Rhyl.—The District Council offer to supply electric current to Queen's Palace-buildings at 3¼d. per unit, if 40,000 units are taken per annum.

Ship Lighting.—The new first-class armoured cruiser "Duke of Edinburgh," which was launched on Tuesday at Pembroke Dock, is lighted throughout by electricity, the installation having been supplied by Peter Brotherhood, London.

There are six dynamos, two sets of electrically-driven air compressors and one electrically-driven ice machine. The boiler installation comprises 20 Babcock and Wilcox water-tubes and six cylindrical boilers. The ship is ventilated by electrically-driven fans conveying air through a system of pipes to the several compartments.

Shrewsbury.—For the twelve months to March 31 the total capital expenditure of the electricity department was £45,319. 11s. 1d., an increase of £1,289. 8s. 9d. during the year. The year's revenue was £6,487. 5s. 11d., including £4,632. 8s. 6d. from private lighting, £32. 9s. 3d. for charging private batteries and repairs, and £1,560. 18s. 10d. for public lighting, &c.

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Total expenses were £3,019. 8s. 8d., including £2,069. 8s. 10d. for generation, cost of distribution £140. 10s., rates and taxes £167. 6s. 5d., management expenses £407. 19s. 6d., &c. Interest absorbed £1,452. 11s. 6d., sinking fund £1,730; £500 was carried to reserve, leaving net profit £353. 13s. 6d. 402,727 units of electrical energy were generated during the year; 246,474 were sold to private consumers, 117,162 supplied to public lamps, and 1,391 sold for charging small batteries. The total maximum supply demanded was 291kw.

Southampton.—Application has been made for sanction to borrow £2,000 for extensions of mains and house services. Sanction to a loan of £2,288 has been received for the electric lighting of St. Mary's-road and for laying new mains in two additional thoroughfares

The electrical engineer (Mr. H. F. Street) recommends the erection of 28 additional arc lamps in various thoroughfares and the town clerk has been instructed to prepare a memorial to the Board of Trade for their consent to the laying of mains and services for private lighting in streets not repairable by the Council, in order that the Council might be in a position to lay mains and services in these streets when the demand for electricity should warrant it.

South Staffordshire Tramways.—The steam cars on the Dudley, Tipton and Wednesbury line were stopped on Tuesday to enable the work of reconstruction to electric traction to be commenced.

Southport.—The receipts of the Corporation tramways department for the past year were £17,646, compared with £16,887 the previous year. Working expenses were £10,986, against £11,231. Out of the balance (£6,600) interest on loans absorbed £3,803 and £3,198 was required for sinking fund, leaving a deficit of £341, compared with £1,223 on the preceding year. The number of passengers carried and the car-miles run show increases of 301,774 and 12,695 respectively.

The electricity undertaking shows a net profit of £3,515 for the past year.

Stafford.—The accounts of the Electricity department for the year ended March 31 show total revenue £2,879. 7s. 10d. (including £2,694. 3s. 10d. from sale of current for private lighting).

Total working expenses were £1,332. 3s. 5d., including generation £989. 11s. 3d., distribution, &c., £60. 8s. 11d., and rents, rates and taxes £232. 13s. 6d. Gross profit £1,547. 4s. 5d. Interest required £889. 8s. 10d., sinking fund instalment £962. 13s. 2d., depreciation £611. 17s. 11d., and bonus to workmen £15. 2s. 10d., leaving a deficit of £931. 18s. 4d. The total revenue per kilowatt capacity of plant was £7. 4s. 8d. and the working expenses £3. 7s. The revenue per 8 c.p. lamp connected was 4s. 4d. The maximum supply demanded was 173kw. The number of private consumers is 195, with an equivalent of 13,398 8 c.p. lamps connected.

In pursuance of an arrangement sanctioned by the Council, a bonus of £22. 10s., representing 4½ per cent. on wages, has been paid to the officials and workmen of the electricity department.

Swinton.—The Swinton and Pendlebury District Council are negotiating with Edmundsons' Electricity Corp. for taking over the Council's electric lighting order.

Taunton.—The gross profit shown in the accounts of the electricity department for 1903-4 was £3,652. After providing for interest and sinking fund instalments, &c., the net profit was £8. 19s. 3d.

Telegraphic Communication with Nigeria.—It is announced that the land line connecting Lagos with Forcados, Southern Nigeria, is to be completed and opened for traffic in a few days. Old Calabar, the headquarters of the Southern Nigeria Government, has also been put into telegraphic communication with the United Kingdom.

Torquay.—The equivalent of 22,176 8 c.p. lamps are now connected (176 above the capacity of the plant), against 20,868 in June last year.

Tunbridge Wells.—The receipts of the electricity department for the year ended March were £12,491, including £7,014 from private consumers, £2,537 from public lighting and £405 from meter rents, &c. Working and management expenses were £7,809, leaving £5,087 gross profit. Dividends on and redemption of stock required £4,375 and interest £339, leaving net profit £372. 11s., which has been added to reserve, now £3,488. £74,442 has been spent on capital account during the year for permanent works. 1,005,210 units were generated (against 892,712 in previous year). Private consumers had the equivalent of 52,504 8 c.p. lamps connected, compared with 49,878 lamps in the previous year.

Tunstall.—The Council have provisionally agreed to consent to an application for an electric lighting order by Burslem Corporation.

West Bromwich.—The borough electrical engineer (Mr. J. H. Wray) has issued a supplementary report dealing with the capital expenditure and revenue of the "free" wiring and motor hiring department to March 31.

In accordance with the sanction to borrow given by the Local Government Board, 10 per cent. per annum of the net cost is charged on all wiring, &c., and any deficiency is made up each year out of revenue. In 1901 materials purchased cost £53. 18s., and in 1902 to £1,986. 3s. 9d., interest carried to credit of revenue account being £45, and wages £101. 7s. 6d. Sales amounted to £415. 11s. 5d., instalments on account of sales under deferred-payment system £62. 10s. 3d., stock of materials carried forward £668. 19s. 9d., leaving a balance of £1,039. 7s. 10d. In 1903 the purchase of materials was £818. 12s. 2d., wages £295. 6s. 11d., interest £53. 8s., and sales £375. 8s. 6d.; instalments on account of sales under deferred-payment system £175. 5s. 4d., stock of material carried forward £486. 3s. 11d., balance £1,838. 16s. 11d. In 1904 materials cost £249. 3s. 2d.; wages were £101. 12s. 4d., and interest £64. 9s. 8d. Sales were £127. 14s. 3d.; instalments on account of sales under deferred-payment system £254. 13s. 5d., transfer to arc rentals £217. 16s. 10d., stock of materials carried forward £304. 19s. 10d., balance forward £1,835. 1s. 8d. On the motors capital account materials in 1902 cost £877. 0s. 3d., and rentals were £7. 14s. 4d. In 1903 materials cost £355. 0s. 7d., rentals were £79. 17s. 4d., and sales £3; 1904 materials cost £574. 17s. 9d., repairs £36. 12s. 2d., rentals £123. 17s. 9d., sales £5. 10s. 4d., £1,323. 11s. being carried forward. On arcs rental account arcs purchased in 1904 cost £34. 2s., and rentals were £45. 4s. 11d., leaving £296. 15s. 1d. to be carried forward.

A special meeting of the Electricity committee on Monday investigated certain complaints made by employés at the electricity works against the chairman of the committee (Ald. Pitt).

Ald. Pitt explained that he appeared to be the main cause of the complaints, and it looked as if his attendance at the works so frequently was not in harmony with the employés' feelings. He regretted that the present trouble had arisen, but to avoid further friction he would undertake to stop his frequent visits to the works, and would only attend when on official business. He would also intimate to the manager (Mr. Wray) any official visit he intended to make.

West Ham.—On Tuesday the Corporation authorised the architect to obtain tenders for wiring the West Ham Park schools.

Westminster (London).—The City Council have received a notification from the Westminster Electric Supply Corporation that, in view of the recent decision as to the charges made to the company by the Corporation for certain works during 1903, the company have reviewed the accounts for 1901 and 1902, and claim that they have been considerably overcharged for such works in each of the two years mentioned, and asking for a readjustment. The Works committee have declined to entertain the matter.

Wigan.—The borough electrical and tramways engineer and manager (Mr. James Slevin) has issued his third annual report, in which it is stated that

Steady progress was made during the past year. Two new boilers had been added, and the large steam set, which at the date of the last report was in course of erection, had come up to expectations. The motor load at Wigan station was in the first rank of power supply stations. The type of motor originally supplied in large numbers to their consumers had, however, proved very unsatisfactory and so costly in upkeep and maintenance as to seriously affect the efficiency of the department. Those motors were now being gradually re-wound and repaired, so as to bring them in line with the best English-made machines. During the past year one of the steam traction routes had been changed to electric, and a great increase of revenue resulted. Mr. Slevin anticipates a corresponding increase on all the routes now undergoing conversion. The total passengers carried were 6,300,432, total revenue from fares £36,124. 13s. 3d., total car-miles run 607,058. Average price paid per passenger 1·37d., number of cars in service 24, passengers carried per car 262,518, revenue per car £1,505. 3s. 10d., average car-miles per car 25,294, total revenue per car-mile 14·28d., total length of track in operation 12 miles 5 furlongs, revenue per mile of track £2,861. 6s. 1d., total passengers carried per mile of track 499,044, total capital expenditure £205,414. 16s. 1d., or £16,270. 9s. 7d. per mile of track open. The units sold during the year were 1,460,564, estimated receipts from sale of current £13,000, estimated gross profit £6,075, estimated interest and sinking £6,000.

Wolverhampton.—The Council have decided to put down electric generating plant at their refuse destructor works, in order to utilise the available steam. Mains are to be laid at a cost of about £2,800. Application is to be made for sanction to borrow £10,000 for extensions to the mains, &c.

Wood Green.—The adjourned inquiry into the application of the District Council to borrow £43,200 for electricity supply works was resumed on the 8th inst.

Councillor Reed announced that the Council had dropped the arc lighting portion of the scheme.

The consulting engineer (Mr. W. C. C. Hawtayne) said the amended scheme was practically what he had submitted to the Council on Oct. 17 last. The estimated profit was now £498. He calculated the scheme would turn the corner in two years, when the equivalent of 20,000 8-c.p. lamps would, he estimated, have been taken up. There would be three generating sets, one 100 kw. and two 250 kw., one of the latter being a stand-by.

Mr. Hawtayne was cross-examined at some length by Mr. Nield (for the North Metropolitan Electric Power Supply Co.) with the object of showing that "bulk" supply would be cheaper than the erection of municipal works.

Mr. James Devonshire, a director of the Power Company, said that the company offered to give a supply of electrical energy on the maximum demand system. By an agreement with the company there would be no surrender of the Council's electric lighting powers.

Opposition was offered by several ratepayers.

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Yarmouth.—It was reported to the Corporation on Tuesday that there was a profit of £1,293. 10s. 8d. on the electricity department for the past year.

Receipts from sale of current for public and private lighting were £13,486 and meter rents £381. Expenditure for generation, distribution, public lamp maintenance, rates, taxes, management and insurance was £7,989, leaving gross profit £5,853. From last account £878 was brought forward. £500 was transferred to relief of rates, £1,926 paid in interest and £2,472. 12s. 7d. allotted to sinking fund.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Rochdale Corporation invite tenders for the removal of lighting and traction switchboards to new switch room, reconstruction of lighting switchboard, additional panels, &c., and the supply of temporary switch gear and connections. The work is to be carried out without interference with the supply of electricity, and has to be completed by Aug. 15. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Sillar and Leigh), 2, Queen Anne's-gate, Westminster, S.W., and 78, King-street, Manchester, and may be obtained from the former address. Tenders to the town clerk (Mr. James Leach), Town Hall, Rochdale, by June 27. See also advertisement.

Rochdale Corporation also invite tenders for supply, delivery and erection of one 412kw. steam dynamo. Specification, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Sillar and Leigh), 2, Queen Anne's-gate, Westminster, S.W., and 78, King-street, Manchester, and may be obtained from the former address. Further particulars are given in an advertisement. Tenders to the town clerk (Mr. James Leach), Town Hall, Rochdale, by July 1.

Exeter Corporation invite tenders for supply and erection of one 200kw. triple expansion engine and traction generator, with condenser, steam, exhaust, circulating water pipes, &c.; or (alternatively) one 200kw. steam turbo-generator, with condenser, pipes, &c.; and one 200kw. two-phase to direct-current motor-generator for traction purposes, with switchboard, cables, &c. Further particulars are given in an advertisement. Specifications, &c, from the city electrical engineer (Mr. H. D. Munro) after June 22. Tenders by noon July 1, to the town clerk, Mr. Geo. Shorto, Municipal offices, Exeter.

West London District School Managers invite tenders for the electric light wiring of new class rooms and the porter's lodge at their school at Ashford, Middlesex. Specifications and plans may be inspected on application to the superintendent. Tenders (addressed to the managers) by 11 a.m. 24th inst. See also advertisement.

St. Pancras (London) Council invite tenders for lead-covered and armoured cables and arc-lamp carbons. Specifications, &c., from the chief clerk (Mr. A. E. Pycraft), electricity department, 57, Pratt-street, N.W. Tenders by noon, June 28, to the town clerk (Mr. C. H. F. Barrett), Town Hall, Pancras-road, London, N.W. See also advertisement.

Penrith District Council invite tenders for supply and erection of two oil or gas engines and dynamos, switchboard and boosters, storage battery and mains. Specifications from the clerk (Mr. George Wainwright, Public Offices, Penrith. Specifications and drawings may be seen at (but not obtained from) the offices of the consulting engineer, Mr. J. W. Speight, M.I.E.E., 13, Victoria-street, London, S.W. Tenders to Mr. Wainwright by 10 a.m. July 5. An advertisement contains further particulars.

Edinburgh Corporation invite tenders for the supply of lead-sheathed paper-insulated copper cables for year ending May 15, 1905. Specifications and forms of tender from the resident electrical engineer (Mr. F. A. Newington), 5, Dewar-place, Edinburgh. Tenders to the town clerk (Mr. Thomas Hunter, W.S.) by June 27. See also advertisement.

Manchester Electricity committee invite tenders for direct-current motors, motor starters, low-pressure cables, cable troughing, service fuse boxes, bitumen and box compound. Tenders to chairman of Electricity committee by June 30. See also advertisement.

Heston and Isleworth District Council invite tenders for electricity meters. Specifications, &c., from the consulting engineers (Messrs. J. and J. S. Enright), 68, Lincoln's Inn-fields, London, W.C. Tenders to the clerk (Mr. H. J. Baker) by noon July 4. See also advertisement.

The Scottish office of the *May-Oatway Fire Appliances (Ltd.)* invite tenders for wiring certain installations set out in an advertisement elsewhere. Tenders close 22nd inst. Particulars from the managing director, 49, Queen-street, Glasgow.

Walthamstow District Council invite tenders for three Westinghouse gas engines, starting appliances, piping and accessories, three continuous-current dynamos with spare armature of approved manufacture, with usual measuring instruments and switchboard. Tenders to Mr. C. Sydney Watson, Town Hall, Walthamstow, by 5 p.m. June 23.

Loughborough Gas and Electric Lighting committee invite tenders from manufacturers for the supply and erection of electric cables (including laying), switchboard, steam, feed, blow-off and other piping and feed pumps (including erection). Tenders to the town clerk (Mr. Harry Perkins) by noon June 25.

Tenders are invited for a complete telephone and fire alarm installation for the Angelton and Parc Gwyllt Asylum, *Bridgend*. Tenders to Mr. W. E. R. Allen, Glamorgan County Offices, Cardiff, by June 18.

West Ham Education committee invite tenders for wiring and fittings required at West Ham Park elementary schools, Stratford. Tenders to Education Department, 95, The Grove, Stratford, E., by 5:30 p.m. June 20.

Wigan Corporation invite tenders for 12 bogie cars (single deck, two-motor equipments). Tenders to town clerk (Mr. Harold Jevons) by noon 21st inst.

Stepney Borough Council invite tenders for an electric light wiring installation at the public baths, Whitehorse-street, Ratcliffe, E. Tenders to town clerk (Mr. George W. Clarke) by noon June 28.

Dartford District Council invite tenders by 22nd inst. for 12 months' supply of electricity meters, demand indicators, fuse boxes, house service cable, jointing material, &c.

Tenders are wanted for a screw-cutting lathe and a 4 H.P. electric motor for driving lathes, &c., at the Fire Brigade workshops, Lauriston-place, *Edinburgh*. Tenders by 29th inst.

Cardiff Corporation invite tenders by 23rd inst. for a motor-driven tower waggon for the electric tramway department.

East Ham Council invite tenders by noon 21st inst. for wiring the new technical college, Barking-road.

Clyde Navigation Trustees invite tenders for two electric coaling hoists for Clydebank dock. Tenders to secretary by noon July 25.

Tenders are invited for a concession for the electric lighting of *Priego*, Cordoba (Spain). Tenders will be opened at the Municipal offices, Priego, on July 10.

TENDERS RECEIVED AND ACCEPTED.

On Tuesday the following tenders for the main switch gear required by London County Council for the first portion of their Greenwich generating station were submitted:—

British Westinghouse Co. (*accepted*)	£22,910	British Thomson-Houston Co.	£25,592
Dick, Kerr & Co.	37,019	Cowans Ltd. (incomplete)	3,881
Elliott Bros.	36,706	Electric and Ordnance Accessories Co. (incomplete)	3,628
Electric Construction Co.	32,000		

The contractors will sub-let the following portions of the work:—To Messrs. Everett, Edgcumbe & Co., synchroscopes; to British Thomson-Houston Co., direct-current wattmeters; to Nalder Bros. and Thompson, direct-current recording ammeters and voltmeters; to W. T. Glover & Co., cables; to the Bostwick Co., Bostwick gates; to St. Helen Cable Co., rubber mats; and to R. W. Blackwell & Co., direct-current circuit-breakers.

For 10 additional water-tube boilers for the first portion of the Greenwich generating station London County Council received the following tenders:—

Stirling Boiler Co. (*accepted*)	£16,271	B. R. Rowland & Co.	£18,845
John Thompson	27,700	J. Musgrave & Sons	18,132
Stirling Co.	23,200	R. Hornsby & Sons	18,132
Babcock and Wilcox	18,878	Richardsons, Westgarth & Co.	18,131

The contractors will sub-let the steel plates to D. Colville & Sons, and the water tubes to the British Mannesman Tube Co.

Wolverhampton Council have accepted the tenders of the Lorain Steel Co. for special work in connection with the car shed extension at £303. 8s. 4d., and for the electrical equipment of the extensions of the Wednesfield-road track, and that of Belliss and Morcom and the Electric Construction Co. for a 300kw. steam generating set at £2,374.

Rochester Corporation have received the following tenders for the construction of tramway permanent way and for overhead equipment:—

Permanent Way Construction.

Dick, Kerr & Co. (*accepted*)	£5,256 12 0	Wm. Underwood and Bros.	£5,897 11 11
J. and W. S. Briscoe	16,208 18 6	British Elec. Equip. Co.	5,873 3 4
W. Kennedy (Ltd.)	9,109 15 1	Peerless, Dennis & Co.	5,839 17 6
E. Nuttall & Co.	7,762 13 4	T. W. Pedrette	5,800 11 10
West Bros.	6,941 11 10	J. G. White & Co.	5,667 6 10
Pethick Bros.	6,395 4 4	J. A. Ewart	5,531 6 4
Fry Bros.	6,298 3 8	Wm. Griffiths & Co.	5,472 9 2
George Law	6,127 7 1	Edmund Taylor	5,471 12 11
R. W. Blackwell & Co.	5,914 0 2	J. Brunton	5,420 14 10
Macartney, McElroy & Co.	5,907 5 2	John Mowlem & Co.	5,395 13 0

Mr. J. Riley's tender was per mile, and therefore not in order.

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Overhead Equipment.

Dick, Kerr & Co. (*accepted*)	£967	11	1	T. W. Pedrette	£1,062	17	4
J. and W. S. Briscoe	1,767	11	6	W. Kennedy (Ltd.)	1,062	17	4
George Hill & Co.	1,409	2	11	Wm. Griffiths & Co.	1,062	17	4
Macartney, McElroy & Co.	1,300	9	5	Brush Co.	1,062	17	4
J. Riley	1,149	17	0	George Law	1,038	12	0
B.I. & Helsby Cables (Ltd.)	1,109	0	0	R. W. Blackwell & Co.	1,021	15	7
Pethick Bros.	1,100	0	0	British Thomson-Houston Co.	1,007	16	3
				J. G. White & Co.	966	5	0
				British Elec. Equip. Co.	940	16	6

The following tenders have been accepted by Kilmarnock Corporation:—

Robert W. Blackwell & Co., overhead equipment for tramways, £3,216. 13s. 9d.

Hurst, Nelson & Co., rolling stock, £5,713. 5s. 8d.

Cox-Walkers, wiring of generating station, £385. 5s. 2d.

Barnes Urban District Council have accepted the tender of the Pfluger Accumulator Works for storage batteries at £1,886. 5s., and that of the British Westinghouse Co. for balancer-booster and switch gear at £434.

Higginbottom and Mannock, Manchester, have secured an order for 20 movable electric Goliath jib cranes, each to lift 30 cwt., 34ft. radius 57ft. high, for the equipment of the New Salford Docks of the Manchester Ship Canal Co.

Loughborough Corporation have accepted the tender of Herbert Morris and Bastert for a travelling crane at £138. Higginbottom and Mannock tendered at £185, Jessop and Appleby at £170 and J. S. Godfrey at £155.

Barrow-in-Furness Council have accepted the tender of Alley and MacLellan for condensing plant at £1,259, that of G. and J. Weir for two steam pumps at £278, and that of the Worthington Pumping Engine Co. for a water meter at £36.

Yarmouth Corporation have accepted the tender of J. and H. Girling for 4,000 tons of Welsh steam coal f.o.b. Cardiff or Newport at 9s. 11d. per ton for the electric light works. This is 6d. per ton less than last contract.

Birmingham Corporation have accepted the tender of Dick, Kerr & Co. for the reconstruction of the Small Heath tramway route for electric traction.

Southport Council have accepted the tender of Hadfield's Steel Foundry Co. for tramway points and crossings at £89. 10s., and that of the British Westinghouse Co. for two 35 H.P. motors at £212.

Fulham (London) Council have accepted the tender of the National Electric Construction Co. to make alterations in the electric lighting installation at the baths at £343. 14s.

Hammersmith (London) Council have placed an order with Heathman & Co. at £20 for an extension ladder.

Epsom Council have accepted the tender of Dorset & Co for wiring the scarlet fever ward of the local hospital.

Bristol Corporation have accepted the tender of the Burnand Transformer Co. for transformers.

An order has been placed with Reavell & Co. by Worcester Corporation for an electrically-driven air-compressing plant at £190.

Croydon Corporation have accepted the tender of Ferranti Limited for extensions to the main switchboard at £197.

Meldrum Bros. have secured an order for a refuse destructor to be erected at Twickenham sewage works.

BUSINESS NOTICES.

We are informed that Mr. Costar, late of the British Insulated and Helsby Cables (Ltd.) has joined the staff of the St. Helens Cable Co., Warrington, as dry-core and paper specialist.

Vandam, Marsh & Co. (Ltd.) will in future be known as Marsh, Son & Co. (Ltd.), Mr. A. Vandam, late of this firm, having gone to South Africa.

Messrs. A. W. Marshall and M. W. Woods, electric light engineers, &c., Gray's Inn road, and Shepherd's Bush, London, and Northwich, have dissolved partnership. Debts by Mr. Woods, who continues as Marshall and Woods.

The Electrical Trade Engineering Co. has removed to 22, York-place, Baker-street, London, W.

Sales by Auction.—Messrs. Wheatley Kirk, Price & Co. will sell by public auction, piecemeal, at an early date, the whole of the modern machine tools and loose effects upon the premises known as Hythe Works, Hythe-road, Willesden Junction, N.W., including high-class lathes, milling, drilling, shaping and profiling machines, accumulators, electric-plating plant, &c. Catalogues shortly on application to the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester. See also advertisement.

Messrs. Thomas Whitehead & Sons have been instructed by the trustee in the bankruptcy of De Lacy Bros., electrical engineers, Old Hall-street, Liverpool, to sell by auction on 27th inst, at 11 a.m., the whole of the machinery, plant and tools and the shop and office fittings, including gas engines, drilling machines, lathes, dynamos, electric fans, electric passenger lift, motors, batteries, electric light fittings, &c. Catalogues from the auctioneers, 67, Hanover-street, Liverpool. Other information may be obtained from the trustee, Mr. Thomas Tranter (Messrs. Tranter, Dolby & Co., accountants, 51, North John-street, Liverpool). See also advertisement.

Sale by Tender.—Pursuant to an order of the Chancery Division of the High Court, the property and assets of Electric Lighting Boards (Ltd.), in liquidation, comprising electric lamps, flexible electric cable, electric lighting boards and strip, machinery, furniture, patent rights, &c., are to be sold in six lots as set out in an advertisement elsewhere. The stock can be viewed on the premises, 80, York-street, King's Cross, London, N., any day up to June 29, and tenders must be delivered to the receiver and manager before 12 o'clock of the 30th inst. Particulars and conditions of sale may be had of the receiver and manager (Mr. Percy W. Straus, F.C.A.), 7, Great Winchester street, E.C.; Messrs. Golding and Hargrove, 99, Cannon-street, E.C.; Messrs. Lee, Davis and Lee, solicitors, 1, Gresham-buildings, Basinghall-street; and Messrs. Dolman and Pritchard, 9 and 10, King-street, Cheapside, E.C.

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 30, Birley-street, Blackpool.

A small electric lighting plant is advertised for sale in another column. Particulars of Messrs. King & Son (Ltd.), Horsham, Sussex.

A battery of 55 E.P.S. cells, complete with trays, insulators, &c., is advertised for sale; two Campbell 12 H.P. gas engines are also offered.

Mr. F. Woolnough, electrical engineer, Norwich, has for sale two dynamos and two motors, instruments, &c. See advertisement.

Three motor-generators, two electric motors (2 H.P. and ½ H.P.), an electric elevator for carriages and an electric goods elevator are advertised for sale in another column, and can be seen on application to the City and Suburban Electric Carriage Co. (Ltd.), Niagara, York-street, Westminster.

Factory to Let.—A two-storey factory is to let in Stoke Newington. Apply to Mr. F. Warman, Highbury Corner, London, N. See advertisement.

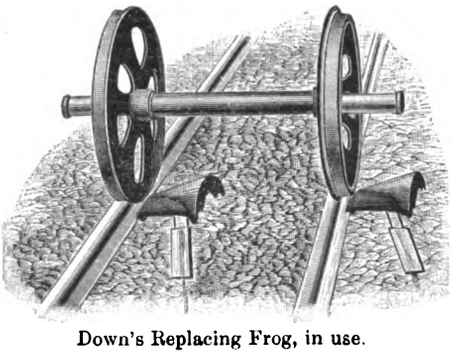
Award.—Electromotors Limited, of Openshaw, Manchester, and 35, Queen Victoria-street, London, E.C., have obtained a silver medal and first-class certificate for their motors at the recent successful Printing Trades' Exhibition in London.

New Works.—Plans of extensive new works to be erected at Northfleet by W. T. Henley's Telegraph Works Co. (Ltd.) have been passed by the Northfleet Council.

A New Belt.—A demonstration of a new belt, woven with hard stitching cords by a new weaving machine invented by Mr. J. W. Hyatt, was given last Friday at the works of Messrs. Marshall and Hyatt, London, S.E. The machine, a combination of loom and sewing machine, worked well and rapidly, and the product is very flexible, and is stated to be impervious to oil, water and weather. A special feature claimed by the makers is that the belt stretches less than 5 per cent. at breaking point, and the breaking strain itself is said to be about 30,000lb. to the square inch.

Catalogues, &c.—The British Thomson-Houston Co., Rugby, forward a pamphlet containing a well-illustrated description of the Central London Railway by Messrs. H. F. Parshall, E. Parry and W. Casson, extracted from the columns of a contemporary. Full particulars are given of various tests made on the railway during the first three years' working.

Particulars have just been published by Mr. F. J. Down, 6-8, Crutched Friars, London, E.C., of a device for replacing on the track derailed electric or other tramcars or light railway stock with a minimum of inconvenience or loss of time. The illustration herewith shows the "Down" replacing frog. It is claimed to be immaterial whether cars are pulled ahead or backed up, as the frogs, being double-enders, re-railing in about one-quarter the usual time by this device is assured. There are, it is stated, in use over 350 on electric tramways throughout the world.



Down's Replacing Frog, in use.

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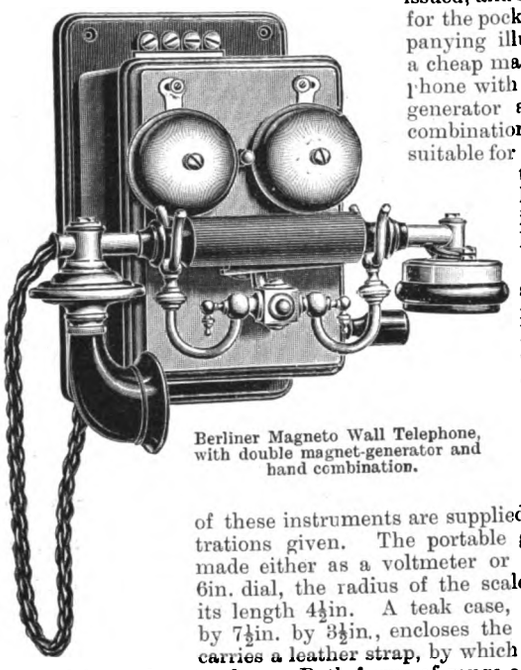
A catalogue (sections VII. and X.) is issued by the Edison & Swan Co., Queen-street, Cheapside, London, dealing with glass and silk shades and telephones respectively. A choice selection of shades for a variety of purposes is well illustrated, and in the telephone section table, wall, and other sets are shown and described.

A new list of telephones and accessories supplied by the Berliner Telephone Mfg. Co, 200, Upper Thames-street, London, E.C., is issued, and is in handy form for the pocket. The accompanying illustration shows a cheap magneto wall telephone with double magnet-generator and with hand combination, claimed to be suitable for any distance up to 7 miles. A large variety of instruments is listed.

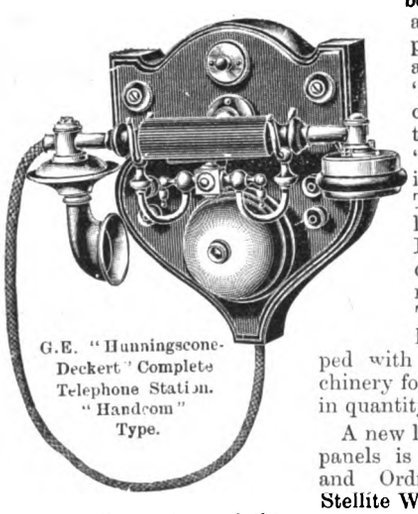


Berliner Magneto Wall Telephone, with double magnet-generator and hand combination.

Messrs. Evershed and Vignoles, Acton-lane Works, Chiswick, London, W., have ready a new catalogue of electric gauges, in which some interesting details of these instruments are supplied and some illustrations given. The portable gauge, which is made either as a voltmeter or ammeter, has a 6in. dial, the radius of the scale being 3in. and its length 4½in. A teak case, measuring 7½in. by 7½in. by 3½in., encloses the instrument, and carries a leather strap, by which it may be transported from place to place. Both forms of gauge are dead beat.

Messrs. Evershed and Vignoles have also ready an abridged price list of instruments, which contains a summary of the firm's larger catalogues of electric gauges and ammeters and voltmeters of the soft-iron and moving-coil types. Considerable reductions have been made in the prices of some of these instruments, and particular attention is called to this feature.

We referred in our last issue to the large new catalogue just issued by the General Electric Co., of telephones, telephone switchboards, fire alarms and accessories. The accompanying illustration shows a compact form of the "Hunningscone-Deckert" complete telephone station, and is claimed to be "the acme of perfection in battery call telephones." The variety of instruments listed proves the General Electric Co.'s ability to cater for the very varied needs of telephone users. The company's factory has been recently equipped with the most modern machinery for turning out such goods in quantity.



G.E. "Hunningscone-Deckert" Complete Telephone Station. "Handcom" Type.

A new list of motor starters and panels is issued by the Electric and Ordnance Accessories Co., Stellite Works, Birmingham. Some excellent illustrations of this apparatus are given. An important feature of the single and double automatic release starters is that the resistances are wound on vitreous porcelain tops, which are entirely non-absorbent, resulting, it is claimed, in a much higher insulation being obtained than in starters with their resistances wound on absorbent materials. Copies of the list can be obtained free on application.

The Blake and Knowles Steam Pump Works have ready a new catalogue of condensing plant in which a large variety of this class of apparatus is illustrated and described. A list of patent oil separators is also ready.

A catalogue of "N.A.C." accumulators, manufactured by the Northampton Accumulator Co., West Bridge Works, Northampton, has been issued, and contains much information concerning this apparatus, combined with working instructions and prices.

A sheet list of Sturtevant motor and dynamo controllers is issued by the Sturtevant Engineering Co., 147, Queen Victoria-street, London, E.C.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from June 8 to 14, with the ports of destination:—

Africa—Alexandria, £100; Cape Town, £994 (including £332 telegraph material); Durban, £685; East London, £576; Port Elizabeth, £2,652 (including £1,156 telegraph material); Port Said, £44. *Argentina*—Buenos Ayres, £18. *Australasia*—Auckland, £182 (telegraph material); Brisbane, £85; Christchurch, £67; Fremantle, £336; Hobart £27; Lyttelton, £33; Otago, £3,993; Perth, £289; Sydney, £658. *Brazil*—Rio Janeiro, £436 (including £157 telegraph material). *Ceylon*—Colombo, £132. *Chili*—Valparaiso, £22 (telegraph material). *Cyprus*, £51. *Denmark*—Copenhagen, £57. *Gibraltar*, £30. *Holland*—Amsterdam, £176; Flushing, £37. *Hong Kong*, £82. *India*—Bombay, £341; Calcutta £1,772; Karachi, £23; Madras, £288. *Japan*—Yokohama, £363. *Portugal*—Lisbon, £56 (telegraph material). *Russia*—Libau, £32. *Siam*—Bangkok, £95. *Straits Settlements*—Singapore, £60. *Uruguay*—Monte Video, £22. Total £14,814, against £39,155 in the corresponding week last year (June 10 to 16).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

March 18, 1904.

6,585 R. C. SHARP. Glasgow. Improved saddle for carrying cables.
6,589 J. BRAY. Southampton. Firing of internal combustion engines, also applicable to firing of marine torpedoes and the like.
6,600 CLEMINSON ELECTRIC LAMP ATTACHMENT LIMITED and W. KING. Manchester. Cement for use in electric lamps and for other purposes.
6,612 G. ACKERMANN and G. ENGISCH. Drum supports for electric lamp and other wires. (Date applied for, March 28, 1903, date of application in Switzerland.)*
6,617 R. A. MARPLES. Controlling devices for electric motors.
6,619 E. COMMELIN and R. VIAU. Secondary batteries. (Date applied for, March 18, 1903, date of application in France.)*
6,637 B. SHERMAN. Galvanic dry cells or batteries.
6,646 V. AMMER. Call system for intermediate telephone stations.

March 19, 1904.

2,772A J. FIDDES and J. F. WATT. Fire alarms. (Date applied for, Feb. 4, 1904.)
6,664 G. DAVIS. Incandescent lamps.
6,666 and 6,667 W. CASSON. Conducting systems for electric railways.
6,678 J. C. ANDERSON. Manchester. Electrical conductors and coils. (Date applied for, April 30, 1903, date of application in U.S.)*
6,679 F. RENDER. Manchester. Fuses for electric blasting.*
6,682 H. SMITH and E. W. LEWIS. Coventry. Sparking plugs and the like.
6,684 W. AITKEN. Liverpool. Telephone exchange systems.
6,690 J. BUSH. Push-button controlled electric lift attachment.
6,716 A. H. BABCOCK. Switches. (Date applied for, March 23, 1903, date of application in U.S.)*
6,724 H. ARON. Electricity meters for alternating currents.*
6,731 W. M. BURLINSON. Overhead trolleys for electric road vehicles and the arrangement of overhead conductors therefor.
6,747 T. H. MARSH and H. H. S. MARSH. Universal joint for electric light fittings and the like.
6,750 S. COWPER-COLES and SHERARD COWPER-COLES & Co. Electro-deposition of metals.

March 21, 1904.

6,780 H. G. HARRISON. Manchester. Life-guard for tramcars.
6,787 G. W. HUSSEY. Birmingham. Globes of electric lamps for advertising and other purposes.
6,792 H. LEITNER. Byfleet. Preliminary treatment for accumulator plates.
6,806 J. H. SUTTON and L. GREGSON. Manufacture of conduits for cables.
6,811 H. W. SULLIVAN. Electrical signalling instruments.
6,832 J. F. WEBB. Electrolytical extraction of metals from solutions.
6,833 J. E. SPAGNOLETTI. Electro-mechanical cutouts.
6,834 J. E SPAGNOLETTI. Automatically controlling the passage of currents.
6,843 A. SAUSER. Terminal attachment for conducting wires.*
6,857 J. R. DICK. Electrical switching apparatus.

March 22, 1904.

6,873 J. H. DALE. Manchester. "Clusters" for incandescent lamps.
6,878 A. ECKSTEIN and H. J. COATES. Manchester. Electric ignition apparatus.
6,889 J. L. WOODBRIDGE. Electrical distribution.*

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6,896 F. W. Baynes. Exeter. Electric tramways and railways.
6,902 L. U. Kamm. Portable searchlight apparatus.
6,936 W. Pfauhauser. Voltametric balances.*
6,959 and 6,960 H. C. Levis (G.E. Co., U.S.). Filaments and manufacturing same.
6,961 B.T.-H. Co. (G.E. Co., U.S.). Electric motors.
6,972 F. J. Gerard and L. Fiedler. Electrodes for arc lights.

March 23, 1904.

11,828A/03 A. Muirhead. Telegraphy. (Date applied for, May 23, 1903.)
7,012 F. Everhart and J. J. Dossert. Cable couplings.*
7,017 J. T. Connell. Reflectors for glow lamps.
7,021 F. E. Klein. Germany. Controlling electrically-operated elevators.*
7,044 J. T. Armstrong and A. Orling. Electro-capillary apparatus.
7,052 W. W. Adams. Supports for the glass globes of arc lamps.
7,056 E. A. Ashcroft. Production of metals of the alkali group by electrolysis.
7,061 Leeds Copper Works and J. C. Jobling. Electro-depositing apparatus.
7,064 O. Holz. Asymmetrical vapour-conducting medium for alternating currents. (Date applied for March 23, 1903, date of application in U.S.)*
7,065 E. Weintraub. Transmitting alternating currents through a vapour. (Date applied for March 23, 1903, date of application in U.S.)*
7,066 C. P. Steinmetz. Alternating current rectifying apparatus. (Date applied for, March 23, 1903, date of application in U.S.)*
7,067 E. Weintraub. Rectifying alternating currents. (Date applied for, March 23, 1903, date of application in U.S.)*

March 24, 1904.

7,073 W. R. Burrows and T. Lyons. Primary battery.
7,118 C. Mackintosh. Electrical emergency railway brake.
7,129 C. G. Burke. Telegraphic signal systems.*

March 25, 1904.

7,197 E. G. Harcourt. Electric bells.
7,208 G. Westinghouse and L. M. Aspinwall. Controlling systems for electric motors. (Date applied for, May 1, 1903, date of application in U.S.)*
7,209 G. H. Gibson. Multi-voltage electric generators. (Date applied for, April 4, 1903, date of application in U.S.)*
7,211 L. Robinson & Co. (Ltd.) and E. Garside. Apparatus for control of switches.
7,217 F. R. Simms. Magneto-electric machines.
7,238 J. G. Lorrain (Società Ceramica Richard-Giuori, Italy). Electric insulators.*

March 26, 1904.

27,044A G. G. M. Hardingham (Electric Boat Co., U.S.). Secondary batteries. (Date applied for, Dec. 10, 1903.)*
27,044B G. G. M. Hardingham (Electric Boat Co., U.S.). Steering gear adapted for use in ships or boats. (Date applied for, Dec. 10, 1903.)*
27,044C G. G. M. Hardingham (Electric Boat Co., U.S.). Observation apparatus adapted for use in submarine or submergible boats. (Date applied for, Dec. 10, 1903.)*
27,044D G. G. M. Hardingham (Electric Boat Co., U.S.). Torpedo ejecting apparatus. (Date applied for, Dec. 10, 1903.)*
7,245 H. M. Salmony. Electric bells.
7,247 L. R. Lee. Manchester. Sealing of electrical conductors.
7,249 L. R. Lee. Manchester. Fuse boxes, junction boxes, &c.
7,267 V. Bornand. Birmingham. Switches.
7,293 Albany Mfg. Co. and F. Lamplough. Sparking plug.
7,298 R. Fleming. Arc lamp electrodes. (Date applied for, March 26, 1903, date of application in U.S.)*
7,299 J. T. H. Dempster. Arc light electrodes and method of making same. (Date applied for, March 26, 1903, date of application in U.S.)*
7,304 G. E. Gaiffe. Method of and apparatus for administering "cold light" electric baths.

March 28, 1904.

7,312 H. H. Lake (Luigi Risso, Italy). Lightning arresters.
7,318 E. Haslam. Derby. Pendant chains for carrying electrical fittings.
7,324 W. H. Pillans. Dundee. Fire alarms or detectors.
7,325 G. Higginbotham. Manchester. Electrical apparatus for timing speed of vehicles over a measured distance.
7,327 British Galvanic Metal Packing Co. (Galvanischen Metall-papier-Fabrik Actien-Gesellschaft, Germany). Preparation of dynamo brushes.*
7,349 H. Foster, Jun. Electrical communicators.

March 29, 1904.

7,418 J. Hutton. Scarborough. Hydrometer for use with storage batteries.
7,428 J. P. Tierney and J. Malone. Dublin. Apparatus for moving electrically the points on electric tramways and railways.
7,429 L. M. Waterhouse and The Simplex Steel Conduit Co. Liverpool. Metallic conduits for electric light cables and the like.
7,489 G. E. Gaiffe. X-ray apparatus.
7,497 J. J. Rathbone and E. R. Smith. Arc lamps.
7,505 W. R. Macdonald and G. E. Heyl-Dia. Electric fuses.

March 30, 1904.

7,526 H. Pieper. Birmingham. Vehicles propelled by electro-engines.
7,527 H. Pieper. Birmingham. Electro-engine vehicles.
7,543 W. E. Walmsley. Liverpool. Signalling, and for controlling the electrification of conductor rails on railways.
7,562 C. Nomdeden. Arc lamps. (Date applied for, April 11, 1903, date of application in France.)*
7,584 A. H. Lucas and T. Greenfield. Overhead wires or conductors of electric tramways and the like, and supports for same.
7,586 I. Kitsee. Submarine telegraphy.*
7,610 C. E. Foster, E. R. Grote and W. C. Ely. Arc lamps.
7,614 F. J. Beaumont and W. M. Still. Apparatus for generating and applying electricity on railway and other vehicles.

March 31, 1904.

7,627 E. W. Sanders. Electroliers, gas and oil pendants, and the like.
7,643 L. R. Lee. Manchester. Fuses.
7,660 H. C. Levis (G.E. Co., U.S.). Arc lamps.
7,661, 7,662 and 7,663 E. A. Coralan (G.E. Co., U.S.). Arc lamps.
7,676 J. H. Lee. Telephonic communication.
7,681 D. Mackenzie. Wire coiling devices.*
7,684 H. Leitner. Byfleet. Combined hat rack and electric light bracket.
7,685 H. Leitner. Byfleet. Light diffuser for incandescent lights.
7,702 W. Broad. Electric toy motor. (Date applied for, October 5, 1903, date of application in U.S.)*
7,710 C. E. Foster, E. R. Grote and M. V. Ely. Arc lamps.
7,733 Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nurnberg, A.-G. Liverpool. Electric igniting device for explosion engines. (Date applied for, Oct. 19, 1903, date of application in Germany.)*

April 2, 1904.

7,742 G. D. A. Parr. Leeds. Electro-mechanical apparatus for automatically operating shunting points on electric tramways and railways.
7,748 G. Chisholm. Birmingham. Electric light switches and the like.
7,755 T. McVey. Glasgow. Adjustable platform and ladder for trimming arc lamps.
7,775 F. H. Glew. Instruments for rendering visible the luminous effects produced by radio-active substances.
7,807 J. L. La Cour and T. Rich. Machines for the transformation and generation of electric currents and energy.
7,812 Improved Electric Glow Lamp Co. and N. Watsham. Supporting and lowering arc lamps or other hanging weights.
7,814 C. Bauer (George Edmund Dutertre and Marie François André Nodet, France). Electric roasting by incandescence and various applications thereof by means of luminous or radiating tubes having combined calorific effects.*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

6,631 Sharman. Production and application of high-frequency currents.
6,899A Walker. Temperature alarms. (Date applied for March 25, 1903.)
7,719 Howell. Creation and multiplication of electricity.
8,971 Shepherd. Electric heating of curling irons and the like.
9,408 Artom. Apparatus for the transmission of electrical energy.
9,551 Boult (Continental Turbine Co.). Electric governors for elastic fluid turbines.
9,552 Harris. Controlling the lighting and extinguishing of gas, the flow of fluids or the supply of electric energy at predetermined times.
9,604 Mawdsley. Dynamo-electric machinery.
9,725 Donlevy. Typewriters, calculating machines, recording instruments, &c.
9,821 Hill and Sir Hiram Maxim Electrical and Engineering Co. Device for locking incandescent lamps to their holders.
9,951 Brander. Central energy telephone systems.
9,990 Fynn. Electric motors and generators.
9,993 Gerretsen. Lightning discharger.
9,998 Norballe and Fulkes. Arc lamps.
10,071 Justice (Morse). Actuating mechanism for secondary electric clocks and other intermittingly electrically-impelled apparatus.
10,207 Bray, Markham, Reiss and Bray, Markham and Reiss (Ltd.). Switches.
10,584 Oppenheimer (A.G. Mix and Genest). Electric light switches operated by opening of doors, windows, &c.
10,667 Brown. Electric conductors or cables.
11,645 Carolan (G.E. Co., U.S.). Recording instruments.
11,729 Carolan (G.E. Co., U.S.). Winding forms for coils.
12,146 Eckstein and Angold. Multi-carbon arc lamps.
13,674 Sheehy and Curphey. Electric selecting and signalling systems for communicating between a central and sub-stations and for performing various operations at such sub-stations.
13,911 Reynders, Auel, Alexander and Spurrier. Automatic circuit-breakers.
13,931 Feilder and Gerard. Secondary batteries.
14,067 Inrig. Automatically reversible dynamo to give a constant voltage irrespective of speed.
14,166 Le Tall (Cooper-Hewitt Electric Co.). Vapour electric apparatus.
14,170 Le Tall (Cooper-Hewitt Electric Co.). Starting means for gas or vapour electric apparatus.
14,171 Le Tall (Cooper-Hewitt Electric Co.). Gas or vapour electric apparatus.
14,223 Burton. Electro-pneumatic action for organs.
14,373 Siemens Brothers & Co. and Ferreira. Illumination of railway signals by incandescent lamps.
14,375 Jacobs and Nicholson. Switches for use with selective electric signalling apparatus.
14,598 Carolan (G.E. Co., U.S.). Electric motor-driven machine tools.

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14,877 Eckstein and White. Mounting electrical fittings in metal cases.
14,908 Prestwich and Lea. Electric contacts.
15,746 Guest, Keen and Nettlefold (Ltd.) and Symons. Arc lamps.
17,232 Stevens. Terminal holders for wires, leads or cables.
17,431 Savelsohn. Electric connections for railway trains.
20,128 Lamme. Electric lighting. (Date applied for, Sept 29, 1902.)
20,926 Müller. Electric current transformer.
22,388 Howorth (Turchi and Bruné). Apparatus for enabling telephonic and telegraphic messages to be transmitted over the same line wire.
23,548 Jones and Smith. Electric lamp pendants.
25,567 Morck. Process and apparatus for producing a shifting of phase of 90deg. in alternating-current meters.
26,242 Siemens Brothers & Co. (United Telpherage Co.) Telphers.
26,242A Siemens Brothers & Co. (United Telpherage Co.). Controlling vehicles propelled electrically from a distance. (Date applied for, Dec. 1, 1903.)
26,595 Schaffler reste Glössl and Jilek. Electric igniting apparatus.
26,773 Carbone. Arc lamp with convergent downwardly directed carbons.
26,848 Fairweather (Stromberg Carlson Telephone Mfg. Co.). Telephone systems.
27,153 Mitscherling. Electric signalling apparatus.
28,051 Lincoln. Synchronising apparatus for dynamo-electric machines. (Date applied for Dec. 29, 1902.)
28,700 Rugh. Telegraphy.
28,782 Eimer. Electric sectional furnaces. (Date applied for May 28, 1903.)

1904.

124 Barbará. Electrically transmitting receiving and checking signals.
1,258 Tiffany and Van Inwagen. Electric clocks.
2,494 Friedlander. Shields for X-ray and like tubes. (Date applied for, March 9, 1903.)
3,385 Murray. Automatic telegraph transmitter.
3,660 Hennig. Magneto-electric ignition gear for internal combustion engines.
4,075 and 5,227 Doulton and Morris. Supports and guards for conductor rails of electric railways.
4,413 Spalding. Switches.
4,590 Eckstein and Bell. Telephone indicator switchboard.
6,333 General Contracts Co., Cook and Chipperfield. Strut-piece for switches.
6,678 Anderson. Electrical conductors and coils. (Date applied for April 30, 1903.)
7,209 Gibson. Multi-voltage electric generators. (Date applied for, April 4, 1903.)
7,238 Lorbain (Soc. Ceramica Richard-Ginori). Insulators.
7,303 Efes. Tellurians.
7,327 British Galvanic Metal Packing Co. (Galvanischen Metall Papier-Fabrik A.G.). Preparation of dynamo brushes.
7,702 Broad. Electric toy motors. (Date applied for Oct. 5, 1903.)

COMPANIES' MEETINGS AND REPORTS.

West African Telegraph Co. (Ltd.).

The nineteenth ordinary general meeting was held yesterday (Thursday), the Marquess of Tweeddale, K.T., presiding.

The SECRETARY (Mr. John Cambrook) read the notice calling the meeting and the report of the auditors.

The CHAIRMAN then said: The gross revenue for the year under review amounted to £62,514. This, however, includes an amount of £1,321 for interest on reserve fund investments hitherto carried to the reserve fund, but which it has now been decided to introduce into the revenue account. That has been done this year and it will also be done in the future. Deducting this amount, the gross revenue was £61,193, as against £70,399 for the year 1902, or a decrease of £9,206. This decrease is due, in the first instance, to the readjustment of the proportions of the South African Joint Purse, in consequence of which this Company now receives a smaller share than heretofore, and also to the loss of traffic with the French stations which were taken over by the French Government under the arrangement which I fully explained to you at our last general meeting. With regard to the expenses, it is difficult to attempt any comparison as between the present year and the year 1902 for the reason that the withdrawal of the French stations from this Company's system has naturally caused a considerable reduction in the items of expenses under practically every head. Repairs to cables shows an increase of £1,125. I may state in this connection that we have been very fortunate as regards the year 1903 in not having been put to any expense whatever in maintaining in a state of electrical efficiency those cables which were sold to the French Government in 1902, but I would point out that such a favourable state of things cannot be expected to continue for the period of two years during which this Company is pledged to maintain those cables; in fact, there has already been incurred some expense for such repairs during the present year. Income-tax shows an increase of £1,004, due to the improved financial condition of the Company. The result of the year's working shows a profit of £37,127, and, after providing £1,459 for income-tax, placing £25,000 to reserve, and allowing for an interim dividend paid in January last, your Directors are able to recommend a final dividend of 3 per cent., making 4 per cent. for the year, leaving £2,663 to be carried forward to next account. The sum placed to reserve is large, but not larger than is deemed advisable having regard to the age of our cables, to the prospective termination of the Portuguese guarantee, and to our obligations under our agreement with the French Government, which I have referred to, and which will come to an end in another year. I think that the result I have laid before you will be considered eminently satisfactory. I now move the adoption of the report and accounts.

The motion was carried unanimously. The Hon. A. G. Brodrick was re-elected a director, and the retiring auditors (Messrs. Deloitte, Dever, Griffiths & Co.) were reappointed. A vote of thanks to the chairman and directors terminated the proceedings.

India Rubber, Gutta Percha and Telegraph Works Co. (Ltd.)

The half-yearly meeting was held at the company's offices, 106, Cannon-street, London, E.C., on Tuesday, under the presidency of the Hon. Henry Marsham.

The SECRETARY (Mr. A. P. Crouch) having read the notice convening the meeting,

The CHAIRMAN said: Since the last meeting in December we have had no large contract which calls for special notice. Our cable ships have had their share of repairing work, the "Buccaneer" being employed at the end of last year by the Commercial Cable Co., while at the beginning of this year the "Dacia" was chartered by the Post Office for about 3½ months for work round the coasts of England and Ireland. This latter ship is now engaged in repairing the Atlantic cable of the Direct United States Co. With regard to cable manufacture, our machines have been busy with an order for 500 miles which was shipped and despatched about a month ago. In addition to this cable we have had small orders from the British and Norwegian Governments, and from one or two companies. The Spanish Government asked for tenders for the laying of cables in the Mediterranean and between Spain and the Canary Islands. This tender entailed financial arrangements of considerable magnitude, as the Spanish Government has adopted a system of paying by annuities during a period of 25 years, and the board considered that, under the conditions offered, they were not justified in tendering, although the relations the company has had with the Spanish Government in past years have always been agreeable. We have added another to the small electrical installations we practically finance, and the board believe that these businesses, which pay their their expenses and their debenture charges and leave a small surplus, will show some further development. The board have decided to issue £100,000 of 4½ per cent. second debentures. These will be unified with the existing first mortgage debentures when the latter come forward for renewal. I now move that an interim dividend of 2½ per cent. (5s. per share), tax free, be declared.

The motion was carried unanimously.

Prior to the holding of an extraordinary meeting, the chairman remarked that he had been spending some months in Japan, and had learned from electrical engineers and manufacturers in that country that the manufactures of the Silvertown Company ranked very high, especially in regard to insulated cables. The Japanese were themselves carrying on similar work, but feebly; they had, however, made a beginning in endeavouring to make cables.

At the extraordinary meeting which followed, the articles of association, as amended by the board, were approved, and a vote of thanks to the chairman and directors terminated the proceedings.

BUENOS AYRES GRAND NATIONAL TRAMWAYS CO. (LTD.)—The directors' report states that a 55-year concession for the electrification of the system has been obtained from the municipality. To meet the cost of the conversion, £300,000 conversion debenture stock had been issued. A concession for the electrification of the Nueva system has also been obtained on identical terms and the Nueva Company has made a corresponding issue of £150,000 of similar stock.

CAPE ASBESTOS CO. (LTD.)—The directors' report states that during the greater part of the past year there was no break in the severe drought which devastated Griqualand West, in which the company's properties are situated. The working conditions at the mines remained in the same unsatisfactory state as before, and the supply of blue crude continued to be inadequate. The year's result has been disappointing, owing to these causes and also to the low prices for white asbestos goods ruling in 1903. After writing off £802 for depreciation of machinery, plant, buildings, &c., the loss for the year amounted to £5,894. The unprecedented drought of three years has at last been broken, and in consequence better facilities for transport and for obtaining native labour are now available. The good demand for the company's specialities and manufactured articles in blue asbestos continues.

MEXICO ELECTRIC TRAMWAYS (LTD.)—At the meeting last week, the chairman (Sir C. Euan-Smith, K.C.B.) said, owing to the rapid development of the traffic, they had found it necessary to order a considerable addition to their rolling stock, and had already added another unit to their power station. Last autumn they invited Mr. W. B. Rommel, tramway and electrical engineer, to proceed to Mexico to report as to the advisability of certain changes which the directors had in contemplation, and during his visit he was able to carry out many improvements. Mr. Ludwig Breitmeyer (a director) also paid a short visit to Mexico to assist Mr. Rommel, and those gentlemen had concluded the purchase of controlling interest in the Banos Line Company, the only section of tramways in Mexico which remained out of their control, and which presented possibilities of competition. Mr. Clegg had resigned his position as

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general manager, and was succeeded on April 4 by Mr. W. W. Wheatly, of New York.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—The directors' report for the year ended March 31 last shows gross receipts (in sterling) in the River Plate £134,824. 4s. 1d., against £124,470. 6s. 11d. for last year. Deducting interest and interim dividends paid and adding interest received, &c., there is a profit of £39,215. 3s. 8d., added to £3,713. 11s. 3d. brought forward, making £42,928. 14s. 11d. £10,000 is put to reserve for renewal of plant and £15,000 to general reserve, and the directors recommend a final dividend of 5 per cent. on the ordinary shares, making 8 per cent. for the year (tax free), the balance carried forward being £3,428. 14s. 11d. To provide for continued expansion of the business it is proposed to increase the authorised capital by an early issue of £60,000 in ordinary shares, which will be offered to the ordinary shareholders.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

CUTTING BROS. (LTD.) (81,178).—Reg. June 8, capital £6,000 in £10 shares, to acquire business of electrical engineers now carried on by Cutting Bros., of Derby and London, to adopt an agreement with C. H. Cutting and G. H. Cutting, and to carry on the business of electrical engineers and contractors, electricians, manufacturers of and dealers in all apparatus used in generation, distribution, supply, accumulation and employment of electricity, mechanical and ventilating engineers, &c. The first directors: C. H. Cutting and G. H. Cutting. Reg. office: 165, Parliament-street, Derby.

LONDON ELECTRON WORKS CO. (LTD.) (81,209).—Reg. June 10, capital £26,000 in £10 shares, to acquire and take over as a going concern the business of a metallurgist and electro-chemist carried on by A. de Back as the London Electron Works Co., and to carry on the business of iron, steel, tin, lead, brass and general metal masters, founders, smelters, engineers, smiths, metallurgists, electrical and electro-chemical engineers, chemists, &c. First directors are A. de Back and Dr. T. Zettel.

MORTGAGES AND CHARGES.

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—Issue on June 3 of mortgage debenture for £5,000, part of a series created Feb. 18, 1904, to secure £100,000, charged on company's undertaking and property, present and future, except uncalled capital. Holders, T. E. Hodgkin and J. W. B. Pease. No trustees. Previously issued of same series, £20,600.

PERTH ELECTRIC TRAMWAYS (LTD.)—Trust deed dated Dec. 30, to secure £50,000 debentures created Dec. 22, 1903, has been registered. Property charged, company's undertaking and property, present and future, including uncalled capital. Trustees, Lord Arthur Butler and J. S. Austen.

VAUGHAN, BROWN & CO. (LTD.)—Debenture dated May 21, 1904, to secure £250, charged on company's undertaking and property, present and future, including uncalled capital, has been registered. Holder, T. W. Vaughan.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 25$\frac{3}{16}$d. per oz. (June 16). Consols 90$\frac{1}{16}$—90$\frac{3}{16}$ for money, 90$\frac{3}{16}$—90$\frac{5}{16}$ for account; 2½ per cent. annuities 89½—89$\frac{3}{8}$ (June 16). Consols Pay Day, July 1; Stocks and Shares Continuation Days, June 27 and July 2; Ticket Days, June 28 and July 13; Pay Days, June 29 and July 14; Mining Share Carry-over Days, June 25 and July 11.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—The coupons on this company's 4 per cent. mortgage debentures due July 1 will be paid at Parr's Bank, Bartholomew-lane, London, E.C. The debenture register will be closed from 24th to 30th inst. inclusive.

ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)—The transfer books and register of members will be closed from 22nd inst. to July 6 inclusive.

MOTOR MANUFACTURING CO. (LTD.)—The secretary states that the recent appointment of a receiver and manager was made with the consent of the directors; that the company is able to meet its liabilities if time is given, as its debts (mostly of recent date) amount only to between £8,000 and £9,000, exclusive of debentures, and that the company has £10,000 worth of orders in hand.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed June 22 a special settling day in and have granted a quotation to £250,000 4½ per cent. second debenture stock of the *British Electric Traction Co. (Ltd.)* and have also ordered further issues of 50,000 £1 fully-paid ordinary and 50,000 £1 fully-paid 7 per cent. cumulative preference shares of the *Electrolytic Alkali Co. (Ltd.)* to be quoted. The committee have been asked to appoint special settling days in and grant quotations to 120,000 £5 fully-paid ordinary shares of the *Anglo-Argentine Tramways Co. (Ltd.)* and 6,135 £1 fully-paid ordinary and 38,000 £1 fully-paid vendors' ordinary shares of the *Rhodes Electrical Mfg. Co. (Ltd.)* and also to allow a further issue of 1,235 £10 fully-paid ordinary shares of the *British Electric Traction Co. (Ltd.)* and £3,599,200 5 per cent. profit-sharing secured notes (8,450 of £100, 1,111 of £200, 774 of £500 and 2,145 of £1,000 each) in lieu of fully-paid provisional certificates of the *Underground Electric Railways Co. of London (Ltd.)* to be quoted.

R. WAYGOOD & CO. (LTD.)—For the year ended March 31 the profits, including £4,949 brought forward, amounted to £31,821. After placing £2,600 to reserve, and writing £500 off patents, a final dividend is recommended at the rate of 13 per cent. per annum (making 9 per cent. for the year) on the ordinary shares. £6,074 is carried forward.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	June 11	1,418	+ 252	2	2,985	+ 522
Airdrie	,, 8	212	...	17	3,219	...
Ayr Corporation	,, 4	359	- 21	4	1,260	- 69
	,, 11	387	- 84			
Barnsley	,, 8	152	- 164	22	3,598	- 289
Bath Electric Trams, Ltd.	,, 8	671	...	23	13,115	...
Barrow	,, 8	192	+ 107	17	2,659	+ 1,625
Bexley District Council	,, 9	289	...	85	6,082	...
Birkenhead	,, 11	1,050	+ 48	...	...	...
Birmingham Corporation	,, 11	260	...	22	6,471	...
Birmingham Tramways Co.	,, 11	5,589	+ 592	23	122,085	+ 7,045
Blackburn Corporation	,, 13	1,032	+ 187	11	10,413	+ 660
Blackpool Corporation	,, 9	840	+ 65	10	8,788	+ 668
Blackpool and Fleetwood	,, 11	585	- 816	24	8,215	- 683
Blackp'l, St. Anne's & Lytham	,, 9	485	- 227	82	7,354	+ 5,599
Bolton Corporation	,, 12	1,880	- 114	11	20,110	- 128
Bournemouth Corporation	,, 8	1,028	+ 45	‡10	11,093	+ 504
Bradford Corporation	,, 11	4,796	+ 1,188	10	47,122	+ 4 987
Brighton Corporation	,, 12	913	+ 72	10	9,562	- 54
Brisbane Tramways	April 27	2,330	+ 114	17	38,764	- 134
Bristol Trams & Carriage	June 10	5,118	+ 396	3	16,492	- 2,131
Buenos Ayres & Belgrano	May 15	3,373	+ 181	4	13,570	+ 1,196
Burnley Corporation	June 11	1,061	+ 345	11	11,483	+ 2,737
Burton Corporation	,, 12	381	...	11	3,545	...
Calcutta Tramways Co.	,, 11	R32,242	+ R940	24	R818,797	+ R100,288
Camborne-Redruth	,, 13	107	+ 8	6	9,579	- 47
Cardiff Corporation	,, 11	2,086	+ 112	10	21,067	+ 692
Carlisle Tramways Co.	,, 11	208	+ 8	23	4,298	+ 272
Central London Railway	,, 11	6,781	- 31	24	165,187	- 2,665
Chatham & Dist. Lt. Rys.	,, 9	606	+ 54	23	12,565	+ 1,885
City & South London Rly.	,, 12	2,628	- 98	24	71,598	- 2,224
Cork Electric Trams Co.	,, 9	559	- 113	23	9,807	- 687
Darwen Corporation	,, 10	237	+ 7	10	2,386	- 156
Devonport & Dist. Trams	,, 8	680	+ 78	22	10,791	+ 1,625
Dover Corporation	,, 11	204	- 14	11	2,182	- 152
Dublin & Lucan Railway	,, 12	132	+ 16	24	2,593	+ 207
Dublin Southern District	,, 10	1,227	+ 185	¶24	107,587	+ 2,316
Dublin United	,, 10	4,380	+ 254			
Dudley—Stourbridge	,, 8	787	- 861	22	17,768	+ 501
Dundee Corporation	,, 8	870	+ 8	...	...	...
East Ham Council	,, 11	766	+ 177	10	7,946	+ 883
Gateshead & Dist. Trams	,, 3	865	- 168	22	19,302	+ 922
Glasgow Corporation	,, 11	15,870	+ 846	†2	25,377	- 2,716
Glossop	,, 11	118	...	24	2,361	...
Gravesend—Northfleet	,, 3	247	- 178	22	5,167	+ 608
Gt. Northern & City Rly.	,, 11	903	...	17	15,769	...
Greenock & Port Glasgow	,, 3	617	+ 6	22	11,144	+ 659
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 3	804	- 142	22	5,868	+ 571
Huddersfield	,, 11	1,304	+ 186	10	13,572	+ 734
Hull Corporation	,, 11	2,092	+ 366	10	21,858	+ 2,216
Ilford District Council	,, 11	495	+ 99	11	5,074	+ 496
Ilkeston Corporation	,, 8	189	- 32	...	...	...
Ipswich Corporation	,, 11	489	...	10	4,906	...
Isle of Thanet Co.	,, 11	648	+ 25	...	...	...
Kidderminster & District	,, 3	119	- 178	22	2,444	- 124
Kirkcaldy Corporation	,, 8	294	...	23	4,953	...
Lanarkshire Trams Co.	,, 9	730	...	23	13,926	...
Leeds Corporation	,, 11	5,990	+ 871	12	63,784	+ 3,527
Leicester Corporation	,, 11	1,086	...	4	4,508	...
Liverpool Corporation	,, 4	10,881	- 1,576	23	226,381	+ 8,676
Liverpool Overhead Rly.	,, 12	1,613	+ 53	24	37,924	+ 27
*London County Council	,, 4	11,949	- 828	§9	105,411	+ 15,286
Lowestoft	,, 11	177	...	¶46	8,989	...
Manchester Corporation	,, 11	12,559	+ 1,194	10	122,176	+ 1,875
Mersey Railway	,, 11	1,892	+ 169	23	34,127	+ 7,095
Merthyr	,, 8	204	- 27	23	4,886	+ 166
Middleton	,, 3	621	+ 38	22	6,498	+ 193
Nelson Corporation	,, 11	124	+ 62	11	1,292	+ 114
Newcastle-on-Tyne Corp.	,, 11	3,722	+ 518	23	81,551	+ 10,153
Newport (Mon.)	,, 4	521	- 125	10	5,237	+ 1,324
	,, 11	507	+ 140			
Oldham, Ashton & Hyde	,, 3	693	- 118	23	11,623	- 650
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams.	,, 10	1,316	+ 152	23	31,071	+ 4,16
Peterborough	,, 3	143	- 130	22	2,938	- 19
Poole and District	,, 3	306	- 192	‡2	5,894	- 5
Portsmouth Corporation	,, 11	1,065	+ 376	‡11	19,682	+ 1,778
Potteries	,, 3	1,649	- 177	23	36,933	+ 2,755
Reading Corporation	,, 9	686	...	...	...	...
Rochdale Corporation	,, 13	186	+ 13	11	1,486	- 157
Rothesay	,, 3	110	- 33	22	1,602	+ 19
Salford Corporation	,, 13	4,007	+ 584	11	43,573	+ 4,479
Sheerness	,, 1	65	- 65	22	1,100	- 869
Sheffield Corporation	,, 12	4,612	+ 590	§11	52,408	+ 1,687
Southampton Corporation	,, 9	1,056	- 275	...	...	...
Southend Corporation	,, 8	328	+ 7	10	3,050	+ 144
Southport Tramways	,, 3	452	- 216	22	6,390	+ 420
S. Staffordshire Trams.	,, 8	712	- 900	22	17,165	- 803
Stockport Corporation	,, 10	664	+ 251	10	5,983	+ 2,453
Sunderland Corporation	,, 12	1,200	+ 51	10	12,955	+ 305
Swansea Trams	,, 3	526	- 194	23	11,035	+ 702
Taunton Trams	,, 3	58	- 37	22	1,122	- 96
Tynemouth and District	,, 3	317	- 314	22	5,301	- 318
Tyneside Trams Co.	...	...	...	...	...	...
Wallasey District Council	,, 11	764	+ 64	§10	7,427	+ 250
Walsall	...	...	...	...	...	...
Warrington Corporation	,, 9	329	+ 18	10	3,148	...
West Ham Corporation	,, 9	1,126	...	15	9,878	...
Weston-super-Mare	,, 1	119	- 178	22	1,195	- 70
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 3	353	- 447	22	8,126	- 354
Worcester	,, 3	329	+ 25	17	4,817	+ 2,000
Wrexham	,, 8	106	- 97	22	2,397	- 250
Yorkshire Woollen District	,, 3	569	- 28	22	12,402	+ 5,267

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 8 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., June 15.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to June 15	
				£ s. d.		Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	5 —5½	4 15 8	April, Oct	5½	5⅜
St.	6%	Do. Permanent 6% Deb. Stock	131 —136	4 9 6	..	134	..
St.	3½/2	Auckland Elec. Trams 5% Deb. (red.)	98 —100	..	..	99⅛	99¼
10	6/0	†Barcelona Tramways Ord.	7 —8	3 15 0	..	7⅛	7⅛
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	92 —97	4 14 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	96 —99	5 1 9	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	⅛—⅜	..	..	..	..
1	..	Do. 5% Cum. Pref.	1/16—1	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	..	4	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98 —103	4 9 1	..	100	99
10	8½	Bristol Tramways and Carriage Ord.	18½—19½	4 2 1	Feb, Aug	..	..
10	4½	Do. Cum. Pref. (fully paid)	10⅜—10⅝	3 17 8	..	..	..
St.	4½%	Do. 4 per Cent. Debs.	107 —109	3 13 4	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100 —103	5 16 6	..	102	100½
St.	5%	Do. Pref. Ord. Stock	98 —101	4 19 0	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10¾	5 11 7	..	10⅛	10⅛
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104⅞	4 6 7	..	103⅜	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	100⅜	..
10	6/0	British Electric Traction Ord.	10 —10½	7 12 5	..	10⅜	10
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅜—11⅛	5 6 6	Feb, Aug	11	13⅜
St.	5/0	Do. 5 per Cent. Perpetual Debs	116 —119	4 6 3	..	117⅛	116⅜
5	3/0	Buenos Ayres and Belgrano Ord.	2⅜—3	5 0 0	..	2⅝	2⅝
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5½—5⅝	5 4 4	..	..	..
5	3/0	Do. "B"	5 —5⅛	5 9 1	..	..	..
St.	5%	Do. 5 per Cent. Debs.	107 —110	4 12 6	..	109	108
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	103 —106	4 16 3	..	105	104½
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	96 —101	5 0 0	..	..	..
5	3/6	Calcutta Tramways	7 —7½	4 0 0	..	7¼	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	107 —110	4 3 6	..	..	..
1	1/0	Cape Electric Tramways Shares	2 —2¼	7 11 1	..	2⅛	..
St.	4%	Central London Ordinary Stock	92 —95	4 4 2	June, Dec	94¾	93½
St.	4%	Do. 4 per Cent. Pref. Stock	102 —105	3 18 0	..	..	..
St.	4%	Do. Deferred Stock	83 —86	4 13 0	..	84¾	84⅜
100	4%	Do. 4 per Cent. Debs.	112 —115	3 10 6	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2%	City and South London Rly. Con. Ord.	50 —52	4 11 4	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —126	4 0 0	Feb, Aug	..	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	121½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 —109	3 18 5	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	99 —102	4 18 3	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8¾	Gt. Northern & City Rly. Prf. Ord. (4%)	5 —6	5 0 0	..	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	18 —19	5 5 3	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	1½%	Liverpool Overhead Railway Ord	4½ —4¾	3 1 1	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	4 0 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11 —11½	4 7 0	..	11½	11⅛
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —105	3 17 6	..	..	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	1/16—¼	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅛—1	5 0 0	..	⅛	..
100	5%	Montreal St. Rly. St'g 5%Mrt. Dbs.(1908)	102 —105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs.(1922)	105 —107	4 5 0	..	..	..
5	..	New Gen. Tract. 6 per Cent.Cum. Pref.	1 —2	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1st Mt.Db.Stk.	100—103	4 19 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	89 —92	3 7 11	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 6	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	12/6	Anglo-American	48 —51	5 14 8	F,My,Ag,N	..	..
St.	25/0	Do. Preferred	91 —93	6 3 6	F,My,Ag,N	93	92
St.	2/0	Do. Deferred	6¾—7½	1 7 6	F,My Ag,N	7	..
100	$2	Commercial Cable Capital Stock	175 —185	4 6 6	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 —96	4 5 0	Jn Ap,Jy,O	95½	..
10	5/0	Cuba Submarine Ord.	7 —8	7 10 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	6⅝	..
50	4½%	Do. 4½ per Cent. Deb.	100%—103%	4 9 0	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10½	6 4 0	Ja,Ap,Jy,O	10⅛	10⅛
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	100 —103	4 9 0	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	126 —131	5 7 0	Ja,Ap,Jy,O	130	128½
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —90	3 17 9	Ja Ap,Jy,O	88	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 6	May, Nov	106	..
10	6/6	Eastern Extension	11¾—12¼	5 14 0	Ja,Ap,Jy,O	12⅛	11⅛
St.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 15 0	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	99 —102	3 19 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99%—102%	3 18 9	May, Nov	..	..
10	20/0	Great Northern (of Copenhagen)	25 —26	5 15 6	Jan, July	..	..
100	4½%	Halifax & Bermuda4½%1stMt.Db. (red.)	100 —103	4 9 0	June, Dec	..	..
25	37/6	Indo-European	42 —45	5 11 2	May, Nov	44	43½
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	2/0	West African Telegraph Shares	6 —7	2 17 2	..	..	..
2½	..	West Coast of America	1/16—3/16	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 10	Jan, July	..	..
10	..	West India and Panama	⅜—½	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	5¾—6¼	9 12 0	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 18 4	Jan, July	..	..
10	3/0	Western Telegraph	12¾—13¼	5 6 6	Mr,Jn,O,D	13	12⅞
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 17 9	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	100 —103	3 17 8	..	102¾	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5⅛	5 9 1	..	..	..
10	5/0	Globe Telegraph and Trust	8¾—9¼	5 19 0	Ja Ap Jy O	9⅜	8⅜
10	3/0	Do. 6 per Cent. Pref.	13 —13½	4 8 11	Ja Ap,Jy,O	13⅛	13⅛
8	4/0	†Reuter's	6½—7½	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	117 —122	4 18 4	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed., June 15.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to June
				£ s. d.		Highest.
		TELEPHONES.				
5	3/0	Chili Telephone (fully paid)	4½—5½	5 14 3	August ..	..
1	7½	Monte Video Telephone Ord.	⅝—¾	..	..	..
St.	6%	National Co. Pref. Stock	104 —106	5 13 3	..	105⅜
St.	5%	Do. Def. Stock	86 —89	5 12 4	..	88
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 —13	4 12 4	Feb, Aug	12⅞
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5½	4 15 3	Feb, Aug	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —100	3 11 0	June, Dec	98½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 —105	3 17 0	..	104⅝
		Do. Do. Prov.Certs.70%tobepd.	29 —31	..	..	30
1	0/8⅝	Oriental	⅛—1⅛	6 6 3	April, Oct	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1½	6 4 6	..	..
5	3/0	United River Plate	6 —6½	5 7 8	July	6⅜
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5½	4 15 3	June, Dec	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 —106	4 15 10	June, Dec	..
		ELECTRICITY SUPPLY.				
1	..	Blackheath & Gr'nwich. Elec. Ord.(f.p.)	⅜—⅝	..	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅜—1⅝	5 1 9	..	1⅝
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	120 —125	3 12 0	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power Shares	£½—6	..	..	..
		Do. Do. 1st Debs	100 —103	4 7 5	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 0	..	11⅛
1	0/8½	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	..
5	4/0	Calcutta Electric Supply Ord.	7 —7½	4 13 4	..	7½
St.	4%	Central Elec. Sup. Co.4% Guar. Db. Stock	105 —108	3 14 1	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7⅜—8	5 0 0	Feb, Aug	7⅝
5	2/3	Do. 4½ per Cent. Pref.	5⅝—5⅞	4 3 6	Feb, Aug	5⅞
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	..	..
5	1/7	Do. Do. (1903)	4½—5	..	..	4⅝
St.	4%	† Do. 4% Deb. Stock (red.)	102 —104	3 17 0	..	105
5	3/6	Chelsea Electric Supply Ord.	6½—6¾	4 1 6	March ..	6⅝
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —110	4 3 0	Jn, Dec ..	..
10	5/0	City of London Electric Lighting Ord.	11 —11½	4 7 0	Feb, Aug	11⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅜
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec ..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	102⅛
10	4/0	County of London Elec. Supply Ord.	7½—8½	4 14 3	..	8
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	11⅜
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106 —109	4 2 11	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	100 —103	4 8 0	..	103⅛
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	90 —95	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 8	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 8 0	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	10
5	5/0	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..
St.	4½%	I of W. Elec Lt. & Power 4½% Db St (red.)	101 —103	4 7 6	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	⅜—⅝	..	..	..
5	7/0	Kensingtn & Knghtsbdge Ord.	12 —13	4 12 4	..	12½
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	..
3	..	London Electric Supply Ord.	1½—1¾	..	..	..
10	8/0	Do. 6 per Cent Pref.	4⅜—5½	5 14 6	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Deb.	93 —96	4 3 4	Mr,Jn,S,D	..
10	9/6	Metropolitan Electric Sup. Ord.	19½—20½	4 5 6	April, Oct	20¼
5	1/4½	Do. 4½ per Cent. Cum. Pref.	5⅜—5⅝	4 1 0	..	5⅜
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec ..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 —100	3 11 0	..	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 —98	4 11 9	..	..
10	6/0	Notting Hill Electric Ord.	12½—13½	4 8 11	March	..
5	4/0	Oxford Electric Ord.	5½ - 6	5 8 4	March ..	..
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 3	..	..
		Rand Electric	¾—1	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 —103	4 7 9	April, Oct	..
5	9/6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	..
5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	8¾
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3 —3½	5 14 3	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..
5	3/0	South London Electric Supply Ord.	3¾—4¼	3 10 7	..	4⅛
5	2/6	Urban Electric Supply Ord.	4½ 5	5 0 0	..	..
		Do. 5% Cum. Pref.	4½—5	5 0 0	..	..
5	7/0	Westminster Electric Supply Ord.	12¾—13½	5 0 0	Mar, Sept	13⅛
5	2/6	Do. 5 per Cent. Cum. Pref.	6¼—6¾	3 14 0	..	6¼
		ELECTRIC MANUFACTURING &c.				
1	..	Aron Elec. Meter 6% Cum. Pref.	⅛—⅜	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5½—6	6 13 4	July, Feb	..
5	3/0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —105	4 7 0	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..
5	3/0	British Westinghouse 6% Pref.	3½—3¾	8 0 0	..	3⅝
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	87 —90	4 10 9	..	..
2	2/4½	Brush Electrical Engineering	½—1	..	March ..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	¾—1½	9 12 0	Mar, Sept	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	73 —78	5 17 8	Jan, July	..
5	7/6	Callender's Cable Con. Ord.	9½—10½	5 14 3	Jan, July	10⅜
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 6 11	Jan, July	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 3	Nov, May	106½
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	⅜—½	6 17 2	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¾—2½	6 13 4	Jan, July	..
100	6%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95 —98	5 4 6	Jan, July	..
5	..	Dick, Kerr & Co. Ord.	8 —8½	..	..	..
5	3/0	Do. 6% Cum. Pref.	5 —5½	5 9 1	..	5⅜
St.	4½%	Do. 4½% Deb. Stock	102—104	4 7 2	..	..
5	..	Edison & Swan United("A"Sh.)(£3 pd.)	½—⅝	..	Feb, Aug	..
5	..	Do. (£5 paid)	½—1½	..	Feb, Aug	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	73 —78	5 5 3	June, Dec	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	75 —79	6 11 8	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5⅜—6	5 16 8	H'lf-yearly	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅜—5¾	5 2 6	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105 —108	4 4 6	..	107½
2	1/2½	Electric Construction Co.	1⅝—1⅞	7 2 10	Jan, July	1⅞
2	2/9½	Do. 7 per Cent. Cum. Pref.	2½—2¾	5 2 0	July	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9¼—9¾	5 2 6	..	9¼
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..
5	9/0	Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	11⅝
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	19 —20	5 0 0	Feb, Aug	19⅝
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 —103	3 18 5	Mar, Sept	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..
12	36/0	Telegraph Construction & Mainten'ce.	36 —39	6 3 0	Mar, July	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..
5	..	Willans and Robinson Ord.	2½—3½	..	Apr, Oct	..
5	..	Do. 6 per Cent. Cum. Pref.	3½—4½	..	Apr, Oct	..
St.	4½%	Do. 4 per Cent. 1st Mort. Debs.	89 —94	4 5 1	May Nov	..

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NOTES.

As will be seen by our Parliamentary columns this week, a Committee of the House of Lords, presided over by the Duke of NORTHUMBERLAND, has enunciated the principle of a new clause to be imposed upon electrical undertakings on the lines of the now famous "Bermondsey" clause; but it cannot be said that the gas companies, who were the initiators of the opposition which led to the framing of this new clause, have gained much by the transaction. It will be seen that all new undertakings have been given a period of grace of five years, after which triennial revisions of prices are to be made so as to obviate, as far as possible, any loss falling upon the ratepayers. One thing which should be noted, however, is that by coming to this decision the Committee of the House of Lords has differed from the opinion of the Board of Trade that the principle of any clause similar to the "Bermondsey" clause is wrong, but their application of the principle almost meets the objection of the Board of Trade in so far as it gives any electrical undertaking worked under proper management an ample period in which to establish itself upon a financially sound basis. The further safeguard that contracts will not be affected by the clause in question practically leaves municipal electrical undertakings working under it in as free and unfettered a position as in the days before the original "Bermondsey" clause was drafted.

CONSIDERABLE developments in the distribution of electrical energy for driving motors and other industrial purposes are now taking place on every hand, and the article on the extension of the Poplar scheme, which appears on another page of this issue, is indicative of the trend of events. That Mr. HOOPER has done wisely in selecting an extra-high-tension three-phase system is without doubt, especially when the growing popularity of the three-phase motor is borne in mind. Moreover, it is anticipated that the Board of Trade will sanction extra-high-tension cables being taken into a consumer's premises when these are factories or works requiring a very large supply of power. This arrangement will, of course, be subject to the approval in each particular instance of the Board of Trade. Some difference of opinion will probably exist as to the desirability of allowing the consumer access to extra-high-tension gear, but it is to be expected that the Board of Trade will only sanction such a proceeding on its being satisfied that a responsible person has charge of the installation. Moreover, the Home Office, as represented by the Electrical Inspector of Factories, is in a position to insist on proper precautions being observed for safety. The idea of taking 5,000 or 6,000 volts, three-phase, directly to the stator of an induction motor used in a workshop is very nice in theory, and there are many firms who would be only too glad to supply excellent switch gear and other appliances calculated to render the working absolutely free from risk or danger; but we think it will be agreed that the adoption of such methods would, at present at all events, be anything but beneficial. Mr. RAM'S regulations as to how far into the factory the high-pressure circuits may penetrate will be awaited with interest, but in the meantime the permission to bring the extra-high-tension mains right into a consumer's own sub-station will result in considerable economy. In a district such as Poplar, where a fraction of a penny per unit may either make or mar the undertaking, it is essential that supply be given at the very lowest figure compatible with efficiency.

AN article of general industrial interest is abstracted in this issue. The great increase, even in this poor country, of electro-metallurgical operations is a sufficient reason for a full dis-

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cussion of the various methods by which such operations may be applied. Dr. J. W. RICHARDS (who must not be confused with his approximate namesake) has delivered a lecture which, deliberately put forward as a popular exposition, is at the same time a philosophical disquisition. His description of a process for sorting ores by electrostatic means is novel and worth attention; the mode of preparing elementary silicon and the pungent comment that now nothing is needed but a use for it, are racy in themselves; the opinion that the days of crucible steel are numbered—an opinion set forth in this paper at least 10 years ago—is now so generally accepted that it needs only the additional cachet of a transatlantic expert to be received and perpended by our rather sluggish Sheffield friends. The whole Paper shows the hand and grasp of one who has studied his subject in such manner that he writes as having authority and not as the Scribes.

THERE is a rumour to the effect that the United States Government intends to take over the entire control of wireless telegraph stations on its coast, and adopt a uniform system to the exclusion of all others. This rumour has created a mild panic among the various Government departments, owing to the fact that each of them has a pet system of its own. The Navy department uses the Slaby-Arco; the Army department is experimenting with a composite system consisting of a combination of the De Forest and Wildman systems; the Treasury department, a New York contemporary informs us, employs a nameless system which is only good for 12 miles; and lastly, the Agricultural department works the Fessenden system, and claims it for its own, since Prof. FESSENDEN was in the employ of the department when he devised the system. Moreover, other systems, including the Marconi, are in use on the high seas, just outside the three-mile limit. On the whole, therefore, the state of affairs is highly interesting and the Government has an unpleasant task before it. But it will become more unpleasant if action be delayed, for then the number of systems will have increased enormously, and the difficulty of controlling them will be greater. If the United States Government succeed in carrying out the proposal, perhaps our own Government will see its way clear to pursue a similar policy.

IN cases where single motors have to be tested, or where HOPKINSON'S method of testing is not practical, the power tests are usually carried out by means of one of the various forms of friction brakes. Such tests, if complete arrangements have not been made, are cumbersome and messy, on account of the cooling water used, and the heat generated by the friction brake often gives rise to serious troubles. In this connection, it may interest our readers to learn that the well-known French engineer, Col. RENARD, has lately been investigating theoretically and experimentally a method of apply the brake test to small and medium-sized motors by means of air vanes fixed to a beam which is directly rotated by the motor to be tested. In an instrument of this type described in the *Zeitschrift für Elektrotechnik*, two aluminium vanes are bolted to a wooden beam. Judging from curves which show the dependency of the power absorbed on the speed of rotation, it would appear that the accuracy of the method is very fair. Provided that the apparatus is substantially constructed, and that efficient means are taken to protect the experimenters from the revolving blades, there appears no obvious reason why such a testing arrangement should not give satisfaction, at least with smaller types of motors. One disadvantage is, of course, that, owing to the length of the arms which carry the vanes, the motor will have to be placed as a rule on a pedestal for testing. While this may be of small objection at the manufacturer's works, it will usually exclude the application of the method to motors fixed in position.

FOLLOWING the sensible lead of Willesden, Stoke Newington have been advised by their Electricity Committee to purchase their electrical energy "in bulk," so that all they have to do is to retail it to consumers and not to generate it. It is proposed that the Stoke Newington Council should build their own sub-station, receiving the supply of electricity at extra high tension, and then converting it and distributing it. As a matter of fact, the Stoke Newington Council are in a particularly favourable position to take a "bulk" supply, for their district is adjacent to no less than three different electricity supply areas, Hackney, Islington, and the Tottenham district of the North Metropolitan Power Supply Co., and thus they have the benefit of competitive tenders for supply from large electricity works which should be able to generate at a far less cost than could be done in a smaller station owned by the Stoke Newington Council themselves. Messrs. TALBOT and STEVENSON, who are the consulting electrical engineers to the Council, have certainly given sound and disinterested advice.

Society of Arts Conversazione.—The annual conversazione of the Society of Arts will be held at the Gardens of the Royal Botanic Society, Regent's Park, on Monday next from 9 to 12 p.m.

University Intelligence.—The University of Oxford on Wednesday conferred the degree of Doctor of Science *honoris causa* upon Sir William Church, Sir William Crookes, Prof. Dewar, Prof. Forsyth, Sir David Gill, Prof. Horace Lamb, Prof. Larmor, Signor Marconi, Prof. Alfred Marshall, Sir John Murray, Sir Andrew Noble, the Hon. Charles A. Parsons and Prof. J. J. Thomson.

Durham College of Science.—Sir Lothian Bell has promised £4,500 to the building fund of the Durham College of Science, this being the sum required for erecting a central tower to complete the building. The donor was one of the original founders of the college and has always been one of its most generous supporters.

Newcastle-under-Lyme Electricity Works.—The new electricity works of the Newcastle-under-Lyme Corporation were formally opened on Wednesday. A provisional order was obtained in 1899, and the system adopted is a three-wire one, with 440 volts between the outers. Messrs. Lacey and Sillar are consulting engineers.

Great Northern and City Railway.—A slight short-circuit occurred in a signal box near the Moorgate-street station of the Great Northern and City Railway yesterday morning and some smoke penetrated to the station. The station was cleared for a few minutes, but there was no cause for alarm, although some exaggerated reports as to a fire were circulated at the time. Of course, no one was injured, and the interruption to traffic was very slight.

The Kelvin Science School.—The Kelvin Science School at Trent College, Derbyshire, named by the special permission

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of Lord Kelvin, who is one of the subscribers to the building fund, is to be opened next Wednesday. The opening ceremony will be performed by Sir Douglas Fox, past president of the Institution of Civil Engineers. The Bishop of Liverpool has also promised to attend.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Dakar—Konakry	May 13, 1904
Accra—Lagos	June 1, 1904
Chio—Tenedos	June 21, 1904

Junior Institution of Engineers.—The next visits of the Institution are to take place on Saturday afternoon, June 25th, when the Chelsea generating station of the Underground Electric Railway Co., and the London County Council pumping station in Lots-road are to be seen; and on Saturday, July 9th, an excursion is to be made to Dover. The new turbine steamer "The Queen," the Admiralty harbour works and the works of the Dover Harbour Board are included in the programme, and in the afternoon the Mayor and Mayoress of Dover are to receive the Institution at the Town Hall.

Cooper's Hill College.—The following circular has been issued by the India Office:—

The Secretary of State for India in Council has now arrived at a decision as to the date of closing the Royal Indian Engineering College at Cooper's Hill. The prospectus for 1904 states that the college will be permanently closed at the end of the session of 1905-6, and that the entrance examination to be held in July of this year, under the conditions explained in the prospectus, will be the last. It also states that, from those passing the entrance examination, 25 appointments will be made in the engineering branch of the Public Works Department, one appointment in the accounts branch of the department, and two appointments in the telegraph department. Applications for admission to the entrance examination must be made in writing to the president of the college, on a printed form to be obtained from the secretary of the college, on or before Friday, July 15th next. A further communication will be shortly made as to to the future education of candidates for the Public Works and Telegraph Departments in India.

Wireless Telegraph Notes.—*The Times* correspondent in Paris states, on the authority of the St. Petersburg correspondent of the *Journal*, that the installation of a wireless telegraph station at Lake Baikal is almost complete, and will probably be in working order by the end of this week. There will be three stations, one on either shore and one upon the ice breaker, so that the latter will maintain communication throughout its passage across the lake.

An illustrated description of the wireless telegraph installation, which the Gesellschaft für Drahtlose Telegraphie intended to erect for reporting the Gordon-Bennett race appeared in *The Electrician* of June 3rd, p. 262. We learn from the company, however, that they were prevented at the eleventh hour from carrying out the arrangements owing to an unexpected influx of orders which made it impossible for them to spare operators for the race.

Radcliffe Electricity Works.—These works, which are the property of the District Council, were opened last week. A provisional order was obtained in 1895, and Messrs. Lacey and Sillar were subsequently appointed consulting engineers. It was decided to adopt a three-wire continuous-current system, and for this purpose there have been installed two Browett-Lindley high-speed vertical engines driving directly two Mather and Platt multipolar generators, having an aggregate capacity of 240kw. Steam is supplied to these engines by two Lancashire boilers, and electrical energy is distributed by Callender paper-insulated lead-covered mains, laid solid in Howard conduits. The engines run in conjunction with a Mather and Platt jet condenser, and a storage battery, made by the British Accumulator Co., is provided. At the station there is a 50-ampere Crompton balancer. A McPhail superheater has been installed, natural draught is used and the boilers are hand-fired.

Curtis Turbines in St. Louis.—The British Thomson-Houston Co. inform us that the Union Electric Light and Power Co. of St. Louis (a consolidation of the Missouri-Edison Electric Co.), the Imperial Electric Light and the Citizens Electric Light and Power Co. are building a large power station on the Mississippi river in North St. Louis. This power station when completed will supply all their demands, and will allow three existing power houses to be shut down. It will be equipped with four 5,000kw. and two 2,000kw., 25 ~ per sec., 6,600-volt alternators, directly-connected to Curtis turbines. In several sub-stations throughout the city motor-generators will be used for distributing continuous current at 110 and 220 volts. The power station is situated on the river front, and, being provided with a railway siding, coal may be received by barges and by rail. The two 2,000kw. turbines will be worked in conjunction with Wheeler condensers; the four 5,000kw. turbines with Worthington condensers. The Union Company is to furnish the St. Louis Transit Co. with 9,000kw. continuously, and the St. Louis Transit Co. is now installing two sub-stations. One will have seven 1,000kw. converters and the other two 1,000kw. converters. The distribution mains to the Transit Company's power stations will be underground.

American Visit of the Institution of Electrical Engineers.—We are informed that Mr. Calvin W. Rice and Mr. R. W. Pope, the organising honorary secretaries of the American visit of electrical engineers, are using every endeavour towards ensuring a most hospitable welcome to the members of the Institution on their arrival in the States. A large contingent of the Italian Electrical Society have made arrangements to participate in the tour, and these will meet the British Institution on their arrival at Boston. The official reception of the party is to take place at the Waldorf-Astoria Hotel, New York, on the evening of September 5th, on which occasion all the visiting members will be the guests of the American Institute of Electrical Engineers. In view of the anticipated large number of distinguished guests from the United Kingdom and Italy, the American Institute is sparing no pains to make this a most complete and memorable visit, and everything is being done to ensure the comfort and convenience of the members throughout the journey.

Exhibits at the Royal Society Conversazione.—Amongst the numerous scientific exhibits and demonstrations at the annual conversazione of the Royal Society, held at Burlington House on Wednesday last, there were several of interest to the electrical profession. Mr. W. Duddell exhibited a very sensitive thermo-galvanometer (see *The Electrician* of May 20th, p. 190, and the letter from Prof. R. Fessenden in the Correspondence columns of this week's issue), which was made to measure telephonic currents and also the currents in the receiving vertical wire of a wireless telegraph system erected in the room, the transmitting station being at the other end of the suite of rooms. Photographs of sparks and spiralling arcs were amongst the objects shown by the Royal Meteorological Society. Mr. J. W. Gordon exhibited a microscope with a magnification of about 10,000 diameters. It is of the compound type, and has, between the two microscopes, a small screen which is kept continuously oscillating by a tiny electric motor, in order to render its grain invisible. A number of photographs and drawings, illustrating the behaviour of lightning on some half a dozen buildings struck and damaged, although provided with lightning conductors, had been prepared from observations taken by the Lightning Research Committee, and were shown by Mr. Killingworth Hedges. Mr. W. Hibbert had on view a new magnetic balance, and Prof. A. Schuster and Dr. G. Hemsalech gave demonstrations of oscillating electric discharges. Some photographs, illustrative of induced radio-activity of bacteria, were shown by Dr. A. B. Green. The Hon. R. J. Strutt exhibited what might be termed a radium clock, which works on the following principle:—A specimen of radium salt in a glass tube is hung up by an insulating support in an exhausted vessel. An electroscope is attached to the radium tube. Negatively-electrified particles are shot off by the radium, and penetrate the glass tube, which is covered with a conducting coating of phosphoric acid, so as to act as an inductor. Thus a positive charge is left, and causes divergence. When the electroscope leaf touches the outer vessel, which is earthed, it

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collapses and begins to charge up again. This will go on as long as the radium lasts. Mrs. Hertha Ayrton explained the way in which sand ripples and sand banks are formed. Her explanations were made quite clear by an elaborate set of glazed tanks, partly filled with pepper to represent the sand. Stationary waves were produced in the water above the sand by a rocking motion imparted to the tanks by small electric motors. This exhibit was most interesting, and attracted an appreciative crowd of visitors.

The Arc Works.—A most enjoyable function took place last Saturday, when a considerable number of ladies and gentlemen were entertained at luncheon and afterwards at an athletic race meeting by Messrs. Crompton & Co. At the Arc Works, previous to the luncheon, an inspection of the various shops and of the processes of manufacture carried on within them was made, much interest being displayed in the fine work in connection with instrument making. At 1:15 luncheon was served in the admirable new mess rooms which have been provided for the use of employés. In proposing the toast of Messrs. Crompton & Co., the Mayor of Chelmsford said that the firm were intimately connected with the prosperity of the town, and he hoped they would long continue to flourish. Col. Crompton, in replying, said how glad he was to see so many of their friends there that day, and although trade had been in a very depressed condition for some time, yet he was glad to be able to say that the corner had been turned and that matters were improving greatly. Referring to the sports which would be held that afternoon, he could not lay too much stress on the treatment which employés should receive at the hands of the masters. They should not be treated as mere toilers, but as living human beings, and their leisure hours should be made as comfortable as possible. The firm had built that mess room for men who lived too far away to go home to meals, and he thought it would compare very favourably with anything that could be found in other countries. In apologising for making such a serious speech on anything but a solemn occasion, Col. Crompton said his speech was grave because he recognised that unless employés were treated rationally England would no longer be able to hold her position in the world as the premier commercial country. He trusted that his grave demeanour would be somewhat counteracted by the happy faces they would see in the afternoon. At the conclusion of the luncheon the guests were conveyed to the sports ground, where the rest of the day was spent in witnessing some excellent races.

International Electrical Congress at St. Louis.—We are informed that the acceptances of membership in the International Electrical Congress to be held at St. Louis on September 12th-17th, number 1,702, and that over 160 specially invited Papers are promised, in all. 1,000 certificates of membership have been issued to those who have become members by sending in their subscription, and about 100 more certificates are about to be issued. Efforts are being made to secure the MSS. of as many of the 160 Papers as possible by July 1, in order to have them printed in advance and distributed among the Congress members at St. Louis. Thus far, six Papers have been delivered, and many more are promised by that date. The programmes scheduled for sections D and E are given below. We published similar programmes of sections A, B and C in *The Electrician*, Vol. LIII., pp. 88 and 296. All communications concerning the Congress should be addressed to the general secretary, Dr. A. E. Kennelly, Harvard University, Cambridge, Mass.

Section D.—Electric Power Transmission.

Sig. E. Bignami, "Electrical Transmission Plants in Switzerland"; Mr. H. M. Hobart, "Conditions Conducive to Economy in Motor Design"; M. Maurice Leblanc, "Transmission of Alternating Currents Over Lines Possessing Capacity"; Prof. G. Mengarini, "Utilisation of Hydraulic Powers in Italy"; Prof. S. G. Baum, "High-potential Long-distance Transmission and Control"; Mr. P. O. Blackwell, "The Tower System of Line Construction"; Mr. H. W. Buck, "The Use of Aluminium as an Electrical Conductor"; Mr. V. G. Converse, "High-tension Insulators"; Mr. M. H. Gerry, jun., "Line Construction and Insulation for High Tensions"; Mr. L. M. Hancock, "Bay Counties Transmission System"; Mr. R. L. Hayward, "Some Practical Experiences in the Operation of Many Power Houses in Parallel"; Messrs. J. F. Kelly and A. C. Bunker, "Long-distance Power Transmission"; Mr. P. M. Lincoln, "Transmission and Distribution Problems Peculiar to the Single-Phase Railway System"; Mr. R. D. Mershon, "The Maximum Distance to which Power can be Economically Transmitted"; Mr. P. N. Nunn, "Pioneer Work of the Telluride Power Co."; Mr. J. S. Peck, "The High-Tension Transformer in Long-Distance Power Transmission"; Dr. F. A. C. Perrine, "American Practice in High Tension" (N.E.L.A. Paper); Dr. C. P. Steinmetz, "Theory of Single-Phase Motors" (A.I.E.E. Paper).

Section E.—Electric Light and Distribution.

Prof. André Blondel, "Impregnated Arc Light Carbons"; Herr Ma Déri, "Single-phase Motors"; Herr E. de Fodor, "Rates for Electricity Supply"; Sig. Ing. E. Jona, "Insulating Materials in High-tension Cables"; Prof. W. Kübler, "Upon a Means for Compensating the Series-connection of Induction Motors"; Herr Karl Roderbourg, "Storage Batteries"; Sig. Ing. Cuido Semenza, "Commercial Limits of Electric Transmission, with Special Reference to Lighting Service"; Dr. G. Stern, "The Superiority of the Alternating Current for Distribution in Large Cities"; Dr. W. Wedding, "Measurements of the Energy of Light and Heat Radiation from Electric Light Sources"; Mr. Arthur Wright, "Recent Improvements in Electrolytic Meters"; Prof. S. P. Thompson, subject to be announced; Mr. B. A. Behrend, "The Testing of Alternating-current Generators"; Mr. George Eastman, "Protection and Control of Large High-tension Distribution Systems" (N.E.L.A. Paper); Mr. W. C. L. Eglin, "Rotary Converters and Motor Generators in Connection with the Transformation of High-tension A.C. to Low-tension Street Current" (Assn. Ed. Illg. Cos. Paper); Mr. W. L. R. Emmet, "The Effect of Steam Turbines on Central Station Practice"; Mr. Louis A. Ferguson, "Underground Electrical Construction" (Assn. Ed. Illg. Cos. Paper); Mr. Gerhard Goettling, "Storage Batteries as an Adjunct to Central Station Equipment" (Assn. Ed. Illg. Cos. Paper); Mr. G. Ross Green, "American Meter Practice" (N.E.L.A. Paper); Mr. Caryl D. Haskins, "Metering Efficiency on Customers' Premises"; Mr. Francis Hodgkinson, "Steam Turbines"; Mr. John W. Howell, "Incandescent Lamps"; Mr. Philip Torchio, "Distributing Systems from the Standpoint of Theory and Practice"; Mr. W. F. White, "The Selection of a Distributing System for a Large City."

The chairmen of the respective sections are Mr. Chas. F. Scott and Mr. J. W. Lieb, jun. The secretaries are Dr. Louis Bell and Mr. Gano S. Dunn.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, June 24th.

Physical Society.

5 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Papers to be read:—(1) "Chemical Dissociation and Electrical Conductivity," by A. E. Garrett and Dr. R. S. Willows; (2) "The Magnetisation of Iron in Bulk," by Dr. W. M. Thornton.

SATURDAY, June 25th.

Junior Institution of Engineers.

3 p.m. Visit to the generating station of the Underground Electric Railways Co. of London, Lots-road, Chelsea.

WEDNESDAY, June 29th.

Incorporated Municipal Electrical Association.

10 a.m. Meeting at the Technical College, Green-lane, Derby. Reception by the Mayor. Agenda:—(1) Presidential Address by Mr. T. P. Wilmshurst; (2) "The Commercial Practicability of Electric Traction by Surface Contacts," by C. E. C. Shawfield; (3) "The Organisation and Management of a Central Station Meter Department," by A. J. Cridge.

THURSDAY, June 30th.

Incorporated Municipal Electrical Association.

10:15 a.m. Meeting at University College, Nottingham. Papers to be read:—(1) "Polyphase Sub-stations: their Equipment and Working," by S. L. Pearce; (2) "Some Notes on the Bristol Electricity Works Fire," by H. Faraday Proctor.—*2:30 p.m.* Visits to the Nottingham Electricity Works and Tramways.

FRIDAY, July 1st.

Incorporated Municipal Electrical Association.

10:15 a.m. Meeting in the Town Hall, Sheffield. Papers to be read: "Boiler House Economies," by R. S. Downe; (2) "The Financial Position of Municipal Electrical Undertakings," by Councillor J. R. Blakeway.—*2:30 p.m.* Visits to Messrs. Hadfields's Steel Works, the new Sheffield Electricity Works, and the Tramway Station.

SATURDAY, July 2nd.

Incorporated Municipal Electrical Association.

10:30 a.m. Annual General Business Meeting in the Technical College, Green-lane, Derby, for the election of officers for the ensuing year, &c. A Special General Meeting will then be held to consider a proposed revision of the Articles of Association with regard to "Qualifications for Membership."

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MIDDLESBROUGH DOCK ELECTRIC AND HYDRAULIC POWER PLANT.*

BY VINCENT L. RAVEN.

Now that the question of electric appliances for dock purposes is so generally considered, the author thinks that it may be of interest to record the particulars of the installation and the tests which have been made at Middlesbrough Dock, on the North-Eastern Railway, comparing hydraulic with electric. These are working side by side, and are all thoroughly up to date, giving an excellent opportunity for judging the value of the one against the other, so far as economy in working is concerned.

When the dock, Fig. 1, was constructed, it was equipped with steam cranes, and had a small hydraulic power station for working the bridge and gate machinery. Twelve years later, a further extension was made, and hydraulic cranes were then supplied to the new extension. A separate electric lighting station was also put down for dock lighting. With this plant, in the year 1900, the following tonnage was dealt with :—

Coal and coke exported	222,616	tons.
Merchandise exported	197,933	,,
,, imported	36,941	,,
Ballast worked	1,751	,,
Total	459,241	,,

	Tons.	Cwts.	
To do this work : The steam cranes burnt	1,989	0	of coal.
The hydraulic station burnt	994	15	,,
The electric station burnt	932	11	,,
Total	3,916	6	,,

The total merchandise worked per ton of coal burnt was, therefore, 117 tons.

When the present extension was proposed, after careful consideration, it was decided to abandon the steam cranes and to supply their places with electric cranes, and, at the same time, make one large power station, which would supply both the electric power for the cranes and for the lighting ; and the hydraulic power water for the hydraulic plant. The work in connection with the power station was divided into two contracts, Messrs. Siemens Brothers & Co., of Woolwich, being responsible for the electrical portion, and Messrs. Carrick and Wardale, of Gateshead-on-Tyne, for the hydraulic installation.

The power station contains three sets of Messrs. Belliss and Morcom's compound three-crank self-lubricating quick-revolution vertical engines, discharging into independent condensing plants, each developing 360 B.H.P. at a steam pressure of 150lb. per square inch at a speed of 380 revs. per min.; these engines are direct coupled to three Siemens dynamos, which have an output of 240kw. at 430 volts when running at a speed of 380 revs. per min.

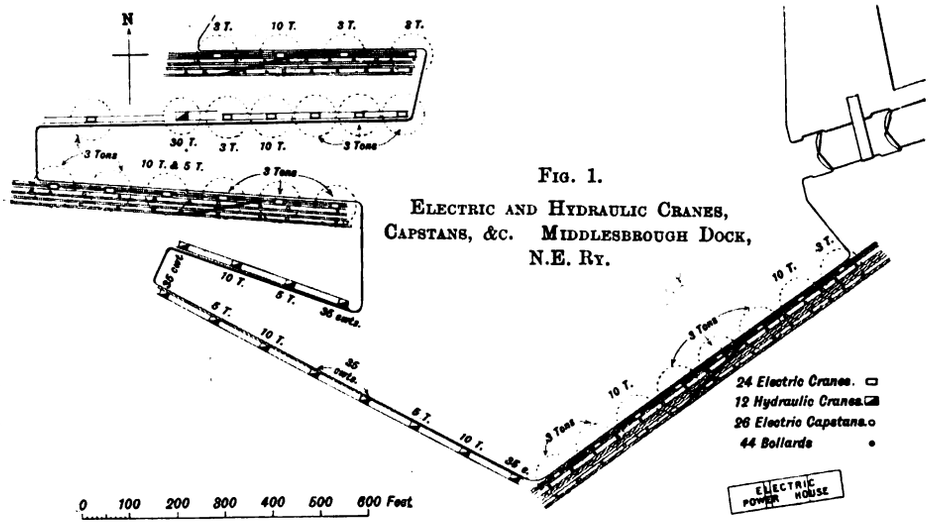

FIG. 1.

ELECTRIC AND HYDRAULIC CRANES, CAPSTANS, &C. MIDDLESBROUGH DOCK, N.E. RY.

The engines on a six hours' test run gave the following results :—

Steam pressure on range	154lb. per sq. in.
,, ,, in steam chest	128lb. ,,
Vacuum	24in.
Revolutions per minute	380
Volts	430
Amperes	552·5
Exciting amperes	6·75
Kilowatts	237·5
Water consumption	21·1lb. per E.H.P.†
Efficiency	$\frac{318{\cdot}3 \text{ E.H.P.}}{359{\cdot}321 \text{ I.H.P.}‡} = 88{\cdot}6$ per cent.

The switchboard is of marble, and consists of four machine and one feeder panel, in addition to the lighting panel. The instruments are of the moving coil type. The shunt winding of each dynamo is brought to a switch on the board, and these shunt switches are interlocked with their respective main switches, so that it is impossible to break the exciting circuit of any machine until the armature has been cut out of circuit, nor can the armature be thrown in until the shunt circuit is made. The three machines are run in parallel upon the 'bus bars, and the shunt circuits are excited from the bars.

The three hydraulic engines are of the triple-expansion surface-condensing inverted vertical marine type. The pressure pumps, three in number, are of the ordinary ram type, worked directly off the piston rods, and each set is capable of delivering 300 gallons per minute at a maximum speed of 240ft., against an accumulator pressure of 800lb. per square inch. Both the hydraulic and electric engines can also be worked non-condensing, and the piping and valves are so arranged that either engine can be changed over from condensing to non-condensing, or vice versa, without any stoppage whatever. There are two hydraulic accumulators, 20in. diameter by 23ft. stroke, and situated between these is a large water tank which holds 12,000 gallons for supply to the pressure pumps.

The hydraulic engines on a six hours' test run gave the following results :—

Water pumped at a piston speed of 240ft. per min.	311 gallons.
,, per cwt. of coal burnt	5,090 ,,
Steam consumption per I.H.P. per hour	14·1lb.*
Total I.H.P.	181·5†
Steam pressure per sq. in.	150lb.
Vacuum	28·5in.
Efficiency $\left\{\begin{array}{l}\text{Pump H.P.} \ldots 162{\cdot}5 \\ \text{I.H.P.} \ldots\ldots 181{\cdot}2\end{array}\right.$	$= 89{\cdot}5$ per cent.
Accumulator pressure	750lb. per sq. in.

There are two sets of condensing plant in connection with the electric steam engines, each capable of dealing with 15,000lb. of steam per hour ; these were supplied by Messrs. Carrick and Wardale, of Gateshead-on-Tyne. Each set comprises a compound steam-driven air and circulating pump, together with a surface condenser combined on one bedplate. The circulating water is passed zigzag through the condenser, and the quantity used is 30 times the amount of steam dealt with, and the vacuum maintained from 27in. to 29in. The circulating water is drawn from the dock a distance of 300ft. through an 18in. suction pipe, and at low water these pumps have a lift of 15ft., but no difficulty has been experienced in getting the water even at such a great distance. There is also a circulating pump, fitted by the same makers, for supplying water to the condensers of the hydraulic engines, and it is similar in design to the electric plant. The three feed pumps and filters were supplied by Messrs. Henry Watson & Sons, High Bridge Works, Newcastle-on-Tyne.

The boilers for both plants are of the ordinary Lancashire type, six in number, 30ft. long, 8ft. 6in. diameter, working pressure 160lb. per square inch, and were made by Messrs. H. and T. Danks, of Netherton. The boilers are fitted with Proctor shovel stokers, and the coal is supplied thereto by a coal elevator and conveyor supplied by Messrs. Graham Morton & Co., of Leeds, the coal in the first instance being raised from ground level in truck by means of a diagonal hydraulic hoist to the top of the coal cells and there discharged. A Green economiser of 384 tubes, 9ft. long, $4\frac{8}{16}$in. diameter, is fitted in connection with the boilers.

The boilers on a six hours' test gave the following results :—

Grate area	38 sq. ft.	
Coal burnt	5,208lb.	
Clinker and ashes	356lb., or 7 per cent. of	
Net consumption of combustible	4,852lb.	coal burnt.
Combustible burnt per hour	809lb.	
,, ,, per sq. ft. of grate area per hour	21·3lb.	
Lbs. of water evaporated	36,300	
,, ,, per hour	6,050	
,, ,, per lb. of coal burnt	7·5lb.	

* Abstract of a Paper read at the Chicago Meeting of the Institution of Mechanical Engineers. Some particulars and photographic illustrations of this plant have already been published in *The Electrician*, Vol. XLVIII., pp. 606 and 688.

† Exclusive of steam used by the condensing plant.

‡ Exclusive of power abstracted by the condensing plant.

* Exclusive of the steam used by the circulating pump.

† Exclusive of the power absorbed by the circulating

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Feed-water from hot well at 110°F. was run to waste on account of measuring the water, and town water was put in feed tank at a temperature of 54°F., or equal to a loss of 241lb. of coal. The steam and hydraulic mains are laid in circuit in the engine and boiler houses respectively. The contract for the electric cranes and capstans consisted of 19 3-ton and five 10-ton cranes, Figs. 2 and 3, and 26 1-ton pull capstans, Fig. 4. The following are the principal particulars of the 3-ton cranes, Fig. 2, as specified :—

Height of jib top pin from quay level.....	60ft.
Radius of jib	44ft. 9in.
Speed of lift, 3-ton load	150ft. per min.
Speed of lift, 1½-ton load	250ft. per min.
Revolving speed at hook	400ft. per min.
Travelling speed	30ft. per min.
Lifting motor, 50 B.H.P.	300 revs. per min.
Revolving motor, 8 B.H.P.	1,000 revs. per min.

The travelling gear motion is fitted with both hand and electrical gear, the latter consisting of an enclosed series-wound multipolar motor, which is coupled to a steel worm working into a delta metal worm wheel. The power is communicated to the trod wheels

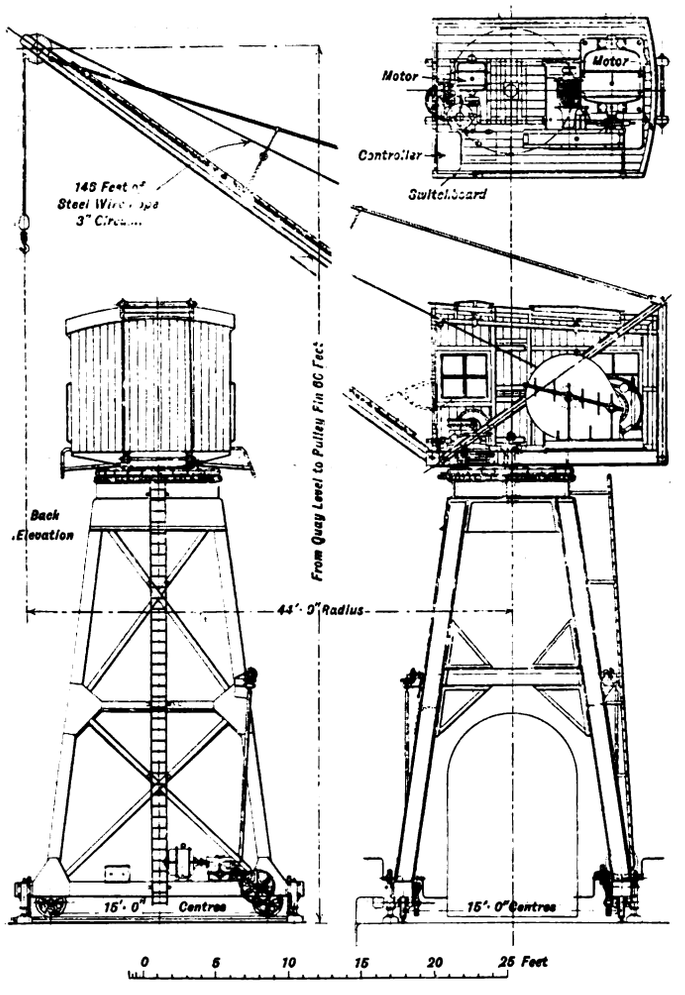

FIG. 2.—3-TON ELECTRIC TRAVELLING CRANE. MIDDLESBROUGH DOCKS, N.E. RY.

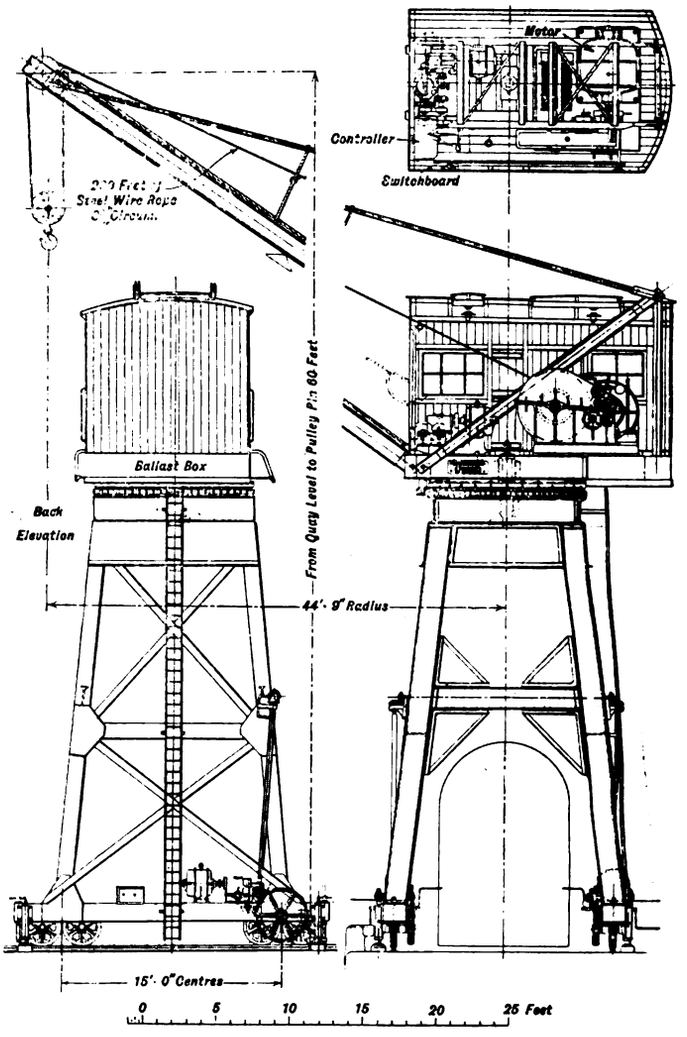

FIG. 3.—10-TON ELECTRIC TRAVELLING CRANE. MIDDLESBROUGH DOCKS, N.E. RY.

by means of spur and bevel gearing, the wheels on each side being coupled together by means of a cross shaft, thereby ensuring uniformity of movement and avoiding any twisting strain on the gantry. The switch gear for the travelling motor is placed in a water-tight case upon the bottom framing of the gantry. To prevent the possibility of unauthorised persons starting the gear, the switch is provided with a detachable key, which is kept in the charge of the crane driver. The top framing is constructed of H beams riveted up into box shape and carrying the heavy plate which takes the roller path. H-beam cross-stays take the thrust and stiffen the structure. The roller path and rack are of cast steel They are not bolted to the top plate, and whilst they are held down by a groove turned out of the latter, they admit of some movement and ease the crane in case of a sudden stop when revolving. The rollers are 24 in number and of cast steel.

The collector is fitted to the centre pillar, through which the mains are passed and attached to two copper rings mounted upon ambroin and separated by rings of the same material. The collecting brushes consist of two gauze straps, each encircling one ring, the tension being regulated by springs. These straps are attached to terminals, which in turn are mounted upon porcelain insulators, from which the cables for the wiring of the cranes are taken. The crane cabin is of teak, and the front consists of a wrought-iron framing, glazed to enable the driver to have full view of his load throughout the operation. The cabin contains the lifting and slewing gear and the controlling apparatus.

The lifting gear consists of a barrel, wheel and pinion. The wrought-steel pinion is cut from a blank forged solid with the shaft, which is fitted with a half-coupling to meet that upon the motor spindle. Upon this shaft there is a band brake, actuated by an electromagnet, which will be described later. The pinion gears into a cast-iron spur-wheel keyed on the barrel shaft. Both pinion and wheel have machine-cut teeth, and work in a cast-iron gear-case, which forms an oil-bath. The revolving gear consists of a motor, worm, worm-wheel and spur gear. The worm is cut from a blank forged solid with the shaft, which, in turn, is fitted with a coupling to meet the motor. The worm engages with a delta metal worm-wheel, and a pinion keyed to the worm-wheel shaft engages with a spur wheel which is fitted to a short shaft actuating a pinion. This pinion travels round the rack of the crane, and thus slews the cabin and jib. A brake actuated by a foot-treadle is fitted to the first-motion spindle, so that the slewing motion is always under control. The slewing motor is of similar type to the lifting.

The electric brake magnet, referred to previously, offers some points of interest. It is placed in series with the armature of the lifting motor, and consists of a horse-shoe magnet (with poles arranged as those of a two-pole dynamo) with a solid steel armature of special shape capable of revolving between them. The passing of the current round the field coils tends to move the armature through a right angle. A lever is fixed to the end of the armature, and the brake, which is normally held on to the brake wheel by a weight, is connected thereto by a rod. The movement of the armature lifts the brake and releases the brake

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wheel. The great advantage of the particular form of magnet described lies in the strong pull and long range which it affords. The brake is also connected to a lever which stands at the driver's left, so that it can be operated instantly by hand when necessary. The controller is of the so-called Universal type, and consists of two separate controllers combined in one case and actuated by one handle. One controller actuates the lifting, and the other the slewing, and both are connected by pinions and quadrants to the lever. The latter is so arranged, by means of a Universal device, that when moved in a vertical plane it actuates the lifting, and, in a horizontal plane, the slewing controller. Thus it will be seen that the hook follows the motion of the driver's hand, lifting when he raises the lever, and so on. One conspicuous point about the controller is the ease with which it is manipulated, owing to the absence of click gear upon the immediate contacts. Notches are provided only at the two extremes and the off positions, and, in consequence, the controller may be operated throughout the day without fatigue and its attendant slackness. The resistances are fixed inside the cabin.

The switchboard consists of polished slate, framed in teak, and fitted with main D.P. switch and automatic cut-out in lifting circuit, and isolating switches in slewing circuit, fuses and lighting switches.

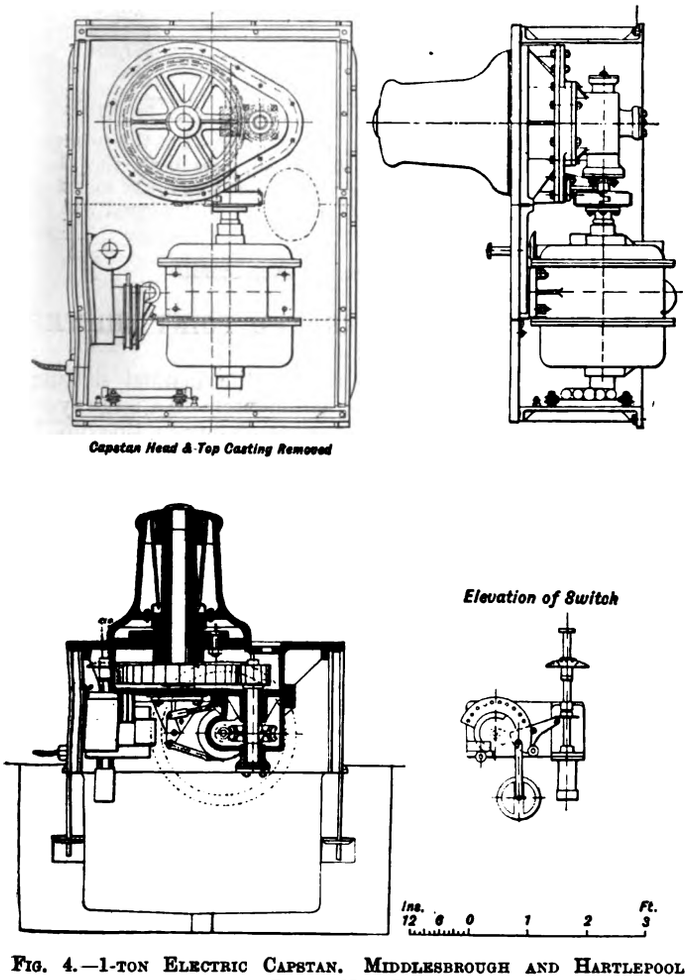

FIG. 4.—1-TON ELECTRIC CAPSTAN. MIDDLESBROUGH AND HARTLEPOOL DOCKS, N.E. RY.

The crane cabin is well lighted by fixed and portable lamps, and a cluster, in an enamelled iron reflector, is fixed beneath the jib halfway up its length. Terminals are provided upon the switchboard, to which may be connected an inspection voltmeter and ammeter.

Each 3-ton crane on being completed was tested in the following manner:—

A large iron tub (fitted with a valve at the bottom), weighing 1 ton net, brought close to the quay wall, lowered into the dock, filled through the valve, there being a port in the side of the tub so that the weight of water could not exceed 2 tons, or a total load of 3 tons. This was lifted 30ft., and slewed through a half circle simultaneously, then lowered on to the quay, where the valve on the bottom of the tank opened, and the water returned into the dock. The tub was again lifted empty, taken back, and the same process continued.

Each crane was worked in this manner for three hours, making on an average 100 lifts in the stated time. The energy used was: Lifting, 18·3 Board of Trade units; slewing, 6·4 Board of Trade units, or a total of 24·7 Board of Trade units, or 2·74 units per 1,000 foot-tons, or a total cost of 5·4d. per 1,000 foot-tons.

The 10-ton cranes, Fig. 3, are of the same design as the 3-ton cranes. The revolving motor is 12 B.H.P. at 1,000 revs. per min., and the lifting motor, which is of 60 B.H.P., in single gear drives directly through a pinion on to the barrel shaft, the ratio of gearing being 8 to 1, and a double part of rope is used. The double gear gives a multiplying power of 20 to 1. With the single gear loads up to 2 tons are lifted, and the double gear is used for loads from 2 to 10 tons. As it was impossible to get both the hydraulic and the electric cranes working together under similar conditions into a vessel on account of the cargoes at Middlesbrough being of such a varied nature and the vessels differing so much in dimensions, to obtain comparative figures as to the cost of the work done, a special test was made, which was considered to be the nearest approach to the actual working conditions in loading cargo into a vessel's hold. The first load was 2 tons lifted through a height of 20ft. by the single gear, slewed through 180deg., and then lowered 20ft.; the light chain hoisted 20ft. and the crane slewed back through 180deg. This cycle of evolutions was performed five times. The load was then increased a further 2 tons each time up to and including 10 tons, and the same number of evolutions made with each load as in the first case, but double gear being used for the lifting. The total current used being 8·1525 Board of Trade units, or 2·717 per 1,000 foot-tons, at a cost of 5·4d. per 1,000 foot-tons, equivalent to 358,710 foot-pounds of energy per minute for the total work.

The hydraulic crane was of up-to-date design, with a capacity of 10 tons, and having three vertical cylinders for lifting. Water is admitted to the centre cylinder for the light power, the two outside cylinders for the second power, and all three cylinders for the full load. The slewing is done by gearing driven by a small ordinary four-cylinder capstan engine, and the working pressure at the crane during the test was 700lb. The hydraulic cranes are 15 years old, but are all of exactly the same design as supplied by the same firm at the present day, and were overhauled and in perfect condition before the trials were made; and the capstan is quite modern.

The power water was measured by means of two Kent's high-pressure water meters, one on the lifting and the other on the revolving motion, and the crane was worked at its ordinary speed. Precisely the same evolutions were carried out as in the case of the electric crane, and the total gallons of pressure water used was 2,391, equivalent to a cost of 10·25d. per 1,000 foot-tons lifted, or equivalent to 687,412 foot-pounds of energy per minute for the total work.

Another test was made on a Sunday with six hydraulic cranes arranged to be as near as possible on one quay, and water meters were attached to each crane. Waggons of rails were brought underneath the cranes and worked as if they had been ordinary cargo into a ship. They were lifted to a height of 20ft., slewed half circle, lowered down to empty waggons; the light chain lifted a height of 20ft., revolved through half circle and lowered down again. Six hundred tons were dealt with as constant loads and 600 tons as variable loads. The cost of power per 1,000 foot-tons of work was 1s. 6d., the time occupied seven hours.

The same work was done on the following Sunday by the electric cranes, and the cost per 1,000 foot-tons was 1s. 2·28d., and the time occupied 5¼ hours.

The total saving effected by the electric cranes, including cranemen and labourers, was 25 per cent., but the load-factor for the electric was only 7·3 per cent., as against the hydraulic 14·4 per cent., so that, if more cranes had been working and a better load on at the power station, better results would have been obtained for the electric cranes. It is estimated that the total gain would have been 50 per cent.

The electric capstans, Fig. 4, are 24 B.H.P. at 1,000 revs. per min., and are capable of exerting a steady pull of 1 ton at a speed of 200ft. per min., or of hauling a load of 100 tons along a level road. The capstan-head is driven by a cast-iron spur-wheel, which is engaged with a steel pinion. The latter is keyed on the same shaft as a brass worm-wheel. The driving worm is cut from a blank forged solid with its shaft, and is coupled direct to the motor spindle. The worm and wheel work in an oil bath. The motor runs at 1,000 revs. per min. and is completely enclosed. In construction and design it is similar to the crane motors, but is shunt wound to avoid large variations in speed of the capstan head. Upon the motor shaft there is fixed an automatic mechanical brake, the principle of which provides that when the capstan-head is driven by the motor the brake releases itself automatically, but should the capstan tend to run back through being overhauled by the weight, the brake at once locks itself and sustains the load. Such a brake is absolutely necessary upon an electric capstan, as the latter differs from a hydraulic capstan in one important respect—namely, that in the hydraulic capstan the water in the cylinders holds the load, whereas in the electric capstan there is nothing to sustain the load upon the current being cut off, and if the load is allowed to run back a serious

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accident may ensue. It is also essential that the brake should be automatic so as to claim none of the driver's attention from his work.

The electrical switch gear consists of a controller with magnetic blow-out, and with overload release gear. The controller is worked by a pedal projecting above the capstan case by about 4in. This pedal is removed when the capstan is out of use. The pedal is connected to a dash-pot which prevents the controller being operated too rapidly when a driver is starting the capstan, but, at the same time, by means of valves in the plunger, allows the controller to return rapidly to the off position. The return to the off position is effected by means of a weight which is lifted as the pedal is depressed. In the event of the capstan being pulled up by sudden overload, the release gear works instantaneously and breaks the main circuit. Upon the pressure being removed from the pedal, the return of the controller to the off position automatically replaces the release switch, and the capstan is ready to start again. The whole of the gear is contained in a water-tight cast-iron case sunk in the ground, the top of which consists of chequered plates flush with the quay-side.

The distribution of current is effected by a network of feeders and distribution cables laid below ground. These cables are fibre-insulated and lead-sheathed; they are laid in wooden troughs on the solid system, and are at a depth of about 2ft. from the surface. Water-tight junction boxes are provided at the junctions of the feeders. The crane connection boxes are in two portions, the bottom of which contains the positive and negative distributing cables, and the top the connection apparatus for the cranes. The connection socket consists of a circular gunmetal hood which accurately fills the aperture in the cover of the box, and is so shaped as to shield the joint from wet. The interior of this hood contains two gunmetal tongues which meet the two clip contacts in the interior of the box. A stud and groove ensures that the socket shall enter the aperture only in the correct position. The flexible crane cable enters the hood of the socket through a trumpet mouth, and the whole apparatus is shaped so as to obstruct the quay-side as little as possible. There are 52 boxes in all, placed 20yd. apart. They have withstood the test of the severest weather, and have given no trouble. The cost of cables complete is about 50 per cent. of the cost of hydraulic mains for the same power.

About ½ mile from the power station a sub-station, fitted with switchboard for the lighting, has been put down. There is only one cable for supplying the power both for the electric machinery and the lighting of the docks, offices and station.

Summary—The traffic department (see Table I.) find the electric cranes to be a great advantage. There is very little time required for oiling, as the crane has ring lubricators to all main bearings, and the wheels run in oil-baths which only require attention about once a month. The oil-bath effectually prolongs the life of the wheels and deadens any noise, which is a great advantage to the drivers in hearing instructions. The controlling of the crane by one handle is also a distinct advance both over the steam and the hydraulic cranes. With the steam cranes the driver had to attend to four levers and a foot-brake, in addition to the feed-pump and the firing of the boiler. In the case of the hydraulic crane two levers are in use which require considerable force.

The automatic cut-out in the electric cranes cuts off the current in one case at 3 tons 5 cwt., and the other at 10 tons 10 cwt., and this device prevents an overload upon the crane. Should the current fail at any time the brake on the lifting gear is applied automatically, and will hold the full load in any position with safety. To obtain some definite idea of the speeds of the various cranes when working under ordinary conditions, they were tested separately. The steam crane had a load of 2 tons put on, and this was lifted 30ft., slued through 106·5ft., lowered 30ft., light hook lifted 30ft., slewed 106·5ft., and light hook lowered 30ft. The total time for these operations was 1 min. 44 sec., or at the rate of 34 cycles per hour. The hydraulic cranes, under precisely the same conditions, occupied 1 min. 40 sec. per cycle, or equivalent to 36 cycles per hour.

The electric cranes did the same work in 64 seconds per cycle, or 56 cycles per hour, and this is capable of being increased beyond even this point with a good driver. Therefore, in ordinary working, the electric cranes are doing 50 per cent. more work per hour than the hydraulic or steam cranes. On actual test it was found that the electric cranes can be released from the rails, travelled 30ft., and re-fixed to rails in three minutes.

When it has been necessary to move the hydraulic cranes to suit the working into the various ships' holds, six men have had to be called one hour earlier in the morning to set the four cranes which are required for each vessel. With the electric cranes the men have not to be called earlier, as two men in summer and four in winter can disconnect and connect up four cranes in 15 minutes. In winter, on frosty nights, four men have been employed six hours each for the purpose of keeping fires to prevent water in the cylinders of the hydraulic cranes from freezing; on the other hand, he electric cranes have no need of this. When a steam crane had o be got ready for work, the driver had to commence one hour earlier in order to obtain steam, whereas the hydraulic and electric cranes are ready for work at any moment. In 1903, when the steam cranes were superseded by the electric cranes, the quantity of traffic dealt with at this dock was:—

Table I.—*Summary of Results.*

—	Description of Cranes.		
	Hydraulic.	Electric.	Saving.
Number of lifts made	825	834	..
Weight of rails lifted ....tons	1210·4	1224·9	..
Time occupied in loading ....hrs. min.	7 0	5 15	1 45
Coal burnt at power station during test ....pounds	3,584	2,912	672
Cost of working at power station during test ....pence	167·34	151·38	15·96
Cost of working at station, incl. capital, interest & repairs during test ..pence	436·74	351·48	85·26
Cost of men's wages handling cargo during test ....pence	3,528	2,646	882
Cost of handling cargo ....pence	3964·74	2997·48	967·26
,, per 100 tons ....pence	327·5	244·7	82·8
Saving effected by elec. cranes pr. 100 tons	..	..	82·8
,, ,, ,, ..per cent.	..	..	25

	Tons.
Coal and coke exported	259,746
Merchandise exported	297,304
,, imported	33,696
Total	590,746

To do this work, the quantity of coal burned at the new power station, which, as previously stated, supplies both the electric power, lighting and hydraulic power water, was 3,428 tons 4 cwt., or the total merchandise worked per ton of coal burned was 172·3 tons, or a gain of 47·2 per cent.

AN ELECTRICALLY-OPERATED POINT SHIFTER.

The expenses in connection with the manual shifting of tramway points become a very serious item on a large system, and it is with the idea of effecting economy in this direction that an ingenious point shifter has been devised by Messrs. S. Dixon & Son.

The apparatus may be worked by the motorman of any car, without the addition of any extra appliance whatever to the car, or any alteration of its wiring. The cast-iron street box B in the elevation contains a powerful electromagnet or solenoid, B_1, wound to suit the line voltage and having a core of suitable size and stroke to pull over both the rail point and that of the overhead wire. The core B_2 is connected to the rail point tongue D by rod E, and also to a lever, L, projecting upwards, so that when desirable the points may be actuated by hand. A flexible steel cable, G, connected to this lever L, is carried to the overhead point F, and is adjusted so that the necessary movement is obtained, when the lever is thrown over either by hand or by the magnet B_1. The working of this magnet is controlled by an electrically-operated switch mounted in the same street box. The switch consists of two electromagnets, M and N, mounted, as shown, side by side, with their cores connected to a pivoted lever forming the moving portion of the switch, at one end of which are the switch contacts 4, well insulated from the lever. At the other end of the lever is an adjustable balance weight, so that when the core of magnet M is attracted the switch is closed, and when that of magnet N is attracted the switch is opened.

The closing of this switch completes the circuit thus: From the overhead trolley wire by means of cable J, main switch and fuse 1, connecting wire 2, fuse 3, switch 4, magnet B_1, to earth or rails, thus causing the core of magnet B_1 to be attracted and the points pulled over. On the switch being opened the core is released, and the points resume their original position owing to the tension of a powerful spring. The necessary current for working magnets M and N is derived from the line as follows:—At a position some convenient distance short of the rail point, a section insulator, A, of the air-gap type is fixed in the trolley wire. By means of the insulated cable J which is connected to the overhead wire at insulator A and run down the pole bracket H to box B, current is conveyed to the main switch and fuse 1 to magnet M, from there to return fuse 7 and back through the wire I to the

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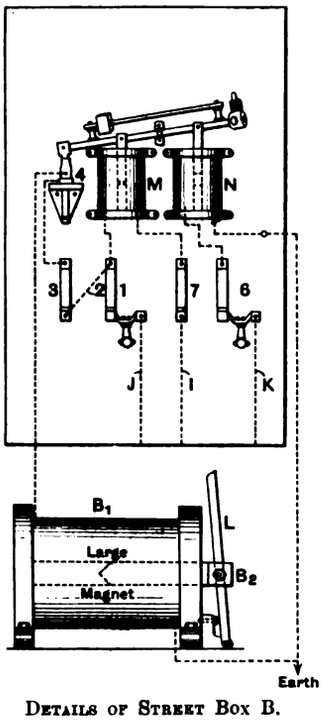
insulated piece of the section insulator A. A cable, K, is also run from the hanging switch C to the box B and on to the switch and fuse 6, and is then connected to the magnet N, from whence it returns to the rails.

If on approaching a junction the motorman does not intend to turn on to the branch route, he will, on nearing insulator A, switch his motor controller off and coast through the insulator, thereby not interfering with the points in any way. Should he, however, desire to turn on to the branch line, he would, on approaching the section insulator A, keep his controller on. Current would then flow from the line by means of wire J to switch and fuse 1, through magnet M, return fuse 7, wire I to insulated piece A, down the trolley to the motors and thence to rails. The large magnet would then become energised owing to the switch 4 being closed, and it would, therefore, pull over the points.

The car having passed the points, now comes to the hanging switch C, and, this being closed by the trolley head, a current is sent through the wire K to the switch and fuse 6, through magnet N and thence to the rails. Switch 4 is thus opened, and the core of magnet B_1 is released, allowing the points to resume their original positions.

The makers of this point shifter inform us that they are prepared to instal it on any electric tramway system in England and maintain it in first-class working order for a period of two years, they to receive the amount of money that would have been paid in pointsmen's wages for that period, and at the end of the two years hand the whole installation over to the owners of the tramways free of charge. Up to date, five of these devices have been installed in Leeds, Bradford and Sheffield have sample points working and the Gloucester tramways are shortly to be equipped with four.



Details of Street Box B.

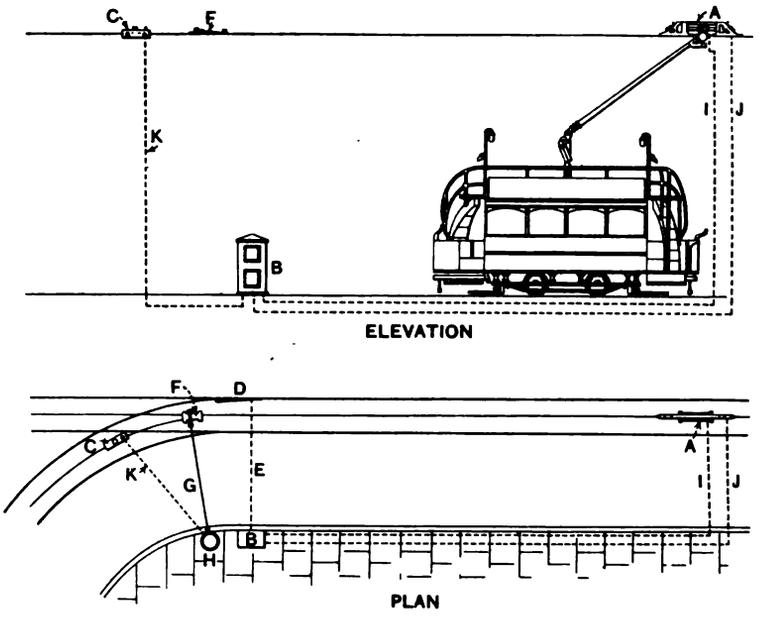


Diagram of Track Connections.

ELECTRICAL PLANT AT HEYSHAM HARBOUR.

Heysham Harbour is the name of the large new harbour which is being built by the Midland Railway Co. on the north Lancashire coast about 3 miles south of Morecombe. The harbour when completed will take the whole of the Midland Railway Co.'s passenger, goods and cattle traffic to and from the Isle of Man and Ireland, and also a fish traffic, and it is expected that the opening of the new facilities will result in an enormous increase of business in this direction. It is not within the province of this article to describe the harbour works themselves, although the particular nature of the ground and the large tidal rise have presented many problems for solution that necessitated a considerable exercise of engineering skill.

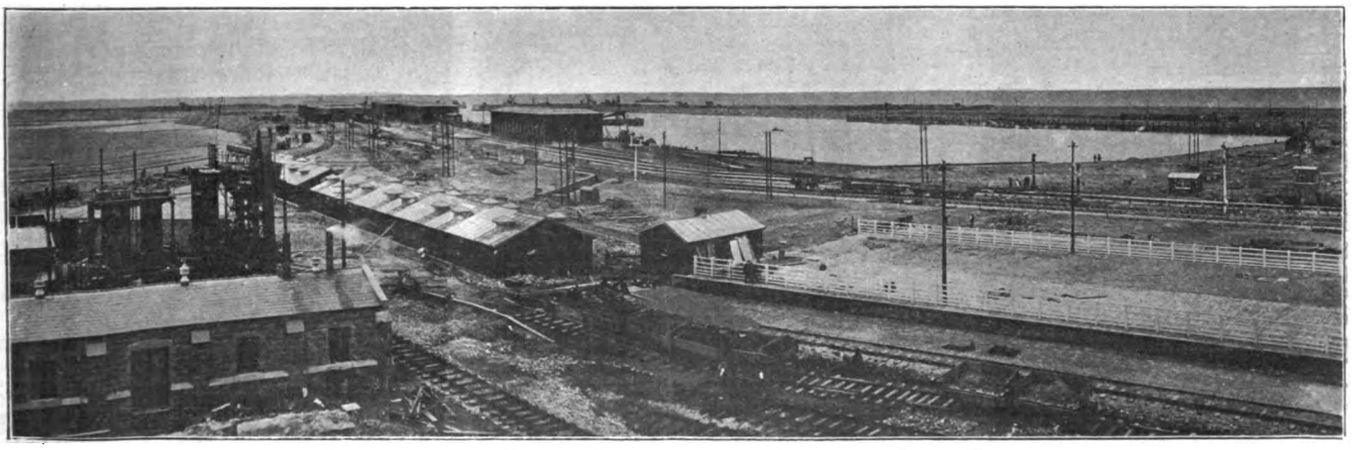


Fig. 1.—General View of Harbour, showing Position of Power House.

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Fig. 1, however, will give a general idea of the extent of the works, and it may be mentioned that the harbour covers an area of 45 acres, that it extends over a mile from the present high-water level and that the power house, which is 1,000yds. from the high-water mark, supplies some points over ¾ mile away. The buildings to the left in Fig. 1 contain the power plant, and by them is the gas-producer plant—for the station is driven by Mond gas—and the furthest points to be supplied with elec-

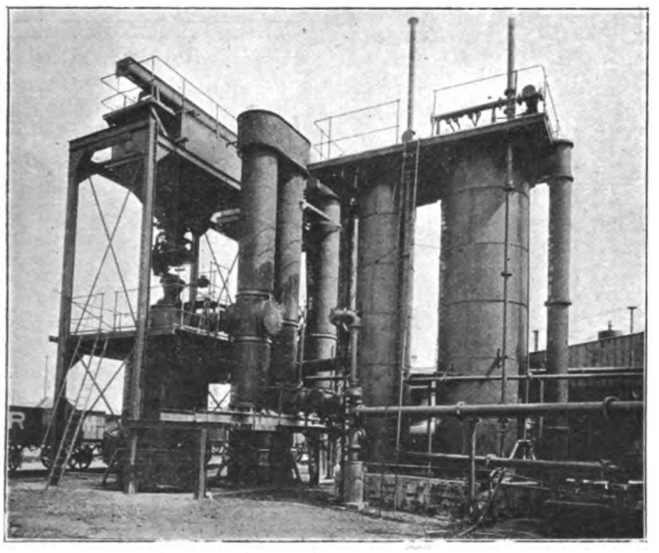

Fig. 2.—The "Mond" Gas Plant.

trical energy are the fish dock, just seen in the distance on the extreme right of the illustration, and a bore-well about a mile inland. In addition to arc and incandescent lighting, the electricity works supplies current to the whole of the electric cranes, capstans, lifts, &c., and thus offers many interesting examples of electric driving.

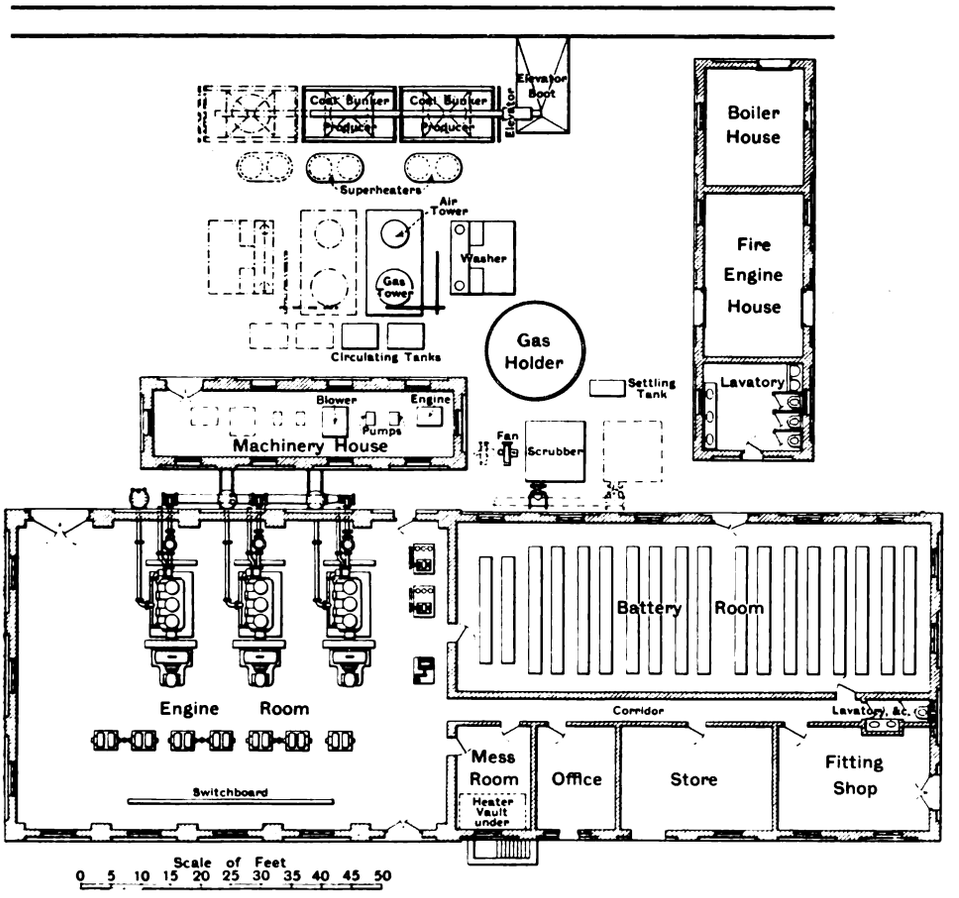

Fig. 3.—Plan of Power House and Gas Plant.

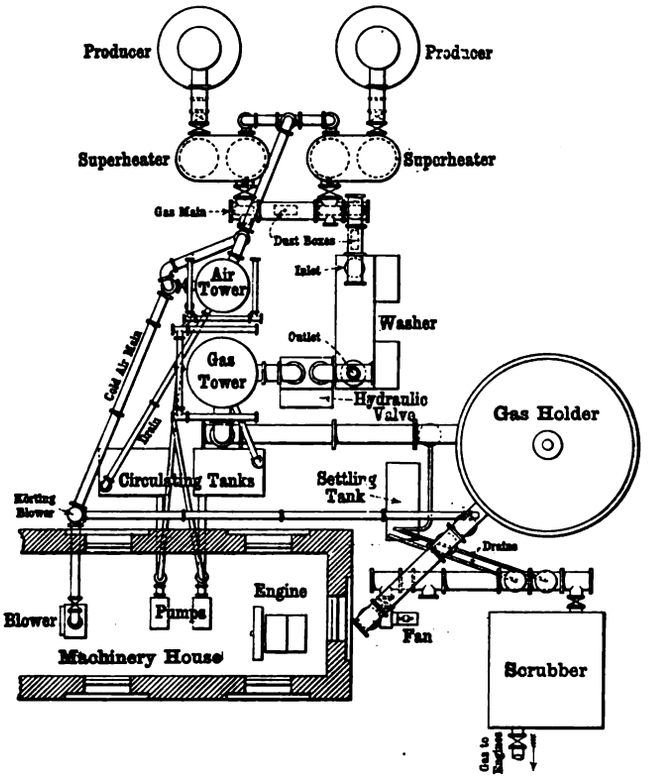

Fig. 4.—Sketch Diagram Plan of Gas Plant.

The system adopted for the electrical generation and distribution is a 2×230-volt three-wire system, the incandescent lamps being connected on the 230-volt mains, the motors across the 460-volt outers and the arcs, which are of the enclosed type two in series, off the 230-volt mains. Westinghouse generating plant is employed, in conjunction with an E.P.S. battery of large capacity and reversible boosters, there being, however, some departures from standard practice in the booster and balancer arrangements. The dynamos are driven by gas engines supplied with Mond gas.

The employment of a gas-driven central power house is by no means a new departure for the Midland Railway, this company having already a large Dowson gas station at Leicester, which has been running successfully for some years. On this occasion it was decided to give a trial to the Mond gas system, and the Power-Gas Corporation, who supplied the plant, were given a fairly free hand in order that no effort might be spared to make the plant thoroughly successful. Fig. 2 is a view of the plant, Figs. 3 and 4 being plans (the latter only a sketch diagram and not to scale) showing the position and arrangement of the various pieces of apparatus. The Mond method of producing gas is to pass a heated blast of air and steam through the gas producer, in which it comes in contact with small bituminous coal at a comparatively low temperature and pressure. The heating of the air-blast is effected by a regenerative arrangement, so that the heat of the out-going gas is transferred to the in-coming air, which is also heated in the shell of the furnace itself. The steam employed

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for mixing with the air-blast is the exhaust from the blower, pumps and auxiliary engine, these machines being supplied from two small boilers in a separate boiler house. These two boilers generate steam at 60lb. pressure, and each is rated to evaporate 1,000lb. of water per hour from and at 212°F., this being amply sufficient for one of the two 500-750 I.H.P. gas producers and its auxiliary plant. The Power-Gas Corporation states that about 1 ton of steam is required for each ton of coal gasified. A Roots blower is employed for the circulation of the air-blast, and there is a Körting injector as reserve. Before being mixed with the exhaust steam, the air passes up through the "air tower," down which the water employed for cooling the gas in the adjacent gas cooling tower trickles over circular earthenware tiles with which the tower is packed. On leaving the air-tower it is led, together with the exhaust steam already referred to, into the "superheater." This is a ∩-shaped structure consisting of two vertical pipes, each providing a wide internal passage for the gas to flow through, surrounded by an annular passage for the air. In these pipes the major part of the heat of the gas is transferred to the air and steam-blast which then passes down a similar outer shell of the gas producer itself and enters the bottom of the producer in a superheated state.

Coal is supplied to the hoppers above the producers by an ordinary elevator from which it falls into producers through an automatic arrangement, made by Messrs. Avery, for weighing and registering the coal used. The producer itself consists of a main inner chamber lined with fire brick and the outer annular chamber already referred to through which the air passes before coming into contact with the furnace. A water-seal at the bottom of the producer renders it possible to remove the ash without interfering with the working of the plant.

The gas formed is a mixture of carbon dioxide, carbonic oxide, hydrogen, marsh gas and nitrogen, the carbonic oxide and hydrogen representing only some 38 per cent. of the whole. It is thus seen that the volume of the gas is considerable as compared with ordinary coal or town gas when comparing horse-power with horse-power, this being compensated, however, by the lower cost of the gas volume for volume. The carbon dioxide formed at the bottom of the producer where the air-blast enters is partly reduced to carbonic oxide, part of which is, in its turn, employed in the generation of hydrogen and carbon dioxide by the reaction between the carbonic oxide and the water vapour. There is also a direct combination of carbon with the water vapour, producing either carbonic oxide and hydrogen or carbon dioxide and hydrogen. Nearly 50 per cent. of nitrogen (from the air-blast) together with a small amount of marsh gas (CH_4) also comes over with the gas.

From the producer the gas passes directly to the superheater, where some of the dust it carries over with it is deposited into dust-boxes, and thence to the "washer." In the washer a four-bladed dasher revolves, throwing a fine spray of water into the gas as it passes through, and removing the remaining and lighter portion of the dust. Between the washer and the gas tower there is a hydraulic check valve to prevent the gas being forced back into the annular air chamber of the producer should the air-blast fail for any reason.

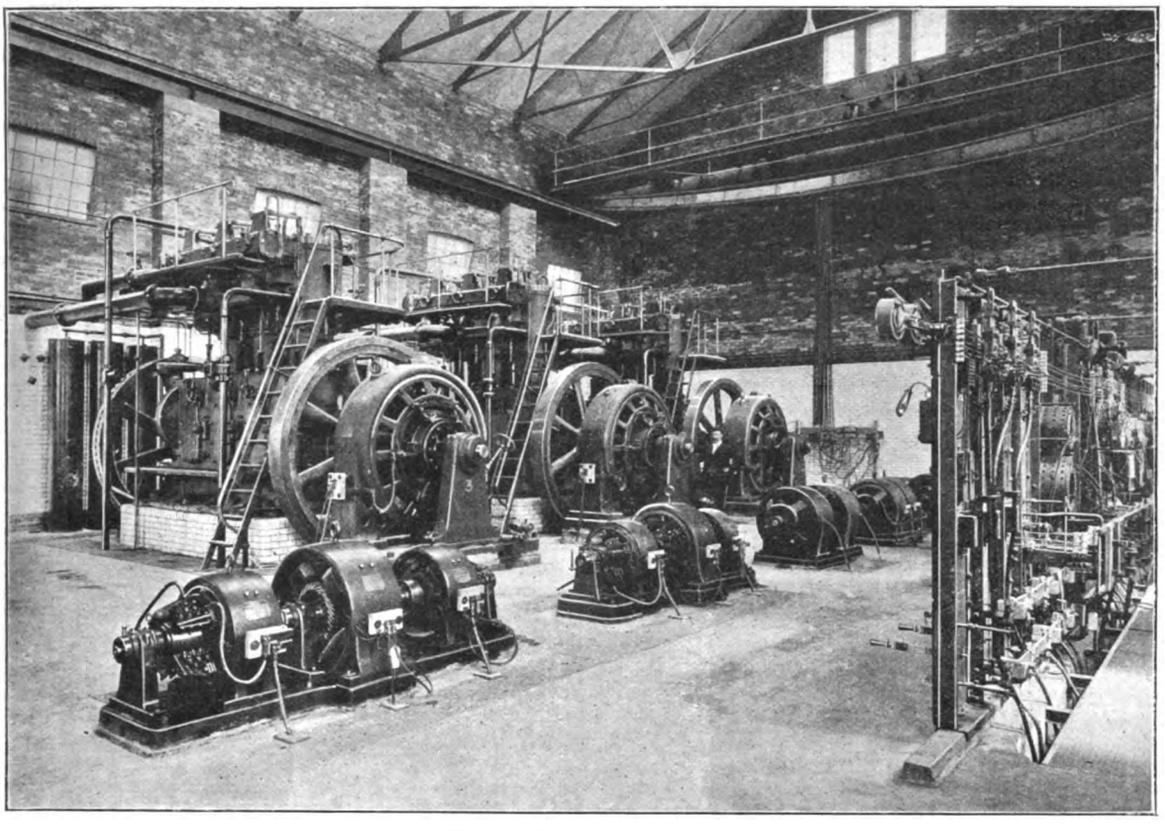

FIG. 5.—THE ENGINE ROOM.

After undergoing a further cooling in the gas tower, the gas is led to a small gasometer, which holds only enough gas for a few minutes' supply, and is simply for the purpose of keeping the pressure constant. Tar is, of course, contained in considerable quantities in the gas, and this comes out during the various cleaning processes; the bulk of it is removed from the water in the settling tanks, and some also from the water in the "washer," in the circulating tanks for the air and gas towers, and in the hydraulic check valve. In order to remove the last trace of tar from the gas, it passes through a fan in which it is dashed violently against the sides of the fan chamber, and thence through a sawdust scrubber.

As seen in Fig. 3, the machine room containing the blower and pumps is a separate building adjoining the engine room.

Two producers have been erected at Heysham Harbour, and space is left for a third. Each producer is rated for a maximum output of 750 I.H.P., and will deal with 7½ tons of fuel in 24 hours, producing, the makers inform us, 150,000 cubic ft. of Mond gas per ton of fuel. The gas engines are guaranteed to work with 70 to 75 cubic ft. of gas per brake horse-power-hour, the calorific value of the gas being 150 B.Th.U. per

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cubic foot. There will be a 25 per cent. proportionally larger consumption of gas at half load.

The generating plant represents more or less standard practice. The Westinghouse gas engines run at 200 revs. per min. and are directly coupled to six-pole Westinghouse dynamos, there being three 150kw. sets, with space for a fourth of 300kw. at a later date. The ignition for the gas engines is effected electrically with the aid of a small motor-generator, and the engines are started by means of compressed air, for which there are two compressors driven by 4 H.P. motors. Two 3½ H.P. motors work the pumps supplying the circulating water for the cooling jackets.

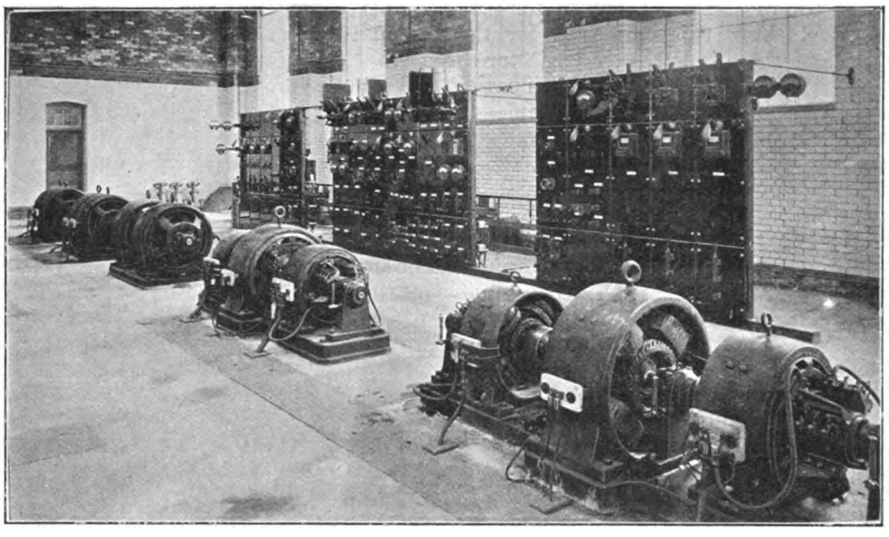

Fig. 6.—Boosters, Balancers and Switchboard.

The auxiliary plant in the engine room consists of four boosters—two for the batteries, one for the lighting feeders and one for the power feeders—and a balancer. The battery boosters are automatically reversible boosters, each with a shunt-wound motor driving a 16kw. generator and a 5kw. exciter. They can increase the pressure by hand regulation of their exciters from 0-80 volts for charging at 200 amperes, and decrease it 0–45 volts on discharging up to 300 amperes, and can also be set to work automatically on varying power loads so as to charge up to 200 amperes and discharge up to 300 as loads vary. The speed is 950 revs. per min. As seen in Fig. 7 the booster motors are connected in series across the three-wire system, and can be used as a balancer, the sets being then mechanically coupled together. The booster itself is separately excited by a small exciter on the same shaft and this exciter is differentially compound-wound, one of its field-windings being connected to the 'bus bars and the other to a very low resistance shunt in the 'bus-bars between the main generators and the outgoing feeders. The boosters have also a series winding on their fields carrying their main current, this winding causing a cumulative effect to take place.

The lighting feeder booster is made up of two 7½kw. series generators driven at 850 revolutions by a shunt motor. The machine is designed to increase the pressure by 25 volts on each side of the lighting feeders when necessary, and to deal with a current of 300 amperes. Each of the generators of

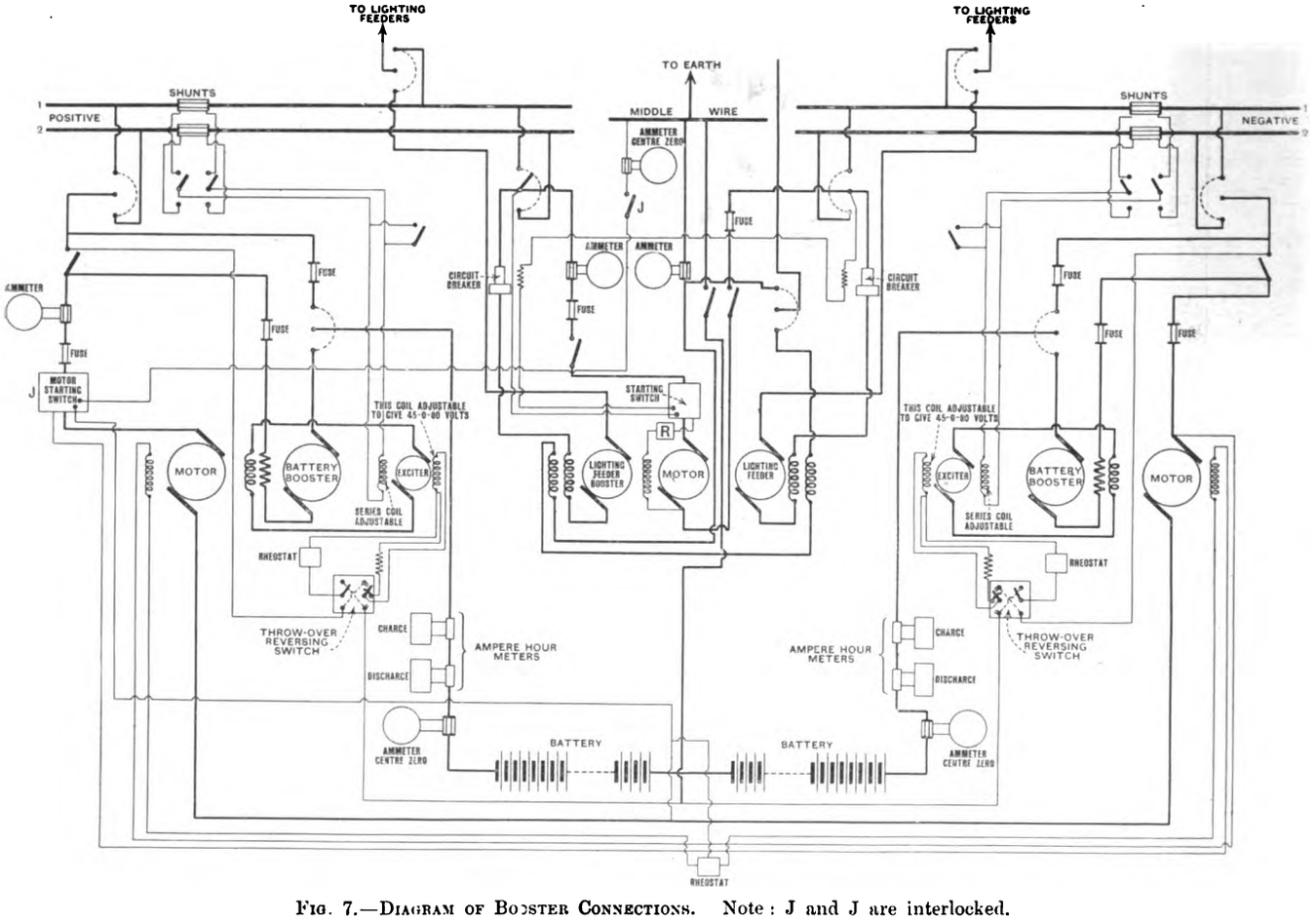

Fig. 7.—Diagram of Booster Connections. Note: J and J are interlocked.

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this machine has, in addition to the series-winding, a second series-winding connected in series with the middle wire, as shown in Fig. 7. Thus, when there is a large out-of-balance current flowing through the middle wire, the pressure on the more heavily loaded side is automatically increased, and the middle wire drop is compensated for. In addition to this, there is the usual cross-connected balancer, consisting of two 24kw. machines running at 950 revs. per min. The power feeder-booster is an ordinary booster, capable of raising the pressure 35 volts and dealing with 250 amperes of current. It is driven by a motor at 400 revs. per min.

As seen in the illustrations, the boosters and balancers are in a row in front of the switchboard The number of these machines necessitates an unusual number of switches on the board, but interlocking arrangements are added to lessen, as far as possible, the making of a wrong connection. Duplex fuses are provided for the lighting feeders, but the power feeders have circuit-breakers with time-element relays. In series with each generator there is an ordinary overload cut-out and a separate reverse-current cut-out. All the fuses are of the carrier type, and are placed at the back of the switchboard.

The battery (Fig. 8), which is of the E.P.S. make, consists of 230 cells, capable of supplying 180 amperes for six hours, or 300 amperes for three hours, and of supplying, without damage, 540 amperes for periods up to 30 seconds. The battery is of

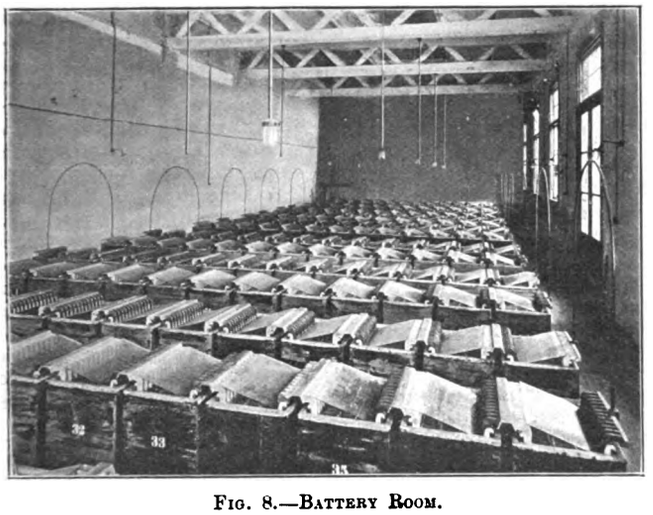

Fig. 8.—Battery Room.

large capacity in comparison with the capacity of the plant, in view of the fact that there may be occasionally considerable overloads on account of the number of crane, capstan and lift motors, and the fact that the generating plant is gas-driven. Its large size will also considerably decrease the running costs, as it will enable the plant to be entirely shut down for portions of the 24 hours

In the building which contains the small boilers and the lavatories is space for two electrically-driven Merryweather fire engines, which take water from an 8in. main and deliver jets at high pressure. Each fire engine consists of two Hatfield pumps driven by an 80 H.P. motor, the two pumps being capable of delivering 700 gallons per minute. A by-pass pressure relief valve is being fitted so that the delivery may be returned to the suction when the pumps are pumping without there being a proportionate demand for water. A switch is provided in the pump room, by means of which the fire engine electric mains may be connected directly to the battery should a fire occur on the switchboard, or in the engine room, and cut off the supply of power to the fire engines. Automatic circuit-breakers are also provided in the leads from the battery to the switchboard, so that a short-circuit on the latter in the course of such a fire would not have the energy of the battery discharged into it.

(To be concluded.)

PHYSICAL SOCIETY.

At a meeting of the Physical Society, held on June 10th, Dr. R. T. Glazebrook, F.R.S., president, in the chair, a Paper entitled

"A Model illustrating the Propagation of an Alternating Current along a Telephone Cable, and a Simple Theory of the Same,"

was read by Prof. J. A. Fleming. Although the mathematical theory of the propagation of alternating currents along lineal conductors having capacity, inductance, resistance and leakage has been developed by many writers in great fulness, the conclusions reached by them have not always been readily assimilated by practical engineers, and in some cases unsound theories have been put forward regarding the conditions limiting telephonic speech along wires. The present Paper contains an account of a model (exhibited at the meeting) which has been constructed by the author for the purpose of explaining in a simple manner the physical meaning of the mathematical expressions which are reached in discussing the propagation of alternating currents along a telephone or telegraph cable. The first part of the Paper is concerned with a presentation of the elementary theory of the phenomena expressed in terms of complex quantities, which forms a more suitable mode of investigation than the use of ordinary trigonometrical analysis, as the time-element is thereby eliminated. Beginning with the fundamental differential equations for the distribution of potential and current in an element of such a cable when traversed by any current, these are then thrown into the form appropriate when considering simple harmonic currents, and a solution given for the potential and current distribution in the case of a semi-infinite cable, having a simple periodic E.M.F. applied at the end. The solution is of the form $V = Ee^{-\alpha x}(\cos \beta x - \iota \sin \beta x)$, and it indicates that the potential V at any point in the semi-infinite cable has a maximum value which is less than that at the origin, (E), in an assigned ratio, and shifted backwards by an assigned angle in phase. A geometrical interpretation was then given of the above equations, leading to a graphic representation of the distribution of potential in the cable at any moment, and the model shown illustrated the meaning of the above equation and the graphic interpretation of it. The model consists of a steel axis, on which are keyed a number of wooden discs grooved on the edge. These are set on the shaft eccentrically, and the eccentricity of the wheels diminishes in geometrical progression. Each eccentric is shifted backwards in phase compared with its preceding neighbour by an equal angle, and these eccentricities and phase-angles can be varied. Each eccentric wheel is embraced by a long string, the ends of which are attached to metal blocks which can slide up and down on a steel wire. These strings are all of equal length. When the axis carrying the wheels revolves, each block moves up and down with a nearly simple harmonic motion, but the amplitude of that motion decreases from block to block, and, moreover, the phase of the motion of each block is delayed behind that of its next preceding neighbour by an equal amount. Hence, when the axis is turned round, the blocks, of which there are 48, are arranged in a periodic curve of decreasing amplitude, and move up and down in a manner which imitates the propagation of a wave of alternating current or potential along a cable. The Paper then proceeds with a discussion of the theory, and a very simple proof is given of Mr. Heaviside's condition for the distortionless propagation of a wave of electric current The criterion of distortion is then applied in the case of one long submarine cable, and it is shown how far removed such a cable is from being a distortionless cable. The remedies which have been proposed are then discussed, and it is shown that it is hopeless to expect any real advantage merely by bringing the iron armour closer to the cable-conductor, but that a large reward awaits any inventor who can bestow upon a long submarine cable inductance up to 300 or 400 henries per naut, without at the same time increasing much the usual capacity of 0·3mfd. per knot. Allusion is made to Prof. Pupin's investigations concerning the insertion of inductance coils at intervals along the telephone lines, and the suggestion is made that there is no difficulty in applying this plan to subterranean telephone trunk lines, and that considerable improvement in the transmission of telephonic speech could thereby probably be effected.

Mr. T. H. BLAKESLEY congratulated the author upon the interesting result contained in his Paper, that under a certain critical relationship among the properties of the cable relatively distortionless waves might take place whatever the frequency. But he thought some other of the consequences of this relationship might be more simply exhibited in the forms for potential and current,

$$V = Ee^{-\alpha x}\cos(\beta x - pt),$$

$$I = \frac{Ee^{-\alpha x}}{\quad}\cos(\beta x - pt + m),$$

where $q^2 = \frac{R}{K}\left\{\frac{1+\left(\frac{Lp}{R}\right)^2}{1+\left(\frac{Cp}{K}\right)^2}\right\}^{\frac{1}{2}}$ and $\tan 2m = \frac{(LK - RC)p}{RK + LCp^2}$.

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q is of the nature of resistance, and m is the angle of lag of the current behind the potential, and is constant for all points of the cable. This lag-angle disappears when $LK - RC = 0$, but from the expression for q^2 it is clear that this quantity will be independent of the frequency if $L/R = C/K$, which is again the same condition. Thus the real degradation of current would be the same for all tones, and the conjunction of current and potential, for all points, would be secured by this condition. It would not, however, be easy in practice to fulfil this condition. There was, however, something to be said for keeping both L and K small, as, in fact, they are in practice. For, looking at the expression for q^2, it will be seen that it diminishes as the frequency rises if $CR > LK$, and this is true of cables in practice. Hence, though e^{-ax} grows less with rising frequency, the resistance q also becomes less, so that the degradation of current is not so great as that implied in the mere increase of a with frequency. Mr. Blakesley pointed out that in operating upon equations 13 and 14 to obtain equations 20 and 21, the quantity $\sqrt{(R^2+p^2L^2)(K^2+p^2C^2)}$ could be written in two ways:— $\sqrt{(KR \pm p^2LC)^2 + p^2(LK \mp CR)^2}$. The author had chosen the top signs, but interesting results could be obtained by choosing the bottom signs and contemplating the equality of KR and p^2LC.

The CHAIRMAN read a letter from Mr. Jacob pointing out that the dielectric resistance of the 1880 Anglo-American cable, considered in the Paper, is much higher, as it lies in the sea, than the figure quoted by the author, which was obtained at 75°F. and atmospheric pressure after one minute electrification. The electrification or absorption of the dielectric, however, masked all the effects of the high insulation value. An inductance of 300 or 400 henrys per naut was beyond possibility; the inductance should not be of a higher order than 1 henry per naut.

Dr. FLEMING, in reply, said that the relation between the electrical constants of the cable which gave distortionless transmission was discovered and announced 20 years or more ago by Mr. Oliver Heaviside. All that he (Dr. Fleming) had attempted to do was to simplify and illustrate the proofs of this condition. The employment of complex quantities in the discussion of alternating-current problems led to a considerable simplification of the analysis. As in practice we were only concerned with the maximum or root-mean-square values of the potential and current, the introduction of the time-variable into the equations led to complicated expressions the physical meaning of which was not readily apparent to most students. All the usual algebraic expressions for current and potential at any point could, however, be readily obtained from the vector equations he had given. As regards the practical realisation of Heaviside's distortionless condition for submarine cables, the figures given in the Paper were merely intended to indicate the remoteness of its possibility. The correction furnished by Mr. Jacob for the insulation resistance of the dielectric when the cable was immersed did not affect the general conclusions, as if the insulation resistance was greater, the departure from the distortionless condition would be then still greater. He recognised that the "absorption" of the dielectric introduced a factor not taken into account in the mathematical theory. As regards the practical superior limit of inductance which might be given to a cable, no one could say what invention might not bring forth. He was glad to hear that an inductance of 1 henry per naut might improve matters sensibly, because he had devised a plan by which an approximation to this might be reached. Mr. Jacob only confirmed the statement in his Paper in expressing the opinion that an inductance of 300 to 400 henrys per naut was impracticable.

SOME PROPERTIES OF ALTERNATORS UNDER VARIOUS CONDITIONS OF LOAD.*

BY A. F. T. ATCHISON.

(*Continued from page 318.*)

Self-excited and Compounded Asynchronous Generators.

The problem of devising a generator which can operate satisfactorily without requiring a large synchronous machine in parallel, and which at the same time retains the value properties of the simple asynchronous generator in the matter of parallel running, has, as a matter of fact, been solved, and such machines have recently been constructed in large sizes.

The subject of self-excited and compounded alternators has, indeed, been so largely developed in recent years, and so many devices have been brought out, that it is not proposed in the present Paper to follow out the subject in all its branches, but only to examine those principles which give promise of adoption in practice.

The principles employed are the outcome of the earlier devices of Latour, Heyland and others for "compensating" for the wattless current taken by the ordinary induction motor. In the "compensated" induction motor developed by Heyland the power-factor is made practically equal to unity throughout the greater range of its load, and hence such a machine when run as a generator could supply a non-inductive load without the necessity of running a large synchronous machine in parallel with it.

Space will not permit a discussion at full length of the mathematical theory of the "compensated" induction machine, but the recent developments in this direction are of so great importance to the electrical engineer that it may be as well to consider the chief points in connection with the invention.

The basis of Mr. Heyland's device is this: The considerable wattless component of current required by the induction machine (lagging in a motor and leading in a generator) is due to the "magnetising" current supplied by the stator winding and the reactance of this circuit, and, therefore, the tangent of the angle of phase difference is proportional to the frequency of this magnetising current. In the simple induction machine this current is of the full frequency of the supply, and hence gives rise to a power-factor which may be considerably below unity, especially if magnetic leakage is not reduced to the smallest possible amount. If, however, instead of furnishing the magnetising current from the stator windings it be introduced by a commutator into the rotor windings, it would become in that winding a current of very low frequency (always equal, in fact, to that of the slip or asynchronism), although of full frequency in respect to its reaction upon the stator currents, and hence would only require a small impressed E.M.F. to maintain it, and would not cause the objectionable decrease in the power-factor of the machine. For simplicity, let us consider an induction machine without resistance or magnetic leakage. The vector diagram of Fig. 18 becomes that shown in Fig. 28, where OF is the flux, and OI_1, OI_2, OE_1, OE_2 the stator and rotor currents and E.M.F.s respectively.

The magnetic flux is due to the combined action of the stator and rotor ampere-turns, so that OF is the vector sum of OI_1 and OI_2.

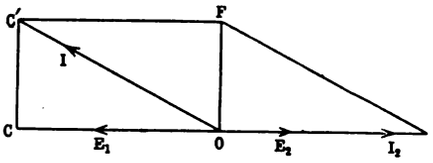

Fig. 28.

In order that the power-factor of the machine may be unity, the vector OI_1 must coincide in phase with OE, and, therefore, to maintain the flux OF unaltered, the current introduced into the rotor must be that corresponding to the vector CC_1. Now, the magnitude of this extra current introduced into the rotor depends upon the E.M.F. applied to the brushes, and its phase (relative to the stator currents) depends upon the position of the brushes on the commutator, as the following consideration will show. Since this rotor current alternates with the frequency of the slip at all loads, and since the rotor winding itself rotates in space at a speed equal to the difference between synchronous frequency and the slip frequency, it is clear that the rotor winding is equivalent to a winding *fixed in space* and carrying currents of the full synchronous frequency. Further, since the brushes constitute the terminals of the rotor winding, it follows that by merely displacing the brushes through a certain angle, it is possible, as it were, to turn the "equivalent" stationary winding through the same angle in space; and thus to keep the flux unaltered, it must be adjusted so as to exactly replace that furnished by the stator magnetising current in the uncompensated motor.

Further, by sufficiently increasing the magnitude of the magnetising current introduced into the rotor, it becomes possible to reverse the power-factor of the stator circuit and make the stator take a leading current as a motor, or enable it to supply an inductive load as a generator (angle COE, Fig. 29).

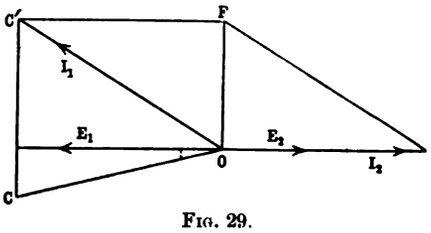

Fig. 29.

As pointed out above, this extra current introduced into the rotor only requires a small impressed E.M.F. to drive it. This may be supplied from a small transformer, whose primary is connected across the stator terminals, or in low voltage machines may be obtained by "tapping" a small fraction of the stator winding, the necessary adjustment being made by resistances or altering the transformer ratio.

If such a compensated machine be worked as a motor its power-factor will remain practically unity at all loads, although to obtain this condition exactly the amount of compensating current should be increased slightly with the load in order to make up for the increase of magnetic leakage. Conversely, as a generator it will maintain a nearly constant terminal voltage on a non-inductive load.

Compounding of Asynchronous Generators.

In order to regulate for constant voltage on inductive loads, it is necessary that the magnetising current introduced into the rotor be increased with the load. This represents the next step developed by Mr. Heyland in connection with his asynchronous machines, and may be effected by passing the stator current through the primary of a second transformer, whose secondary terminals are connected to brushes on the rotor commutator, or the entire stator current may be sent through the rotor by connecting the ends of the stator windings, which would otherwise be joined together as the "neutral point," directly to the brushes, in which case use of the current transformer would be obviated. If it is desired to use the same set of brushes for the compounding and for the exciting current, the secondary of the transformer supplying the latter current must be mesh-connected in order that the magnetising current thus

* Abstract of a Paper read before the Birmingham Local Section of the Institution of Electrical Engineers on April 20th.

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introduced into the rotor may be a quarter of a period ahead of the stator voltage from which the primary of the transformer is supplied. The arrangements of connections in such a compounded self-exciting asynchronous generator are of the form shown in Fig. 30.

The extent of the compounding can be varied by altering the ratio of the current transformer or by placing suitable shunts across the brushes, and by making the necessary tests before finally adjusting these, the machine can be made to over-compound at high loads if required.

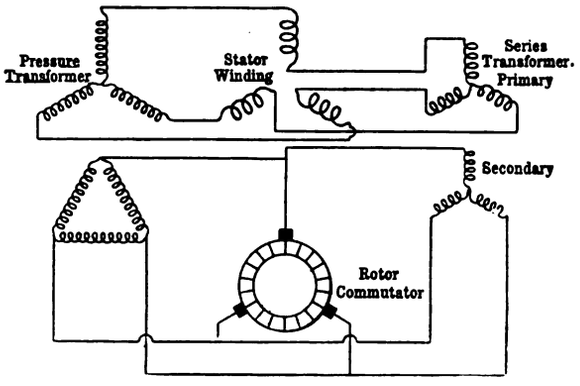


FIG. 30.—CONNECTIONS OF HEYLAND COMPOUNDED, SELF-EXCITING ASYNCHRONOUS GENERATOR.

By connecting adjacent commutator segments by low-resistance shunts, and by winding the rotor with a duplicate winding so as to obviate the self-inductive E.M.F. on opening the circuit, Mr. Heyland has been able to eliminate all troubles arising from sparking at the brushes.

THE HEYLAND COMPOUNDED SYNCHRONOUS MACHINE.

The latest development in connection with the compounding of alternators has been made by Mr. Heyland in applying the principles of his compensated asynchronous generator, as outlined above, to machines of the synchronous class.*

PART II.

SOME OSCILLOGRAMS SHOWING THE BEHAVIOUR OF ALTERNATORS AND SYNCHRONOUS MOTORS UNDER DIFFERENT CONDITIONS.

(*a*) *An Electrical Resonance Phenomenon and its Effect on the Wave Form of an Alternator.*

It occurred to the writer that the effective inductance of an alternator armature might be measured without an abnormal condition of the excitation by loading it into condenser loads of various magnitudes and obtaining a resonance effect either with the fundamental, or, if possible, with a higher harmonic of the E.M.F. wave.

The experiments resulted in a very interesting series of oscillograms, which are shown in Fig. 31. The machine used was the Fynn inductor alternator, whose open circuit E.M.F. wave contains pronounced triple and quintuple harmonics (Fig. 31 *j* and Fig. 1).

By gradually increasing the capacity of the load by adding condensers in parallel, the change of wave from across the terminals was very remarkable, and is shown in Fig. 57, *a* to *e*, until, when a capacity of 27·25 microfarads was reached, exact resonance with the harmonic of quintuple frequency took place, the wave-forms taking the form of *e* (Fig. 31). The current at this stage is seen to be almost a simple sine wave of five times the fundamental frequency, and, as would be expected, each of these higher pulsations is in quadrature with the corresponding peak and hollow of the P.D. wave. On further increasing the capacity, the resonance was quickly destroyed, the wave-forms becoming again more normal, as shown by Fig. 31, *f* to *i*.

The rise of voltage at the condition of complete resonance with the 5th harmonic was from 200 to 286, though this would partly be due to the fact that the machine was then giving a wattless leading current of three-quarters of its full-load current, which, as previously shown, gives in itself a rise of terminal pressure. To calculate the effective inductance of the armature, we have at resonance

$$pL = \frac{1}{p \cdot k}.$$

The frequency of the fundamental wave was in this case 57 ∼ per sec., and hence at quintuple frequency

$$p_5 L = \frac{I}{2\pi \times 285 \times 27{\cdot}25 \times 10^{-6}} \text{ohms} = 20{\cdot}5,$$

i.e., a reactance of 4·1 ohms at the fundamental frequency.

This shows a very fair agreement with the value 4·38 of the synchronous reactance, found from the open and short-circuit characteristics of the machine at that frequency. It is clear that, owing to the introduction of resonance with the higher harmonics of the E.M.F. wave, the theoretical regulation curve of an alternator on a capacity load of given power-factor cannot possibly be obtained in practice unless the E.M.F. wave be a simple sine wave. In practice, however, capacity loads of any great magnitude are seldom met with, so that the point is chiefly of theoretical interest.

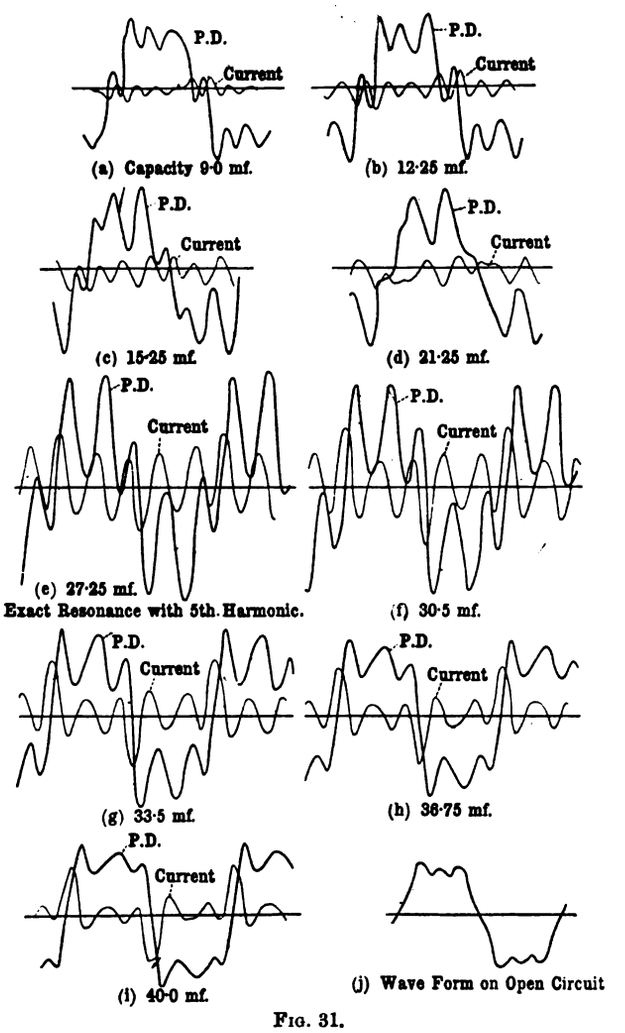
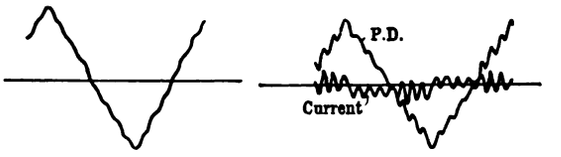


FIG. 31.

(*b*) *Some Oscillograms illustrating the Modification of Wave-forms under different conditions.*

Fig. 32 shows the open circuit E.M.F. wave-form of the Fuller-Wenström single-phase alternator, showing very distinctly the ripples of high frequency due to the slots on the armature. These ripples can be greatly intensified by resonance, as is exemplified by Fig. 33, which represents the P.D. wave-form when working on a condenser load of 27·25 microfarads capacity. The current is then a wattless current of 15 times the fundamental frequency.

FIG. 32. FIG. 33.



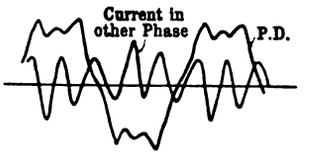


FIG. 34.

The lack of exact symmetry about a vertical axis is further increased.

Fig. 34 shows a slight alteration in the E.M.F. wave-form on the *unloaded* phase of the Fynn 2-phaser when a capacity current is taken from the other phase. The capacity in this case was such as to give nearly exact resonance with the quintuple harmonic, as described above.

(*To be concluded.*)

* See *The Electrician* Vol. LI., p. 969.—*Ed. E.*

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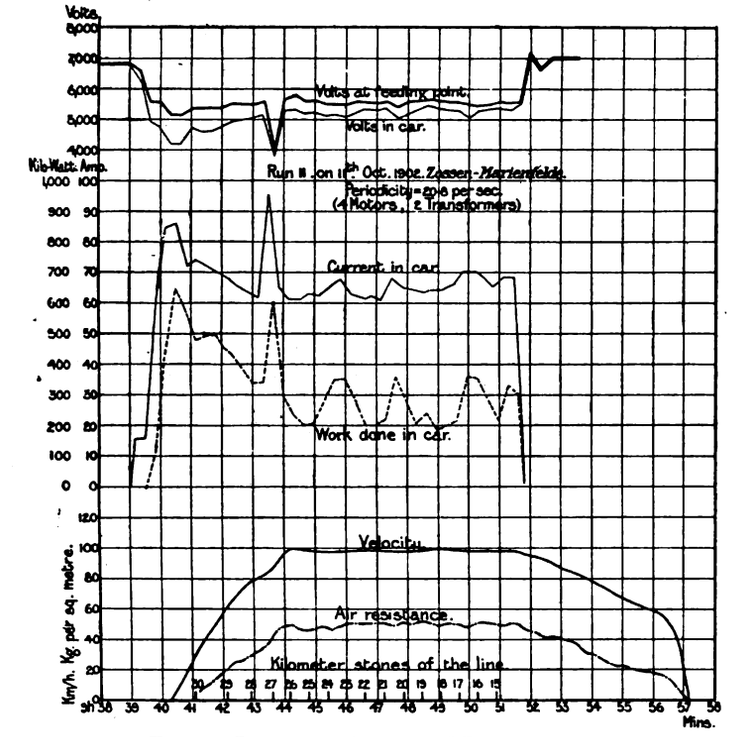
HIGH-SPEED ELECTRIC RAILWAY EXPERIMENTS ON THE MARIENFELDE-ZOSSEN LINE.*

BY ALEXANDER SIEMENS.

(*Continued from page 348.*)

From their experiments the Studiengesellschaft draw the conclusion that the front of the car should be a rather steep paraboloid. Owing to the necessity of arranging the cabin of the driver in front, and providing buffers and drawbars, it is not possible to carry this out in practice, but the nearest approach to the correct form is suggested to be a cylindrical front, extending for 86deg., then plain surfaces which join the sides of the car by easy curves, as represented in Fig. 9. Very careful measurements were made as to the amount of energy required, and a measuring station was established at the feeding-point to avoid the calculations of the losses in the feeder. The ammeter and wattmeter at this station were connected direct to the high-tension circuit, to avoid the use of transformers and to make them almost independent of periodicity and of difference in phase. In the cars the instruments were joined to the same phase as at the feeding-point. In spite of all precautions, however, the readings were not all reliable, especially in wet weather. The measurements are divided into two groups: one to determine the energy during acceleration, and the other to measure it at constant speed. In both cases the cars were sometimes running by themselves and sometimes pulling trailing cars. It will be noticed that the acceleration is not very great, but this was the consequence of the generating set not being powerful enough to supply more energy.



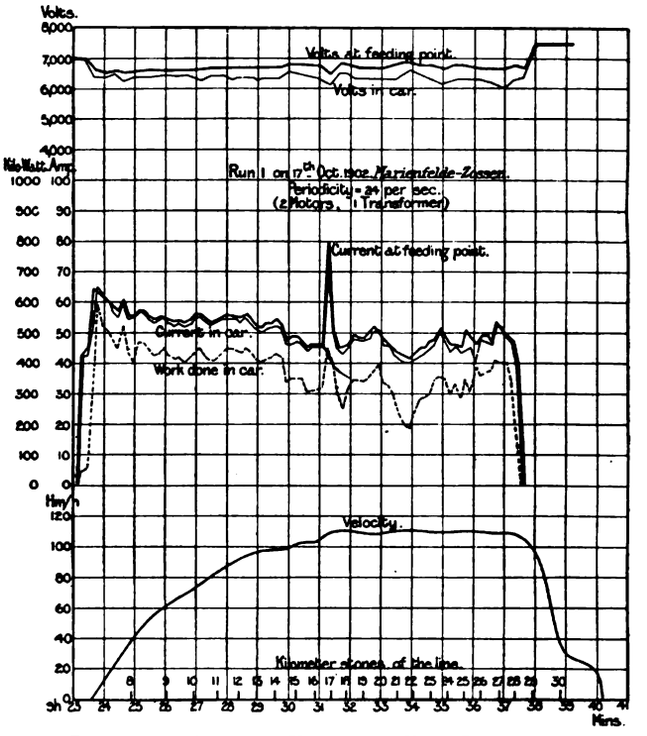


FIG. 8.—RUNS WITH CAR "A" (WEIGHT = 89,500KG.) (VELOCITY, AIR RESISTANCE, CURRENT, VOLTS AND WORK DONE.)

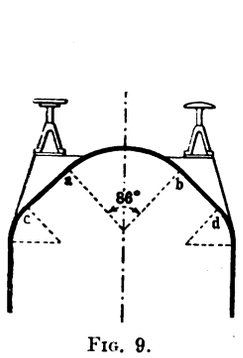


FIG. 9.

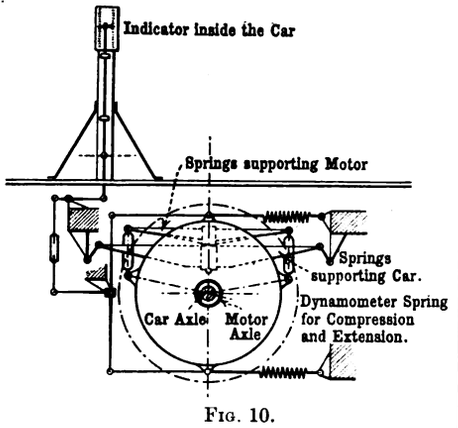


FIG. 10.

N.B.—The shaded parts are fixed points, either on the Car Frame or on the Bogie.

Compared with the theoretical amount of energy required to give the cars the same acceleration, the figures of the table show an efficiency of about 45 per cent., due, no doubt, to the losses in the starting resistances; but for long-distance travelling the period of acceleration is almost negligible. In Tables A and B the results of these experiments are summarised, and diagrams in Figs. 8, 12 and 13 give some details of runs with and without trailers. An attempt was made to measure the turning moment of a motor direct by fitting on car "A" a special apparatus represented in Fig. 10. Instead of attaching the motor rigidly to the frame, it is held by springs, as shown diagrammatically, and the movement of the springs is transmitted by suitable levers to a registering indicator in the interior of the car. The instrument was calibrated by weights, and gave useful results when a resistance was inserted in the secondary circuit of the motor, but of course the direct comparison between the indicated turning moment and the electrical readings is thereby prevented. The diagram Fig. 13A shows the turning moment during a run of car "A" on November 8th, and the curve, Fig. 11, is drawn in accordance with these indications. About the measurements made to ascertain the loss in feeders and conductors, nothing need be said, as no novel features with regard to them are disclosed in the report. Nor need the brake experiments be described, as they were again unsatisfactory, and eventually it was considered advisable to alter the whole of the braking arrangements. A good opportunity for doing this was afforded by

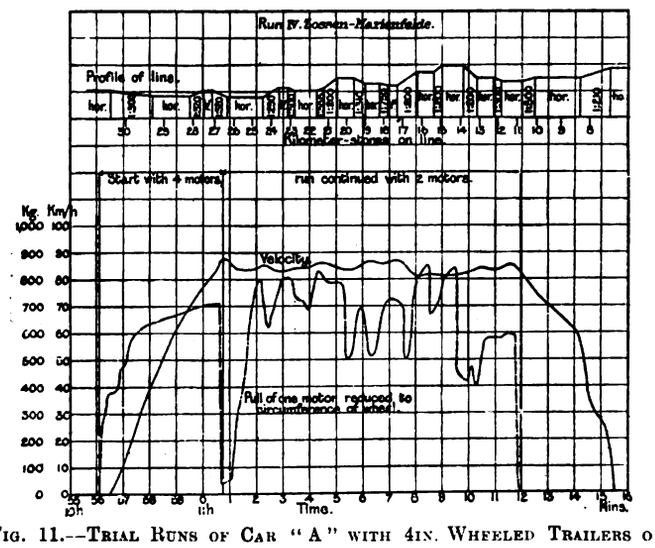


FIG. 11.—TRIAL RUNS OF CAR "A" WITH 4IN. WHEELED TRAILERS ON NOVEMBER 8, 1902. (PULL, VELOCITY AND PROFILE OF LINE).

* Paper read before the Institution of Electrical Engineers on May 26th.

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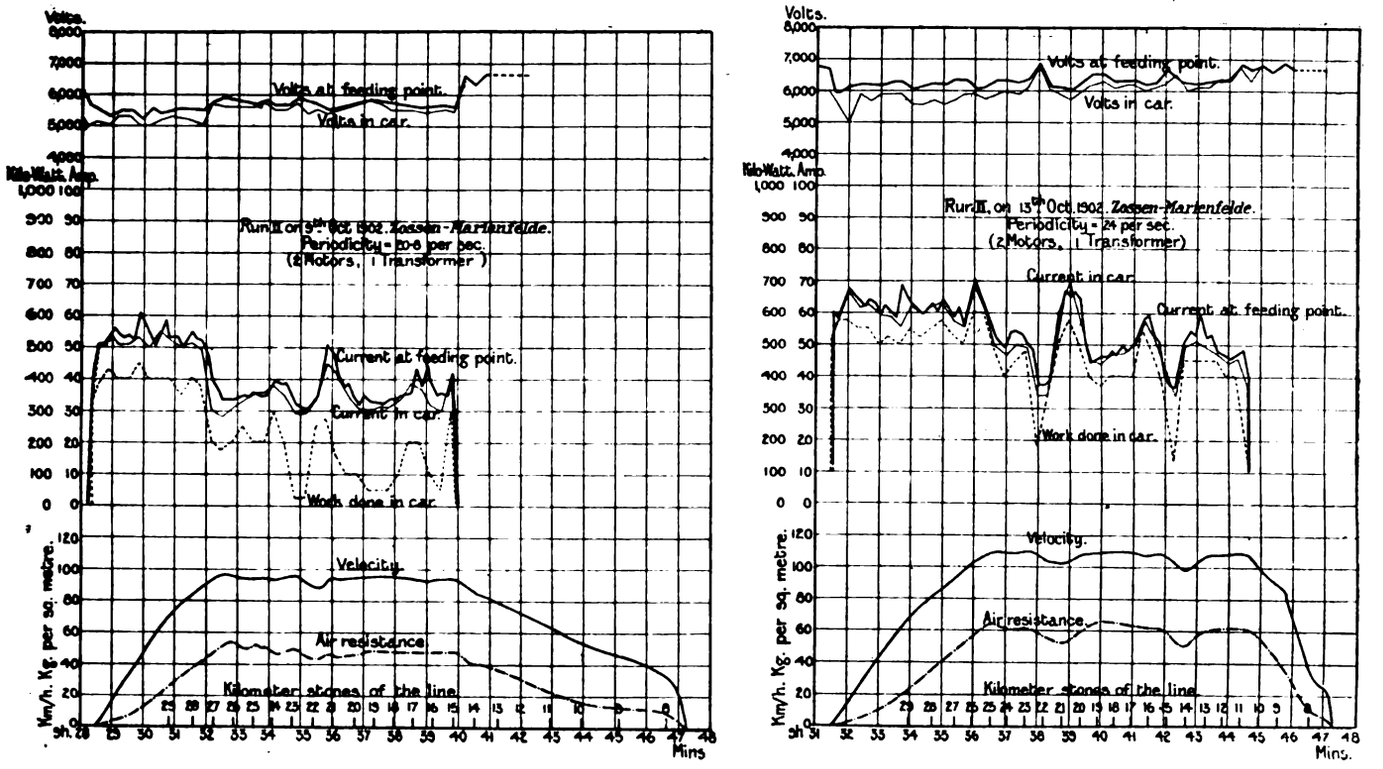

FIG. 12.—RUNS WITH CAR "S" (WEIGHT = 77,900KG.) (VELOCITY, AIR RESISTANCE, CURRENT, VOLTS AND WORK DONE.)

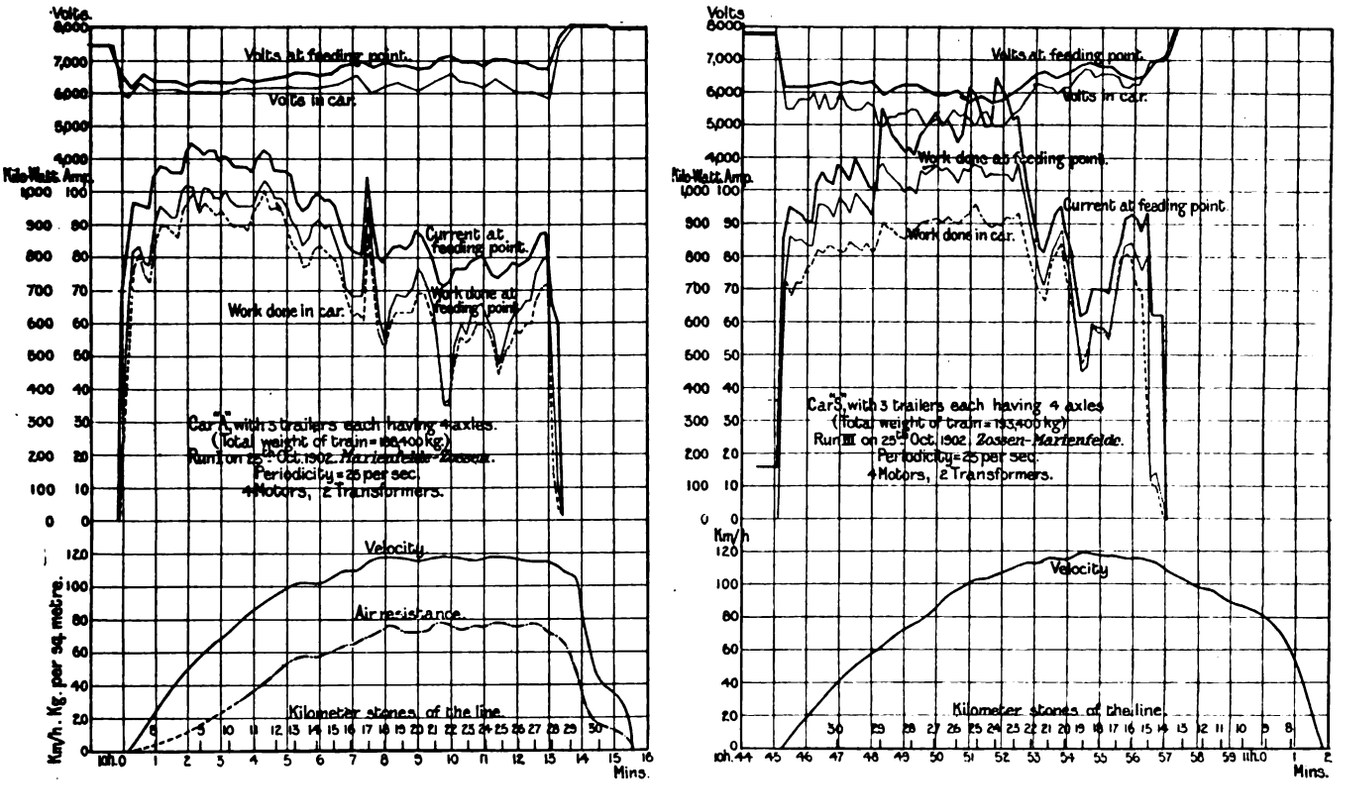
Volts.
Volts at feeding point.
Volts in car.
Kilo-Watt. Amp.
Current at feeding point.
Work done in car.
Work done at feeding point.
Car A with 3 trailers each having 4 axles.
(Total weight of train = 193,400 kg.)
Run I on 25th Oct. 1902. Marienfelde-Zossen.
Periodicity = 25 per sec.
4 Motors, 2 Transformers.
Km/h. Kg. per sq. metre.
Velocity.
Air resistance.
Kilometer stones of the line.
Mins.
Car B with 3 trailers each having 4 axles
(Total weight of train = 193,400 kg.)
Run III on 25th Oct. 1902. Zossen-Marienfelde.
Periodicity = 25 per sec.
4 Motors, 2 Transformers.
Km/h

FIG. 13.—RUNS WITH TRAILERS. (VELOCITY, AIR RESISTANCE, CURRENT, VOLTAGE AND WORK DONE.)

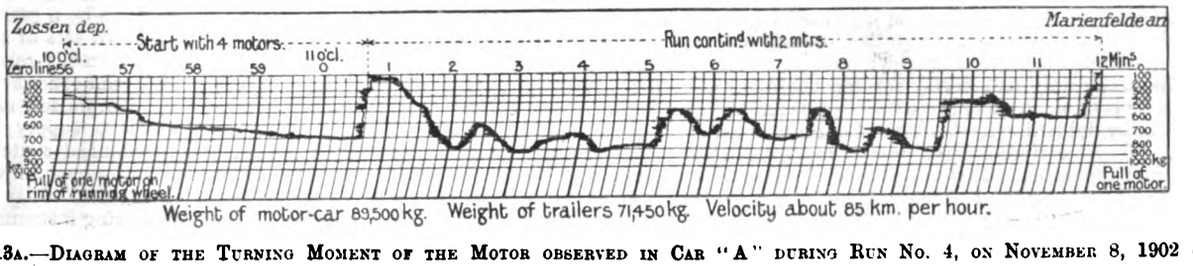
Zossen dep.
Marienfelde arr
Start with 4 motors.
Run continued with 2 mtrs.
10 0 cl.
11 0 cl.
Zero line
12 Min.s
Pull of one motor on rim of running wheel.
Pull of one motor.
Weight of motor-car 89,500 kg. Weight of trailers 71,450 kg. Velocity about 85 km. per hour.

FIG. 13A.—DIAGRAM OF THE TURNING MOMENT OF THE MOTOR OBSERVED IN CAR "A" DURING RUN NO. 4, ON NOVEMBER 8, 1902 (WITH FOUR SIX-WHEELED TRAILERS).

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Table A.—*Average Value of the Electrical and Mechanical Measurements taken during Acceleration.*

No. of runs.		No. of motors working.	Total weight of train in tons.	Distance in metres.	Falling gradient. Average %.	Average acceleration. M./sec.	Final speed. Km./hr.	No. of periods per sec.	At feeding point.			At collector of car.				Remarks.
									Amp.	Volts.	Kw.	Amp.	Volts.	Kw.	H.P.	
Car A	5	2	89·5	4,430	0·30	0·08	88·6	20·6	51·2	5,662	..	50·0	5,376	358	487	Car alone
	2	4	89·5	3,950	0·84	0·12	97·5	20·8	..	5,165	..	74·2	4,835	446	606	Ditto
	6	2	89·5	7,930	0·54	0·07	106·0	24·0	51·1	6,383	..	50·1	6,024	407	553	Ditto
	2	4	89·5	4,550	0·57	0·11	102·5	25·0	..	6,740	..	76·0	6,360	535	727	Ditto [cars
	3	4	188·4	8,700	0·61	0·07	113·3	25·0	101·0	6,253	880	..	..	813	1,105	Car drawing 3 pass.
Car S	9	2	77·9	2,744	1·11	0·13	91·2	20 8	52 6	5,472	..	51·8	5,257	394	535	Car alone
	9	2	77·9	4,294	0·68	0·12	105·6	24·0	51·1	6,290	..	50·5	5,950	484	590	Ditto
	6	4	159·6	5,583	0·60	0·11	116·7	25·0	108·2	6,237	1,010	105·6	5,938	928	1,261	Car and 2 pass. cars.
	1	4	193·4	8,300	..	0·07	115·0	25·0	110·0	6,140	988	107·0	5,450	855	1,160	Car and 3 pass. cars.

Observations taken in autumn, 1902.

Table B.—*Average Value of the Electrical and Mechanical Measurements taken during Periods of Running at Constant Speed.*

No. of runs.		No. of motors working.	Total weight of train in tons.	Average speed. Km./hr.	No. of periods per sec.	At feeding point.			At collectors of car.'				Efficiency of elec. output. %	Power exerted on wheels.		Remarks.
						Amp.	Volts.	Kw.	Amp.	Volts.	Kw.	H.P.		H.P.	Pull in kg.	
Car A	4	2	89·5	95	20·6	43·4	5,835	..	42·1	5,543	246	335	82·7	277	788	Car alone
	2	4	89·5	96	20·8	..	5,450	..	64·0	5,190	247	336	69·7	234	660	Ditto
	5	2	89·5	107	24·0	45·6	6,460	..	43·8	6,089	302	410	86·4	354	892	Ditto
	2	4	89·5	113	25·0	..	6,830	..	71·5	6,390	365	496	79·1	392	938	Ditto
	2	4	188·4	117	25·0	84·7	6,647	694	..	..	644	875	87·1	762	1,760	Car and 3 pass. cars
Car S	8	2	77·9	92	20·8	36·7	5,781	..	34·5	5,619	197	268	84·0	225	660	Car alone
	8	2	77·9	106	24·0	39·2	6,447	..	36·8	6,162	283	385	86·5	333	850	Ditto
	4	4	159·6	117	25·0	69·2	6,937	566	65·0	6,685	499	679	85·5	580	1,330	Car and 2 pass. cars
	1	4	193·4	118	25·0	81·5	6,700	713	75·0	6,425	680	925	87·7	810	1,840	Car and 3 pass. cars

Observations taken in autumn, 1902.

the reconstruction of the bogies, which became necessary to ensure the steady running of the cars during high speeds.

In the new bogies the following points were to be observed: 1. The wheel-base is to be increased from 3·8 to 5 metres. 2. The bogie frames are to be constructed with simple Z girders. 3. The bearing springs are to be connected by balancing levers, and are to be visible and easily accessible throughout their whole length. 4. The car body is to be supported at four points on each bogie. 5. The centre pin of the bogie is to be movable for a distance of 30mm. in every direction. 6. The motors are to be connected to the axles by springs. 7. The brakes are to be reconstructed as shown in outline by Fig. 14, which explains itself.

During the trials the bending of the rails was measured in the same way as in the previous year; but as the speed of the cars had been restricted, no abnormal observations occurred and no extraordinary repairs became necessary. When the trial runs of the high-speed cars had been completed, some further experiments were made with a three-phase locomotive built by Siemens and Halske, and the Studiengesellschaft comments on them in a separate report.

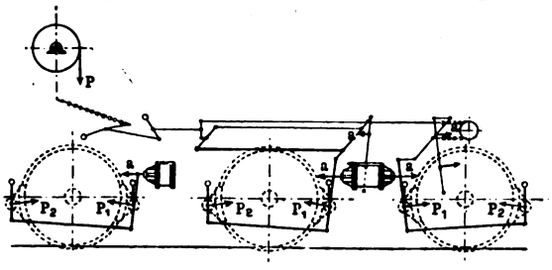

Fig. 14.

In this case they say that the high-speed cars have proved suitable for their work as far as their mechanical and electrical outfit is concerned, but their weight is too great and the proportion of their dead-weight to the paying load is not favourable. The trouble with the permanent way and the very high power required during the acceleration period were a consequence of this weight, and for economical high-speed traffic it should, if possible, be diminished so as to load the axles only sufficiently for the necessary adhesion. It would not be possible to effect this object by altering the construction of the car or by lightening its mechanical outfit without endangering its safety. It is therefore necessary to try to diminish the weight of the electrical apparatus. This may be done by removing the transformers from the car and placing them along the line, or by dispensing with them altogether. In the first case a double set of conductors is required, increasing the losses and the capital expenditure. It is therefore preferable to employ motors which are capable of utilising high-tension currents,

With a view of trying the possibility of using such motors on the high-speed cars, Messrs. Siemens and Halske built two motors of approximately the same outside dimensions, but suitable for working with 10,000-volt currents, and fitted them each to a four-wheeled bogie with a wheel-base of 3·25 metres. The car body, 12·5 metres long, is of the usual shape for electric locomotives, and in its centre is a driver's cabin, 4 metres

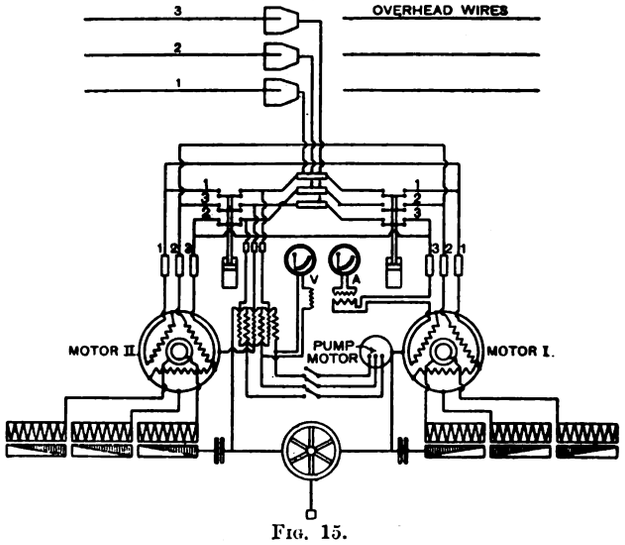

Fig. 15.

long by 2·8 metres wide by 2·3 metres high. In the iron boxes on either side of it are the starting switches and resistances, and on the top it carries the collecting gear, which is like that of car "S." The motors are suspended from the bogie frames after the manner of tram motors, driving the axles by a gearing of 1 : 2. Between the car body and the wheels are two sets of springs, and provision is made for a slight lateral movement relative to the bogie. The diagram (in Fig. 15) of the connections shows that there are separate switches, moved by compressed air, for each direction of running, a small transformer to supply low-tension current to the air-pump motor, and mechanical switches for the resistances which are actuated by a hand-wheel in the driver's cabin, geared to a horizontal shaft. Some difficulties were experienced in obtaining readings of the measuring instruments on the locomotive of sufficient accuracy, so that finally only the measurements at the feeding point were taken into consideration.

(To be concluded.)

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

N-rays and Phosphorescence.—E. Bichat has observed some properties of N-ray emission which show a strict analogy to phosphorescence. If a plate of copper 1mm. thick is exposed to N-rays from a Nernst lamp and tested by means of a calcium sulphide screen, it is found to emit N-rays. If, while observing the screen, one heats the copper very slightly, the screen shows a further brightening, but only for an instant. A striking experiment is the following :—The N-rays are refracted by an aluminium prism and the refractive indices of the various rays noted. A body exposed to the same rays for about a minute, and capable of storing them up, is then put in the place of the source, and the refractive indices again determined. They are all found to be slightly superior to the former values. Since the refraction in aluminium increases with the wave-length, it follows that the secondary rays have a greater wave-length than the original rays, as in the case of phosphorescence, according to Stokes' law.

[E. BICHAT, *Comptes Rendus*, May 30, 1904.]

Action of Anæsthetics on N'-rays.—J. Becquerel has shown that sources of N-rays are deprived of their activity by the action of anæsthetics, such as chloroform and ether. But this result is not entirely convincing, owing to the fact that those bodies themselves emit N'-rays, which would in any case mask the N-rays. J. Meyer has, therefore, devised a crucial experiment. It consists in stretching a wire in a tube of chloroform vapour. Both the stretching and the chloroform produce N'-rays, and if there were no action of the anæsthetic as such, there should be simply an increase of the effect. But there is, on the contrary, a diminution of the sum of the two effects as soon as the vapour bathes the wire. Hence there is a true anæsthetic action.

[J. MEYER, *Comptes Rendus*, May 30, 1904.]

Simultaneous Emission of N-rays and N'-rays.—Jean Becquerel has found that in all cases where a surface emits N-rays normally, it emits N'-rays tangentially, and vice versa. This fact establishes a close correspondence between the emission and absorption of these rays, which leads the author to some interesting generalisations. A brick exposed to the sun emits N-rays normally and N'-rays tangentially. A patch or cross of the phosphorescent sulphide alternately brightens and darkens as successive surfaces of the brick are exposed to it When the screen is observed tangentially instead of normally, it darkens and brightens instead of the reverse. When a body is compressed, it emits N-rays from the compressed surface and N'-rays from the surfaces perpendicular to it. The author lays down the following general rules :—The rays produced by the compression of a body (N-rays) have the property of increasing the sensibility of vision, and produce, on a surface capable of storing them, and the same effect as regards radiation as does a compression normal to that surface. And : The rays produced by the stretching of a body (N'-rays) have the property of diminishing the sensibility of vision, and produce on a surface capable of storing them the same effect as a tension normal to that surface. The author seeks the origin of the rays in the vibrations of the molecules attaining a new position of equlibrium. In looking for some regularity in the spectrum of the rays, he found that Blondlot's values may be arranged in two series, one of them containing multiples of $2{\cdot}9\mu\mu$, the other containing simple fractional multiples of $4{\cdot}9\mu\mu$.

[JEAN BECQUEREL, *Comptes Rendus*, May 30, 1904.]

Electric Equilibrium of the Sun.—Svante Arrhenius frames a theory of the process by virtue of which the sun is able to give out a continuous supply of negative electricity without its positive electrification being raised to such a high point as to retain the negative electrons in the sun. This process necessitates some form of circulation or renewal of the negative electricity in the sun, and the author makes such a circulation very plausible. We know that negative ions condense vapours more easily than positive ions. The gases in the atmosphere of the sun are ionised by the ultra-violet radiation. Therefore, we have to suppose that among the little drops formed by condensation in the sun's atmosphere far more are negatively charged than are positively charged. As these drops are driven away by the pressure of radiation they charge with negative electricity the atmosphere of celestial bodies, such as the earth, till the charge is so great that discharges occur, and cathode rays are formed, which carry the charge back to the universe. The author makes an interesting calculation of the speed with which the drops will be driven from the sun, assuming that the radiation pressure is twice their weight. A drop which partly reflects the light will arrive at the earth in about 46 hours. Now, according to Ellis, the interval elapsing between the passage of a sun spot across the meridian and the maximum of the consequent magnetic storm upon the earth is 42·5 hours. This agreement renders the base of the calculation reasonably probable. The author then goes on to show that the charge of the sun is sufficient to attract and absorb negative electrons travelling with observed velocities anywhere within 1·25 light-years of the sun. Since the nearest star is four light-years away, and there are other stars about 10 light-years off, not many electrons can traverse interstellar space without being attracted by some star or other. Thus the suns recover from space as much negative electricity as they lose. The electric charges of the suns are very effective regulators. If the charge is quadrupled the mean distance of the caught electrons is doubled, or, in other words, as they are uniformly disseminated in space, their quantity is quadrupled. Therefore, the supply of negative electricity to the suns is proportional to their defect thereof.

[S. ARRHENIUS, *Proceedings of the Royal Society*, June 2, 1904.]

Physiological Effect of Radium Emanation.—C. Bouchard, P. Curie and V. Balthazard have examined the effect of radium emanation on the life and the tissues of mice and rabbits. They found that the confinement of the animals in an atmosphere containing radium emanation, but maintained at a constant composition by the renewal of the oxygen and the absorption of the carbonic acid, led to death in a few hours, the cause of death being inflammation of the lungs. The tissues of the animals which had succumbed became highly radio-active, more especially the fur and the lungs. Injection of fluids containing the emanation has no toxic effect.

[BOUCHARD, CURIE and BALTHAZARD, *Comptes Rendus*, June 6, 1904.]

Subjective Phenomena in N-Ray Observations.—F. P. Le Roux points out the important part played by subjective effects in many of the usual N-ray observations. The apparent increase of luminosity of a faint patch by a sound may be simply a nerve phenomenon due to the temporary suspension of the fatigue incurred in its contemplation. The author mentions another source of error in observing the effect of anæsthetics. If the faint patch is observed with only one eye, and a bottle of chloroform held closed with the thumb is brought near the nasal orifice on the side of the observing eye, the brightness of the patch diminishes with the slightest inhalation. On opening the other eye, the patch appears as bright as before. The reverse effect is produced by substituting alcohol for the chloroform.

[F. P. LE ROUX, *Comptes Rendus*, June 6, 1904.]

Mode of Action of N-Rays.—R. Blondlot agrees with J. Becquerel's theory of the action of N-rays on a calcium sulphide screen. That theory maintains that the sulphide absorbs the N-rays and emits secondary N-rays, which, reaching the eye together with the light, increase the sensitiveness of the retina and produce the appearance of greater luminosity. This theory accounts for the failure of all attempts to record photographically a change of luminosity of the screens. The author then inquires whether the mechanism is the same in the case of the small electric spark. On applying Becquerel's method—viz., observation through a trough of distilled water, which intercepts the N-rays—it is found that, contrary to what happens in the case of the sulphide screen, the changes of luminosity are seen as clearly as they were without the trough. This objective effect is confirmed by the photographic records. Incandescent platinum behaves in the same way as the spark.

[R. BLONDLOT, *Comptes Rendus*, June 6, 1904.]

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ELECTRIC *v.* HYDRAULIC CRANES.

Several able Papers discussing the best means of equipping dockyards with the necessary power appliances, treating the subject from both the commercial and the engineering points of view, have appeared from time to time in our columns, the last being the Paper by Mr. WALTER PITT, read last year before the Engineering Conference and reported in *The Electrician*, Vol. LI., p. 449. In that Paper Mr. PITT expressed the opinion that ". . . he would be a more than conservative engineer who would seriously recommend the adoption of a complete hydraulic equipment in a new scheme of any magnitude." This opinion was, at that time even, more or less generally accepted, but since then the electrical equipment of dockyards has made further and rapid progress, and complete statistics are now to hand which most convincingly emphasise the superiority of electrical means over all others in connection with dockyard work. Such a quantitative comparison of the commercial efficiencies and the technical capacities of cranes and capstans of the electric, hydraulic and partly of the steam type, erected and working side by side at the Middlesbrough Dock, has been compiled by Mr. VINCENT L. RAVEN, chief assistant mechanical engineer to the North-Eastern Railway. This Paper, which appears in this week's issue, is most thorough, and leaves little, if anything, to be desired in the way of commercial or technical information. It is suggestive in many ways, and brings numerous points to the front which often are either overlooked or accorded but a secondary place when comparing the various forms of power distribution. Let us first, however, pass in brief review the more conspicuous advantages of electric over hydraulic machinery. There is, to begin with, the great flexibility of electric power distribution, which makes possible the efficient use of temporary machinery and apparatus at practically any distance from the power station and at any altitude and place, even on the ships and barges themselves, if it be so desired. This is a strong point, which can hardly be over-estimated, especially when possible repairing and overhauling of ships is taken account of. The electric cables themselves are obviously more flexible than hydraulic mains, and the bridging of waterways and similar obstructions and the shifting in case of alterations

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to the buildings and so on offers little difficulty. A source of trouble with hydraulic power distributions is the freezing of the water in severe weather; and the frequent occurrence, in certain yards, of leaky valves, owing largely to the impossibility of effectively excluding sand from finding its way into the pipes is another drawback of the hydraulic system. Large water pipes are most costly, and it is generally preferred to employ medium-sized pipes, and to put up with a large drop of the water pressure. This is the more unfortunate since the drop in pressure, contrary to the analogous case of an electric current, is not proportional to the quantity of water passing in unit time, but increases much more rapidly, so that it may come about that at times of maximum traffic the useful pressure is very low, and the rate of work done by the cranes is diminished accordingly. The possibility of keeping up the speed of working during busy periods, or even of slightly forcing the speed is, therefore, much greater in the case of an electric equipment. It appears, too, at least in the case of the Middlesbrough Dock, that the cable system is much cheaper than a hydraulic pipe-system designed for the same capacity.

It has frequently been pointed out that in yards where the lighting is done electrically, the addition of an electric power installation increases the load-factor of the plant. This may be so in certain cases, but too much importance must not be attached to this point, as in the peculiar conditions existing in dockyards it may frequently happen that the maximum demand for power coincides with that for light, and in any case the load-factor for dock and harbour lighting is an extremely high one.

One of the less-recognised points in favour of an electric plant throughout is the saving in labour. We desire to lay particular stress upon this, as the advocates of hydraulic machinery are apt to contend the contrary. It is often urged by them, for instance, that the handling of electrical appliances requires labour of a more skilled and, therefore, more costly order. This is not so, certainly not for installations of considerable size, where a regular workshop and repair shop with competent mechanics has to be kept in any case. Moreover, we have it on the authority of Mr. RAVEN that there is a distinct saving of labour in other miscellaneous directions. In this connection it is worth while to consider carefully what he says in the last part of his summary, where he lucidly sets forth the time and the number of men required for connecting up cranes of the various types. While four electric cranes can be connected up to suit the working into the various ships' holds in 15 minutes, by two men in summer and four in winter, it takes at least six men one hour to make the connections for the same number of hydraulic cranes. On frosty nights, moreover, four men are engaged six hours in keeping up fires to prevent the water in the cylinders of the hydraulic cranes from freezing. The disadvantages of the steam crane in respect of attention are too well known to be repeated here. While discussing the subject of the manipulation and handling of cranes, it may be mentioned that in the case of the electric cranes all operations are performed by one handle only, while with the other types of crane at least two operating levers are required. This may seem a fine point, but practical engineers will fully appreciate its value. Another advantage of utmost practical merit is the high speed at which electrical cranes and capstans may be worked. When considering the initial costs of electric and hydraulic cranes of the same power, this ability of the electric type to get through more work in a given time must be given every consideration.

Exigencies of space prevents us from fully discussing the most interesting comparative figures given by Mr. RAVEN in his Paper. They are, however, so clearly set forth as to require no further elucidation on our part. If any doubt still exists in the minds of our readers as to the progress made at the present time in equipping dockyards and harbours with electrical power plant, a perusal of the description of the electrical plant of Heysham Harbour, which is commenced in this issue, should convince them that some of the leading English railway engineers are now thoroughly alive to the advantages of electricity applied to such purposes. The Midland Railway, in its new harbour at Heysham, will be absolutely dependent on electricity for furnishing the motive power to its cranes, capstans and lifts. Moreover, even the more conservative owners of dockyards to the East of London are also awakening to the enormous economies which may be derived by the utilisation of electrical energy for their lifting and hoisting plant, and another article in this issue describes the preparations which the Poplar electricity works are now making for meeting an extensive demand for this purpose.

EXTENSIONS OF THE POPLAR ELECTRIC SUPPLY UNDERTAKING.

At present, taken as a proportion of the total load, the actual lighting load at the Poplar electricity works is not inconsiderable, but its potentialities are not great and to all intents and purposes it may be considered of small consequence compared with the motor load. Poplar possesses great possibilities with regard to the development of electric motive power, and the scheme which the Council have recently commenced was originated with this fact in view. There are a large number of industrial undertakings carried on within the statutory area, many of which have an approximately level 24 hours' load curve, and as the River Thames forms part of the borough boundary it is safe to assume that a considerable demand may be anticipated for dock lighting and machinery. Already, energetic canvassing has been commenced, and the horse-power of electric motors connected within the past few weeks has reached a substantial figure. But, as a set-off against these propitious circumstances there are, naturally, certain features which tend to retard the progress of the undertaking, one distinct disadvantage, impossible to remedy, being the physical shape of the area. Instead of an approximation to a circle, which is, of course, the ideal shape for a supply area, the Borough of Poplar is simply a long narrow strip, with the docks at one end and the most important industrial concerns at the other. This is peculiarly unfortunate, especially as the existing system of supply is a continuous-current one, with the generating station about mid-way between the two ends. Many large works, finding no cheap supply of electrical energy available, have already installed their own plant, and therefore the task of persuading them to take energy from the mains has been rendered much more difficult. They are loth to scrap their own generating plant, but, to their credit, certain of them have decided to do even this on having it pointed out to them that such a course would be the means of effecting economy.

Last winter the load on the Council's generating station was so great as to cause serious anxiety regarding the capacity of the existing plant to deal with it, and applications for connection to the mains were actually refused. Although, as we pointed out at the time, such a proceeding is not within the law, it appears that no action has been taken against the Council, and it is unlikely that the undertaking will ever find itself in a similar position. Something had to be done, however, and in order to meet the increasing demand, and also provide means for still further enlarging the scope of the undertaking, the borough electrical engineer, Mr. Percy N. Hooper, submitted a three-phase scheme which bids fair to overcome all existing difficulties. Mr. Hooper succeeded Mr. Blackman only a few months ago, and one of his first acts after taking command was to ask his committee to sanction a

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loan of £59,000. This was done, the contracts were let, and the contractors have guaranteed, under penalty, to have the entire plant installed and working by September 17, 1904. Unfortunately, the generating station is already equipped with plant to its maximum capacity, and although there is room for extensions by removing one end, the delay caused by building operations, to say nothing of the extra expense involved, at once precluded the idea of seeking for a solution in this direction. Among the possibilities of what could have been done, there was the alternative of removing certain of the small sets and replacing them by others of very much greater capacity; this course is to be adopted.

At present, the steam-raising plant consists of four B. & W. boilers, each having an evaporative capacity of 6,000lb. of steam per hour, and two B. & W. boilers having an evaporative capacity of 14,000lb. per hour each. All these are fitted with chain-grate stokers in connection with hand-fed hoppers, and no additions will be made, nor is there any alteration contemplated in their constitution. It is anticipated that they will be quite large enough to supply the extra quantity of steam required. In the engine-room there are four Belliss-Mather and Platt sets, two having a capacity of 100kw. each, and two of 200kw. each; there are also two 500kw. Willans-Mather and Platt sets. All the generators are 460-500 volt. machines, the pressure at consumers' terminals being 230 volts There is already a 1,500-volt continuous-current supply to the Isle of Dogs, the arrangement being to couple three of the generators in series and work them in conjunction with a reducer at a sub-station. Nearly all the load on this high-tension system is due to motors and occurs mostly in the daytime, but a large demand is occasionally made during the night. The alterations to be carried out in the generating station consist in the removal of the two 100kw. sets and the substitution therefor of two 1,000kw. tubo-generators, together with all necessary switch gear. Turbines were chosen—although there was very little choice in the matter—on account of the limited space for disposal, and a three-phase system of generation because of the nature of the districts throughout which distribution has to be effected, and also because of the greater adaptability of three-phase generators to turbine driving.

The turbines will be of the newest type manufactured by Messrs. C. A. Parsons & Co., in which steam enters at the bottom half of the cylinder. They will be fitted with the under-type governor and the top half of the cylinder will be removable for inspection without disturbing any gear or pipe work. For condensing purposes Allen surface condensers will be employed. These will be of the latest patent submerged tube pattern, through which the condensing water is caused to travel three times before finally emerging. Steam will be superheated by 150deg.

Coupled directly to the turbines will be two Bruce Peebles revolving field 4-pole alternators, giving 6,000 volts between phases at a speed of 1,500 revs. per min. and a frequency of 50 ~ per sec. Each of these machines will be protected by overload and reverse-current automatic oil-break switches and there will be no high-tension fuses. The switchboard is to be of the cellular type and all switches will be situated under the board and worked by mechanical gear from above.

There will be two sub-stations, one at Bow and the other at the Isle of Dogs. Each is designed to accommodate eight converters although only one 250kw. and one 500kw. machines are to be installed in each to begin with. The particular motor-converter to be employed is of the La Cour pattern (manufactured by Messrs. Bruce Peebles & Co.) and is really a hybrid of a motor-generator and a rotary converter. Each set consists of two distinct machines, one a three-phase induction-motor and the other a continuous-current generator, and both are rigidly connected together on one bed-plate. The peculiarity of the machine is that the winding of the rotor is connected electrically to that of the continuous-current generator, the contention being that as a certain amount of energy is conveyed electrically, from one machine to the other, the efficiency is thereby higher than that of an ordinary induction motor-generator. Current from the high-tension transmission lines, at 6,000 volts, will be taken to the station of the motor, and the voltage of the generator will be 470 to 530. The motor converters will be protected by overload motor switches and reverse-current generator switches.

One sub-station is 2½ miles and the other 2 miles from the generating station; for these distances three-core E.H.T. duplicate mains will be laid on the draw-in system in continuous concrete conduits such as were described in *The Electrician*, Vol. LII., p. 41. These feeders will be protected at the generating station end by overload switches, and at the sub-station end by overload and reverse-current cut-outs. Twelve-way ducts have been laid to each sub-station so that when additional cables have to be laid the work will be comparatively easy.

In addition to the motor-converters to be installed in the sub-stations, there will also be one of these sets, having a capacity of 500kw., put down at the generating station, so that at times of light load only one generator, either continuous or alternating, will have to be run for both systems. Rotary synchronisers will be used, and for charging cables it has been decided to employ "Still" charging transformers, manufactured by Messrs. Cowans, who are supplying the switch gear for the entire scheme.

We have to express our indebtedness to Mr. Percy N. Hooper, borough electrical engineer of Poplar, for his courtesy in furnishing us with the above particulars.

THE APPLICATIONS OF ELECTRICITY TO METALLURGY.*

BY JOSEPH W. RICHARDS, PH.D.

Electricity is used to assist the metallurgist in three fundamentally different ways—viz., (1) mechanically, (2) thermally, (3) electrolytically.

1. *Mechanical Applications.*—The mechanical assistance of electricity is here meant as not including the ordinary electric devices, such as elevators, cranes, motors, &c., but is intended to include all those mechanical processes, which, when applied to ore or metal, aid in its extraction. It refers particularly to the electromagnetic and electrostatic concentration of the heavy metallic parts of ores, with the rejecting of the worthless gangue material. This branch of electrometallurgy is already rendering important service to the iron industry in making it possible to use ores which were otherwise too lean or too impure to be put into the blast furnace, and has thus added largely to our availbble supplies of iron ore. A principle differing from the time-honoured electromagnetic concentration is the electrostatic process, based on the repelling force of electrostatically charged particles, devised by Blake and Morscher. When the mass of ore and gangue particles is brought into contact with a statically charged metallic surface, particles of low conductivity become charged and repelled, while those of high conductivity are not repelled. Some interesting separations, differing radically from electromagnetic separations or specific gravity separations, can be thus accomplished. As a general rule, the metallic compounds present, as sulphides, &c., are good conductors, while the gangue of quartz, lime, &c., is a poor conductor; but there are interesting exceptions, such as zinc blende, which is a poor conductor, and can be thus separated from pyrite, galena and chalcopyrite, or from magnetite and pyrrhotite, dryness being the only requirement and proper sizing. A 1 H.P. static machine, generating current at 10,000 to 20,000 volts, will treat 12 to 15 tons in 24 hours. This process is, therefore, a mechanical separation on a newly applied electrical principle, and gives promise of being extremely useful to the metallurgist in some special cases, such as the treatment of mixed complex sulphide ores.

2. *Thermal Methods.*—The electrothermal processes useful to the metallurgist are numerous and important. In them the energy of the electric current is converted into heat, and the processes are either merely mechanical processes, such as melting, volatilisation or heating alone; or chemical processes, such as purification of ore, or reduction to metal, in which the electric current acts simply as the source of the heat needed.

Quite recently, Mr. F. J. Tone, of Niagara Falls, has devised a furnace for the reduction of oxides whose temperature of volatilisation lies close to the temperature of reduction. This furnace contains a vertical column of carbon blocks piled upon each other, and forming practically a solid carbon core, around which is the mixture of fine carbon and the oxide to be reduced. As the reduction of the charge proceeds, being heated up to the reacting tem-

* Abstract of Paper read before the Society of Arts, Massachusetts Institute of Technology, January 15, 1904.

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perature by the incandescent core, the reduced metal trickles down the furnace and thus escapes from the intense heat as fast as it is reduced. This pretty metallurgical operation has already resulted in the production of metallic silicon at a low cost. I have seen two heavy barrels full which Mr. Tone has made, and the principal difficulty now is to find commercial uses for this pure silicon at a reasonable selling price.

There is not the slightest doubt that within a short time electric steel furnaces will be as numerous as ordinary open-hearth steel furnaces, and, in the writer's opinion, the days of the crucible steel process are numbered, for the electric furnace can already compete in any locality with the crucible furnace for manufacturing high-grade and special steels.

One horse-power-year costs from $10 to $25 at established water-power installations, and its heat-producing power is 15,000 calories per day, or the equivalent of the full calorific power of 2kg. of good coal. This gives the heating power of a horse-power-year as that of 730 kg., or ¾ ton of coal. But for a given heating effect the electric heat can be applied (for instance, to melting steel) at an efficiency of 75 per cent., whereas the heat of combustion of coal is at most applied at an efficiency of 25 per cent. We may say, therefore, in general, that the electric heating will cost less where coal costs per ton over one-half of the price paid per electrical horse-power-year. This is on the assumption that coal can be so used as to produce the effect desired, and ignoring many other advantages which electrical heating possesses, and which in many cases make its use preferable even at several times the cost of a ton of fuel per horse-power-year.

3. *Electrolytic Methods.*—These are the processes where the chemical decomposing power of the current, its ability to perform electrolysis, is utilised. They may be all classed under three heads:—(1) The material being treated is the electrolyte or part of the electrolyte. (2) The material being treated is the anode, or placed in contact with the anode. (3) The material being treated is the cathode or placed in contact with the cathode. The electrolyte may be a solution in water or a fused salt.

If a fusible compound of the metal desired is not readily obtainable, or a suitable one not to be found, the problem of decomposing a practicably infusible compound may be solved by the beautiful principle discovered and illustrated in Hall's process for obtaining aluminium. The most abundant source of aluminium is its oxide, alumina, but this is not fusible except at electric furnace heat at a temperature at which aluminium itself volatilises. Hall sought for a fusible salt which would dissolve alumina and be electrically more stable than alumina. After long search he discovered this solvent in a mixture of fused sodium fluoride and aluminium fluoride, both of which salts are chemically and electrically more stable than alumina. By passing the direct current through the solution of alumina in this bath only the former is decomposed, yielding its products at the electrodes, and the process is made continuous by supplying fresh alumina as the bath becomes impoverished thereof. The discovery of this principle of working has established the aluminium industry, which is now using in America alone 22,000 H.P., and producing 4,000 tons of metal annually. I am surprised that the same principle, within the large variations which it permits, has not been applied to the reduction of other metallic oxides. It is certain that easily fusible silicates of manganese and calcium, for instance, would dissolve manganese oxide to a considerable extent, which would be decomposed by the passage of the current. Any chemist could sit down and in a half-hour excogitate a whole series of possible applications of this principle which would need only simple experiments to test them. I consider this one of the most promising fields for experiment in the whole realm of electro-metallurgy.

Copper alone to the value of $100,000,000 is being thus refined annually, while silver, gold, nickel, antimony, zinc and bismuth are also refined by analogous methods, also amounting in value to millions of dollars annually. It has been suggested, and the process patented, to refine aluminium, using it as a melted anode in a fused salt as electrolyte; but the process has not been industrially applied to my knowledge. It is interesting, however, as opening up another method of electrolytic refining.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Electricity in Agriculture and Horticulture." By Prof. S. Lemström. (London: "Electrician" Printing and Publishing Co.). 3s. 6d.

"Professional Papers of the Corps of Royal Engineers." Edited by A. T. Moore, R.E. Vol. XXIX. 1903. (Chatham: W. and J. Mackay & Co.) 10s. 6d.

"Molesworth's Pocket-Book of Engineering Formulæ." By G. L. Molesworth. 25th edition. (London: E. and F. N. Spon.) 6s.

"Elementary Manual on Steam and the Steam Engine." By Andrew Jamieson. 10th edition. (London: Griffin & Co.). 3s. 6d.

CORRESPONDENCE.

ON THERMO-GALVANOMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Mr. Duddell's "Thermo-Galvanometer,"* some of the methods used by the writer in constructing instruments of this type may be of interest. The first instrument of this type was constructed by the writer in 1898, and was described at the Columbus meeting of the American Association of Science at that or the following year. While quite sensitive, its time period was rather large.

Later, the efficiency of the heating coil was increased by using two oppositely-placed small parabolic reflectors, with the heating coil at the focus of one, and the suspended thermo-junction arranged just outside the focus of the other. This was found to be of a considerable advantage, but the time period was still too long.

The thermo-junction was later made by dipping two fine wires of copper and constantan or German silver into an electrolyte and electrolysing them so as to produce an extremely long fine point, looking something like a bee's sting under the microscope. This method of producing fine points was discovered by Mr. Fisher, of the Standard Underground Cable Co. These two fine points were then held in clamps with a micrometer adjustment, and electrically welded together under a microscope with a voltage of about 2 volts and a resistance of about 100,000 ohms in series. The other ends of the wires were bent together and soldered. In this way, a thermo-junction having an extremely small heat capacity was constructed, and proved very much more efficient.

This apparatus was used in connection with electromagnetic radiation in 1899 and 1900, but was finally abandoned for another method—*i.e.*, the barretter method described in some of the writer's patents, as the latter method was not only capable of measuring alternating currents down to as small a value as one-ten-millionth (0·0000001) of an ampere—*i.e.*, one-tenth (0·1) of a microampere—with a resistance of only 30 ohms, but also has the advantage that the readings are absolutely proportional to the energy absorbed (an unexpected and remarkable fact, but one which has been established by a great many accurate tests).

I found additional advantage in the wire barretter in the fact that the heat capacity was so small, being in the neighbourhood of one-tenth (0·1) of an erg, that on connecting a telephone with a barretter and battery in circuit with it, and speaking with the mouth placed within 6in. or 8in. from it, the speech is produced clearly and distinctly in the telephone, owing to the heating and cooling of the barretter by the compression and expansion of the wire by the sound waves. This experiment has been confirmed by Dr. Kennelly, professor of electrical engineering at Harvard, who has also during the past year made use of a modified form devised by him for measuring telephonic currents, and I understand an extremely interesting Paper on this subject is in course of publication, and I might also mention that the remarkable property of the barretter being able to reproduce speech has led Dr. Kennelly to suggest that the barretter should be used as an absolute standard for measuring the intensity of sounds.

In performing the experiment referred to above, the wire should preferably be straight and at right angles to the direction of sound waves. A still better result can be obtained by placing the barretter at the apex of an ear trumpet. This phenomenon is of course reversible. The hot wire of the barretter is mounted in an ear piece, similar to that used for phonographic tubes. By attaching one terminal to a vertical wire and the other to a ground wire, it is possible to read wireless signals, the heating of the barretter causing the air to expand, affecting the ear directly. The sensitiveness of the barretter when used in this way is greater than that of the coherer. This same form of receiver has been used for receiving telephone messages.

Rather an amusing experiment can be performed by running wires from one terminal to the head and from the other

* See *The Electrician*, May 20th, p. 190.—ED. *E.*

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terminal nearly to the ground, when it is possible for the experimenter to walk around at a distance of several hundred yards from the sending station and yet to hear everything that is being said, without the uninformed observer being able to detect the means by which this is done.—Yours, &c.

Washington, June 4. REGINALD A. FESSENDEN.

A NEW SINGLE-PHASE MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I find described in your issue of May 13, 1904, under the title "A New Single-phase Motor," an apparatus which is nothing more than one of the elementary forms of my repulsion motor, as brought out in 1887. You refer to it in the terms: "An interesting patent for 'Improvements in Single-phase Alternate-current Motors' (No. 3,705/1903), has just been published. The patentees are Messrs. Crompton & Co. and Rudolf Goldschmidt." Such a patent can be only "interesting" at this time in emphasising the need of some sort of search in the Patent Office granting the patent; and the term "new" as applied to this motor can only be proper if applied somewhat ironically.—Yours, &c.,

West Lynn, Mass., June 3. ELIHU THOMSON.

ELECTROLYTIC IRON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The excellent article which you published on June 17th by Messrs. Burgess and Hambuechen relating to the electro-deposition of iron reminds me of some experiments I tried about 15 years ago in the physical laboratory of the Owens College, Manchester. I wished to deposit rings of pure iron for the purpose of determining the permeability by the method of Rowland. The solution with which I obtained the best results was the same the authors advise—namely, one containing sulphates of iron and ammonium. I obtained fine deposits of iron on flat rings of copper, but was unable to get any considerable thickness. The arrangements for current supply were then not very convenient, and my deposits were obtained in an intermittent way. One difficulty that I encountered was the oxidation of the solution and the electrodes. To obviate this I fitted up an arrangement for carrying on the electrolysis in an atmosphere of hydrogen. The authors are to be congratulated on the outcome of their labours, and a more complete account will be awaited with interest.—Yours, &c.,

W. W. HALDANE GEE.

School of Technology,
Manchester, June 20.

A FERRARIS FIELD DETECTOR OF HERTZIAN WAVES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of June 3rd you published a Paper by Prof. Arnò on "A Ferraris Field Detector of Hertzian Waves," and refer to the same in your editorial columns as follows:—"As nothing has been heard of the magnetic detector for some months . . . But now Prof. Arnò, of Milan, comes forward with an article of considerable interest, describing a new magnetic detector in which the initial magnetisation is given by a rotary magnetic field produced by polyphase currents. . . ." Considering that a Paper on the same subject was published as recently as March 4th in your columns, the above is a little astonishing, and, in fairness to Prof. Ewing and myself, I beg to be allowed space for the following brief remarks.

At the conclusion of Prof. Arnò's Paper he refers to our own Paper, and without any additional comment one might suppose it was another case of independent and contemporaneous inspiration. Independent it certainly was, but seeing that Prof. Arnò has only just applied for provisional protection for his method, whilst our application for the mechanical detecting method was filed in October, 1902, and published in June or July, 1903 (the patent describing the use of an alternating rotating field and illustrating a differential instrument like Prof. Arnò's), the idea of simultaneous invention is removed.

Prof. Arnò does not accept the physical explanation which was offered at the end of our Paper, yet he does not suggest a better one, or even one at all. Further, he was working with an alternating induction, while our experiments all related to the reversed flux of constant strength; we long ago discarded the alternating induction as being comparatively insensitive. This insensitiveness would also from theoretical considerations have been expected, as with an alternating induction one is rarely at the sensitive point, and if the mean induction is to be about right, the maximum will be much too high. With the rotating field of fixed strength, on the other hand, it is possible to work all the time at the most sensitive part of the curve.—Yours, &c.,

L. H. WALTER.

London, S.W., June 20.

LIGHTNING PHENOMENA.

TO THE EDITOR OF THE ELECTRICIAN.

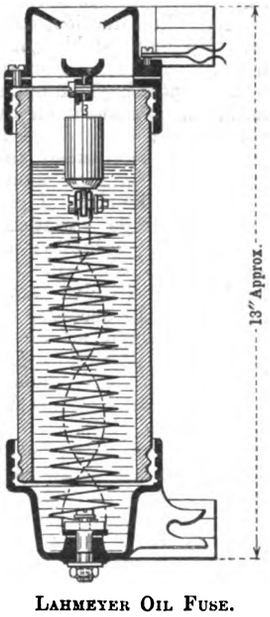
SIR: Referring to the account of a curious lightning stroke published in your issue of June 17th, on p. 337, it was the writer's good fortune to witness in the summer of 1895 a somewhat similar phenomenon. During a very heavy rainstorm, accompanied by some thunder, he was observing the storm through a thick plate-glass window, when suddenly a ball of fire of about 20cm. diameter fell, without any previous flash or explosion, striking the centre of a gravel path some 12ft. from the observer, when it exploded with a loud report, shaking the windows violently, but without breaking them, owing, no doubt, to their thickness. In the gravel path was a spherical cavity about 1in. deep by 3in. across, but there were no traces of any foreign body observable in the vicinity.—Yours, &c.,

R. GULEY-LEWIS.

Madrid, June 20.

EXPERIMENTS WITH H.T. OIL FUSES.

Herr F. Collischonn, in the *Elektrotechnische Zeitschrift* of June 9th describes some of the experimental safety fuses devised and tried by the Lahmeyer Company, and concludes his article with a detailed account of the latest oil fuse. At first the company tried fuses in which the fuse wire was surrounded with a thick layer of tenacious cable compound. Very good results were obtained with this type in connection with a 400kw. 10,000-volt machine. For breaking larger powers, however, this kind of fuse was found unsuitable on account of the powerful explosions which completely shattered the fuse, preventing the smothering action of the covering material. An oil fuse was next tried—*i.e.*, a fuse of ordinary design was made to work under oil. If the receptacle for the oil was sufficiently large, then the breaking of large currents at high voltages presented no difficulties, but whenever receptacles of practical size were tried the force of the explosions invariably burst the tubes. The metal vapour which is produced at the fusion of the fuse is a fairly good conductor of electricity, and experiments are quoted which show that, at a voltage of 5,000 volts, the spark is able to jump a gap of nearly 30in. In the latest design of the Lahmeyer Company (see illustration) the fuse, which is vertical, is contained in a small but strong metal shell lined with insulating material. This shell has a fine orifice at the top for the passage of the fuse wire, but is open at the bottom. The shell is placed inside a glass tube, which is capped at both ends and partly filled with oil. Both caps of the glass tube are of metal; the top one has an aperture for pouring in the oil and for the escape of the gases. The small fuse shell mentioned above is fixed to it by a screw and hangs down into the oil, only so far, however, that the oil does not reach the fuse wire. The second terminal is the bottom metal cap, which is connected with the fuse wire in the shell by a tension spring. When the fuse melts the fuse wire is quickly and completely broken by the action of the spring, and the metal vapours are simultaneously



LAHMEYER OIL FUSE.

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cooled by coming into contact with the oil. It is stated that fuses constructed on these lines stand a continuous overload of 50 per cent. and an overload of between 70 and 80 per cent. for about five minutes, but melt within two minutes when loaded with double the normal current. Such fuses, designed for 50 amperes and 10,000 volts, have been installed by Messrs. Lahmeyer & Co. in the Fenchurch sub-station of the Charing Cross and City Electric Supply Co.

PARLIAMENTARY INTELLIGENCE.

A SUBSTITUTE FOR THE "BERMONDSEY" CLAUSE.

ELECTRIC LIGHTING PROVISIONAL ORDERS CONFIRMATION BILLS, NOS. 2, 3 AND 6.

The House of Lords Committee presided over by his Grace the Duke of Northumberland continued consideration, on Monday, of the numerous applications by local gas companies for the insertion of the "Bermondsey" clause in a large number of the electric lighting provisional orders contained in the above bills. The Maidenhead order was considered last week (*The Electrician*, June 17, p. 360.)

Maldens and Coombe Order.

Mr. WEDDERBURN, K.C., who appeared on behalf of the local authority, said that this order applied to a new undertaking, and was for supplying electricity within the municipal area only. For these reasons he maintained that there was no necessity for the "Bermondsey" clause to be inserted. Mr. Paddon, in the Maidenhead case, had put it forward as an argument that where a local authority sought to supply outside its own district it ceased to be an authority looking after its own inhabitants, but it became a commercial undertaking, and that, therefore, it was not fair that any loss which might be incurred should fall upon the ratepayers inside the municipal area. He submitted that whatever might be said in respect of a local authority seeking to go outside its district, there was no reason why a new undertaking should be saddled with what was, after all, a penal clause. It had been decided by Parliament, and it was also provided for in the general law, that municipalities were to be allowed to embark upon the business of electrical supply, and he could not help feeling that a great deal of the argument put forward by the supporters of the "Bermondsey" clause really mixed up the question of a local authority being allowed to supply at all and whether it should supply under certain restrictions. He protested against the assumption that Malden would necessarily conduct its undertaking upon uncommercial lines, and the Board of Trade in granting the order had assumed the contrary.

Mr. C. C. HUTCHINSON, who appeared for the Kingston Gas Co., contended that there was nothing in the "Bermondsey" clause which prevented a local authority from making a profit. Even in the Aberdeen and Dundee Tramways Bill the "Bermondsey" clause had been inserted. He did not contend that gas companies should not be liable to competition, for it was quite obvious that Parliament had laid down that the local authority should supply electrical energy in opposition to the local gas companies under certain conditions. It had even been assumed that such competition might have a disastrous effect upon the gas company, for it was provided that in such cases the gas undertakers might apply to the Board of Trade to be relieved of their obligations. But this was all the more reason why the "Bermondsey" clause should be inserted, because it should be remembered that people who had invested their capital in gas undertakings should not be subject to unfair competition, which would inevitably leave their undertaking valueless. He did not ask for the "Bermondsey" clause, however, and at a later stage would submit a copy of what he asked for.

Tamworth Order.

Mr. WEDDERBURN, in opening the case for this bill, said it was absolutely on the same footing as the previous one, and he therefore would not labour the points in connection with it. If it could be proved that local authorities fixed the rates so absurdly low as to destroy the gas undertaking, then it might well be said that the municipalities should be fettered in this manner, but this must absolutely depend upon evidence, and in the cases before the Committee there was absolutely no evidence of the kind produced.

Eastleigh Order.

Mr. NEVILLE, who appeared for the local gas company, asked for the insertion of a clause somewhat on the lines of the "Bermondsey" and "Marylebone" clauses, and also asked for the further provision that the ratepayers should be consulted before any money was borrowed for the purpose of putting the order into force.

Mr. WEDDERBURN, in reply, said that the Marylebone case was a peculiar one, because the local authority had been saddled with a heavy responsibility from the commencement in order to pay the award of the arbitrator to buy out the existing company, but even in this case the clause was so modified that it gave the Borough Council three years in which to set their house in order, and it also excluded the question of forward contracts.

Hanwell Order.

Mr. NEVILLE asked for the insertion of the "Bermondsey" clause in this order.

Mr. C. E. ALLAN, who appeared for the promoters, said that his clients, the local authority, felt that the insertion of the clause would throttle the undertaking. With regard to Mr. Neville's point that the ratepayers should be consulted before any money was raised, he stated that the Local Government Board held an inquiry at which it was possible for any ratepayer to make an objection. Hanwell was a rapidly-growing district, and it was necessary to make provision for the needs of the district a few years ahead.

Watford Order.

Mr. WEDDERBURN, in opening for the Watford Urban District Council in respect to this extension order, said he admitted that in this case the circumstances were somewhat different to the previous ones, inasmuch as there had been a loss upon the existing electric light undertaking of the local authority. The original order was obtained in 1897 and the works were opened in 1899. A year or two ago there had been an extension of the municipal boundaries, and the order now before the Committee was to enable a supply of electricity to be given within the extended boundary. The average annual loss upon the undertaking was £198, apart from sinking fund and interest. He resisted the insertion of the "Bermondsey" clause for the reasons he had already given.

Mr. TURNER, clerk to the Watford Urban District Council, was then called and stated that the total deficiency upon the undertaking since the commencement was £4,058, but provision had been made for repayment of principal and interest to the extent of £4,434. He saw a difficulty in applying the "Bermondsey" clause, and in the absence of any evidence as to mismanagement he considered the clause unnecessary.

Mr. W. H. F. COLEBROOK, the electrical engineer to the Council, was also called, but Mr. Paddon did not cross-examine him on the accounts on his stating that he was not responsible for the manner in which they had been made out.

Mr. PADDON, in addressing the Committee on behalf of the Gas Company, contended that the loss upon the Watford undertaking was evidence of bad management. In criticising the accounts, he maintained that in some years even rates and taxes had been omitted. The Council had been hawking the undertaking about recently with the idea of getting some one to buy it. At the present time electricity was being sold in Watford at absolutely fanciful prices, and at prices which no gas company could compete with. Therefore, in the ratepayers' interest, some limitation was necessary, and he asked for the clause already referred to.

Bath Order (Rural).

In connection with this order, which seeks to authorise the supply of electrical energy within the rural district of Bath by the Rural District Council, no speech was made for the promoters.

Mr. FIPPARD, consulting electrical engineer, was called, and said that the district comprised 27,420 acres and the population was 27,672. A penny rate realised £571. The Council did not intend to erect its own generating station, but would probably take a supply in bulk. There were three such sources—viz., the Somerset and District Electric Power Co., the Bath Corporation and the Bath Electric Tramways Co. He estimated that there would be 4,000 consumers in the first year and 7,000 in the second. Assuming an average selling price of 4·75d., and that the total cost to the Council would be 3·5d., a loss would be incurred in the first year of £63, in the second year the accounts would about balance, and after that there would be an increasing profit.

Cross-examined by Mr. BAGGALLAY, for the Bath Gas Co., he said he did not know the financial condition of the Somerset Power Co., and was not quite clear as to the legal powers of the Bath Corporation and the Bath Tramways Co. to give a supply in bulk. He had not made any estimates as to the number of distributing stations that would be necessary.

Mr. BAGGALLAY, in a brief speech, after criticising the sources of supply mentioned by Mr. Fippard, asked for a clause on the lines of the "Bermondsey" clause.

This completed the whole of the opposed orders in the bills.

The CHAIRMAN then asked for the views of the Board of Trade on the matter.

The Hon. T. H. W. PELHAM said that the Board of Trade had consistently refused to insert the "Bermondsey" clause in electric lighting provisional orders since 1902, because they were of the opinion that they were not entitled to do so in the absence of any instructions from Parliament. It had, however, been inserted by agreement in several cases. The opinion of the Board was that the clause would defeat the very object which the supporters of the clause professed to have in view—viz., that the undertakings should be carried on upon commercial lines. Further, it would be difficult to define what the first year's working was. Such a clause tended to restrict the development of an undertaking. For instance, if a municipality had the opportunity of entering into a contract for the supply of electricity to a large estate which would only be profitable in a few years, they were prevented from doing so under this clause. The Board of Trade's view was that, if an electrical undertaking showed a loss, the best way of rectifying this would be to reduce the price, but, of course, under the applications of the "Bermondsey" clause this would be impossible. Further, the Electric Lighting Acts provided that any profit above 5 per cent. should go to the benefit of the ratepayers, and if the ratepayers were to benefit by the profits in this way it did not seem unfair to the Board of Trade that they should incur some risk of loss. For instance, the local authorities might find themselves at the end of the year with 4 per cent. in hand, which would be a profit in the case of a company, but in the case of a local authority, if it had to pay 5½ or 6 per cent. for interest and sinking fund, it would result in a loss. Therefore, it seemed very difficult to determine what was the expenditure for the year unless it was definitely laid down that it was the sum expended upon the undertaking with or without the payment of interest and sinking fund charges. The clause might have the effect of crippling the undertaking altogether, and it was a matter which should receive the most careful attention.

Sir RALPH LITTLER, K.C., for the Colney Hatch Gas Co., then made an application to be heard in respect of the Colney Hatch order. He said his reason was that the Board of Trade opposed the granting of the

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"Bermondsey" clause in spite of the fact that it had been agreed upon between the company and the local authority.

After some discussion,

The Committee decided to hear Sir Ralph Littler.

Colney Hatch Order.

On Tuesday, Sir RALPH LITTLER addressed the Committee, and asked the Committee if there was any inherent vice in the "Bermondsey" clause which prevented it being inserted when both parties were agreed. At any rate, the doctrine laid down by the Board of Trade was that it was wrong in principle; but the right tribunal to decide this was Parliament, and no public department ought to have the power of saying that, because it had laid it down as a rule never to grant the clause, it should not be discussed before Parliament. The Board of Trade apparently considered that the best way to reduce a loss was to reduce the price. But in the case of the gas companies, when there was an increase in the price of coal, they increased the price of gas to meet that loss. A district council was at present absolutely uncontrolled in these matters, but the shareholders of a company had control of their undertaking. This clause put a check upon municipal trading, and it was a dangerous practice not to put a check upon it. The Board of Trade had hinted that the gas companies wished to cripple the municipal electric supply business, and he did not think it worthy of a public department to suggest any such thing. If the suggestion of the Board of Trade was to be entertained that the clause prevented the development of electrical contracts which would only be remunerative after a term of years it would be a monstrous proposition. A gas company would not undertake such contracts, an electric lighting company should not, and a municipality using the ratepayers' money should be debarred from entering into them. In the Colney Hatch case the company and the local authority had agreed to insert the clause with a full knowledge of the local conditions, yet the Board of Trade objected. It it had been in a private bill no one could have objected, and he would ask the Committee to allow the clause to remain in the order as agreed.

Huddersfield Order.

Mr. BAGGALLAY said that an agreed modified "Bermondsey" clause had been inserted by agreement with the Corporation of Huddersfield. The Huddersfield Corporation had at the present moment an elec tric lighting undertaking within the borough. The proposal of the order was to extend the undertaking into Golcar, outside the borough. The Longwood Gas Co. had works in Huddersfield, in respect of which they were large ratepayers. The company also had works in Golcar, and petitioned against the extension altogether, and at the same time asked for the insertion of the "Bermondsey" clause. An agreement had been come to, however, whereby the gas company's opposition had been withdrawn upon the Corporation agreeing to insert the "Bermondsey" clause in the order. He, therefore, asked for the insertion of the clause as a part of the bargain. The reason that the gas company asked for the clause was that inside the borough of Huddersfield there was a good field for electric supply at a profit, but in Golcar the country was poorer and thinner, and not likely to be remunerative. The objection was, consequently, to the profits made in Huddersfield being used to bolster the undertaking in Golcar.

The Hon. T. H. W. PELHAM, of the Board of Trade, pointed out that the clause in the Huddersfield order enabled the Corporation to charge rates 10 per cent. higher in Golcar than were now charged in Huddersfield.

Mr. BAGGALLAY said this was part of the machinery for giving effect to the agreement between the parties.

After consultation for over an hour,

The CHAIRMAN made the following announcement:—The Committee find the preambles of all the orders in the bills proved. With regard to the "Bermondsey" clause, the Committee would be obliged to counsel if they would bring up a clause carrying out the following provisions:—

1. The accounts of the undertaker shall be published annually in the form prescribed by the Board of Trade under the statute.

2. The local authority at the end of five years after the undertakers supply energy, in the case of a new undertaking, and three years in the case of an existing undertaking, and thenceforward triennially shall, so far as it is reasonably possible, revise its rates so that no loss shall be incurred by the ratepayers on the undertaking.

3. Nothing shall prevent a local authority from entering into a contract to supply electrical energy on special terms, but the rates charged in future contracts shall be either subject to revision at the triennial revision or rise and fall (but not excepting by consent below any minimum named in the contract) pari passu with the general electric lighting rates fixed at the triennial revision, and the promoters in each case will decide which alternative they prefer inserted in their order.

Continuing, the CHAIRMAN said that it was not intended to prevent or discourage a more frequent revision of the rates, other than the contract rates, should the local authority desire to enter upon it. Further, the Committee did not want the clause to be drawn that it could possibly be so interpreted as to prevent a revision annually or bi-annually if the municipality prefer to make it. This clause will be inserted in all the orders where application had been made for it in substitution for the "Bermondsey" clause. In those orders for which it had not been applied nothing could be done.

With regard to the special clauses, apart from the "Bermondsey" clause, asked for in certain orders, the Committee agreed to insert in the Hampton Wick, Maldon and Coombe and Huddersfield orders a clause to the effect that there shall not be charged against the general rate in respect of street lighting or other municipal purposes for which such energy shall be employed, any larger amount than is charged to the ordinary consumer using energy during like hours of supply. The Committee also agreed to allow the Huddersfield Corporation to charge rates in Golcar 10 per cent. higher than those now charged in Huddersfield.

Applications were then made on behalf of the opposition to the Eastleigh, Watford, Hanwell and Tamworth orders for a clause compelling the local authority to hold a meeting of ratepayers before application was made to the Local Government Board for a loan under any of the orders named.

The Committee refused to grant this clause, and decided to consider the clause as suggested by the Chairman, above, on Tuesday morning.

TRANSFER OF ELECTRIC LIGHTING PROVISIONAL ORDERS TO ELECTRIC POWER COMPANIES.

Before the Unopposed Committee of the House of Commons on Friday last week, presided over by Mr. J. W. Lowther, an interesting point was argued with respect to the transfer of electric lighting provisional orders from one authority to another. It arose in connection with some unopposed bills promoted by a number of electric powers companies.

Mr. FRERE, who appeared on behalf of the Derbyshire and Nottinghamshire Electric Power Co., said that the bill proposed, among other things, to take powers for the company to pay interest out of capital during construction and to take transfers of electric lighting orders from local authorities or other undertakers. In respect of the latter point, the Local Government Board had presented a report upon the bill to the effect that any such powers should only authorise the company to take transfers and not other people to give transfers. The point was this: In some electric lighting orders power to transfer the undertaking with the approval of the Board of Trade was given, and in others it was not given. If the company were in negotiation with the owner of a provisional order, say, in December, to take a transfer of that order, if the owner had not the power to transfer it would necessitate a two years' delay for the power to do this to be obtained. In the Cleveland and Durham Electric Power Act of last year and the South Wales Electric Power Act of last year the Board of Trade had consented to a clause giving the companies power to take and the owners of any existing orders power to give a transfer, but refused to allow the clause to apply to any subsequent provisional orders which might be granted. This clause was inserted in the bill. Now, however, the Local Government Board argued that the power to transfer an order was contained in sec. 11 of the Electric Lighting Act of 1882, which reads as follows:—"Any local authority who has obtained a licence, order or special act for the supply of electricity may contract with any person or persons for the execution and maintenance of any works needed for the purposes of such supply or for the supply of electricity within any area mentioned in such licence, order or special act, or in any part of such area; but no local authority, company or person shall by any contract or assignment transfer to any other company or person, or divest themselves of any legal powers given to them, or any legal liabilities imposed on them by this act, or by any licence, order or special act, without the consent of the Board of Trade." On the face of this, continued Mr. Frere, it would appear that the Board of Trade had the power to do all that was necessary, but he had consulted with Mr. Pelham, of the department, that morning, and that gentleman stated that the Board of Trade was emphatically of the opinion that this clause did not give them the power to transfer a whole undertaking. In fact, the Board had refused to do so on one occasion when an application was made for it. The clause which he proposed to embody in the bill, therefore, was clause 2, as follows:—"(1) The company may by agreement, but not otherwise, acquire from any local authority or other undertakers, to whom a provisional order under the Electric Lighting Acts, 1882 and 1888, shall have been or may be granted, relating to a district or place within the company's area of supply, the undertaking authorised by such provisional order, and the property, powers, rights, authorities and privileges of the undertakers under such provisional order, and any such undertakers to whom a provisional order has been or may be granted may, with the approval of the Board of Trade, transfer their undertaking, property, powers, rights, authorities and privileges to the company on such terms as may be agreed upon, and in the event of the company so acquiring such undertaking, properties, powers, rights, authorities and privileges they shall be deemed to be undertakers for all the purposes of the provisional order so acquired by them; and the provisions of such provisional order shall apply to the supply of electricity by the company within the area of supply as defined by such order, and the company shall be entitled to charge for electricity supply within such area the prices prescribed by such order. Provided that, in the case of any provisional order granted prior to the year 1900 to any local authority, the provisons of the Electric Lighting Clauses Act, 1899, shall from and after such transfer be deemed to have been incorporated in such provisional order, and shall control and supersede such of the provisions of that order as are at variance or inconsistent therewith. (2) Any capital moneys received by any local authority in respect of any transfer under this section shall be applied by such authority in manner provided by sub-sec. 2 of sec. 7 of the schedule to the Electric Lighting Clauses Act, 1899." Continuing, Mr. Frere said that a clause similar in principle to the above was inserted in the Kent Electric Power Act of 1902.

After some discussion the Committee decided to allow the clause, and found the preamble of the bill proved. (The full objects of the bill were set forth in our issue of May 13, when it was before the Unopposed Committee of the House of Lords.)

Mr. FRERE then asked for the same clause to be inserted in the Lancashire Electric Power Bill, which also sought powers to pay interest out of capital during construction, the acquisition of a new site for a generating station, an extension of time of two years for the completion of works, &c.

The Committee granted the clause and found the preamble proved. (The proceedings before the House of Lords Committee were reported in our issue of April 22.)

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Mr. BELL, Parliamentary agent for the Leicestershire and Warwickshire Electric Power Bill, said that the transfer clause was also asked for in this bill, which further sought an extension of time for the completion of works.

The Committee granted the clause in this case and found the preamble of the bill proved. (This bill has also passed the House of Lords, see *The Electrician*, May 13.)

COMPETITION WITH A POWER COMPANY REFUSED.

DONCASTER CORPORATION BILL.

A Committee of the House of Lords, of which the Chairman is His Grace the Duke of Northumberland, considered the Doncaster Corporation bill on Tuesday. The bill, which is of an omnibus character, has already been passed by the House of Commons (*The Electrician*, April 22, p. 27).

Mr. BALFOUR BROWNE, K.C., for the promoters, in dealing first of all with the electrical part of the bill, said that it proposed to supply electricity to a number of districts outside the borough, the local authorities of which were all consenting parties. These districts were little likely to get a supply of electricity if it did not come from the Doncaster Corporation. The only opposition was by the Yorkshire Electric Power Co., which was authorised by Parliament in 1901 to supply electricity over a large portion of Yorkshire including the districts round about Doncaster which the Corporation proposed to supply. At present, however, the company had done very little, and their only generating station, which was not yet in operation, was 30 miles away.

Mr. J. H. WYLD, late electrical engineer to the Doncaster Corporation, said that the electricity works in Doncaster started in 1899 with a capacity of 188kw. which had now been increased to 920kw. The buildings were also large enough for extension to 2,000kw. Current was now being supplied to the tramways of the Doncaster Corporation which ran outside the borough. There was a great demand for current in the districts proposed.

Cross-examined by Mr. FREEMAN, K.C., for the Yorkshire Power Co., Witness said he did not consider that the company had a monopoly of the district.

Mr. F. NICHOLSON, solicitor to the Doncaster Corporation, also gave evidence as to the demand for current which existed in the outside districts.

Mr. GILL, builder and contractor, said that there were a large number of villa residences in the outside districts wired for the electric light, but which could obtain no supply up to the present.

Mr. MARK DUNSTAN, chairman of the Electric Light committee of the Doncaster Corporation, said that the municipal electrical undertaking in Doncaster had been a loss during the first few years, but was now making a yearly profit.

Mr. A. G. LUPTON, chairman of the Yorkshire Electric Power Co., gave particulars as to the progress which the company was making with the erection of its works at Thornhill, from which it was expected, he said, that a supply would be given in November this year. The works had cost £400,000, and the remaining generating stations authorised under the Act of 1901 would be proceeded with as soon as the demand increased. Contracts had been entered into, however, for the erection of the second generating station. They were quite prepared to supply this district, and he resented the action of the local authorities in trying to secure the best part of the company's area. He did not wish to have to fight rate-aided competition.

Mr. FREEMAN, K.C., addressed the Committee for the Yorkshire Electric Power Co., and said that this was the first time that a Corporation had sought power to supply electricity outside its area in competition with a power company.

Mr. PAGE, K.C., replying for the Corporation, contended that Parliament had never yet given a monopoly to a private company under the conditions of the Yorkshire Electric Co.

After a short consultation, the Committee refused to give the Corporation the districts asked for, and found the preamble of the electrical portion of the bill not proved.

WEIGHTS AND MEASURES (METRIC SYSTEM) BILL.

When this bill comes into the House of Commons for second reading, Mr. Herbert Robertson has a motion down on the paper to move that the bill be read a second time that day three months.

SUPPLY OF ELECTRICITY BILL.

The following is the Committee of Peers to which the Supply of Electricity Bill has been referred:—The Marquis of Bath, the Earl of Ellesmere, Lord Colchester, Lord Stanley of Alderley and Lord Wolverton.

ELECTRIC LIGHTING (LONDON) BILL.

This bill is now under consideration by a Committee of the House of Commons of which Mr. Bousfield is Chairman.

OTHER ELECTRICAL BILLS.

A Committee of the House of Lords, presided over by Lord Hawkesbury, has just completed consideration of a bill promoted by the Soothill Nether Urban District Council, and tramway provisional orders promoted by the Urban District Councils of Dewsbury and Ossett to construct short lengths of electric tramways in these localities. As all three schemes connected up with each other, they were considered by the Committee as a whole. In the case of the Soothill Nether tramways full particulars of these were given in our issue of March 18, when it was before a House of Commons Committee. The other two schemes are of a very similar nature, and the only preamble opposition was by the Great Northern Railway Co. on the ground of competition. Mr. Bury, general manager of the Great Northern Railway Co., said that by a connection between the proposed lines and the Wakefield light railways there would be a line of competing tramways all the way from Leeds to Wakefield. The object of the Great Northern Railway Co. was to prevent these long through routes being established, because railways should carry the through traffic, and tramways should restrict themselves wholly to local traffic. He therefore asked that a substantial break should be maintained between all the systems. After hearing speeches by counsel, however, the Committee decided to pass the preamble of all three bills. On the consideration of clauses, the Yorkshire Electric Power Co. asked that the Dewsbury and Ossett Urban District Councils should be restricted from supplying electrical energy outside their areas except with the written consent of the power company. The Committee granted this clause, and ordered the bill to be reported for third reading. A clause in the Soothill bill is to the effect that no junction shall be made with lines outside the district except with the consent of the Board of Trade.

The *Shipley Urban District Council Bill* was passed by the Unopposed Committee of the House of Commons on Friday last week. The bill, which has already passed the House of Lords (*The Electrician*, April 29), authorises an extension of area in which to supply electricity, as well as other things not of an electrical nature.

In the House of Lords on Thursday last week the following bills were read a second time:—*Carlisle Corporation, Radcliffe Tramways and Improvements, London United Tramways, Middlesbrough, Stockton and Thornaby Tramways, London County Council (Tramways and Improvements), London County Council (Money) and the North-Western Electricity and Power Gas.* On Tuesday the following bills were read a third time and passed:—*Stretford Urban District Council, South-Western and Isle of Wight Junction Railway* and the *Harrow Road and Paddington Tramways.*

In the House of Commons on Monday the *Swindon Corporation Bill* was read a third time and passed, and the *Loch Leven Water Power Bill* a second time. On Tuesday the *Lancashire Electric Power Bill* was read a third time and passed. On Wednesday the *Lothians Electric Power Bill* was read a second time.

The *Tyneside Tramways and Tramroads Bill* which gives the company compulsory running powers over certain of the Newcastle Corporation lines and in respect of which Mr. Plummer, the member for Newcastle, has a motion down for the deletion of these powers, will come up for third reading in the House of Commons on Thursday next.

The *West Riding Tramways Bill* is now unopposed.

THE POST OFFICE AND WAYLEAVES.

On p. 361 of our last issue we reported a statement by the Postmaster-General as to the difficulties he had encountered in securing wayleaves in connection with the telephone line for life saving purposes between Padstow and Hawker's Cove.

On Tuesday, however, Lord STANLEY explained that this statement had been made through a misunderstanding, and that nothing of the kind described had happened. The owner of the property over which the telephone wire in question ran was willing to give the fullest facilities in the matter. The bill dealing with cases of unreasonableness in connection with such wayleaves, referred to last week, would, however be proceeded with.

ELECTRIC RAILWAY FATALITIES.

In the House of Commons on Monday,

Mr. BELL asked the President of the Board of Trade whether his attention had been called to a recent fatal accident to a child at Jesmond, a fatal accident to Joseph Innes at the Manors Station on the 13th inst., an accident to James Hughes on the same date, and an accident to Philip Gilroy at the Newcastle Central Station on the 14th inst., all of them through coming in contact with the live rail on the electric section of the North-Eastern Railway, and whether he would consider what steps were necessary and what means could be adopted to protect such rails upon electric railways in existence and which might be constructed in future.

Mr. GERALD BALFOUR, in a printed reply, said that the Board of Trade had received information from the railway company in regard to each of these unfortunate accidents. In the last-named case, however, the injury appeared to have been slight, not necessitating absence from duty. He had ordered an inquiry into the circumstances attending the fatal accident at Manors Station, and the report made by the Board's inspecting officer would receive careful consideration.

In the House of Commons last night,

Mr. RENWICK asked the President of the Board of Trade whether arrangements were being made to protect the public and railway servants from contact with live rails between platforms at stations where electric trains stop or pass through.

Mr. G. BALFOUR: I understand that on most railways which are being worked electrically the live rail is guarded where it passes through stations. Inquiries have been ordered into two recent accidents arising from electrical working, and when the reports of these inquiries are received the question of the precautions to be taken will be considered.

Mr. RENWICK: Might I inform the right hon. gentleman that I can give him the names of certain lines on which, in many important places, live rails are unprotected. It is an extremely important question, and I hope the right hon. gentleman will take notice of it.

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LEGAL INTELLIGENCE.

Poole and District Electric Traction Co. v. Bournemouth Corporation.

ARBITRATION.

(*Continued from p. 323.*)

Saturday, June 18.

Mr. W. ANDERSON, managing director of the Dublin United Tramways Co. and a director of the Cork Electric Tramways Co., said he had visited Bournemouth and Poole recently, and was of the opinion that it was a place where the population was increasing very rapidly. It was thus fair to anticipate a corresponding increase in the receipts. In Dublin, since 1897, when the horse lines had been converted to electric traction, the receipts had increased by 27 per cent. per annum, whilst since 1902, when all the lines ran through instead of stopping in the centre of Dublin, there had been a further increase of 24 per cent., making a total increase of receipts of 51 per cent. since 1897. He placed considerable importance upon the carrying of parcels on the Bournemouth lines, for in Dublin last year a profit of £2,412 was made upon this branch alone. Dealing with the question of raising capital, he said that it was usually impossible to raise money upon such good terms if the undertaking was purchasable under the terms of the Tramways Act of 1870. In Dublin this was not so, and, therefore, capital had been raised upon favourable terms, and the same thing would apply to these lines.

Cross-examined by Mr. H. LLOYD, K.C., he said he thought the Parkstone loop which the company had powers to make would compete with the main line traffic at the beginning, but eventually it would develop a traffic of its own owing to the change in the character of the neighbourhood. All the lines in Dublin dealt with a more populous district than the Pool lines, and only one was at all comparable with this one. But his percentage increase, he thought, could very well be applied. The system of parcels delivery was by means of main receiving offices from whence the parcels were sent by tramcars to sub-depots, and from there they were delivered by boys. The tramway company also had a working arrangement with the railway company in connection with the parcels traffic. In fact, the company did almost the whole of the parcels traffic in Dublin and suburbs. The gross receipts per car-mile for passenger traffic on the Dublin lines was 8·74d., and the expenses 4·96d. per car-mile. The company generated its own electricity at a cost of ½d. per unit.

Mr. EVE asked the witness for the increase per car-mile since 1897. The percentage increase of 51 per cent. given really meant nothing, as they might have run more car-miles to get this increase.

Mr. ANDERSON promised to get these figures and hand them in.

In answer to Mr. LLOYD, Witness said his figures of receipts and expenditure per car-mile did not include anything for depreciation.

Mr. H. F. PARSHALL, examined by Mr. CRIPPS, K.C., said he had been over the lines of the company, and considered the undertaking was in first-class condition. Using the 3½ per cent. table and the balance-sheet of 1901 as the basis, his valuation of the existing undertaking was £214,170. The prospective increase of profits over the existing line and the authorised Parkstone extension he had estimated at 3 per cent. for 25 years, which was borne out by the growth of population in the district. Based upon the profit shown in the 1903 balance-sheet, he arrived at a figure of £22,370, after having deducted for capital expenditure. The value of the running powers he put at £45,000, which was calculated upon the estimated traffic receipts upon the mile of the Corporation lines running to the County Gates and the mile of the company's lines from the County Gates. This was being done in connection with the running powers of the Glasgow Corporation over the Paisley lines. In the ordinary course, with the break existing at the County Gates, there was a diminishing return upon both lines as the cars reached the point of the break. This would be done away with if the running powers existed, and he estimated that the result would be practically one extra passenger per car-mile to both undertakings. This increase of receipts would be all profit, as the existing cars would carry it. The value of the Christchurch lines he put at £42,000, based upon a 7½ years' purchase, in consideration of the fact that the lines were not constructed. He had estimated the profits upon the Christchurch lines at the same rate as the existing line—viz., £5,600 per year. The Parkstone loop he valued at £37,000. The other items he had not taken into consideration, as he was not sufficiently acquainted with the local circumstances.

Cross-examined by Mr. LLOYD: He had made his valuation absolutely independently of anyone. His opinion was that the company's lines were in as good condition as the lines of the Corporation, and no one would say that the latter were not in first-class condition. With regard to the raising of capital for tramway undertakings, the bankers had lent the money for the construction of the Paisley lines at 4½ per cent. For an average tramway concern he should think that the debentures should be 3½ per cent., preference shares 4 to 5 per cent. and the ordinary shares 5 per cent. His figures had been based upon the 1901 balance, and he had not considered whether his figure of £214,170 would be the fair market value leaving out the 1901 balance-sheet. He had assumed that the increase in the visitors' traffic would be the same as the traffic due to the resident population. It was estimated that the visitors' traffic was 35 per cent. of the whole traffic. The earnings per car-mile, he contended, had no bearing whatever upon the commercial value of an undertaking. As an instance of this, he referred to the Dublin undertaking where the receipts per car-mile were about 8½d. and yet the shares were at a considerable premium. The exact receipts per car-mile over the last mile of the Corporation lines towards County Gates was not in his possession, but the figure he had given in evidence in chief had been averaged out.

Mr. STEPHEN SELLON was then recalled and explained why, when before the House of Lords Committee which considered the Tyneside Tramways Bill, he had stated that there would be an increase of traffic to the extent of 10 to 20 per cent. if the running powers were granted, and that before the House of Commons last week in the Tyneside Bill and in this case he had put the increase at 35 per cent. He had recently had some experience in connection with the through running between the Birmingham and Aston Manor lines which confirmed this figure of 35 per cent.

Mr. LLOYD then asked the Umpire's ruling as to whether the correspondence and conference in Bournemouth at which Mr. Sellon made an offer to the Corporation should be expunged from the notes. (See *The Electrician*, June 3, p. 280).

The UMPIRE, after inspecting the correspondence and hearing the facts of the case stated, decided that it had all taken place without prejudice, and that, therefore, this matter should be eliminated from the proceedings.

This closed the case for the company.

Mr. LLOYD then briefly addressed the arbitrators on behalf of the Corporation, prior to calling his evidence, and dealt first with the interpretation of the clause in the agreement between the Corporation and the company which stated that the balance-sheet for 1901 should be taken as the basis in determining the fair market value of the undertaking. The first question which arose, he said, was the meaning of the words in the clause which stated that the balance-sheet for 1901 should be taken as the basis. The company argued that the Umpire was to take merely one particular figure in the balance-sheet, which was to be stereotyped for the nine months and then averaged out for the full year, and that figure was to be taken as a maintainable figure for evermore. He joined issue at once upon this. He was going to take the balance-sheet as a basis upon which he was asking for a valuation, but he was going to take the balance-sheet as a whole, and not one particular figure in it. In the agreement nothing was said as to whether the balance-sheet for 1901 was for 12 months or nine months, and therefore he would be justified in taking it as it stood, which was nine months; but he at once agreed that it would be obviously unfair to the company that this should be done, and he made no objection to an average being obtained for the whole year. This the company had done, but, on the other hand, the purchaser was, he contended, quite at liberty to ascertain if anything had been left out of the balance-sheet which ought properly to have been included. In considering the matter from this point of view, there were many things in the 1901 balance-sheet which struck him at once. In the first place, one had even struck Mr. Balfour Browne, who had turned the nine months shown by the balance-sheet into 12 months, notwithstanding that nothing in the clause actually made this clear. There were other things in the balance-sheet, however, which would do a monstrous injustice to the Corporation if the company's figures were accepted, and it could not be suggested that, taking the basis as he had set it forth, the Umpire could give anything but a fair market value of the undertaking. Another item was the cost of obtaining the Christchurch powers. The actual figures for these expenses had not been put forward by the company, although they had included a figure in their estimate of the value of the Christchurch undertaking. In addition, the Corporation did not want the Christchurch lines because they considered the company had laid them out in a bad way. The company had laid themselves under an obligation to rebuild a very expensive bridge, and, as a matter of fact, the Corporation would not have gone to Parliament for any lines in the Christchurch district at all, if it had not been that they were under an obligation to the Christchurch Corporation to do so. However, he should ask to see the vouchers for the expenses in obtaining the Christchurch Act. With regard to the value of the Parkstone line, he was bound to say that this was an unnecessary duplication of the existing line. The traffic which it could accommodate was practically accommodated to-day. There must be competition, and he believed it was a matter which was only argued because some peculiar meaning was attached to the word competition by the witnesses for the company. The line was worse than useless because it would increase the expenses without increasing the profit. With regard to the running powers, the Corporation recognised that there was some convenience in doing away with a break of this nature, but the witnesses for the Corporation did not take the same roseate view of the increase of traffic which would be caused by this, as did the company. Their view was that what increase would arise would be more than counterbalanced by the duplication of the Parkstone line. The argument that the visitors' traffic would increase in the same proportion as the population was one that he could not understand. The view of the Corporation was that the traffic on the Poole undertaking had practically reached its high-water mark, but they had added something to the number of car-miles, and given the company some advantage in this in making out their estimates. The Corporation witnesses would state that 11d. per car-mile would be a fair figure to take as the gross earnings, and even Mr. More, one of the company's witnesses, had given this figure as the one which should be earned by a company if it was well managed. It was also accepted that 7d. was a fair figure to take for operating costs, and this left a gross profit of 4d.; but there was still the question of depreciation to be dealt with. This was a matter which had been treated in varying manners by different witnesses. Mr. Hammond had taken 1·09d. per car-mile, and, adopting this, it left 2·91d. profit per car-mile which could be earned. But the Corporation thought that 1·09d. was too low. Their view was, that after making all deductions, about £6,000 per year gross profit would be earned, from which should be deducted £2,000 for depreciation and other things, which left a net profit of £4,000 per annum. The Corporation had also adopted 16¾ years as the period of purchase, and applied this to the £4,000. They would then ask that the depreciation for the three years 1901-2-3, which had not been set aside, and ought to

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have been set aside, should be found by the company, and, after deducting that £6,000, there would also be a sum of £1,400, which he would ask to have deducted in order to put the track into good repair, and this left a net value of the undertaking at £59,000. In addition to this, he would be entitled to the taxed costs of the Christchurch Bill, and the ascertained value of the Christchurch Act, together with various specified sums in the agreement, which would bring his total valuations up to about £70,000. Thus the arbitrators would have claims on the one hand varying from £350,000 to £470,000, against valuations by the Corporation varying between £60,000 and £70,000.

Monday, June 20.

Mr. J. E. WALLER, of Messrs. Kincaid, Waller, Manville and Dawson, consulting engineers, said he was thoroughly familiar with the Poole tramway undertaking, having been engineer to the rival scheme in 1898 referred to by Mr. Sellon. He agreed with Mr. Lloyd as to the construction to be placed upon the clause of the agreement as to the terms of purchase. With regard to the physical condition of the lines, he did not consider this was in any way excellent, not so much from the condition of the permanent way—although the points and crossings were considerably worn—but what he took exception to was the state of the road surface, and to put this into thorough repair he estimated would cost £1,400. Having got the line into good condition there must be maintenance during the coming years, and there was also the question of renewal to be taken into account, because a purchaser was entitled to see that proper precaution was being and had been taken to ensure a continuance of the profits upon which the value of the undertaking was being ascertained. In ascertaining this he had taken the capital expenditure to date, which, in the balance-sheet for 1903, was £67,787, including preliminary expenses, and deducting £10,000 for the latter he arrived at the net figure of £57,787. He then took an average life of 21 years, and upon this basis the amount to be set aside for sinking fund would be 3·48 per cent. per annum, which came, roughly, to £2,000. Mr. Sellon, in his detailed figures, gave it as his opinion that £362 per mile should be set aside annually for sinking fund. Therefore, by multiplying £362 by 3·75—the mileage of the existing lines—a figure of £1,358 was obtained, as against his own figure of £2,000, and as against Mr. Hammond's figure of £1,635. But he would like to draw attention to the fact that Mr. Sellon had taken the capital cost per mile of route at £6,646, which, multiplied by the length of the route, gave a sum much less than the capital expenditure upon the whole undertaking as shown by the last balance-sheet, and he could not see where all the difference between the two sums had gone. However, £6,646 per mile for capital cost was much too low, and if it were doubled, which would be more near the accurate figure, the sum which would have to be set aside annually on the same basis for depreciation would be £2,979. His figure of £2,000, therefore, was not excessive. His result had been obtained by taking the number of car-miles run in 1903 and applying Mr. Hammond's figure of 1·09d. per car-mile for depreciation. But already three years of the life of the undertaking had expired, and £2,000 per annum should have been set aside from the commencement, and up to the present, therefore, £6,000 for depreciation and £1,400 for road repairs would have to be deducted from the sum which was finally determined as the ascertained value of the undertaking. The fact that depreciation had been set aside by the company showed the necessity for such an item. In analysing the accounts of the company, he had abstracted the following figures:—Working expenses: 1901 4·29d. per car-mile, 1902 4·42d. and 1903 4·54d.; repairs and maintenance 1901 0·36d. per car-mile, 1902 0·99d. and 1903 1·15d.; administration and general expenses 1901 1·92d. per car-mile, 1902 1·24d., and 1903 1·13d. per car-mile. The details of these three items were what might be termed the expenses per car-mile, and the total figures for the years 1901, 1902 and 1903 were 5·57d., 6·65d. and 6 82d. respectively, showing a steady increase. Deducting these from the gross receipts he arrived at the following gross profits: 1901 6·08d. per car-mile, 1902 3·09d., and 1903 4·19d. He placed little value upon the 1902 figure, however, as the disorganisation of the traffic due to the construction of the Corporation lines was the cause of the great decrease. But he felt bound to point out that the car-miles run were substantially the same as in 1903. This suggested to him that this car mileage was the maximum which was likely to be run by the undertaking. The receipts per car-mile, in his view, were not likely to increase, because 11d. was a very high figure to obtain upon a tramway of this sort. In 1901 it 11·65d., but there were two circumstances which conduced to this result—viz., the worst three months of the year from the profit-making point of view were not run, and also the large amount of traffic due to the novelty of the tramway. With regard to the increase of traffic which the witnesses for the company had suggested, his own view was that this would not increase to any appreciable extent because Bournemouth was a well-established watering place, and the full use of the line by the visitors was probably made now. This view was corroborated by the fact that during the first week of June this year the receipts were almost identical with those of the first week in June last year. Against this it should be noted that the working expenses had been steadily increasing, as was natural. Therefore, if 7d. per car-mile were adopted as the normal working expenses, he thought it would be fair. As a matter of fact, on the evidence of the witnesses for the company they had been a little more, because electrical energy had been costing more than 1½d. per car-mile. Mr. More stated that 7d. per car-mile would be a fair estimate for working expenses assuming 1½d. for current, but inasmuch as the company had had to pay 2·18d. for energy, the actual figure should be 7·68d. per car-mile. But he was content with 7d. During 1903, the total working expenses were 6·82d. per car-mile, but the company was only paying 1⅝d. per unit for current, so that from the buyers' point of view, the current now costing 1⅛d. per unit, there was something to be added for the extra cost. He was also of the opinion that it was unfair that the company, in order to ascertain the profits for the whole year 1901 to add one-third of the profits for the nine months that were actually worked, because the accounts for the two subsequent years showed that the receipts during the first three months were less in proportion than one-third of the remainder. His whole deduction was that the Poole undertaking, as now developed, was infinitely better than any other similar tramway undertaking in the United Kingdom, and he had specially compared it with such places as Dover, Yarmouth, Southend, Southport and Birkenhead. Therefore, he had accepted 11d. as the earnings per car-mile and 7d. for working expenses, giving a profit of 4d. per car-mile. Assuming 360,000 car-miles per annum, which was a little over the distance run last year, and which really was the high-water mark, the gross profits would amount to £6,000 per annum. Deducting £2,000 for depreciation, this left a net profit of £4,000, and this he considered was the amount which it might be expected could be maintained. So much for the capital value of the existing undertaking, the total figure for which he left out for the present. Dealing with the Parkstone extension, he estimated that this would cost £20,000 to construct. The principal traffic would be through traffic, for there was very little residential traffic to be picked up, and, being through traffic, this would to a large extent be taken from the existing lines. Assuming a 13-minutes' service upon this line, however, which was that suggested at the light railway inquiry, 100,000 car-miles per annum would be run, and in order to pay working expenses £2,900 would have to be earned. Added to this, however, would be the interest on the £20,000, which at 6 per cent., the smallest price at which, in his opinion, capital for tramway purposes could be raised at the present time, would make the amount of money to be earned in order to just make the tramway pay £4,100. This took no account of depreciation. Adopting 1d. per passenger—the figure suggested by Mr. Sellon as the average receipts—984,000 passengers per annum would have to be carried, but where they were to come from he was not quite clear. There were 469 houses along the route and in proximity, and, assuming five persons per house, there would be a resident population of 2,345. Then, assuming the tramway carried this population 70 times over during the year, 164,000 passengers would be carried, leaving a large deficit. This might be counterbalanced by the increased traffic occasioned by through running, and this being so, he felt justified in allowing nothing for the Parkstone extension. With regard to the Christchurch lines, his opinion was that the route authorised to the company was absolutely the wrong one, and the Corporation would only utilise about 6 or 7 furlongs of it, as it was applying for a new route in the same district. These lines were not, therefore, of any value to the Corporation. But in order to ascertain the likely traffic upon the lines he had accepted Mr. Sellon's figures of £66,000 as the cost of construction. At 6 per cent. the interest on this would be £3,950, and adding 20 per cent. for maintenance and renewals would increase the amount to £4,750. The receipts necessary to earn this, and running 180,000 car-miles per annum would be 6·33d. per car-mile, but added to this were working expenses at 7d. per car-mile, so that the total receipts per car-mile would have to be 13·33d. in order to enable the undertaking to be worked without loss. This figure was absurd seeing that the Poole line only earned 11d. per car-mile. This was with a 15-minute service. Taking a 10-minute service 270,000 car-miles would have to be run, and with 6 per cent. interest on the capital as well as maintenance a revenue of 4·22d. per car-mile would have to made in addition to 7d. per car-mile for working expenses, a total of 11·32d. per car-mile. On the basis of an average fare of 1½d. per passenger would involve carrying 2,019,600 passengers, but his estimate of the traffic likely to be carried was 617,100 passengers per annum for business purposes, and allowing the same amount of pleasure traffic as upon the Poole line he could only arrive at a total traffic of 1,428,438 passengers. These items took in all he considered the company could claim for, and in explaining the capital value of the whole of the company's undertaking which he had arrived at, witness made one or two preliminary justifications. First of all, in ordinary times capital for such undertakings as these could not be raised at less than 6 per cent., and at the present time it would be exceedingly difficult to raise money upon these terms. Another element which he considered should be seriously taken into consideration was the future policy of railway companies. The prosperity of most tramway undertakings was due to the miserable train services, but it was common knowledge that railway companies were going in either for the electrification of their lines or for running motor cars upon their lines in order to develop the local traffic. When adopted, such improved means of locomotion would undoubtedly compete with tramways, and they were elements which must be taken into account. Therefore, upon a 16¾ years' purchase of an annual profit of £4,000 upon the 6 per cent. basis, he arrived at the figure of £66,666 as the value of the whole undertaking, but he deducted from this £6,000 for the renewal fund for three years, and £1,400 for immediate repairs, leaving the net value of the undertaking at £59,266. To this had to be added certain agreed sums, making the total sum payable to the company £67,116. In other words, the undertaking was about worth the capital that was in it. In arriving at this valuation, he had not added one-third to the nine months' balance-sheet for 1901, but worked it out in the proportion that the nine months of the two following years bore to the whole year, and on this basis the net profit for the whole year would only be £6,597. He had made no allowance for feeding effect, because, so far as the Parkstone and Poole Harbour lines were concerned, what feeding effect there might be was already there, inasmuch as the lines were so close to the existing one. The Canford Cliffs line he did not take into account, because if there was any feeding effect this would be to the advantage of the Bournemouth Corporation lines and not to the advantage of the Poole line. As to the capital value of this line, he had ignored it because it would be possible

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to mark out such lines all over the district and make a claim in respect of each of them. He differed from Mr. Sellon's view as to the percentage increase of traffic due to running powers, and, apart from the figure, Mr. Sellon had also taken credit for the whole of the increased traffic instead of only half, because the other half would go to the Bournemouth Corporation.

Mr. CRIPPS, K.C., in opening the cross-examination of Mr. Waller, said that the last remark was not accurate.

You have allowed an average life of 21 years for the whole of the undertaking?—Yes.

Do you know that Mr. Sellon gives a number of things an infinite life?—No, but I do know that Mr. Sellon's average life comes out a little higher than mine.

How much of your total valuation is free of depreciation?—£1,859. 18s.

But Mr. Sellon has given me a list of things which would not depreciate which amounts to £10,948. They include concrete and excavation, overhead work, including poles, brackets, insulators, pilot wires, feeder and section pillars, &c., and I put it to you that no depreciation ought to be allowed for these?—I cannot accept that, especially with regard to poles, although they have a long life.

Take feeder and section pillars and manholes. Would any tramway engineer, in dealing with these items, allow anything for depreciation above the sum for repairs?—There would not be a large sum.

All these items that I have given sum up to £10,948. Would any one of these be subject to depreciation?—I cannot accept that.

Beyond the allowance for ordinary repairs?—I cannot accept that, because Mr. Sellon has already given a life of 25 years to poles and now he gives them an infinite life.

After further cross-examination, Mr. Waller said the utmost he was prepared to accept as the sum which would be free from depreciation was £3,881.

Mr. CRIPPS: Mr. Sellon has put down £6,640 per mile as ample if he were renewing and depreciating a single line undertaking such as this?—I cannot find much fault with that, but my estimates are based upon the balance-sheet of 1901.

But if you were dealing with this as an ordinary engineering question, do you think Mr. Sellon has allowed sufficient for renewals and depreciation?—No, not per mile of route. Per mile of single track it might be sufficient.

But surely for a mile of single track £5,000 would be sufficient?—No.

Supposing you were renewing a track of this kind, how much would you get back in the shape of scrap?—Not much.

Have you made any allowance for that in your estimates?—You might get something.

Then I put it to you specifically that you could renew the line for £6,640 per mile of single track with passing places under these conditions?—Per mile of single track you could, but with passing places it is unreasonable to put it at that sum.

The tramway is constructed of tar macadam with the exception of the granite setts at the side?—Yes.

What is the saving in tar macadam as against setts?—About £2,500 per mile.

What would you have constructed this line for per mile with tar macadam?—About £4,000 with single line. Then the overhead equipment would be £1,200 per mile, feeders and conduits £1,000 per mile, a total of £6,200 per mile.

A considerable portion of that would not be subject to depreciation? £5,200 would be subject to depreciation, roughly speaking.

Well, if you were renewing and depreciating the line, how much would you get back under scrap, £500 per mile?—About £100.

I am told that this is too low. How many tons of rails would you get back?—622 tons.

What would the setts be worth?—Practically nothing.

Do you mean to say that if the line was properly repaired and maintained all the setts would have to be broken up?—I do under the conditions of this line.

May I take it then that the only item under the head of scrap which you would allow would be the rails, which would come to £375?—If you took £500 you would include everything.

What is your total figure per mile for the cost of renewing this line?—£7,050 without tools.

What have you allowed for cars?—£600 each.

But I am told that our cars did not cost that?—Well, Mr. Sellon in his estimates for the Parkstone line put them at £650.

With regard to the future traffic upon the Parkstone extension, have you ever previously formed an estimate of the possible traffic by multiplying the number of heads per house as you have done on this line?—No, because I have never had a case in which it was proposed to put a competing line like this.

But in connection with the Christchurch line you did the same thing. Except for the purposes of this compensation case, have you or any other tramway engineer ever made an estimate upon this basis before?—I beg your pardon, I did not make my estimate of the Christchurch traffic on the same basis as the Parkstone line.

The cross-examination was then adjourned until to-day (Friday).

London, Deptford and Greenwich Tramways.

The arbitrator (Mr. H. Graham Harris, M.Inst.C.E.) recently issued his award in connection with the purchase by the London County Council of the undertaking of the London, Deptford and Greenwich Tramways Co. The value of the lines is given at £91,363. 7s. 6d.

The company claimed £110,514. 7s. 5d., and the Council's offer was £53,329.

Bury, Rochdale and Oldham Tramways.

The arbitration proceedings in connection with the purchase of the undertaking of the Bury, Rochdale and Oldham Tramways Co. by the local authorities, in whose districts the tramways are operated, were concluded on Wednesday, when the arbitrator (Mr. H. Graham Harris, M.Inst.C.E.) reserved his award.

Mr. Fletcher Moulton, K.C., M.P., appeared for the purchasing authorities, and Mr. Hugo Young, K.C., for the company.

The following statement of value was put in during the course of the proceedings:—

	Local authorities' value.		Company's value.	
Permanent way in streets	£62,142		..£103,459	
Permanent way in depots	1,346		.. 1,360	
Land for depots.....	1,238		.. 6,810	
Buildings	14,840		.. 18,629	
Water	403		.. 3,063	
Locomotives	26,669		.. 31,921	
Accessories.....	—		.. 1,889	
Cars.....	8,200		.. 13,579	
Payments to local authorities..	—		.. 4,769	
Loops in Drake-street	—		.. 475	
Parliamentary expenses	1,000		.. 14,500	
Plant (agreed)	7,000		.. 7,000	
Consumable stores (agreed) ..	817	£123,784	.. 817	£205,401

Siemens Brothers & Co. (Ltd.) v. Patent Exploitation (Ltd.) and Another.

In the House of Lords on Tuesday (before Lord Macnaghten, presiding, Lords Davey, James of Hereford and Robertson), judgment was delivered in this case as to the validity of certain letters patent for a primary battery. The arguments were delivered in May (see *The Electrician*, May 6, p. 111).

Lord MACNAGHTEN, in moving that the appeal be dismissed, said he had come to the conclusion that the view taken by the Court of Appeal, that the patent was valid and that there had been infringement, was right and should be affirmed.

Lord DAVEY thought that for the purposes of the appeal it must be taken that appellants' battery, both in construction and materials, was substantially identical with that of respondents. The evidence on that subject was meagre, but sufficient. Whatever, therefore, was the construction of the specification, it did not affect the question of infringement, and was only material in considering the question of the validity of respondents' patent. The objection made by appellants to the validity of the patent was that the specification did not point out with sufficient clearness what the real novelty and merit of the alleged invention consisted in, and that the claim was expressed in such wide and vague words as to embrace forms of galvanic batteries which were well known and in use at the date of the letters patent. The patentee might have invented an improvement in the construction of galvanic batteries, but he had not adequately described the nature of it and had claimed a great deal that he never invented.

After setting out the elements of a galvanic battery, which were well known, his Lordship said respondents' patent was for a combination in a new manner of the well-known elements. In such a patent there was no room for the common objection that the patentee had not sufficiently distinguished the old from the new, for, as Lord Cairns pointed out in "Harrison v. Anderton Foundry Co.," the combination itself constituted the novelty and merit of the invention. It was sufficient for the validity of the patent if the combination, being the result of thought or experience, was new and produced some new result, or an old result in a more useful or beneficial way. The patent was for "An Improvement in Galvanic Batteries"; the specification was commendably short, clear and intelligible. The patentee described a cylinder of zinc or other equivalent metal forming one electrode which was lined with an exciting agent, consisting preferably of certain ingredients of a well-known description. For preparing the exciting agents, he said "the materials are mixed, forming a semi-fluid, which is poured into the cylinder around a central core temporarily inserted. The exciting agent soon sets to the condition of a semi-solid, and the temporary coil is removed." The carbon was then inserted, and the space round it was filled with a compound consisting preferably of the following ingredients: Sal ammoniac one part, chloride of zinc or other hygroscopic analogue $\frac{1}{10}$th part, and as depolarising agents pulverised peroxide of manganese eight parts with pulverised carbon 3½ parts. These were mixed with water two parts to form a semi-fluid, which was packed in round the carbon. The top of the cylinder was then sealed. The specification concludes with the following:—"The materials mentioned as electrodes and as exciting and depolarising agents and their proportions may be varied, as the important feature of the invention is the interposition between the positive and negative electrodes of two layers of exciting composition in a semi-solid or plastic slate, the one in contact with the negative electrodes having intermixed with it depolarising agents and the one in contact with the positive electrode having no such depolarising agents in its composition." The claim was for "a galvanic battery having the space between its positive and negative electrodes filled with a semi-solid or plastic exciting agent, in two layers, the one layer in contact with the negative electrode having depolarising agents intermixed therewith and the other layer in contact with the positive electrode having no such depolarising agent, substantially as set forth." It was contended by respondents that the use of peroxide of manganese or other depolarising agent in the form of powder was one of the elements of

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the combination, and a large part of the evidence and argument was taken up in the discussion of the difference between a pounded and a pulverised material. He (Lord Davey) thought it was not necessary to embark on that interesting inquiry or to say whether it was more than a question of degree. He agreed with Mr. Justice Buckley and Lord Justice Cozens-Hardy differing from Lord Justice Vaughan Williams, and presumably from Lord Justice Stirling, that the patentee had not made the use of the material in a pulverised form a necessary element in the combination which he had claimed, or, in other words, if that was his real invention he had not claimed it. He thought that it was not necessary to decide it in the present case, and that the words "substantially as set forth" would cover the use of materials analogous to or having similar chemical or electrical properties to those which he had described as preferable, and the recommendation of pulverised materials might be useful as illustrating the sort of thing he intended by the word "plastic." He did not himself construe the words "semi-solid or plastic" as alternatives, for they were not true alternatives, but he thought that the word "plastic" was meant to be synonomous with and explanatory of "semi-solid," and was used with the intention of giving some definiteness to a somewhat vague expression. The patented battery, their Lordships had been told, had achieved a great commercial success. Mr. Gill, in his evidence, stated up to the time when respondents' battery was introduced to him, the National Telephone Co. had only experimentally used dry batteries. He mentioned the Gassner and the Hellesen, which were two of the batteries relied on by appellants as anticipations. He said it was found that these batteries had not a long life compared with the patented battery. The National Telephone Co. had bought over 120,000 of respondents' batteries, and had also in recent years used appellants' battery, which they found equally efficient. It was remarkable that neither of the very eminent electricians who gave evidence could say with certainty to what particular cause the success of the patented battery was attributable. Mr. Swinburne was disposed to attribute it to the use of the depolarising agent in a pulverised form, which to him was a novel idea. It was unnecessary for their Lordships to form any opinion on that question, though if the issue were whether an alleged infringer had taken the substance of the patented invention, it would be different. The present came within the category of infringers described in Lord Cairns' judgment in "Clark v. Adie." He thought that the evidence established that respondents' combination did produce a known result in a more useful and beneficial way. The establishment of that point had a material bearing on the question of subject matter. The maintenance of the two layers, both containing an exciting agent, was the important element in the combination by which the validity of the patent must be tested. The two previous specificiations which came nearest the description of the patentee were those of Thiébaut (April 26, 1881), with an addition dated Aug. 16, 1881, and the English patent of Castle-Smith of 1889. In the amended form of Thiébaut's specification the contents of the battery were in two layers, but the outer layer was solid, and, as the patentee said, a hammer had to be used to destroy it. Castle-Smith's patent was a communication from abroad of a Dane named Hellesen. In one respect this was more complete, in that it contained an elaborate provision for the escape of the gas which was inevitably formed. The omission of such a provision, however, was not made a point of against respondents' patent, probably because every workman would know that he must make a vent-hole.

Lord Davey then dealt with the specification of the Castle-Smith battery, and said that the phlegmy or jelly depolarising substance might possibly be described as a semi-solid one, but could by no fair use of language be called plastic. It was not a question of degree but a difference of kind. Thiébaut's patent was at best a mere paper anticipation. He had no doubt that Mr. Ballantyne's ability enabled him to make a workable battery out of it, but there was no proof of a battery made in accordance with Thiébaut's directions having been sold or used. The Hellesen battery, on the contrary, was on the market, and, as he had mentioned, was compared unfavourably with respondents' battery by Mr. Gall. It was not, however, proved that the Hellesen batteries in use were made in strict accordance with Castle-Smith's specification, and appellants, although they included the prior use of the Hellesen battery in their particulars of objection, did not pursue the subject. For himself he disclaimed putting either a benevolent or malevolent interpretation on the specification. In his opinion a specification, like any other document, should be construed by the Court according to the fair meaning of the language used after being informed by evidence of the nature of the subject matter, the state of knowledge at the date of the patent and the meaning of any scientific or technical words that were found in it. In his Lordship's opinion this appeal might be summed up in a single sentence. He found that the patentee had described and claimed as his invention a galvantic battery in language which was not anticipated by and did not in terms cover or include any previous description or any battery previously known or described, and his battery was proved to have produced useful and beneficial results; and lastly, he must hold on the evidence that appellants had taken his battery in its entirety. It might be that the invention was a small one, but slight differences in those cases sometimes produced large results. He adopted the words of Sir George Jessel in "Hinks v. Safety Lighting Co.": "Where a slight alteration in a combination turns that which was practically useless before into that which is very useful and very important, judges have considered that though the invention was small, yet the result was so great as fairly to be the subject of a patent, and so far as a rough test goes I know of no better." On the evidence before their Lordships he was of opinion that the respondent's patent was a valid one, and that the appeal failed.

Lord JAMES OF HEREFORD and Lord ROBERTSON concurred.

The appeal was accordingly dismissed with costs.

Lyles v. Southend Corporation.

Mr. Justice Bigham, in the King's Bench Division on Tuesday, had before him in the form of a special case, an action to recover damages for personal injuries to plaintiff while travelling on an electric tramcar owned by defendant Corporation. On August 9, 1902, plaintiff was an outside passenger on a car returning from Leigh to Southend. The conducting rod from the top of the car to the overhead wire broke, and a part of the rod in falling struck plaintiff, severely injuring him.

Defendants denied liability, or that there was any negligence on the part of their servants, and they also pleaded that the claim was barred by reason of sec. 1 of the Public Authorities Protection Act, 1893, as the action was not brought within six months.

After arguments from Mr. English Harrison, K.C., for defendants, and Mr. S. T. Evans, K.C., for plaintiffs, his Lordship ruled that the case came under the act mentioned, and found for defendants with costs.

Spittal v. Glasgow Corporation.

In the Court of Session, Edinburgh, last week, judgment was delivered in an appeal from a judgment in an action which was brought by Mr. R. D. Spittal, carting contractor, against Glasgow Corporation for £7,000 as damages for personal injuries caused by an electric tramcar colliding with and upsetting plaintiff's trap. Plaintiff asserted that he had sustained very serious injuries. Defendants denied negligence, and pleaded sec. 1 of the Public Authorities Protection Act, 1893, as the action had not been commenced within six months, and this plea was accepted by Lord Kincairney in the original action.

Without calling upon counsel for defendant, the Court adhered to the judgment of Lord Kincairney, and gave costs to the Corporation.

National Electric Construction Co. v. Rathmines and Rathgar District Council.

Mr. Justice Gibson, in the King's Bench, Dublin, last week heard an action for damages and for rental of electrical fittings installed by plaintiffs on private consumers' premises in Rathmines and Rathgar. It appeared that defendants agreed to pay plaintiffs 1d. for each unit supplied by defendants for consumption through the fittings in question, with a minimum of 1s. per 8 c.p. lamp or equivalent. The main point at issue was that plaintiffs claimed from defendants such of these minimum charges as could in their opinion have been recovered had action been taken at the proper time. The case, which was adjourned to enable the parties to come to terms, was, we understand, settled out of court by defendants agreeing to make such payments.

Licences for Electric Cars.

Mr. Mahony gave his decision at Dublin Northern Divisional Police Court last week in a test case brought by the police against Mr. Gordon, manager of the Dublin United Tramways Co. to determine whether the obligation of taking out licences for cars owned by the Clontarf and Hill of Howth Tramway Co., which run into the city and over the Dublin United Company's lines, devolved upon the latter company. Mr. Mahony said he could come to no other conclusion than that the Dublin United Company must take licences for such cars, and he could not assent to the proposition that the Howth Company could in any way be made liable while the present agreements remained in force. He fined defendant 10s. and agreed to state a case.

Owles v. River Plate Electricity Co.

Before Mr. Justice Farwell on Tuesday a motion was made for judgment against Bright's Light and Power Co. (Ltd.) in default of defence. Defendants (the River Plate Electricity Co.) were prior mortgagees, and the action against them had been dismissed. The statement of claim alleged the issue of a debenture for £2,000 to plaintiff, charging the leasehold property of the company and all its concessions and plant, both in England and elsewhere, including the uncalled capital.

The usual mortgagee's judgment, and an order made for sale.

Lincoln Tramways Co. v. Dickinson.

At Lincoln County Court on Tuesday plaintiffs sought to recover £50 damages for breach of contract.

Mr. WALKER, for plaintiffs, said the company were desirous of appointing an engineer for the purpose of inspecting and valuing their undertaking with a view to a sale by private treaty to Lincoln Corporation. They communicated with defendant, who replied that he would visit Lincoln, make an inspection of the tramways and prepare a report for 50 guineas. It was further understood by plaintiffs that should there be an arbitration he would give evidence. About three weeks after defendant had been paid his fee for the valuation, he asked to be liberated from giving evidence before the arbitrator, alleging illness. From defendant's letter of Nov. 18 it was evident that he could have given evidence, but that he was unwilling to do so except on terms largely in excess of those arranged for. The company declined this proposal, and had to engage as substitute Mr. John Fell. Mr. Fell sent in his account and £50 had been paid. Defendant's valuation was £10,118, but the company received £10,437.

Mr. LINDLEY, for defendant, submitted there was no case to answer. The contract was in writing, and he argued that a mere promissory expression was not a contract. Under the contract there was nothing binding upon Mr. Dickinson to give evidence before the arbitrator.

His HONOUR (Sir Sherston Baker) found for plaintiffs for the amount claimed, and costs.

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ELECTRIC LIGHTING IN MARYLEBONE.

At the meeting of Marylebone (London) Borough Council last evening, the Finance committee reported as to the temporary loan of £1,300,000 required to provide payment to the Metropolitan Electric Supply Co. by June 30 of the sum necessary to complete the transfer of the company's electric lighting undertaking in the borough under the recent award and the various judgments of the High Court. The Finance committee of the London County Council had (the report states) given an assurance that the total amount of £1,415,000, which the Borough Council have power to borrow under the Marylebone Electric Lighting Bill (1904) will be available by October 20. The Borough Council were, therefore, able to go forward with the temporary loan to be repaid on or before October 20, and they have arranged with the London and Westminster Bank to advance £500,000 from June 30 to October 20, so soon as a definite resolution is passed by the Council that a mortgage of the rates will be executed, if and when demanded, in favour of the Bank in such form as the Bank may reasonably require.

With regard to the remaining £800,000 this will be borrowed (at 3½ per cent. interest) as follows:—Mr. C. W. Ford, £360,000, Mr. C. P. Wood, £200,000, Mr. F. A. Bevan, £90,000, and Mr. W. H. Hargreaves, £150,000.

The Committee recommend that the treasurer be ordered to pay, on June 30 instant, the sum due to the Metropolitan Electric Supply Co. in accordance with the judgment of the High Court of August 7, 1903, and under other orders of the Court, such payment to be made, if necessary, into Court, as a term of obtaining the completion of the purchase of the undertaking; and that on the same day, £50,000 to the High Court, in accordance with the said order of August 7, being part of the sum of £1,212,000 payable to the Metropolitan Company, by the award of the Arbitrator.

Dr. Leaf (chairman of the Finance committee), when the matter came up for discussion, explained that the committee were advised that the Council could not approve these recommendations as their bill had not received Royal Assent, which, however, was expected daily. Immediately this was received it was urgent that the resolutions should be dealt with by the Council. It was necessary, therefore, that a special meeting of the Council should be held early next week. The terms which had been arranged for the temporary loan were most favourable, and no mortgage charges would be incurred by the Council, the only expense, beyond the interest on the loan, being £400 for stamp duties. The loan of £500,000 from the London and Westminster Bank had been fixed at 3½ per cent., the same rate as for the larger amount from the other tenders, but in the former case no expense would be incurred as the Bank was advancing the money merely on a definite promise from the Council to give a mortgage of the rates if and when called upon to do so.

Mr. E. R. Debenham (chairman of the Electric Supply committee) then formally moved that the matter be postponed to a special meeting on Tuesday next, 28th inst., at 6 p.m.

After discussion this was agreed to.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Council of the County Borough of West Ham require a lecturer in electrical engineering for the Municipal Technical Institute. Commencing salary £200 per annum. Applications to the principal of the Institute, Romford-road, West Ham, before noon July 7. See advertisement.

An assistant demonstrator in physics and chemistry departments (at a salary of £150 per annum) and an assistant mathematics lecturer for two evenings per week (at £12 per session per evening) are required at the Northern Polytechnic Institute, Holloway, London, N. Applications to the clerk to the Governors, Mr. W. M. Macbeth, by 28th inst. See also advertisement.

The Pearson Fire Alarm (Ltd.) require a district manager for an important provincial centre. Applications to the manager, 62, King William-street, London, E.C. See advertisement.

The Governing Body of the Battersea Polytechnic require for next session an assistant for lecture classes in elementary electricity and magnetism and elementary physics and laboratory classes in physics and electrical engineering (day and evening). Salary £130. Applications to the secretary. See also advertisement.

There are vacancies for five switchboard attendants with previous experience in three-wire continuous-current system and accumulators for Londonderry electric light and power station; also for one fireman and for a smart man capable of being trained to duties of dynamo attendant and lamp-switch man. Applications to the borough electrical engineer (Mr. R. V. Macrory) by July 16. See advertisement.

The Council of the University of Birmingham, invite applications for a chair of electrical engineering. Stipend £1,000 per annum, with liberty to undertake certain consulting work. Particulars from the secretary (Mr. Geo. H. Morley), to whom applications by Aug. 1.

A lecturer in mathematics is required at Birmingham Municipal Technical School from Sept. 1 next. Commencing salary, £175 per annum. Applications by June 30. Particulars from the secretary (Mr. George Mellor), Suffolk-street, Birmingham.

Finchley Local committee for Technical Instruction require a teacher for electric lighting and wiring for evening classes at Christ's College, Finchley, during 1904-5 session. Applications to Mr. John Cogdale, Bowes-road Council School, New Southgate.

Enfield Committee for Technical Instruction require a teacher for an electric lighting class to be held at Ponder's End on Wednesday evenings during session 1904-5. Applications to Mr. E. K. Andrews, 23, Essex-road, Enfield.

The Governors of the Northern Polytechnic Institute, Holloway, London, N., invite applications for the post of assistant demonstrator in physics and chemistry departments (full time), at a salary of £150 per annum, and for an assistant mathematics lecturer for two evenings per week, salary £12 per session. Applications to the clerk to the Governors (Mr. W. M. Macbeth) by June 28.

Salford Education committee require an assistant lecturer and a laboratory assistant in the physics department. Applications by July 7.

Portsmouth Education committee require an assistant lecturer for mathematics, mechanics and physics, and a workshop instructor in mechanical engineering. Applications to secretary, Municipal Technical Institute, by July 4.

A lecturer in physics (for London University pass and honours class) is required for the East London Technical College in September. Three evenings a week. Salary £120. Applications to Director of Studies.

Mr. R. C. Bullough, of Manchester, has been appointed manager of Colchester borough tramways at £300 per annum.

Mr. B. Croft has been appointed electrical distributing assistant at Belfast Corporation electricity works.

Mr. John H. Mackail, A.M.I.E.E., mains assistant to the Charing Cross and Strand Electricity Supply Corporation, has been appointed electrical engineer to the Municipal Commissioners of Singapore.

Mr. F. Taylor, of Bury, has been appointed assistant tramways engineer at Bolton at £150 per annum, rising to £200.

Aberdeen.—The Deeside section of the Aberdeen Suburban Tramways Co.'s system was officially inspected on Tuesday and was opened for traffic yesterday (Thursday).

A report has been prepared by the city electrical engineer (Mr. J. Alex. Bell) upon the cost of the electric lighting of the various tramway routes, and will be considered by the Lighting and Fires committee at their next meeting.

Aston.—The official inspection of the first complete length of tramways from the boundary of the city of Birmingham to Aston Cross took place on Wednesday.

Alleged False Pretences.—Last week the Blackpool Bench committed for trial Arthur Britch on charges of obtaining goods by false pretences from Messrs. W. T. Glover & Co. and the Liverpool Electric Cable Co. Accused admitted that during the past 18 months he had obtained goods to the value of £54. 9s. 6d. from various electrical firms, and in obtaining such goods had used the names of a number of firms well known in the electrical industry.

Anglo-Belgian Telephone.—Manchester, Liverpool, Bradford, Hull, Leeds and Wakefield will be in telephonic communication with the chief exchange at Brussels on and after 1st prox. The conditions set out in our issue of March 25 (p. 891) for telephoning between other British and Continental exchanges apply to this extension.

Auckland (N.Z.)—The local electric tramway company are purchasing 12 addiiional cars and are increasing the capacity of their generating plant from 1,500 H.P. to 2,500 H.P. The Public Works Department have refused the application of the company for permission to increase the width of their cars from 7ft. 6in. to 8ft.

Bath.—On the recommendation of the Electric Lighting committee, the Council at the last meeting increased the salary of the city electrical engineer (Mr. Francis Teague) to £550 for one year, from April 1 last. In the event of the undertaking continuing to make satisfactory progress, a further increase to £600 per annum is to be made. Several members referred in appreciative terms to the services of Mr. Teague.

Bermondsey (London).—The Provident Clerks' and General Accident Insurance Co. have raised the premium on insurances under the Workmen's Compensation Act to 14s. 6d. per cent., and the Council have renewed the policy at this rate.

Birmingham.—The official inspection of the electric tramway route from Peeble Mill-road to Cotteridge took place on Wednesday. The line has been leased to the City of Birmingham Tramways Co.

Blackburn.—The report of the borough electrical engineer and tramways manager (Mr. A. S. Giles) on the past year's working of the Corporation electric tramways shows that the traffic receipts

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were £43,374. 6s. 7d., parcels £448. 5s. 7d., rents £266. 12s., and income from advertising on cars £593. 6s. 10d.

Total expenses were £29,369. 8s. 7d., leaving gross profit £15,313. 2s. 5d. towards meeting interest (£8,818. 8s. 11d.) and sinking fund instalment (£11,633. 1s. 4d.), a deficit of £5,138. 7s. 10d. 7,742,692 passengers were carried and 951,484 car-miles run, the income per car-mile being 10·89d., against 11·89d. in the previous year. Working expenses were 7·4d. per car-mile, against 7·45d., and Mr. Giles thinks the expenditure per car-mile for current can be still further reduced. With the view of economising the use of current per car a system of bonuses to motormen has been introduced. The Corporation now own over 23¾ miles of tramways and 48 passenger cars.

California (U.S.A.)—In a report on the trade of California for 1903, Mr. Bennett, H.M. Consul-General at San Francisco, refers to the efforts which have been made by the Standard Oil Co. in trying to adapt oil-using plant in the generation of electric current with a view to iron smelting by electric process. Mr. Bennett says these efforts have been unsuccessful, and that the general belief is that if the ore of the district is ever electrically smelted on the spot it will most probably be by current generated by water-power from the Sierras.

The Los Angeles and Salt Lake Electric Railway is being rapidly constructed from both ends, less than 200 miles being now unfinished, and this is expected to be completed early in 1905. The line will be 800 miles long, compared with 1,300 miles of track over heavy grades by the present steam line. The new electric railway is expected to be very popular, and to prove a boon to the district.

Change of Name of Cable Steamer.—The Eastern Extension Australasia and China Telegraph Co. give notice of their intention to change the name of the ss. "Louise" (which has been purchased by the company as an addition to their fleet of cable-laying and repairing vessels) to that of the "Magnet." Any objections to this change of name must be sent in to the Marine Department, Board of Trade, by June 27. See also advertisement.

Cheshunt.—The Council have sealed the deed for the transfer of their electric lighting order to the North Metropolitan Electric Supply Co.

Companies Struck off Register.—The following have been removed from the register of joint-stock companies:—

Railways Electric Supply Syndicate.
Round's Accumulator Co.

The following are to be struck off in three months unless cause is shown to the contrary:—

Gramme's Magneto-Electric Co.
Madras Electric Tramways Co.

Coventry.—In the annual report of the borough electrical engineer and manager of the Corporation electricity works (Mr. Joseph A. Jeckell) it is stated that the profit for the year ended March 31 was £775, against a deficit of £189 in the previous year.

The number of units sold for private lighting was 460,987 at an average of 3·43d. per unit, and for motive power 396,255 units at an average of 1·32d. The gross profit for the year was 5·62 per cent. Total revenue was £10,844, and total cost of generation £4,450, or 41 per cent. of revenue. During the year 87 new consumers were connected, representing 4,871 8 c.p. lamps and 309 H.P. of motors. 6½ miles of mains, besides 4¾ miles of spare pipes, were laid. The equivalent of 8 c.p. lamps connected at the end of the year, including motors, was 63,746, compared with 39,605 at the end of 1902. The works cost has been reduced from 1·513d. to 1·159d. per unit, and is (Mr. Jeckell claims) the lowest cost of any station in the United Kingdom having a similar output, except two stations having a traction load. Mr. Jeckell advises that this year's surplus may be devoted to forming the nucleus of a reserve fund.

The accounts were approved by the Corporation on Tuesday.

Croydon.—The Corporation have decided to apply for a provisional electric lighting order for Purley and Sanderstead. The Croydon, South Norwood and Thornton Heath baths are to be wired for the electric light.

Customs Charges.—The French Customs department notifies that electrical measuring instruments (voltmeters, ammeters, wattmeters and ohmmeters), which have hitherto been classed under No. 634 of the Tariff, are henceforth dutiable (under No. 536) as electrical accessories.

Derby Tramways.—In our article on the Derby electricity works and tramways, concluded in our last issue, it should have been mentioned that there was a considerable amount of special work in connection with the track, and that Messrs. Askham Bros. and Wilson, Sheffield, supplied this as sub-contractors to Messrs. J. G. White & Co.

Dundee.—The total income of the municipal tramways for the past year was £44,437. 3s. 5d., an increase of £2,431. 18s. 5d. compared with previous year.

Working expenses were £28,420. 17s. 11d., leaving gross profit of £16,016. 5s. 6d. 11,420,985 passengers were carried, an increase of 781,058; while the car-miles run were 942,969, increase 34,290. £6,748. 5s. 7d. was expended on capital account during the year, the total now being £263,381. 16s.

Dock and Harbour Lighting.—The Mersey Docks and Harbour Board, who have found the small electrical installations put down to be very costly, are considering an expenditure of £1,150 upon a generating station, or whether current shall be taken from the Corporation mains.

East Ham.—A special allowance of 2½ per cent. is offered to electricity consumers who pay their accounts within 14 days of demand.

Egypt.—Suez will be lighted electrically by the end of August.

The Nazleh waterfall, which will give 800 H.P., is to be utilised by the municipality for generating electrical energy for lighting Medinet-el-Fayoum.

Electric Pumping.—Mr. Hawksley, who is to report upon a new water supply scheme for Watford District Council, is to deal also with the question of electric pumping, and the electrical engineer (Mr. Colebrook) has been instructed to obtain particulars from Continental waterworks where electric pumping has been adopted.

Electric Railway under the Elbe.—Hamburg Corporation have approved a project for an electric railway unper the Elbe.

Electricity in Mining.—Electric driving is to be adopted at the new mill of the Rossland Power Co. at Trail, British Columbia. The estimated cost of the electricity generating plant is about $150,000, and there will be about 500 H.P. in motors.

Six electric motors for working pumps, rock breakers, agitators, &c., and also one motor for the roasting plant, have been installed at the Ivanhoe Co.'s mines, Kalgoorlie.

Electricity for Steamships.—The Midland Railway Co.'s ss. "Manxman," which was launched last week from Vickers, Sons and Maxim's yard, and is intended to ply between Heysham and the Isle of Man and Ireland, is provided with steering gear capable of being operated by steam, electricity or hand, and the steam and electric motors are controlled by the electric telemotor invented by the Hon. C. Brougham. De Laval turbines are to be installed for driving dynamos to supply electricity for lighting and power. In the "Londonderry," one of the three other new vessels recently built for service on the same line, the dynamos are driven by Parsons turbines.

"Electrical Spectacles."—At Scarborough on Friday, Morris Myerson, optician, and Jacob Lawrence Levi, draper's assistant, were committed for trial on a charge of obtaining £9 by false pretences from Thomas Blackwell, retired tailor. It appeared that Levi told Blackwell that he required a pair of gold glasses of special character, costing ten guineas, which would cure him of an eye affection in three months. He said the lenses were charged with electricity!

Electrically-operated Swing Bridge.—The 300-ton electrically-operated swing bridge, over which the transatlantic boat trains are to run at Dover, and which has been constructed by S. Pearson & Son in 18 weeks, is now completed.

Exeter.—The Electric Lighting committee recommend the Council to accept the offer of the Law Accident Insurance Co. to insure the Council's liability under the Workmen's Compensation Act, 1897, the Employers' Liability Act, 1880, Lord Campbell's Act, 1846, and at Common Law, in respect of their employes at the new electricity works, at 7s. 6d. per cent. on the total wages paid per annum.

Fremantle (W. Australia).—Messrs. Noyes Bros. are to equip the Fremantle and East Fremantle electricity works and tramways at an estimated cost of £100,000. The local authorities have arranged to raise a loan of about £80,000.

Glasgow.—For the past year the total revenue of the municipal electric tramways was £724,851, and the expenditure £356,676 (£20,293 for power, £197,362 for traffic, £71,526 for general, and £67,495 for repairs). After providing £139,644 for renewals and depreciation, and paying interest (£59,308), sinking fund (£45,553), rent of Govan lines (£5,068), parliamentary expenses (£12,865), and devoting £25,000 to the Common Good, there was a balance of £80,737, out of which £62,000 is to be applied to special depreciation, and the balance carried to reserve.

The salary of Mr. W. F. Calderwood, chief draughtsman in the electricity department, has been increased to £250 per annum.

Gloucester.—For the year ended March 31 the total revenue of the electricity department was £6,370. 5s. 2d., including £4,839. 6s. 11d. from private consumers and £1,246. 3s. 3d. for public lighting.

Generation expenses came to £1,559. 12s. 5d.; repairs and maintenance of buildings and plant, mains and meters and public lamps (£679. 14s. 1d.), rates and taxes (£259. 15s. 4d.), and management expenses, &c., made the total £3,199. 6s. 3d., leaving gross profit £3,170. 18s. 11d. Interest on loans absorbed £1,751. 1s. 7d., bank interest £396. 14s. 7d., and sinking fund instalments £1,503. 0s. 4d. After taking into account the adverse balance of £1,378. 16s. 3d. from previous year, the deficit to date is £1,858. 13s. 10d. 431,993 units were generated, of which private consumers took 322,440. The total maximum supply demanded was 358kw. Total capital expenditure is £67,275. 9s. 6d., an increase of £8,114. 17s. 9d. for the year.

Great Northern and City Railway.—The station at Highbury, which, it is expected, will largely increase the passenger traffic on this railway, is to be opened on Monday next.

Hackney (London).—Mains extensions, estimated to cost £440, have been authorised.

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Hamburg-Berlin Railway.—A company recently formed is, it is stated, endeavouring to obtain a concession for constructing an electric railway between Hamburg and Berlin, the estimated cost being £7,500,000. The distance between the two cities is about 180 miles, and the object of the promoters is to create a service which will complete the journey in 80 minutes, with a 10 minutes' service during certain hours. A triple track is to be laid, one as a reserve, and the line has to pass either above or beneath all other railways, and roads, canals, &c., level crossings being entirely out of the question.

Hamilton (N.B.).—Sanction to a further loan of £10,000 for electricity supply has been received by the Council.

Hindley.—The Electricity committee have under consideration communications from Mr. F. J. Warden-Stevens, the Lancashire Electric Power Co., the Southern District Electricity Corp. and the South Lancashire Tramways Co. in regard to the supply of electricity.

Hornsey.—The first year's working of the electricity undertaking has resulted in a gross profit of £3,105. 12s.), and a net deficiency (after payment of interest and sinking fund charges) of £1,812. 15s.

The total cost per unit sold was 1·95d. There were in March 445 private consumers, with the equivalent of 26,168 8 c.p. lamps connected, compared with 126 and 9,145 respectively at March last year. The borough electrical engineer (Mr. N. Staniland) states in his report that the cost of generation is lower than in any of the London districts, except Hackney, Stepney and St. Pancras, each of which has a much larger output than Hornsey.

Hospital Lighting.—The isolation hospital at Watford is to be lighted electrically, current being taken from the Council's mains.

The new Glasgow Dental Hospital is provided with independent plant for the generation of electrical energy for lighting and other purposes. In the large hall (which has an area of 1,921 sq. ft.) there is a special design of electric light pendant before each operating chair.

The new sanatorium built at Camberley by the executive of Brompton (London) Hospital for Consumption, and which is to be opened to-morrow (Saturday) by the Prince and Princess of Wales, has an independent electric lighting installation.

Hove.—Underground mains for the electric lighting of Aldrington will shortly be laid, current being supplied in bulk by Brighton Corporation. Hove Council have instructed their consulting engineers (Messrs. Handcock and Dykes) to prepare the specification forthwith.

Ilford.—In the annual report of the electric lighting department it is stated that £10,270 was received from consumers for private lighting, £5,114 for public lighting, £583 for arc lamps, £260 for current supplied through slot meters, and £3,521 from tramways. The total income was £20,443 and the expenditure £10,987. The gross profit was £9,355. 12s. 8½d., the net profit £2,876.

During the past year the tramways department carried 5,274,025 passengers. The income was £23,217. 17s. 9d. and the net profit £4,570. 17s. 9d.

It has been decided to give an increase of ¼d. per hour to those who have been employed on the tramways 12 months, and a bonus of 10s. every three months to motormen and conductors free from accidents, bringing up the wages of the motormen to a maximum of 7d. and of the conductors to 6½d. per hour.

Islington (London).—The agreement between the Council and the contractors for the Highbury arc lighting has been cancelled, and a contract entered into with Crompton & Co. for the supply of 78 arc lamps.

The Lighting committee recommended at the Council meeting last week that the following additional appointments be made:—One shift engineer at £2 per week, one mains engineer at £2. 5s. per week, one jointer at 9½d. per hour, £2. 2s. 9d. per week, two bricklayers at 10½d. per hour, £4. 5s. 4d. per week, one rectifier attendant at 7½d. per hour, £1. 13s. 9d. per week, one stoker at 7½d. per hour, £1. 15s. per week, one metal fixer at 8½d. per hour, £1. 18s. 3d. per week, five labourers at 7d. per hour, £7. 17s. 6d. per week. Also that alterations should be made in the grades and duties of some of the staff by the institution of leading hands as follows:—One leading driver at 9d. per hour instead of 8½d., three leading stokers at 8½d. per hour instead of 7½d., one boiler cleaner at 7½d. per hour instead of 7d., one coal shunter at 7½d. per hour instead of 7d. And recommended that in future shift men be given 10 days' holiday in the summer in addition to Christmas Day, Good Friday and the four Bank Holidays. The maximum salary of shift engineers and mains engineers is at present £2. 10s. per week. Having regard to the qualifications which men holding these positions must have, and to the maximum salaries paid in other works for men occupying similar posts, the committee considered the maximum should be raised to £3 per week.

These recommendations were approved by 37 votes to 19.

Italy.—Concessions have been granted by the municipal authorities of Turin and Brescia (Italy) for the construction, equipment and working of electric tramways in these cities.

Light Railway.—The Guildford Light Railways Order has been submitted to the Board of Trade for confirmation. Objections by July 9.

Limerick.—The tramway project will soon assume definite shape.

Lisburn.—Although the District Council have discontinued negotiations with a company for electricity supply, Belfast Corporation are to be asked to obtain powers for supplying Lisburn with gas and electricity.

London County Council.—At Tuesday's meeting it was agreed to loan £28,589 to Bermondsey for electric lighting and dust destruction, at £3. 15s. per cent.

Tramways.—The Highways committee reported (in connection with the arrangements entered into with the South London Electric Supply Corporation for the temporary supply of electric power) that current was now being supplied from the Loughborough Junction temporary generating station through low-tension cables to the sub-stations at the Elephant and Castle, Brixton and Clapham, for the working of the Tooting, &c., trams. It was reported, however, that the load on the cables feeding the Clapham sub-station had proved to be in excess of that originally anticipated, with the result that at times there was a serious waste of energy. They, therefore, recommended that additional cables (to cost about £3,500) should be laid between the Loughborough station and the sub-station at Clapham. This would result in a probable saving of £1,300 a year, and would improve the running of the cars. The recommendation was agreed to, and the committee was authorised to enter into arrangements with the British Insulated and Helsby Cables (Ltd.) for the supply of the cables.

Rolling Stock Superintendent.—It was agreed to advertise for a rolling stock superintendent at £400 a year, to supervise the construction, maintenance and repair of the electrical rolling stock on the Council's tramways.

London County Council Tramways.—The remainder of the route from Kennington to Streatham was opened for traffic on Sunday last. On the same day electric cars were run for the first time along Newington Causeway, between the Elephant and Castle and St. George's Church. An experimental night service will be commenced on the Streatham route on Monday next.

Loughborough.—Sanction to a loan of £5,000 for electricity supply has been obtained by the Council.

Louth.—Application has been made by the Corporation for a loan of £17,000 for municipal electric lighting works. The consulting engineers (Messrs. Handcock and Dykes) have been instructed to prepare the necessary plans.

Lowestoft.—The flat rate of 5½d. per unit for current for private lighting comes into operation on 1st prox.

The estimates of receipts and expenditure of the electricity department for the half-year ending December next put receipts at £5,649, and expenditure at £6,002. It is anticipated that a credit of £273 on last estimate will make the account balance within £100.

Manchester.—The annual report of the Electricity committee for the year ended March 31 states that the capital expended during the year was £396,805, making the total £2,110,432. The total borrowing powers stand at £2,246,121, but additional powers are now being sought to the extent of £135,000, principally for extensions of mains.

Two 750kw. Parsons-Siemens turbo-generators are being installed at Dickinson-street station in place of certain belt-driven sets of smaller size, and it is expected that both sets will be erected by Nov. 30. The plant required in connection with Dr. Kennedy's installation of 15,000 H.P. at the Stuart-street station, and the equipment of the various sub-stations has been completed for some months, all the steam plant and electrical apparatus having been run on load at various times under ordinary working conditions. Satisfactory tests as to the efficiency of the plant have been carried out. The contractors for the additional 12,000 H.P. are proceeding with the erection of the machinery and plant under Mr. Metzger's supervision; satisfactory progress is being made with the extension, and it is expected that the whole will be ready by the end of Jan. 1905.

The total output of electricity from the works during the year was 38,610,922 units, compared with 22,198,241 in the previous year, an increase of 73·93 per cent. 31,597,253 units were sold for lighting, power, &c. The total mileage of mains laid is 284 miles 1,427yds. The number of units supplied for public lighting last year was 41,553. The net profit of the undertaking was £6,808. 12s. 7d.

Metropolitan Electric Tramways.—The electrification of the lines belonging to the Metropolitan Electric Tramways (Ltd.) is approaching completion, and it is expected that the Board of Trade inspection will take place at the end of the month, and a service of electric cars will be operated immediately thereafter.

Mexborough.—The District Council have applied for sanction to a further loan of £5,500 for the extension of mains, &c.

Municipal Telephony.—Ald. Carden, referring at last week's meeting of Brighton Council to the deficit of £1,800 on the first year's working of the municipal telephone department, said the revenue this year would cover interest and sinking fund charges. The assistant telephone manager (Mr. Gardner) was granted an increase of salary from £130 to £140, with annual £10 increments to a maximum of £200. The Council also decided to pay any member of the telephone staff (except the manager and assistant manager) a commission of 2s. for each £5. 10s. order introduced. There are 1,200 lines now connected.

Norwich.—On the recommendation of the Electricity committee the Corporation have authorised the city electrical engineer (Mr. F. M. Long) to visit St. Louis Exhibition, and he is to be allowed a sum not exceeding £80 for expenses.

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Obituary.—We regret to learn that Mr. Francis J. Tillstone, who has been town clerk of Brighton since 1881, died suddenly on Thursday evening last. Mr. Tillstone was in his 69th year and had been in the service of the Corporation nearly 49 years. He took an active part in the promotion and carrying out of the electric lighting and electric tramway schemes. He died "in harness," having attended a Council meeting within a few hours of his painfully sudden death.

Penang (Malay States).—Georgetown Municipality have acquired the Prince of Wales Island tramways, and are borrowing £80,000 for converting the lines to electric traction.

Perth (W. Australia).—A draft agreement between Perth Electric Tramways and the Council for a revision of the company's concession is under consideration. The company would in future pay 3 per cent. per annum on their gross earnings in lieu of other municipal rates and taxes, and the Council would have the right to acquire the undertaking in 30 or 35 years. The company obtain a preferential right to supply electricity for light and power.

Poplar (London).—The Electricity committee have decided to expend £388 in laying cables and erecting lamp standards and arc lamps for further public electric lighting.

Portsmouth.—The report of the engineer and manager of the Corporation electricity department (Mr. W. S. Foale) states that during the year ended March 31 last the following additions were made to the service: The equivalent of 12,926 16 c.p. lamps, 400 additional consumers, and an addition to income of £5,651. This compares with 7,000 lamps, 300 consumers and £2,391 increased income in the previous year. The total units generated were 3,118,750, costing 0·8d. per unit, and 2,407,037 units were sold realising 1·06d. per unit, compared with 0·97d. and 1·2d. respectively for the previous year. The re-assessment of the electricity undertaking has increased the rates by £350. The total number of consumers was 2,700, and the revenue earned from meter hire £720, compared with £1,148 last year. The sale of current for power had considerably increased (from 50,865 to 79,313 units), the total horse-power in motors connected was 285 and the number of motors 131, against 160 and 102. The increase in expenditure was £1,747. Interest and sinking fund had increased by £2,682, due to expenditure on new works.

Presentations.—Mr. W. Frisby, chief assistant engineer at Colchester, was recently presented with a silver tea service as a wedding present. The gift was subscribed for by the staff and was presented by Mr. A. R. Sillar, borough electrical engineer.

The National Telephone Co.'s staff at Canterbury have presented a gold chain to Mr. E. E. Stockens, late district manager, who has been transferred to Aberdeen.

The employés of the National Electric Construction Co. have made a presentation to Mr. Allen R. Connal, district manager at Wednesbury, on the occasion of his marriage.

Provisional Order Transfer.—Notice is given of the intention of Gorton District Council to transfer their electric supply order, 1899, to Manchester Corporation, the District Council reserving the right to purchase at the end of 21 years or any subsequent five years. The price for current in Gorton is to be the same as in Manchester.

Redditch.—An offer by Mr. Coleman (on behalf of a syndicate) to take over the Council's electricity undertaking has been declined. Steam is to be adopted in place of gas-driven plant.

Rhyndwyclydach (Glam.)—The Parish Council have applied for permission to adopt the Lighting Act to enable them to light Clydach and Trebanos electrically.

Royal Agricultural Society's Show.—The annual show of this Society at Park Royal, Willesden, opened on Tuesday and remains open until to-morrow (Saturday) evening:—

In the implement section there is a good show of engines and small power plants of all kinds. Messrs. Crossley Bros. have a large stand showing several sizes of their well-known gas engines doing various classes of work. At this firm's stand there is a combined engine and dynamo set specially designed for country house lighting. The lighting of the stand by incandescent and arc lamps is being done by this machine. Messrs. Ruston, Proctor & Co. show one of their latest pattern oil engines, designed to consume crude or refined oil, driving an electric lighting plant. Messrs. Babcock and Wilcox show a model water-tube boiler fitted with patent steam superheater, also models of the well-known chain grate, Guttman's patent water softener and heater, turbine tube cleaners, steam piping, boiler parts, &c. Other leading firms who exhibit prominently at these annual shows are Messrs. Ransomes, Sims and Jefferies, Ipswich; Newton's (Ltd.), Taunton (Mawdsley patent direct-current dynamos and motors); Richard Garrett & Sons, Leiston; Blackstone & Co., Stamford, and others. Messrs. W. H. Willcox & Co., Southwark-street, London, make their usual effective display of engineers' tools, lubricating oils, engine packings, oil filters, belting and sundries. Messrs. Merryweather & Sons, of Greenwich-road, London, S.E., were appointed to supply the fire preventive machinery and apparatus for the whole of the extensive range of show buildings, &c.

Ship Lighting.—H.M.S. "Buzzard," the gunboat which has just been rigged as a sloop and anchored in the Thames off the Victoria Embankment, at Blackfriars, London, for the use of the Royal Volunteer Naval Reserve, is to be lighted by the Charing Cross and Strand Electricity Supply Corp., current being supplied by means of a sub-aqueous cable. There is no space available on board the vessel for generating plant. Even the propelling engines have been removed to give added space for drill and athletics.

St. Pancras (London).—At the Council meeting on Wednesday the electric lighting accounts for the year ended March 31 were submitted.

The capital expenditure during the year was £38,677, bringing the total to £460,368. In the following details the figures for the preceding year are in parenthesis. The total revenue was £75,774 (£68,373), including £63,143 (£55,939) from private consumers. For public lighting and maintenance of lamps £11,367 (£11,183) were received. Deducting expenses, there was a net profit of £20,583 (£16,818). Interest required £13,381 and sinking fund instalments £6,122. The Electricity committee propose to deal with the surplus, together with £530 from 1903, as follows:—£2,551 to writing down capital, £16,000 to be added to reserve and £2,319 to be carried forward.

The accounts were adopted.

The borough treasurer and accountant reported that £709 had been paid from the electricity account last year for income tax, and suggested that, in future, in order to save that payment, either the surplus net profit made each year (after providing for depreciation on mains, machinery and plant, which approximately was £5,000 per annum, and should be taken from profits yearly to reserve), should be transferred in payment of general interest, or the price of current to consumers should be reduced or adjusted. If either of these courses was carried out very little need be paid in future for income tax.

This report was adopted without discussion.

Shoreditch (London).—The Electricity committee are organising an electrical exhibition, to be held at Hoxton Baths in October.

South Africa.—Queenstown (Cape Colony) Municipality have in contemplation the establishment of a comprehensive telephone service for the city.

The Cape Town municipal system of electric tramways is about to be largely extended, and the City Council are making large purchases of permanent way and overhead equipment material for this purpose.

The "African Review" states that no contractor can be found to construct tramways in Bulawayo, and that, therefore, the Town Council are discussing the advisability of establishing a municipally-controlled system.

Kalk Bay Municipality has been empowered to contract a loan for the provision of electricity supply to the town.

South Shields.—The annual report of the chief engineer of the Corporation electricity works (Mr. J. H. Cawthra) for the year ended March 31 states that the total capital expenditure was £149,356. 16s. 8d., an increase of £3,541. 16s. 10d. for the year.

The gross revenue was £17,165. 19s. 2d., and the working expenditure £6,601. 0s. 7d., leaving gross profit £10,564. 18s. 7d. After paying interest (£4,869. 9s. 5d.) and sinking fund instalment (£4,070. 1s. 9d.) the balance profit was £1,625. 7s. 5d., less £21. 10s. 9d. loss on Holborn Quay. The units sold were 1,299,289, against 1,148,965 in previous year, an increase of 13 per cent. The equivalent of 53,837 8 c.p. lamps was connected, against 47,674 in 1903, consumers having increased from 906 to 1,010. The maximum load occurred on Dec. 31, when the load was 909kw. The average price obtained for current supplied to private consumers was 3·08d. per unit, and for street lighting 1·3d. per unit. The total cost of generation and distribution came to 0·65d. per unit, a decrease of 0·11d., and the total works costs 1·1d. per unit, against 1·15d. in the previous year. Mr. Cawthra recommends the Council to increase the reserve fund, which at present is £2,415, or 1·8 per cent. on capital outlay on plant.

Stirling.—In his annual report, the burgh electrical engineer (Mr. A. C. Hanson) states that the number of units of electrical energy generated during the year ended May 15 was 228,790, against 194,076 in the previous year. Instead of a deficit of £37 as estimated, there is a net profit of £80.

Stoke Newington (London).—At the meeting of the Council on Tuesday the Electric Lighting committee submitted an interesting report on the proposed electricity scheme:—

The report briefly recites the history of electric lighting in Stoke Newington, and refers to the arrangement by which current is taken in bulk from the adjoining borough of Hackney. The introduction of electric lighting in this way into one part of the borough has (the report continues) created a demand for it in other parts, and the committee have considered the best way of meeting the demand with the least possible expense and risk to the ratepayers. The committee deemed it best, if practicable, to arrange to take supply from an outside source at an agreed price, and entered into negotiations with the boroughs of Hackney and Islington and with other duly authorised generators of electric energy. The most suitable offer came from the North Metropolitan Electric Power Supply Co., which is to supply electricity to the tramways of the Middlesex County Council in this district. The company proposes to deliver in bulk to the Council at a high voltage, leaving the Council to transform the current down and distribute it within the borough. Under the terms of a draft agreement with the company, the Council will take

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all the electrical energy it may require (except that taken from Hackney and such as the Council may generate by means of any refuse destructor it may erect or acquire during the continuance of the agreement). The price to be paid for any quantity in any three months not exceeding 100 hours of the maximum demand is to be at 3½d. per unit, and for any quantity in any one quarter in excess at 1d. per unit. At these rates it is estimated the average cost to the Council will be 1·62d. per unit delivered in bulk at high voltage. After the expiration of seven years the Council may require these rates to be revised, and subsequently the rates are to be subject to periodical revision at the instance of either party. At the end of 12 years, or of any subsequent period of seven years, the Council, by a year's notice, may determine the agreement. The existing agreement with Hackney Borough Council is to be determined as soon as may be after the new supply has commenced.

The committee's proposal is to lay the mains in certain principal thoroughfares where a canvass has been made and support has been promised. The capital expenditure necessary for the whole of this work, including the purchase of land for and the erection and equipment of a transforming station and storage batteries, providing and laying cables and house services, supplying and fixing meters, engineering expenses and other necessary outlay is estimated at £33,300, inclusive of £2,105 already expended. The estimated annual outlay, apart from the cost of energy and including interest and sinking fund at 7 per cent. borrowed for 25 years (£2,330), salaries and wages (£360), and maintenance and depreciation (£770) would be £3,460.

The committee is advised that the transforming plant can be so worked, with the aid of proper storage batteries, that three-fourths at least of the energy supplied can be bought at the low rate of 1d. per unit, while not more than one-fourth would be chargeable at the higher rate of 3½d. The average price paid for the bulk supply would thus not exceed 1·62d. per unit delivered to the Council. The transformation would involve a loss of 25 per cent. of the energy supplied, so that the cost to the Council per unit available for sale to consumers would be 2·16d. in addition to the cost of transforming and distributing.

From sale of current at 5d. per unit the Council could estimate a gross profit of 2·84d. per unit, necessitating, to meet the above charge, the sale of 292,395 units per annum. The committee do not anticipate this quantity would be sold during the early years, but that the undertaking will involve a charge on the general rate of about 1d. in the £ with the selling price fixed at 5d. per unit. On the other hand, the committee are advised that, by the end of the fourth year after commencing supply, a load of 20,000 8 c.p. lamps may be reasonably expected, making, with the existing load, 27,000 8 c.p. lamps, consuming about 400,000 units per annum, which would justify a reduction of the price to consumers to 4½d. per unit, after repayment of any sum which might have fallen on the rates. The committee's recommendation is that, in the first instance, mains be laid at an estimated cost of £22,560, involving an annual outlay of £2,600. To meet this expenditure the sale of 220,000 units annually would be necessary, and towards this there is already about 80,000 units consumed. There is a surplus of income on the year's working, after payment of instalment and interest on loans and making provision of £143. 11s. 8d. for depreciation, of £175. 14s. 3d.

The committee therefore advise the adoption of the agreement with the North Metropolitan Company, and the acceptance of the scheme outlined in the report.

Consideration of the report will take place at the next meeting of the Council.

Straits Settlements.—In 1903 the value of telegraph and telephone material imported into the Straits Settlements from the United Kingdom was $867,000, compared with $90,000 in 1902. The imports of these goods from the European continent were valued at $60,000, compared with $45,000. Electric lighting and gas materials (the two items are not separated) were imported from the United Kingdom to the value of $112,000, compared with $84,000 in 1902. Europe last year supplied these goods to the value of $5,000, and the United States $7,000, comparing in the last-named case with $19,000 in 1902. Electric tramway plant and materials were imported from the Continent of Europe by the Singapore Electric Tramway Co., the switches and crossings for this work being of British manufacture. The Singapore Telephone Co., according to a recent report, obtains its supplies mainly from Belgium.

Superannuation of Municipal Servants.—The town clerk of Bradford was deputed to obtain information on the subject of superannuation schemes for municipal servants, and reports that

The majority of the schemes he has investigated are compulsory only upon all servants appointed after a certain date, and, where the option of participating is given, this option may be exercised at any time upon payment of arrears. The Civil Service scale of pensions had been adopted in some cases (*i.e.*, one-sixtieth of the salary for each year of service, with power to add a number of years to an officer's service under special circumstances), and in other cases the total amount paid in by the officer is paid out to him upon his becoming eligible, with the addition of a similar amount provided by the Corporation. Provision is made that an officer participating should either pay up the amount he would have paid had the scheme been in force from the commencement of his service, or his contributions may be fixed at a rate proportionate to the number of elapsed years to be reckoned.

In most schemes the age of 65 must be attained before the pension becomes operative, but in some 60 years is the age limit, provision being made for payment of the pension at an earlier age in the case of permanent incapacity. The principle of taking no subscriptions, but theoretically fixing the salaries so as to permit of the provision for the pensions being made out of the rates, does not seem to find favour and has been adopted by only one authority. The town clerk advises that the Corporation cannot make contributions to such a fund, or compel officers to participate in such a scheme, without obtaining Parliamentary sanction.

The Finance and General Purposes committee, to whom the report has been submitted, decided to recommend the Council to decide in favour of the principle of superannuation and to instruct the sub-committee to formulate, for the consideration of the Council, a scheme to apply generally to all servants of the established service, which should be compulsory on all officers and servants appointed after a certain date to be specified, and be aided by Corporation contributions.

Supply of Electricity Bill.—A number of the Metropolitan Borough Councils have this week approved resolutions authorising opposition to certain clauses of this measure.

Switzerland.—The towns of Zweisimmen (Canton of Berne) and Murg (Canton of St. Gall), Switzerland, are about to establish electricity supply for lighting and power.

Telephones in Mines.—The Johnson's Reef and New Moon mines, Bendigo (Victoria), have been equipped by the India Rubber, Gutta Percha and Telegraph Works Co. with telephones on the surface and at levels varying from 475ft. to 2,460ft. down the mine. Apart from the value of the telephone in case of accidents and for giving warnings to prevent accidents, it is said the instruments will soon pay for themselves in the saving of time hitherto occupied in sending requests for tools, materials, &c., from one level to another or to the surface.

The Journal.—Part 106 of the *Journal* of the Institution of Electrical Engineers is now ready, price 5s. Particulars of contents are given in an advertisement.

Tokyo.—A new system of electric tramways was opened on Monday.

Trinidad (W. Indies).—An electricity supply station is being constructed and equipped at Trinidad, and also an electric tramway.

Wakefield.—The net profit on the past year's working of the electricity department was £1,894, against £948 in the previous year. On the 1st prox, the price of current for private lighting will be reduced from 4½d. to 4d. per unit, and meter rents will be discontinued.

Walthamstow (London).—The Local Government Board has declined to sanction a loan for "free" wiring.

Tenders are to be invited for the supply of cables during the next two years. An order is to be given to the contractors for the tramcar cables to increase the size of same, at an estimated additional cost of £640, so that power may be provided for running a larger number of cars than originally intended.

Weymouth.—The municipal electricity works are expected to supply electric current by September. Arc lamps will be erected along the fine esplanade which fronts the bay.

Whitby.—The Council are to apply for sanction to a loan of £1,100 expended in excess of amount previously sanctioned for electricity supply.

Wicklow.—A Board of Works inquiry has been held into the engineering aspect of the tramway which Earl Fitzwilliam intends to construct from the railway at Wicklow to the quays.

Willesden.—Mains extensions, estimated to cost £2,369 were authorised by the District Council on Tuesday.

With reference to the proposed adoption of an improved fire alarm installation a committee has been appointed to inspect the Gamewell and Stuart and Moore fire alarm systems.

The new extensions to the Willesden Polytechnic Institute are to have a very complete electric light and power installation. In addition to the ordinary lighting of the class rooms and lecture hall, "power points" are provided for use in experimental work, and also electric motor driving for various machines. The consulting engineer is Mr. Frederic H. Taylor, of Westminster.

Wireless Telegraphy.—The Gesellschaft für Drahtlose Telegraphie have given demonstrations of their portable wireless telegraph system (of the type proposed for reporting the Gordon-Bennett race and described in *The Electrician* of June 3, p. 262) before the military authorities of Spain. In the first test one station was in Madrid, with which station communication was kept up by a portable station in Escurial. The engineer of the company then proceeded over the Guadarrama mountains in the direction of Segovia until communication failed. Afterwards a series of trials were conducted from Madrid to telegraph carts placed in various directions around the city. The King of Spain, who was present during the tests, is stated to have been much pleased with them.

Wolverhampton.—The Wednesfield road tramway route was officially inspected by Col. Yorke on Wednesday.

Dinner.—The first annual dinner of the non-commissioned officers of the 1st and 2nd divisions of the Telegraph Battalion Royal Engineers, encamped for their summer training in the neighbourhood of Plumpton, took place at Lewes on Saturday. Major H. B. H. Wright, R.E., was in the chair, and Brevet-Major E. G. Godfrey Faussett, R.E., was vice-chairman.

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TRADE NOTES AND NOTICES.

TENDERS INVITED.

Exeter Corporation invite tenders for supply and erection of one 200kw. triple expansion engine and traction generator, with condenser, steam, exhaust, circulating water pipes, &c.; or (alternatively) one 200kw. steam turbo-generator, with condenser, pipes, &c.; and one 200kw. two-phase to direct-current motor-generator for traction purposes, with switchboard, cables, &c. Further particulars are given in an advertisement. Specifications, &c, from the city electrical engineer (Mr. H. D. Munro). Tenders by noon July 1, to the town clerk, Mr. Geo. Shorto, Municipal offices, Exeter.

St. Marylebone (London) Borough Council invite tenders for supply and erection of constructional steel work and buildings for their proposed generating station in Richmond-street, Maida Vale, and also for steam generating plant, steam turbines, electric generating plant and cables. Drawings, specifications, &c., can be seen by appointment at the offices of the consulting engineer (Mr. Arthur Wright), 30, Moorgate-street, E.C., or (for buildings) at the offices of the architect (Mr. H. T. A. Chidgey), Charing Cross-chambers, Duke-street, W.C. Tenders to the town clerk (Mr. James Wilson), Town Hall, Marylebone-lane, London, W., by noon July 6. See also advertisement.

Penrith District Council invite tenders for supply and erection of two oil or gas engines and dynamos, switchboard and boosters, storage battery and mains. Specifications from the clerk (Mr. George Wainwright, Public Offices, Penrith. Specifications and drawings may be seen at (but not obtained from) the offices of the consulting engineer, Mr. J. W. Speight, M.I.E.E., 13, Victoria-street, London, S.W. Tenders to Mr. Wainwright by 10 a.m. July 5. An advertisement contains further particulars.

Handsworth District Council invite tenders for the supply and delivery of water-tube boilers, engines and dynamos, hand-travelling crane, storage battery, arc lamps and posts, switchboards and boosters. Specifications, &c., after 25th inst., from the clerk (Mr. H. Ward), Council House, Handsworth, near Birmingham. Specifications and drawings can also be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, London, S.W. Tenders to Mr. Ward before noon July 11. An advertisement contains further particulars.

Tenders are invited for the supply and erection of a complete telephone and fire alarm installation for the Angelton and Parc Gwyllt Asylums, *Bridgend*. Specifications, &c., from the clerk to the Committee of Visitors of Glamorgan County Asylum (Mr. W. E. R. Allen), County Council Offices, Cardiff. Tenders by noon July 6. See also advertisement.

St. Pancras (London) Borough Council invite tenders for supply and erection of main switchboard at the King's-road power house, Camden Town, N.W. Specifications, &c., from the electricity department, 57, Pratt-street, N.W. Tenders to the deputy town clerk (Mr. H. T. Richards), Town Hall, Pancras-road, N.W., by noon July 19. See also advertisement.

St. Pancras (London) Council also invite tenders for lead-covered and armoured cables and arc-lamp carbons. Tenders by noon June 28 to the town clerk (Mr. C. H. F. Barrett), Town Hall, Pancras-road, London, N.W.

The Electricity committee of *Stepney* (London) Borough Council invite tenders for ampere-hour meters, demand indicators and arc lamp carbons. Specifications from the engineer and manager (Mr. W. C. P. Tapper), 27, Osborn-street, Whitechapel, London, E. Tenders by noon July 4. See also advertisement.

Belfast Harbour Commissioners invite tenders for the supply and erection on the Queen's Quay of two portable electric gantry cranes. Further particulars are given in an advertisement. Specifications, &c., at the Harbour Offices. Tenders to the secretary (Mr. W. A. Currie), Harbour Offices, Belfast, by July 11.

Felixstowe District Council invite tenders for extensions to feeders. Specifications, &c., may be obtained at the offices of the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, London, S.W. Tenders addressed to the chairman of the Council, must be delivered at the Town Hall, Felixstowe, by noon of Saturday July 9. See advertisement.

Rochdale Corporation invite tenders for the removal of lighting and traction switchboards to new switch room, reconstruction of lighting switchboard, additional panels, &c., and the supply of temporary switch gear and connections. Tenders to the town clerk (Mr. James Leach), Town Hall, Rochdale, by June 27.

Rochdale Corporation also invite tenders for supply, delivery and erection of one 412kw. steam dynamo. Tenders to Mr. James Leach by July 1.

Manchester Electricity committee invite tenders for direct-current motors, motor starters, low-pressure cables, cable troughing, service fuse boxes, bitumen and box compound. Tenders to chairman of Electricity committee by June 30.

Manchester Electricity committee also invite tenders by 30th inst. for cast-iron plates for condensing bay, silencer, and drain tank in yard, and gangways in boiler house at Stuart-street generating station.

Manchester Corporation also invite tenders by 10 a.m. July 11 for laying telephone pipes, &c.

Edinburgh Corporation invite tenders for lead-sheathed paper-insulated copper cables for year ending May 15, 1905. Tenders to the town clerk (Mr. Thomas Hunter, W.S.) by June 27.

Heston and Isleworth District Council invite tenders for electricity meters. Tenders to the clerk (Mr. H. J. Baker) by noon July 4.

Tenders are wanted by 27th inst. for the supply of 30,000 tons of coal for *Birmingham* Corporation electric supply department.

Fulham (London) Council require tenders by 7 p.m. 29th inst. for supply of coal to electricity station, &c.

Swansea Corporation require tenders by noon July 1 for two tramway switchboards.

Copenhagen (Denmark) Lighting department invite tenders for the supply of electricity meters. Conditions from the engineer, 1, Lavendelstrade, Copenhagen. Tenders to the director of the Lighting department, 22, Vestre Boulevard, before noon July 1.

Tenders are invited for lighting the town of *Airlés* (Spain) by electricity. Tenders to the Alcaldia of Airlés before noon July 22. See also "Madrid Gazette" of June 14.

Tenders are invited until July 4 by the District Finance Commission at *Sophia* for an electric lighting installation in the Government Printing Works.

Utrecht (Holland) municipal authorities invite tenders until July 2 for the establishment of an electric lighting station.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by Christchurch (N.Z.) City Council for the construction of electric tramways:—

New Zealand Electric Construction Co. (*accepted*).	£249,876	Brush Co.	£266,961
Macartney, McElroy & Co.	368,700	Noyes Bros.	262,647
		J. G. White & Co.	256,165

There were eight tenders for the whole of the works and 43 for sections. It is stated that most of the machinery will come from the United States.

Erith Urban District Council have accepted the tender of Friday and Ling at £2,200 for additions to and alterations at the electricity station. There were 11 tenders, varying from £2,198 to £2,780.

For the steel deck bridge and road diversion work in connection with the construction of Erith tramways the Council received 22 tenders, varying from £8,329 to £14,392. 15s. 6d., and the lowest, that of W. Pattinson & Son, has been accepted.

Southampton Corporation have accepted the following tenders for their electric tramways.

North-Eastern Steel Co. (rails, fish-plates and anchor joints) per ton	£5	9	6
Edgar Allen & Co. (tie bars) per ton	9	0	0
Ibbotson Bros. (bolts and nuts) per ton	16	2	6
Hadfields' Steel Foundry Co. (points) per pair	27	10	0
Ditto. (crossings) each	12	0	0

Wolverhampton Council have accepted the following tenders:—

British Thomson-Houston Co., four single-deck and six double-deck tramcars, £2,460.

G. F. Milnes & Co., car bodies, £255 per car.

Lorain Steel Co., equipment of cars.

H. Gough, coal bunkers, £143. 18s. 6d.

The tender of the Melton Mowbray Electric Light Co. has been accepted by Melton Mowbray Council for public lighting for five years at £325 per annum.

Coventry Electric Lighting committee have accepted the tender of Aiton & Co. for pipework at £672 and that of Kelly & Son for extension of engine house at £945. 19s.

Royton Council have accepted the following tenders for tramways:

Wm. Underwood & Bros., permanent way, £41,000.

Brush Company, overhead equipment, £7,784.

W. T. Glover & Co., cables, £5,636. 14s. 2d.

Mr. A. G. Knight of Port Elizabeth has obtained the contract for the electric lighting installation in the new Administrative offices of Port Elizabeth Harbour Board.

Taunton Corporation have accepted the offer of the Langdon-Davies Motor Co. for the supply of electric motors on the hire purchase system on a seven years' agreement.

Warrington Electricity and Tramways committee have accepted the tender of J. A. Ewart for the construction of the permanent way of the Stockton Heath tramway at £2,936.

Swindon Council have accepted the tender of the Keighley Electrical Engineering Co. for an 8 H.P. electric motor.

Bedford Corporation have placed and order with Ferranti Limited for 12 5-ampere meters at £34. 10s.

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Exeter City Council on Wednesday accepted the complete tender of Dick, Kerr & Co. for the construction and equipment of 5½ miles of electric tramway at £42,055. This amount was made up as follows: (1) Permanent way, paving and bonding, £28,848 8s. 10d.; (2) overhead equipment, £3,641 5s. 5d.; (3) feeder cables, &c., £2,897 12s. 10d.; (4) double-deck motor cars, £6,933 16s. 8d. There were 21 tenders for contract No. 1, ranging from £27,893 to £45,043; for contract No. 2 15 tenders were received, ranging from £3,180 to £4,516; for contract No. 3 (20 tenders) the lowest being £2,695, the highest £3,631; and for contract No. 4 (8 tenders) the lowest was £6,701, the highest £7,482.

Wigan Corporation received seven tenders for 12 bogie tramcars (single-deck, two motor equipment), and that of the British Westinghouse Company has been accepted.

Hackney (London) Borough Council have placed an order with the General Electric Co. for a 24in. ventilating fan at £23. 10s.

Southwark Council have given an order to the British Insulated and Helsby Cables (Ltd.) for 440yds. of cable.

Watford District Council have ordered a feed pump from G. and J. Weir at £183. 8s.

Belfast Gas and Electric committtee have accepted the tender of the Reason Mfg. Co. for distributing section pillars.

Birmingham Corporation have ordered from the British Westinghouse Co. one 1,500kw. and three 500kw. three-phase generators.

Walthamstow District Council have accepted the tender of the British Westinghouse Co. at £21,137.2s.6d. for 32 tramcars complete.

Radcliffe Council have accepted the tender of the Lorain Steel Co. for special tramway track work.

BUSINESS NOTICES.

Mr. J. Leopold Harris, A.M.I.E.E., who was till lately connected with the Bastian Meter Co., has opened offices at 165, Queen Victoria-street, E.C. Mr. Harris intends to make a special feature of writing up descriptive pamphlets and lists for engineering firms and generally to undertake the work of a publicity department. He retains his connection with the Bastian Meter Co. with regard to Scheeffer meters for alternating currents.

Messrs. Geo. Newby, jun., and Thomas Wray, electrical engineers, Imperial-chambers, James-street, Harrogate, have dissolved partnership. Debts by Mr. Newby, who continues.

Messrs. J. G. White & Co. have established a branch at 559, Calle Rivadavia, Buenos Ayres. Mr. F. H. Bagge is representative.

LIQUIDATION.

A meeting of the British Electrozone Corp. (Ltd.) will be held on July 20 at Trafalgar-buildings, London, W.C., to receive an account of the winding-up.

Sales by Auction.—Messrs. Wheatley Kirk, Price & Co. will sell by public auction, in one lot at 10 a.m. on July 5 on the premises, the freehold engineering works known as Hythe Works, Hythe-road, Willesden Junction, N.W., and at 10:30 for 11 a.m. on the same date, piecemeal, the whole of the contents of the works, including high-class lathes, milling, drilling, shaping, emery-grinding, screwing and other machines, electric power installation, accumulators, electric-plating plant, &c. Catalogues from the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester. See also advertisement.

Messrs. Fuller, Horsey, Sons and Cassell, in conjunction with Mr. C. P. Whiteley, will sell by auction, at the Crypto Works, 29, Clerkenwell-road, London, E.C., on July 12 and 13. at 11 a.m., a quantity of engineers' machine tools, including lathes, drilling, profiling, shaping and slotting machines, plating plant and dynamo, smiths' forges, brazing hearths, gas engines, &c., and the stock and stores. Further particulars are given in an advertisement. Orders to view and catalogues (when ready) may be had of Messrs. Wilsons, Bristowes and Carpmael, solicitors, 1, Copthall-buildings, E.C.; of Mr. C. P. Whiteley, 82, Queen-street, Cheapside, E.C.; or of the auctioneers, 11, Billiter-square, E.C.

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 30, Birley-street, Blackpool.

A complete electric lighting plant (consisting of two water-tube boilers and two combined generating sets, feed-water heater, two Robey pumps, switchboard, piping, &c.) is for sale by Mr. A. Underwood, 3, Queen-street, London, E.C. See advertisement.

Factory to Let.—A factory (one or two floors) near Westminster Bridge, London, S.W., is advertised to be let in another column.

"Leatheroid."—A correspondent desires to know the name of the manufacturer of a cardboard insulating material called "Leatheroid." We shall be pleased to forward any particulars sent to us for this purpose.

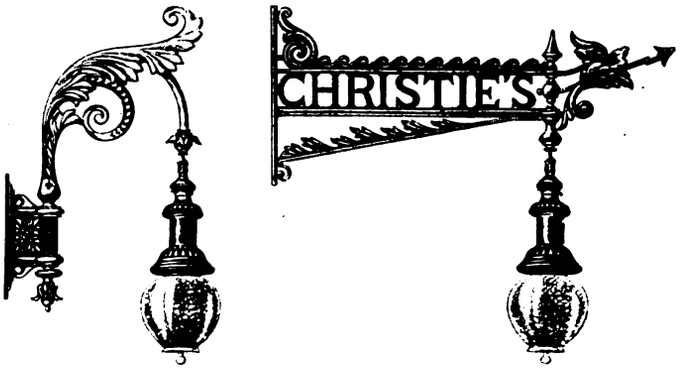
Catalogues.—Messrs. Johnson & Phillips' Electric Cable Works, Old Charlton, Kent, are sending out particulars of "Malite" fire-resisting cable, of which they are the original makers and patentees. It is claimed that the firm (by patents dated 1902) have the sole right of using various methods of perfecting these cables in certain effective ways which make them particularly suitable for meeting the requirements of the electrical industry. The main object of placing this "Malite" cable on the market is to ensure as far as possible that an outbreak of fire shall not spread owing to the use of highly inflammable insulation.

Electric motor and dynamo-controlling apparatus is listed in a pamphlet issued by the Sturtevant Engineering Co.

A new list of distributing boards, fitted with tumbler switches and milled nut fuse terminals is issued by Messrs. Ernest F. Moy (Ltd.), Greenland-place, Camden Town, London, N.W.

From the Electrical Co. we have to announce the receipt of a number of catalogue sheets illustrating a varied class of machinery, including electric winding gear for mining, portable drilling machines, electrically-driven pumping plant, weather-proof motor switchboard, three-phase high-tension generating sets for mining work, portable standardising instruments, induction motors, &c.; also two pamphlets dealing with "Imperial" measuring instruments for switchboards and for standardising and testing purposes.

A good list of Jandus arc lamps, giving full particulars of the various types of this popular illuminating apparatus, is to hand from Messrs. Drake and Gorham, 66, Victoria-street, Westminster, S.W. The list, besides illustrating and describing the better-known patterns of this lamp, contains some particulars of the "Dalite" lamp, specially designed for colour-matching. The various instruments and accessories used in arc lamp lighting are described, and a list of some of the larger users of the Jandus lamps and testimonials therefrom completes the pamphlet. Two bold examples of arc lamp wall brackets are shown in the accompanying illustrations.



A pamphlet entitled "Annealing, Hardening, Tempering and Case Hardening" is issued by Messrs. F. W. Braun & Co., of Los Angeles, California, and contains useful hints regarding these operations by the use of Braun's portable forge and tempering furnace, of which illustrations are given.

The Sun Electrical Co., 118-120, Charing Cross-road, London, W.C., has ready a new list of electric motor fans.

The Mirrlees Watson Co., Glasgow, have ready a pamphlet describing the surface-condensing plant installed at the Manx electric railway power house, Laxey, Isle of Man.

Messrs. J. C. Lyell & Co., 55, Victoria-street, Westminster, S.W., are introducing a new metal called "Patrick" metal, claimed to be a perfect substitute for nickel, being silver white through. Some particulars relating to this metal are available in the form of a leaflet.

In view of the reductions in the cost of telegraphing to Spain, which take effect on July 1, the Direct Spanish Telegraph Co. have issued a new tariff of charges and rules and regulations affecting telegrams sent over the company's route. There is much in this pamphlet of interest to the general public, and an instructive map of the company's cable routes.

Messrs. Vandam, Marsh & Co., 15, Gerrard-street, London, W., have ready a new circular list relating to the "Cantie" switch, which is claimed to have an exceptionally quick and positive "make" and "break," with a practically impossible partial movement or intermediate position. The list is illustrated.

The Diesel Engine Co., 179, Queen Victoria-street, London, E.C., has issued a circular relating to the Diesel oil engine, for which great economy is claimed. It is said that there are more than 600 of these engines in actual use, 50 of these being installed in the United Kingdom. A list of some of the latest orders on hand was published yesterday. The engines are now made up to 650 B.H.P.

"Electricity in Collieries" is the subject of a well-illustrated pamphlet issued by the British Westinghouse Co. Particulars are included of several installations of mining and colliery working plant installed by the company in this country.

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Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from June 15 to 21, with the ports of destination:—

Africa—Alexandria, £35; Cape Town, £8,172 (including £627 telegraph material); Durban, £670 (including £486 telegraph material); Port Elizabeth, £143. *Argentina*—Buenos Ayres, £928. *Australasia*—Auckland, £2,320; Brisbane, £96; Otago, £70; Perth, £65; Sydney, £1,347 (including £150 telegraph material); Wellington, £3,837. *Belgium*—Ghent, £44; Ostend, £90. *Brazil*—Pernambuco, £89. *Canada*—Halifax, £105. *Canary Islands*, £25. *Ceylon*—Colombo, £128 (including £57 telegraph material). *China*—Shanghai, £343 (including £103 telegraph material). *Cochin China*—Saigon, £12. *France*—Bordeaux, £17; Rouen, £25. *Germany*—Hamburg, £431. *Gibraltar*, £1,077. *Holland*—Amsterdam, £78. *Hong Kong*, £41. *India*—Bombay, £256; Calcutta, £568 (including £190 telegraph material); Madras, £450 (telegraph material). *Japan*—Kobe, £288; Yokohama, £1,841. *North Atlantic*, £6,200 (telegraph cable). *Siam*—Bangkok, £18. *Straits Settlements*—Singapore, £30. Total £32,325, against £10,627 in the corresponding week last year (June 17 to 23).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

April 5, 1904.

7,823 W. FAIRWEATHER (American Electric Telephone Co., U.S.). Telephone transmitters.*

7,824 W. FAIRWEATHER (Benjamin Electric Mfg. Co., U.S.). Cluster lamp sockets.*

7,825 W. FAIRWEATHER (Benjamin Electric Mfg. Co, U.S.). Twin lamp socket.*

7,833 L. R. LEE. Manchester. Ventilation and drying of transformers and electrical apparatus.

7,838 J. TROTTER. Glasgow. Medico-electrical apparatus.

7,869 H. F. PIEPER. Automatic power cutout for electric railways.*

7,881 J. F. MCELROY. Dynamos.*

April 6, 1904.

7,937 B. KRAUSSE. Electric meters.

7,977 G. MÖLLER. Receiving devices for wireless telegraphy. (Date applied for, May 2, 1903, date of application in Denmark.)*

7,980 J. H. MERCADIER. Electric fuses or cutouts. (Date applied for, April 7, 1903, date of application in France.)*

7,981 J. H. MERCADIER. Manufacture of spongy or porous lead and of articles therefrom. (Date applied for, April 7, 1903, date of application in France.)*

7,985 H. D'OLIER. Attachments for incandescent lamps.

April 7, 1904.

8,001 T. MORRIS. Electric brushes and the like.

8,004 H. DAHL. Berlin. Signal devices for indicators signalling speeds groupwise.

8,024 A. E. BURTON and T. J. LEACH. Electrical interruptors.

8,054 J. A. L. DEARLOVE. Apparatus for transmitting and reproducing sounds.

8,064 C. M. JACOBS. Working of single lines of railway on the electric staff or other electric systems.

April 8, 1904.

8,077 S. R. THOMSON. Manchester. Trolley heads.

8,078 J. F. DAVIF. Conduits and like means of carrying conductors.

8,079 E. PHILLIPS. Birmingham. Shade carrier.

8,089 STEEL, PEECH AND TOZER and H. E. BOWEN. Sheffield. Electromagnets for lifting a group of objects such as tramrails, bars, ingots and the like.

8,096 H. W. D. INGHAM and T. M. JONES. Device for catching and supporting overhead electric cables or wires when fractured.

8,103 C. G. MAJOR, E. C. STEVENS and P. H. STEVENS. Electric lifting and hauling machinery.

8,134 F. R. WEBB. Automatic regulating apparatus for generating stations.

April 9, 1904.

8,139 L. BARLOW. Bayonet collar for electric lamps and the like.

8,164 A. WENSKY. Berlin. Electric ear-trumpet.

8,188 P. R. TAYLOR. Liverpool. Electric insulation.

8,216 G. GIN. Electric furnace for converting pig iron into steel.*

8,221 A. E. MCCRACKEN. Electric tramways and railways on the overhead trolley system.

8,227 A. P. ZANI. Alternating-current motors.

8,234 A. G. BLOXAM (Joseph Goffin, Belgium). Telegraphic signalling apparatus.*

8,235 J. S. PECK. Systems of electrical distribution. (Date applied for, May 1, 1903, date of application in U.S.)*

April 11, 1904.

3,620 A/03 J. F. MCELROY. Dynamos. (Date applied for, Feb. 16, 1903.)

8,245 A. E. ROBENS. Manchester. Continuous action life-guard for electric tram cars.

8,258 L. ANDREWS. Manchester. Control of circuit breakers and like devices.

8,262 S. J. PORT. Birmingham. Telephones for use in dictating correspondence.

8,269 G. H. CHARD. Electrically illuminated signs for advertising.

8,277 M. SUTHERLAND and E. MARCUSON. Twickenham. Charging storage batteries.

8,294 H. B. LIPPELT. Electrical induction machines.

8,297 P. C. HEWITT. Systems of electrical distribution. (Date applied for, April 25, 1903, date of application in U.S.)*

8,316 J. S. FAIRFAX. Electric machine tools.

8,321 G. MÖLLER. Receiving apparatus for use in wireless telegraphy.*

8,323 J. D. F. ANDREWS. East Sheen. Automatic switches.

8,332 E. V. MORSE. Spark plugs.*

April 12, 1904.

8,347 T. TAYLOR. Sutton Coldfield. Fittings for electric conduits.

8,356 E. LARMUTH. Sheffield. Electromagnetic device for controlling the position of a switch tongue from an electric car or truck.

8,365 W. FAIRWEATHER. (Vesta Storage Battery Co., U.S.)* Storage batteries.

8,378 A. PAGE. Glasgow. Arrangement whereby house electric bells can be used for electro-medical purposes.

8,394 C. RUSS. Apparatus for automatically operating switches and other controlling devices.

8,398 G. D. GRANGER. Electrically energised pendulum clocks.

8,399, 8,400, 8,401, 8,402, 8,403 and 8,404 B.T.-H. Co. (G.E. Co., U.S.) Alternating current motors.

8,444 G. GIBBS. Safety devices for electric railways.

April 13, 1904.

8,454 W. CUBITT, C. M. JAMES and D. L. S. BIGGE. Bristol. Variable-speed electric haulage engine.

8,477 R. E. REES. Incandescent lamp-holders.

8,501 M. CUMMINS. Controllers for the motors of electric vehicles.

8,514 and 8,515. B.T.-H. Co. (G.E. Co., U.S.) Vapour electric apparatus.

8,517 F. HUTCHINS. Covering of wire with fibrous materials and apparatus employed therein.

8,540 F. J. SWIFT. Printing telegraph receivers.*

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1903.

10,213 BOOKER. Automatic switches.

10,296 HARDINGHAM (Felten and Guilleaume Carlswerk A.G.). Counteracting the effects of induction in metal-sheathed cables.

10,342 THOMAS and THOMAS. Switches.

10,502 SYKES. Electrically-actuating railway points and signals.

10,698 ZIEGENBERG. Phase synchronisation in electro-motors with alternating field.

11,585 SMITH. Trolley arms for electrically-driven tramcars.

11,629 SIEMENS BROTHERS & Co. and BERRY. Fuses.

11,846 SIEMENS BROTHERS & Co., HIRD and BARTLETT. Apparatus for transmitting synchronous and equal movements to a distance.

12,105 SIEMENS BROS. & Co. and BERRY. Automatic cutouts for electric circuits.

12,310 CAROLAN (G.E. Co., U.S.). Circuit controllers.

12,479 JERVIS-SMITH. Dynamo-electric generators and motors.

12,480 BARTHELEMY. Microphones.

12,802 SIEMENS BROTHERS & Co., SIEMENS and DUKE. Controlling electric motors, particularly for electrically-propelled vehicles.

12,947 BOLTON. Case for electric light fuse boards and switches.

13,973 STEELE and KRATT. Electric recording instruments.

14,165 LE TALL (Cooper-Hewitt Electric Co.). Electrodes of gas or vapour electric apparatus.

14,601 and 14,602 DU BOIS. Coin mechanism for electricity and other meters.

14,731 WILLIS (Shields). Electrolytic separation of copper and nickel from mattes and ores.

14,963 WILLIS (Sjosted). Electric furnace.

15,366 MARTIN. Safety fuses.

15,838 HEDGES. Fusible cutouts.

16,849 SIEMENS BROTHERS & Co. and CLIFT. Telphers.

17,587 JOHNSON (Chemische Fabrik Griesheim Elektron). Manufacture of electrodes for electrolytic purposes.

17,588 JOHNSON (Chemische Fabrik Griesheim Elektron). Treatment of alkali chromates for the production of bichromates and alkali therefrom.

17,589 JOHNSON (Chemische Fabrik Griesheim Elektron). Treatment of chrome iron stone for the production of potassium chromate.

19,367 PINCHING and WALTON. Insulation of electric conductors.

20,291 RITCHEL. Electric fittings. (Date applied for, Oct. 13, 1902.)

SOCIEDAD HIDRO-ELECTRICA DEL TER.—A contract has been entered into between Count Ramon de Berenguer, Gerona, Spain, and Mr. W. T. McCaskey, London, by which a company with the above title is to be formed to develop a water power of 1,500 H.P. on the River Ter, Gerona, and to distribute energy for lighting and other industrial purposes to city of Gerona, and to San Feliu de Guixols, Palmos and other towns in the vicinity. The capital of the new company is to be 3,000,000 pesetas. All machinery, apparatus and supplies are (we are informed) to be purhased by Mr. W. T. McCaskey.

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COMPANIES' MEETINGS AND REPORTS.

United River Plate Telephone Co. (Ltd.)

The eighteenth ordinary general meeting took place on Tuesday, Mr J. IRVING COURTENAY presiding.

The SECRETARY (Mr. E. M. Reiss) having read the notice calling the meeting,

The CHAIRMAN said: For several years I have had the pleasure of stating the satisfactory progress of our business in Argentina, which from its inception, and through both good and evil report in regard to that country, has shown constant improvement and advance. That there has also been an increase in the rate of dividend we have been able to pay to the shareholders is a tangible and convincing proof of our improved condition. It is recognised by everyone—never so much as at present—that Argentina is advancing in every direction, and that, with good government now seemingly well assured, no country has better prospects of continued prosperity. We naturally look forward to sharing in that prosperity, and in order to do so, have already been preparing ourselves to a certain extent for future business. The acquiring of central office properties and underground plant expenditure are steps in that direction, as are also line extensions and new exchanges, which are being demanded in the more important towns throughout the Republic. Our list of subscribers has increased by 800 during the year ended last March, and the improvement for the two months since completed is at a still higher rate, and is expected to be maintained. Our share capital remains unaltered. Sundry creditors are £1,000 more, due mainly to the incidence of trade bills, most of which have since been paid. £10,000 has been put aside for renewal of plant, while a further £15,000 is being added to reserve fund, now standing at £95,000. On the credit side of the balance-sheet we have the additional capital outlay for the year (£48,925). A considerable portion of this has been required in connection with new subscribers, in addition to which there has been, as there will continue to be, large expenditure on underground plant and the extension of lines in the provinces. Our receipts in the River Plate show the substantial increase of £10,350, while maintenance charges and general expenses are only £1,588 heavier. The final position is an available sum of £7,600 more than a year ago, and after adding substantially to our reserves for renewal of plant and other contingencies, the directors are able, as I have said, to recommend the increased dividend on the ordinary shares of 8 per cent. Increase of business necessitates the issue of fresh capital. At present an issue of £60,000 appears to be all that will be necessary, and it has been decided to offer this to the holders of ordinary shares at par in proportion to their holdings. I now move the adoption of the report and accounts.

The MANAGING DIRECTOR (Mr. Frank W. Jones) seconded the motion, which was, after a short discussion, carried unanimously.

The retiring directors, Mr. J. I. Courtenay and Mr. F. Jones, were then re-elected, as were the auditors.

The CHAIRMAN then proposed a resolution to increase the capital of the company to £1,000,000 by the creation of 100,000 shares of £5 each, which was seconded by Mr. FRANK JONES, the managing director, and carried unanimously.

The MANAGING DIRECTOR then moved a resolution thanking the officials and staff of the company in Buenos Ayres.

This was seconded by Mr. LAWRENCE, and carried unanimously.

A cordial vote of thanks to the chairman, the managing director and the directors of the company, proposed by Mr. J. W. BARCLAY, and seconded by Mr. KINGSBURY, was carried unanimously, and the proceedings terminated.

BRITISH ALUMINIUM CO. (LTD.)—The report for 1903 states that the profit transferred to appropriation account is £34,143, interest, charges on stocks of aluminium, &c., absorb £17,265, leaving £16,877 to be applied in reduction of debit balance of £22,357 from 1902, leaving £5,480, added to £79,982, amount of suspense account in last balance-sheet, which the board has now decided to write off, and also £8,374, part of depreciation on investments. The debit balance, therefore, stands at £93,837. Writing £9 per share off the 10,000 ordinary shares will dispose of £90,000, leaving £3,837 to be provided out of current profits. £10,000 borrowed in January, 1903, in priority to debenture stock was repaid during that year. The sales of aluminium during 1903 were considerably larger than in any previous year, and they continue to steadily increase. The board has accordingly decided to suspend the manufacture of carbide of calcium, and apply the whole of the available power at Foyers to the production of aluminium as soon as the necessary plant which is now in hand can be erected. The continuous expansion in the demand for the metal indicates, however, that the maximum capacity of output of the Foyers works will, before long, be inadequate to satisfy market requirements. The board has, therefore, decided to proceed with the development of its Loch Leven water power. Proposals for providing the additional capital necessary for that purpose will shortly be submitted.

BUENOS AYRES GRAND NATIONAL TRAMWAYS CO. (LTD.)—At the meeting on Monday the chairman (Mr. N. G. Burch) said that Buenos Ayres was conspicuous for the fact that the public of that city make use, in a greater degree than any other city in the world, of the facilities which the tramway companies offered. The number of passengers carried on the tramways of the city last year was 137,000,000, which, upon a population of 900,000, represented 150 journeys *per capita* during the year. As a striking illustration of the advantages of electricity as a medium of traction (comparing that power with animal traction) it was interesting to observe that the increase of passengers carried by the Anglo-Argentine Company, which had not completed the whole of its system at the end of the year, was 9½ millions, an increase of 33 per cent. Their own company had been signally successful in raising the funds to embark upon their electrification. They had organised a local committee to carry out the work, and their manager (Mr. Wall) with Mr. Bocquet, who was an engineer of considerable experience in electrical as well as in horse traction, were representatives of their administrative work. The whole of the materials for the first half of the system had been ordered. All their cars were ordered and all their rails, and the work of laying the track was now actively in hand, and before their next meeting they would have converted 30 miles of line to electricity. The whole of the tramways in Buenos Ayres were rapidly passing into that system of traction. The tramway system of the city aggregated about 300 miles, at present worked half by animal traction and half by electricity. With the concessions granted to the various companies, the whole ground was practically covered. The Metropolitana was electrifying its 17 miles of line, and other companies were proceeding with the work.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 25⅜d. per oz. (June 23). Consols 90—90⅛ for money, 90⅛—90¼ for account; 2½ per cent. annuities 89½—90 (June 23). Consols Pay Day, July 1; Stocks and Shares Continuation Days, June 27 and July 12; Ticket Days, June 28 and July 13; Pay Days, June 29 and July 14; Mining Share Carry-over Days, June 25 and July 11.

AMERICAN STREET RAILWAY INVESTMENTS.—The "Street Railway Journal" (New York) has issued its 11th edition of "American Street Railway Investments," which is the annual financial manual of street railway and traction companies in the United States. There is a largely increased volume of information in the new edition, and many new features of interest to those who invest in this class of property. The maps which accompany the text are numerous and informing. It is satisfactory to learn that the net aggregate earnings of the companies show the industry to be in a prosperous condition, the increase in the gross receipts of 310 companies, comparing the figures for 1903 with those of 1902, was 8·5 per cent.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD.)—The transfer books and register of holders of the debenture stock is closed till the 1st prox. preparatory to payment of interest due July 1.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The transfer books and register of numbers will be closed from the 30th inst. to July 14 inclusive.

COMMERCIAL CABLE CO.—The regular quarterly dividend of 1 per cent. on the preferred shares in the "Mackay Companies" will be paid on July 9. The transfer books will be closed from June 30 to July 9.

ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)—For the year ended May 31 the gross profit was £15,804. 7s. 8d. After deducting all general charges and interim dividends on preference and ordinary shares, and providing for proportion of final dividend accrued on preference shares, the net balance is £6,813. 17s. 9d., out of which the directors recommend a dividend of 1s. per share (absorbing £1,000) on the ordinary shares, making 10 per cent. for year on the capital paid up on these shares. In view of the depreciation in market values of the investments held by the company, the directors propose to place the balance (£5,813. 17s. 9d.) to "Provision for Contingencies," raising that fund to £41,575. 13s. 7d., which the directors consider to be an ample provision. The trustees for the founders' shares reserve fund propose to distribute £10 per share to the holders of such shares. All dividends are less income tax.

ELECTRIC CONSTRUCTION CO.—In the course of the proceedings at Bow-street (London) Police Court against E. Terah Hooley and H. J. Lawson for conspiracy, &c., an "Electric Construction Co." has been frequently mentioned. The Electric Construction Co. (Ltd.), Dashwood House, New Broad-street, London, E.C., and Wolverhampton, desire it to be known that they are in no way associated with the company referred to in the proceedings at the police court.

JOHN I. THORNYCROFT & CO. (LTD.)—At a meeting of preference shareholders on Monday, Mr. William Beardmore gave particulars of the agreement entered into for the acquisition of Mordey, Carney (Southampton), Ltd., for £89,500. The capital of the company has been increased to £350,000 by the creation of 40,000 new preference and 50,000 new ordinary shares of £1 each.

THOMAS PARKER (LTD.)—The directors have resolved to carry forward the available balance of £1,410, after writing off the usual depreciations.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have granted quotations to a further issue of 2,500 £10 fully-paid cumulative preference and 2,500 £10 fully-paid ordinary shares of the *Potteries Electric Traction Co. (Ltd.)* and £3,599,200 5 per cent. profit-sharing secured notes (8,450 of £100, 1,111 of £200, 774 of £500 and 2,145 of £1,000 each) of the *Underground Electric Railways Co. of London (Ltd.)*.

R. WAYGOOD & CO. (LTD.)—At the meeting last week Mr. Henry C. Walker said the company had during the year made improvements in their push-button electric lifts and had put down a complete plant for testing motors and gears for single-phase, two phase and tri-phase current. A dividend at the rate of 13 per cent. per annum for the half-year was declared, making 9 per cent. for the year]

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WESTERN TELEGRAPH CO. (LTD.)—The coupons on this company's second issue of 5 per cent. debentures, due 30th inst., will be paid at Parr's Bank, Bartholomew-lane, London, E.C.

WITTY AND WYATT (LTD).—Mr. H. H. Witty retires from the board on June 30, Mr. R. C. Wyatt remaining sole managing director. Mr. A. de Zulueta has joined the board in place of Mr. Witty.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

THOMAS BEELEY & SON (LTD.) (81,245.)—Reg. June 14, capital £75,000 in £1 shares, to acquire business carried on by Thomas Beeley & Son as boiler makers, electric, hydraulic and pneumatic engineers, &c., at Hyde, near Manchester. First directors, T. Beeley, T. C. Beeley and J. C. Beeley.

GRATZE PATENTS AND ENGINEERING SYND. (LTD.) (81,236.)—Reg. June 14, capital £5,000 in £1 shares, to carry on business of manufacturers and repairers of and dealers in magnetic or other speed indicators, pressure and speed gauges, magnetic and electric apparatus, &c.

SIMPSON AUTOMATICS (LTD.) (81,242.)—Reg. June 14, capital £2,000 in £1 shares, to acquire patents for ventilators, fire alarms, fire extinguishers and automatic machines generally, and to carry on in Europe, the United States of America or elsewhere the business of engineers, manufacturers of fire alarms, fire sprinklers, ventilators, telephones and electrical and other appliances, &c.

STATUTORY RETURNS.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD).—According to return to April 7 the capital is £300,000 in 15,000 ordinary and 15,000 preference shares of £10 each, of which 12,000 ordinary and 12,000 preference have been taken up. £10 per share has been called up on 7,500 ordinary and 15,000 preference and £4 per share on 4,500 ordinary, and £243,010 has been received, including £10 paid on 10 forfeited shares. Mortgages and charges, £130,000.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO. (LTD).—In the return to June 1 the capital is £750,000 in 75,000 ordinary and 75,000 preference shares of £5 each, all of which have been taken up. £750,000 is considered as paid. Mortgages and charges, £425,000.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD).—The return to March 28 (filed June 7) gives the capital as £1,600,000 in 80,000 preference and 80,000 ordinary shares of £10 each, of which 30,000 preference and 40,000 ordinary have been taken up. £700,000 has been received. Mortgages and charges, £650,000.

GLOBE TELEGRAPH AND TRUST CO. (LTD.)—In the return to May 31 the capital is £5,000,000 in 250,000 preference and 250,000 ordinary shares of £10 each, of which 180,877 preference and 180,877 ordinary shares have been taken up. £10 per share has been nominally called up on 45,009 shares and £433,115. 5s. has been received, £3,167,450 is considered as paid on 316,745 shares. Mortgages and charges, nil.

KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION CO. (LTD.)—The return to April 22 gives the capital as £100,000 in 5,000 preference and 5,000 ordinary shares of £10 each, of which 3,000 preference and 4,700 ordinary have been taken up. £10 per share has been called up and £77,000 has been received. Mortgages and charges, £15,000.

ORIENTAL TELEPHONE AND ELECTRIC CO. (LTD.)—In the return to May 11 the capital is £300,000 in 200,000 ordinary and 100,000 preference shares of £1 each, of which 179,313 ordinary and 50,000 preference shares have been taken up. £1 per share has been called up on 7,816 ordinary and 50,000 preference shares, and £57,828. 10s. has been received, including £12. 10s. paid on 50 ordinary shares. 171,497 ordinary shares are considered as fully paid. Mortgages and charges, nil.

PETERBOROUGH ELECTRIC TRACTION CO. (LTD.)—In the return to May 11 the capital is given as £60,000 in 6,000 ordinary and 6,000 preference shares of £5 each, of which 4,000 ordinary and 4,000 preference have been taken up. £5 per share has been called up and £40,000 has been received. Mortgages and charges, £20,000.

FRANK SUTER & CO. (LTD.)—According to the return to May 20 the capital is £20,000 in 6,500 preference and 13,500 ordinary shares of £1 each, of which 2,050 preference and 13,404 ordinary shares have been taken up. £1 per share has been called up and paid on 5,454 shares, and £0.000 are considered as fully paid. Mortgages and charges, £6,000.

WEST COAST OF AMERICA TELEGRAPH CO. (LTD).—The return to May 7 gives capital as £132,520 in 53,008 shares of £2. 10s. each, of which 45,008 have been taken up. £2. 10s. per share has been called up on eight and £20 has been received. £112,500 is considered as paid on 5,000 shares. Mortgages and charges, £170,000.

WESTERN TELEGRAPH CO. (LTD.)—According to return to May 31 the capital is £2,500,000 in £10 shares, of which 207,930 shares have been taken up. £10 per share has been called up on 130,000 shares and £1,300,000 has been received. £779,300 considered as paid on 77,930 shares. Mortgages and charges, £613,955.

WEST INDIA AND PANAMA TELEGRAPH CO. (LTD.)—The capital is given in the return to June 1 as £2,445,630 in 200,000 ordinary, 34,563 first preference and 10,000 second preference shares of £10 each, of which 88,321 ordinary, 34,563 first preference and 4,669 second preference shares have been taken up. £1,275,530 is considered as paid. Mortgages and charges, £80,000.

MORTGAGES AND CHARGES.

HEADLEY LIMITED.—Issue on June 1 of £1,000 debentures, part of series created May 12, 1904, securing £2,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	June 18	1,502	+ 348	8	4,486	+ 870
Airdrie	,, 10	216	...	18	3,485	...
Ayr Corporation	,, 18	396	+ 19	5	1,586	- 50
Barnsley	,, 10	165	...	23	3,768	- 289
Bath Electric Trams, Ltd.	,, 15	623	...	24	18,739	...
Barrow	,, 10	172	+ 104	18	2,831	+ 1,729
Bexley District Council	,, 16	224	...	36	6,317	...
Birkenhead	,, 19	1,118	+ 8	...	...	...
Birmingham Corporation	,, 18	294	...	23	6,759	...
Birmingham Tramways Co.	,, 18	5,653	+ 920	24	127,668	+ 7,965
Blackburn Corporation	,, 17	1,046	+ 309	12	11,460	+ 862
Blackpool Corporation	,, 16	798	+ 19	11	9,577	+ 656
Blackpool and Fleetwood	,, 18	559	- 94	25	8,774	- 777
Blackp'l, St. Anne's & Lytham	,, 16	894	+ 69	33	7,748	+ 5,667
Bolton Corporation	,, 19	1,829	+ 25	12	21,939	- 104
Bournemouth Corporation	,, 15	1,019	+ 184	‡11	12,112	+ 638
Bradford Corporation	,, 18	4,671	+ 1,186	11	51,794	+ 9,174
Brighton Corporation	,, 19	985	+ 96	11	10,497	+ 21
Brisbane Tramways	May 4	2,486	+ 204	18	41,250	+ 70
Bristol Trams & Carriage	June 17	5,146	+ 632	4	21,038	- 1,499
Buenos Ayres & Belgrano	May 22	3,241	- 658	5	16,811	+ 533
Burnley Corporation	June 18	1,081	+ 382	12	12,564	+ 3,119
Burton Corporation	,, 19	854	...	¶11	3,899	...
Calcutta Tramways Co.	,, 18	a84,436	+ a3,516	25	a853,383	+ a108,804
Camborne-Redruth	,, 20	108	+ 8	7	534	- 44
Cardiff Corporation	,, 18	2,090	+ 258	11	23,157	+ 949
Carlisle Tramways Co.	,, 18	208	+ 16	24	4,501	+ 288
Central London Railway	,, 18	6,582	- 142	25	171,719	- 2,807
Chatham & Dist. Lt. Rys.	,, 16	664	+ 155	24	13,229	+ 1,991
City & South London Rly.	,, 19	2,521	- 427	25	74,119	- 2,651
Cork Electric Trams Co.	,, 16	489	- 117	24	10,296	- 804
Darwen Corporation	,, 17	231	+ 33	11	2,617	- 123
Devonport & Dist. Trams.	,, 10	611	+ 146	23	11,402	+ 1,771
Dover Corporation	,, 18	229	+ 9	12	2,411	- 143
Dublin & Lucan Railway	,, 19	130	+ 8	25	2,728	+ 210
Dublin Southern District	,, 17	1,001	+ 189	¶25	112,705	+ 2,815
Dublin United	,, 17	4,167	+ 428			
Dudley—Stourbridge	,, 10	878	+ 184	23	18,646	+ 685
Dundee Corporation	,, 15	869	+ 37	...	...	...
East Ham Council	,, 18	775	+ 179	11	8,721	- 1,011
Gateshead & Dist. Trams	,, 10	888	+ 54	23	20,191	+ 977
Glasgow Corporation	,, 18	14,650	+ 988	†3	40,028	- 1,782
Glossop	,, 18	110	...	25	2,471	...
Gravesend—Northfleet	,, 10	271	+ 88	23	5,438	+ 611
Gt. Northern & City Rly.	,, 18	890	- 13	18	16,659	...
Greenock & Port Glasgow	,, 10	739	- 84	23	11,882	+ 625
Halifax Corporation	,, 8	1 619	+ 204	11	16,297	+ 1,073
	,, 15	1,486	+ 369			
Hartlepool Tramways	,, 10	807	+ 12	23	6,175	+ 583
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 18	2,167	+ 454	11	24,025	+ 2,671
Ilford District Council	...	...	...	..	...	...
Ilkeston Corporation	,, 15	189	- 9	...	...	...
Ipswich Corporation	,, 18	536	...	11	5,443	...
Isle of Thanet Co.	,, 18	786	+ 76	...	...	...
Kidderminster & District	,, 10	136	+ 15	23	2,580	- 109
Kirkcaldy Corporation	,, 15	221	- 37	24	5,175	...
Lanarkshire Trams Co.	,, 16	662	...	24	14.588	...
Leeds Corporation	,, 18	5,798	+ 720	12	69,582	+ 4,247
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	,, 11	10,917	+ 738	24	237,380	+ 4,496
Liverpool Overhead Rly.	,, 19	1,575	- 45	25	39,499	- 18
*London County Council	,, 11	12,508	+ 3,008	§10	117,714	+ 18,289
Lowestoft	...	...	...	...	...	...
Manchester Corporation	,, 18	12,618	+ 1,742	11	134,789	+ 3,617
Mersey Railway	,, 18	1,582	+ 108	24	35,639	+ 7,193
Merthyr	,, 10	197	- 3	23	4,584	+ 163
Middleton	,, 10	423	- 148	23	6,921	+ 44
Nelson Corporation	,, 18	196	+ 69	12	1,371	+ 604
Newcastle-on-Tyne Corp.	,, 18	3,500	+ 487	24	85,351	+ 10,640
Newport (Mon.)	,, 18	514	+ 138	11	5,750	+ 1,462
Oldham, Ashton & Hyde	,, 10	585	- 105	23	12,208	- 756
Oldham Corporation	,, 5	1,205	...	14	15,991	...
	,, 12	1,186				
Perth (W. A.) Elec. Trams.	,, 17	1,261	+ 186	24	32,332	+ 4,354
Peterborough	,, 10	188	+ 4	23	3,076	- 189
Poole and District	,, 10	328	+ 14	23	6,223	- 41
Portsmouth Corporation	,, 18	1,964	+ 420	‡12	21,646	+ 2,198
Potteries	,, 10	1,663	+ 208	23	38,536	+ 2,998
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	,, 20	181	- 19	12	1,567	- 176
Rothesay	,, 10	181	- 2	23	1,782	+ 16
Salford Corporation	,, 20	8,994	+ 94	12	47,567	+ 4,594
Sheerness	,, 8	65	- 8	23	1,165	- 377
Sheffield Corporation	,, 19	4,705	+ 376	§12	57,113	+ 2,014
Southampton Corporation	,, 16	966	- 221	...	...	...
Southend Corporation	,, 15	315	+ 76	11	3,395	+ 218
Southport Tramways	,, 10	330	- 99	23	6,729	+ 321
S. Staffordshire Trams.	,, 10	781	- 70	23	17,945	- 873
Stockport Corporation	,, 17	618	+ 356	11	6,602	+ 2,810
Sunderland Corporation	,, 19	1,314	+ 82	11	14,260	+ 887
Swansea Trams	,, 10	553	+ 49	23	11,648	+ 752
Taunton Trams	,, 10	68	+ 11	23	1,189	- 85
Tynemouth and District	,, 10	326	+ 6	23	5,697	- 311
Tyneside Trams Co.	...	...	...	...	...	...
Wallasey District Council	,, 18	788	+ 187	§11	8,211	+ 887
Walsall	,, 18	473	...	24	11,840	...
Warrington Corporation	,, 16	324	+ 58	11	8,471	+ 56
West Ham Corporation	,, 16	1,118	...	16	10,988	...
Weston-super-Mare	,, 8	140	- 4	23	1,334	- 75
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 10	407	+ 76	23	8,533	- 278
Worcester	,, 10	337	+ 163	18	5,154	+ 2,163
Wrexham	,, 10	198	- 24	23	2,519	- 273
Yorkshire Woollen District	,, 10	658	+ 338	23	13,060	+ 5,604

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., June 22.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS WEEK TO JUNE 22	
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.		Highest.	Lowest.
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	5 —5½	4 15 8	April, Oct	5 5/16	5 5/16
5t.	6%	Do. Permanent 6% Deb. Stock	182 —187	4 9 8	..	..	..
5t.	34/2	Auckland Elec. Trams 5% Deb. (red.)	100 —102	..	..	100	99½
10	6/0	†Barcelona Tramways Ord.	7 —8	3 15 0	..	7⅞	7⅞
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
5t.	4½%	Do. 4½% Deb. Stock (red.)	92 —97	4 14 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	96 —99	5 1 9	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	⅜—½	..	..	..	..
1	..	Do. 5% Cum. Pref.	⅜—½	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1¼—2¼	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	..	..	..
5t.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98 —103	4 9 1	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	18½—19½	4 2 1	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10½—10½	3 16 2	..	..	..
5t.	4%	Do. 4 per Cent. Debs.	107 —109	3 13 4	Feb, Aug	..	..
5t.	6%	British Columbia Elec. Rlwy. Def. Ord.	100 —103	5 16 6	..	..	..
5t.	5%	Do. Pref. Ord. Stock	98 —101	4 19 0	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10¾	5 11 7	..	..	..
4t.	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103¾—105¾	4 6 2	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	100½	..
10	6/0	British Electric Traction Ord.	9⅜—10½	7 16 1	..	10⅛	9⅝
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅜—11½	5 6 6	Feb, Aug	10⅜	10⅛
5t.	5/0	Do. 5 per Cent. Perpetual Debs	116 —119	4 6 3	..	117½	116½
5	3/0	Buenos Ayres and Belgrano Ord.	2½—3½	4 16 0	..	3⅛	2⅛
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5½—5⅝	5 4 4	..	5⅛	5⅛
5	3/0	Do. "B"	5 —5½	5 9 1	..	5⅛	5⅛
5t.	5%	Do. 5 per Cent. Debs.	107 —110	4 12 6	..	..	..
5t.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	103 —106	4 16 8	..	104½	..
5t.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	96 —101	5 0 0	..	..	..
5	3/6	Calcutta Tramways	7 —7½	4 0 0	..	7⅛	..
100	4½%	Do 4½% 1st Deb. Stock (red.)	107 —110	4 3 6	..	..	..
1	1/0	Cape Electric Tramways Shares	1⅞—2⅛	8 0 0	..	..	..
5t.	4%	Central London Ordinary Stock	92 —95	4 4 2	June, Dec	94	93
5t.	4%	Do. 4 per Cent. Pref. Stock	102 —105	3 18 0	..	104⅜	102½
5t	4%	Do. Deferred Stock	79 —82	4 17 7	..	82	79½
10t	4%	Do. 4 per Cent. Debs.	113 —116	3 10 0	..	115½	115
5	2/6	City of Birmingham Trams. 5% Cm. Pref	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
5t.	2%	City and South London Rly. Con. Ord	50 —52	4 11 4	Feb, Aug	51½	50½
5t.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —126	4 0 0	Feb, Aug	..	..
5t.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
5t.	5%	Do. (1901)	119 —122	4 2 10	..	121½	120
5t.	4%	Do. 4 per Cent. Perpetual Debs	106 —109	3 18 5	May, Nov	108	..
5t.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 10	..	101½	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord	12½—13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8½	Gt. Northern & City Rly. Prf. Ord. (4%)	5 —6	5 0 0	..	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	18 —19	5 5 3	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
5t.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf	3½—4	6 5 0	..	..	..
5t.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	91	..
10	1½%	Liverpool Overhead Railway Ord	3⅝ - 4	3 8 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
5t.	4%	Do. 4 per Cent. Deb.	100½—10½	3 19 6	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11 —11½	4 7 0	..	11⅛	..
5t.	4%	Do. 4% 1st Mort. Deb. Stock	104 —106	3 16 11	..	105	104½
5t.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
5t.	..	Do. 5 per Cent. Perp. Pref.	12 —15	..	..	..	..
5t.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅜—½	..	..	..	..
1	..	Do. 5% Cum. Pref.	⅜—½	5 0 0	..	..	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 5 0	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 —2	..	..	..	..
5t.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	100—103	4 19 0	May	..	..
10	10/0	Potteries Electric Traction Ord.	8 — 9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	..	..	..
5t.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	Feb, Aug	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	..	..	..
5t.	..	Do. 4½% Deb. Stock (100% paid)	..	..	April, Oct	..	..
5t.	3%	Waterloo and City Ord.	89 —92	3 7 11	Jan, July	..	..
					June, Dec	90½	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 6	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
8t.	12/6	Anglo-American	47 —50	5 17 0	F,My,Ag,N	47½	47
8t.	25/0	Do. Preferred	91 —93	6 3 6	F,My,Ag,N	92½	91½
8t.	2/0	Do. Deferred	6¾—7½	1 7 6	F,My Ag,N	..	..
100	£2	Commercial Cable Capital Stock	175 —185	4 6 6	Jn,Ap,Jy,O	..	..
8t.	4%	Do. 4 per Cent. Deb. Stock	94 —96	4 5 0	Jn Ap,Jy,O	96½	96½
10	5/0	Cuba Submarine Ord.	7 —8	7 10 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100⅞—103⅞	4 9 0	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10½	6 4 0	Ja,Ap,Jy,O	10½	10⅞
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —103	4 9 0	Jn, Dec	..	..
8t.	25/0	Eastern Ordinary	126 —131	5 7 0	Ja,Ap,Jy,O	130½	128½
8t.	17/6	Do. 8 per Cent. Pref. Stock	87 —90	3 17 9	Ja Ap,Jy,O	89½	89
8t.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 6	May, Nov	106⅞	..
10	6/6	Eastern Extension	11½—12½	5 14 0	Ja,Ap,Jy,O	11⅛	11⅛
8t.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 15 0	Feb, Aug	106½	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	99 —102	3 19 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99½—102%	3 18 9	May, Nov	..	..
10	20/0	Great Northern (of Copenhagen)	25 —26	5 15 6	Jan, July	25½	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 —103	4 9 0	June, Dec	..	..
25	37/6	Indo-European	42 —45	5 11 2	May, Nov	44½	..
100	4%	Pacific&Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..
10	2/0	West African Telegraph Shares	6 —7	2 17 2	..	..	..
2½	..	West Coast of America	⅛—⅜	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 10	Jan, July	..	..
10	..	West India and Panama	⅜—½	..	May, Nov	⅜	⅜
10	6/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 7	May, Nov	6¼	6
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 18 4	Jan, July	102	..
10	3/6	Western Telegraph	12½—12¾	5 6 6	Mr,Jn,O,D	13⅛	12¾
100	5%	* Do. 5% Debs. (2nd Series, 1906)	102 —105	4 17 4	June, Dec	..	..
8t.	4%	Do. 4% Deb. Stock (red.)	101 —104	3 18 5	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
10	5/0	Globe Telegraph and Trust	8½—9½	5 19 0	Ja Ap Jy O	9	8½
10	5/0	Do. 6 per Cent. Pref.	13 —13½	4 8 11	Ja Ap,Jy,O	13⅛	13
8	4/0	†Reuter's	6½—7½	5 6 8	April, Oct	7⅛	..
100	6%	Submarine Cables Trust (Cert.)	117 —122	4 18 4	April, Oct	..	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed., June 22.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS WEEK TO JUNE 22	
		TELEPHONES.		£ s. d.		Highest.	Lowest.
5	2/0	Chili Telephone (fully paid)	4½—5½	5 14 8	August ..	5⅛	..
1	7½	Monte Video Telephone Ord.	½—¾	..	..	..	..
8t.	6%	National Co. Pref. Stock	104 —106	5 13 8	..	105	10
8t.	5%	Do. Def. Stock	85 —88	5 15 9	..	88½	8
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 —13	4 12 4	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5½	4 15 8	Feb, Aug	5⅛	5⅛
8t.	8½%	* Do. Deb. Stock 3½ per Cent. (red.)	99 —101	3 10 6	June, Dec	..	..
8t.	4%	Do 4 per Cent. Deb. Stock (red.)	103 —105	3 17 0	..	104½	104
		Do. Do. Prov. Certs. 70% to be pd.	29 —31	..	..	30½	..
1	0/8½	Oriental	⅛—1⅛	6 6 8	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1½	6 4 6	..	1½	..
5	3/0	United River Plate	6 —6½	5 7 8	July	6½	6½
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5½	4 15 8	June, Dec	5⅛	5⅛
8t.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 — 106	4 15 10	June, Dec	..	..
		ELECTRICITY SUPPLY.					
		Blackheath & Greenwich. Dist. Ord. (f.p.)	⅜—½	..	..	..	..
1	0/8½	Do. 7% Cum. Pref.	1¼—1⅝	5 1 9	..	..	..
8t.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	120 —125	3 12 0	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
8t.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
5	..	Bromley (Kent) El. Lt. & Power Shares	5½— 6	..	..	..	..
8t.	4½%	Do. Do. 1st Debs	100 —103	4 7 5	..	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	10¾—11½	4 8 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7 —7½	4 13 4	..	7⅜	..
8t.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105 — 108	3 14 1	..	105½	..
5	4/0	Charing Cross & Strand Electric Sup.	7½— 8	5 0 0	Feb, Aug	7⅝	6⅞
5	2/3	Do. 4½ per Cent. Pref.	5½—5⅝	4 8 6	Feb, Aug	5⅝	5
5	1/7	Do. City Undertaking 4½% Cm. Pref.	4½— 5	4 10 0	..	..	..
5	1/7	Do. Do. (19. 3)	4½— 5	..	..	4¾	..
8t.	4%	† Do. 4% Deb. Stock (red.)	102 —104	3 17 0	..	105	104½
5	3/6	Chelsea Electric Supply Ord.	6½—6¾	4 1 6	March ..	6⅝	6½
8t.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —110	4 3 0	Jn, Dec ..	..	..
10	6/0	City of London Electric Lighting Ord.	11 —11½	4 7 0	Feb, Aug	11⅛	11½
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13½	..
8t.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec ..	123½	..
8t.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 7 8	..	104	103½
10	6/0	County of London Elec. Supply Ord.	7½— 8¼	4 14 3	..	7⅝	7½
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	11⅛	..
8t.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106 — 109	4 2 11	..	..	..
8t.	4½%	Do. Second Deb. Stock Prov. Certs.	100 —103	4 8 0	..	101½	..
8t.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	90 —95	..	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 8	..	..	..
8t.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 — 103	4 8 0	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	10	..
5	5/0	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
8t.	4½%	I of W. Elec Lt. & Power 4½% Db. St (red.)	101 —103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	½—¾	..	..	..	..
5	7/0	Kensington & Knightsbdge Ord.	12 —13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
8t	4%	Kensington. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	..	..
8	..	London Electric Supply Ord.	1½—1⅝	..	..	..	..
5	2/0	Do. 6 per Cent Pref.	4½—5½	5 14 6	..	5⅝	..
8t.	4%	† Do. 4 per Cent. 1st Mort. Deb.	93 —96	4 3 4	Mr,Jn,S,D	94½	..
10	9/6	Metropolitan Electric Sup. Ord.	19½—20½	4 5 6	April, Oct	20⅛	20
5	1/4½	Do. 4½ per Cent. Cum. Pref.	5⅜—5⅝	4 1 0	..	5⅝	5½
8t.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec ..	..	..
8t.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 —100	3 11 0	..	99	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	96 —98	4 11 9	..	..	..
10	6/0	Notting Hill Electric Ord.	13½—14½	4 2 10	March ..	..	..
5	4/0	Oxford Electric Ord.	5½— 6	5 8 4	March ..	5⅜	5⅛
8t.	4%	Do. 4% Deb. Stock	98 —101	4 0 3	..	..	..
1	..	Rand Electric	½—1	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 —103	4 7 9	April, Oct	104½	..
5	9/6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	14⅜	..
5	3/6	Do. 7 per Cent. Pref	8 — 9	3 17 9	Feb, Aug	..	..
8t.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2⅜—2½	6 8 1	..	..	..
8t.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	3/0	South London Electric Supply Ord.	3⅜— 4½	3 10 7	..	..	..
5	2/6	Urban Electric Supply Ord.	4½— 5	5 0 0	..	..	..
5	7/0	Do. 5% Cum. Pref.	4½— 5	5 0 0	..	..	..
5	2/6	Westminster Electric Supply Ord.	12½— 13½	5 0 0	Mar, Sept	13⅛	13½
5	2/6	Do. 5 per Cent. Cum. Pref.	6½—6¾	3 14 0	..	..	..
		ELECTRIC MANUFACTURING &c.					
1	..	Aron Elec. Meter 6% Cum. Pref.	⅜— ½	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5½— 6	6 13 4	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5½— 6	5 0 0	Jan, July	..	..
5	4/0	Do. 4½% 1st Mort. Deb. (red.)	102 —105	4 7 0	..	..	..
8t.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
8t.	4½%	British Westinghouse 6% Pref.	8½—8¾	8 0 0	..	8⅜	8½
5	3/0	Do. 4 per Cent. Mort. Deb. Stock	87 —90	4 10 9	..	89	..
8t.	4%	Brush Electrical Engineering	1 —1¼	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼—1½	9 12 0	Mar, Sept	..	..
8t.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
8t.	4½%	Do. Perpetual 2nd Deb. Stock	73 —78	5 17 8	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½—10½	5 14 8	Jan, July	10	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 6 11	Jan, July	..	..
8t.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 3	Nov, May	..	..
1	9⅞d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
8t.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
8t.	4½%	Crompton and Co. (Nos. 1 to 54,000)	1¾—2¼	6 18 4	Jan, July	..	..
5	1/6	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95 —98	5 4 6	Jan, July	..	..
100	5%	Dick, Kerr & Co. Ord.	8 —8½	..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
8t.	4½%	Do. 4½% Deb. Stock	104—106	4 6 9	..	..	..
		Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	..
		Do. (£5 paid)	¾—1¼	..	Feb, Aug	..	..
8t.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	73 —78	5 5 8	June, Dec	..	..
8t.	5%	Do. 5 per Cent. 2nd Deb. Stock	75 —79	6 11 8	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5⅜—6	5 16 8	H'lf-yearly	5½	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅜—5½	5 2 6	..	5½	..
8t.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106 —109	4 4 0	..	107½	..
2	1/2½	Electric Construction Co.	1⅜—1⅝	7 2 10	Jan, July	1⅝	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2½—2¾	5 2 0	July ..	2⅝	..
8t.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
8t.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—9¾	5 2 6	..	..	..
8t.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	12⅜	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
8t.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	19 —20	5 0 0	Feb, Aug	19	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 —103	3 18 5	Mar, Sept	100⅜	100
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	36/0	Telegraph Construction & Mainten'ce.	36 —39	6 3 0	Mar, July	38½	37½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
5	..	Williams and Robinson Ord.	2½—3½	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3½—4½	..	Apr, Oct	..	..
8t.	4%	Do. 4 per Cent. 1st Mort. Debs.	85 —90	4 9 6	May Nov	..	..

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NOTES.

IN his Presidential Address to the Incorporated Municipal Electrical Association on Wednesday, Mr. T. P. WILMSHURST touched upon a variety of subjects which will not be discussed during the Convention that is now sitting, unless, indeed, an opportunity is afforded of considering some of them on Saturday, when the report of the Council is submitted. Chief among these is the grievance—and it is decidedly a grievance—that Parliament does not make up its mind as to the principles which should underlie the granting of powers to electricity undertakers. We sympathise with Mr. WILMSHURST'S desire that there should be a Department to assist the various Parliamentary Committees in these matters by fixing for them certain definite principles for their guidance. The poor hard-worked Board of Trade already does this, but Parliamentary Committees do not always follow its recommendations. If they did, there would be no "Bermondsey" and "Willesden" clauses, and no "electrolysis" clause.

IT is only right that some restrictions and safeguards should be introduced when municipalities embark in trading enterprises in districts outside their borough boundaries; but the principle having been accepted that it lies within the proper province of a Local Authority to supply electrical energy to its ratepayers, it is unwise to hamper the industry by the imposition of clauses such as the "Bermondsey" clause, which may effectually condemn a small undertaking of this character to work perpetually at a loss if it is not prosperous during the initial stage of its existence. For this reason we welcome what will probably be called the DUKE OF NORTHUMBERLAND'S clause, which, in accordance with the decision announced in our columns last week, is to be imposed by the House of Lords as a substitute for the "Bermondsey" clause in a number of Provisional Orders this session. The clause agreed upon will be found in another column of this issue. It will give a municipal undertaking five years in which to put itself upon a paying basis, and we trust that it will be accepted by the House of Commons and become standard practice in the case of electric lighting orders.

THE question of a lamp department, and the expediency of the electricity works providing "free" lamps to the consumer, is no new one. Bradford Corporation still continues its free lamp scheme, we believe, but its example has not been followed by many other electric light undertakers. Mr. WILMSHURST'S recommendation that some similar scheme should be adopted, in view of the methods followed by the gas people to push the incandescent gas burner, is worthy of consideration; but we think a better plan would be to encourage wiring contractors, rather than the supply authorities, to enter into maintenance contracts with consumers. Such contracts could include the periodical inspection and repair of the fittings, as well as the replacement of lamps, and should be advantageous alike to the consumer, the contractor, the lamp maker and the electricity undertaking, if the arrangements are made in a business-like manner.

THE Lorain Steel Co. must be praised for its enterprise and persistency in working out the surface-contact system of traction introduced in this country at Wolverhampton three years ago, and so far it has certainly proved itself the best that has been put into operation over a considerable length of line for a lengthy period of time. But a perusal of Mr. SHAWFIELD'S Paper in another part of this issue will lead to the conclusion that the best surface-contact system, although Mr. SHAWFIELD has much to say in its favour, cannot compare on the ground of general expediency with the popular overhead system for tramways. Taking Mr. SHAWFIELD'S figures, the cost of the electrical equipment of a mile of double-track is from £1,500 to £2,000 on the overhead system and £4,000 to £5,000 on the surface-contact system, and the running costs of the latter system are 19 per cent. greater. When it is remembered that all that is obtained

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for this extra expenditure is, in exchange for the trolley line, a set of surface contacts with an unfortunate reputation for knocking down horses and for emitting crackling sparks, the verdict must necessarily be in favour of the trolley system. Mr. SHAWFIELD'S Paper contains most interesting figures and data, among the most interesting of which are those which show that the surface-contact is not as bad as its reputation would lead us to believe; but he has been unable to prove that the system has sufficient advantages over the overhead system to warrant an expenditure upon it of more than double the capital and an increase of 19 per cent. in the cost of working.

ON another page of this issue we commence the publication of an article descriptive of the newly-electrified portion of the North-Eastern Railway, and of the Carville power house of the Newcastle-upon-Tyne Electric Supply Co. Although articles upon both have appeared in *The Electrician* from time to time, the present will be the first complete and detailed account of the complete scheme which has been published. Special interest attaches to the design of the Carville power station, particularly with regard to the arrangement of the switch gear, and this portion of the article will repay careful study. The official opening ceremony of the lines which have been converted to electric traction will take place in the course of two or three weeks, although electrically-propelled trains have now been running for some time. It is announced that electric traction will be commenced to-day (Friday) on the "electrified" line from Newcastle Central Station to Tynemouth, via Wallsend.

IT is not often that a Parliamentary Committee can be prevailed upon to order costs against opponents to Bills, and the ground of the application must be particularly strong to ensure success. On p. 360 of our issue for June 17th, we reported a case in which costs were ordered against the Sunderland Corporation by a Committee of the House of Lords for vexatious opposition. The facts of the case are these. The County of Durham Electrical Power Distribution Co. applied to the Board of Trade this year for a provisional electric lighting order for certain districts adjoining the boundaries of the Sunderland Corporation. At the Board of Trade inquiry no opposition was made by the Sunderland Corporation, but when the order, together with a number of others, was incorporated in a Bill for the purpose of confirmation by Parliament, a petition was entered against it by the Corporation, the plea being that at some future date their boundaries might be extended to embrace the districts in question. Consequently, when the Confirmation Bill came before a House of Lords Committee, presided over by the DUKE OF NORTHUMBERLAND, the County of Durham Company had all its witnesses ready, as well as counsel, only to find that the Sunderland Corporation had made no appearance. Hence the application for costs, which was granted. Now, however, it is announced that the Corporation refuse to carry out the order of the Committee, and it will be interesting to see the measures taken to enforce it should this attitude of the Corporation be persisted in. The amount of the costs is said to be about £500, and the Corporation Parliamentary agents have advised that the Committee has exceeded its rights in ordering costs against the Corporation. As a matter of fact, however, the Standing Orders of the House of Lords empower a Committee to do this.

AS evidence of the extraordinarily rapid strides which are being taken by electricity in the coal mining industry, there is nothing better than the Colliery Exhibition now being held at the Agricultural Hall. The electrical exhibits far outnumber those at last year's exhibition, and are typical of some of the very best practice in this direction. Whatever else the draft rules of the Departmental Committee on the Use of Electricity in Mines may accomplish, they have already set manufacturers of electrical apparatus thinking, and there are several devices at the Agricultural Hall, London, which have been specially designed to meet the suggestions embodied in these rules. We have consistently advocated the use of electricity as being more economical and in every respect superior to any other form of power transmission for colliery work, and it is exceedingly gratifying to find that our views are being adopted to such a large extent.

Personal.—Lord Kelvin celebrated his 80th birthday on Sunday.

Royal Meteorological Society.—His Royal Highness the Prince of Wales has consented to become patron of the Royal Meteorological Society.

The Victoria University of Manchester.—Royal assent has been given to the Victoria University Bill, which incorporates Owens College with the University.

Röntgen Society.—The annual general meeting of the Röntgen Society will be held on Thursday next, July 7th, at 20, Hanover-square, London, W., at 8:30 p.m. The election of officers for the ensuing year will take place at this meeting.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Dakar—Konakry	May 13, 1904 ..	—
Accra—Lagos	June 1, 1904 ..	June 23, 1904
Chio—Tenedos	June 21, 1904 ..	—

St. Petersburg-Manchuria Telegraph Line.—A correspondent of the *Journal* (Paris) states that, with a view to accelerating telegraphic communication between the Russian capital and the Far East, a special overhead telegraph line has been completed connecting St. Petersburg and the frontier station at Manchuria, passing through Moscow, Samara, Omsk, Tomsk and Irkutsk, a distance of 6,577 versts. It is further stated that the line was completed in 88 days.

The "Central."—The third number of the *Central*—the magazine of the Central Technical College Old Students' Association—has just been published. It contains a well-written "appreciation" of Prof. W. C. Unwin, who is retiring at the end of the present college session; an article on motor cars by Mr. M. O'Gorman; the first part of a serial on "The Mechanism of Combustion," by Prof. H. E. Armstrong; a well-illustrated article on "The Manufacture of Wood-Pulp," by Mr. R. W. Sindall; a note on "The Elongation Equation for Ductile Test-bars," by Mr. J. W. Hayward; a brief notice on the report of the Moseley Commission, and the "Old Student Notes," which are appreciated by all old Central men.

Conversazione of the Institution of Electrical Engineers.—The annual conversazione of the Institution of Electrical Engineers was held on Tuesday evening at the Natural History Museum, South Kensington. The guests, numbering about 1,500, were received by the President of the Institution, Mr. R. Kaye Gray, the President-elect, Mr. Alexander Siemens, and Mrs. Siemens, and also by members of the Council. Among the visitors were: Lord Kelvin, the Hon. C. A. Parsons, Mr. James Swinburne, Lieut.-Col. H. A. Yorke, Mr. Justice Jelf, Sir J. I. Thornycroft, Sir W. Ramsay, Sir W. H. Preece, Sir Hiram and Lady Maxim, the Mayor

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and Mayoress of Colchester, and Professors S. P. Thompson, W. L. Callendar, W. E. Ayrton, A. B. W. Kennedy and H. E. Armstrong.

Contact Resistance of Carbon Brushes.—Although the effects of current density, brush pressure, &c., on the contact resistance of carbon brushes have been investigated from time to time by various experimenters, the subject is still rather obscure. Herr Schenkel, according to the *Zeitschrift für Elektrotechnik* has made a series of experiments on the resistance of carbon brushes in contact with a rotating bronze ring. His conclusions are: That at constant brush pressures and constant speeds, the product $i \times w$ is constant, i being the current density and w = contact resistance; if current density and brush pressure are kept constant, then the contact resistance is nearly independent of the speed, provided that the ring be perfectly centred. If, however, this condition is not fulfilled, the brushes begin to vibrate and the contact resistance rapidly increases with the speed; the contact resistance diminishes with the brush pressure.

The Efficiency of Switchboards.—Mr. A. Boje, in an article to the *Elektrotechnische Rundschau* of June 15th, discusses the question of the efficiency of switchboards, and he tabulates the various losses observed in the switchboards of a small station, comprising two 80kw. continuous-current dynamos, one 160kw. dynamo and two accumulator batteries. The distribution is on the three-wire system at 2 × 110 volts. There are, of course, many places where losses occur; chief amongst them are the voltmeters, the fuses, the ammeters and the switches. Switchboard I., serving one of the two 80kw. dynamos, passed energy to the amount of 74,948kw.-hours during a year, the loss in this time being 75·9kw.-hours. The efficiency, therefore, comes to 99·89 per cent. Similar efficiencies were observed for the switchboards of the other machines, the lowest being that of the accumulator switchboard during charge (98·84 per cent.).

The Electric Locomotives for the New York Central Railway.—The new electric locomotives which are being built for the New York Central and Hudson River Railway Co. by the General Electric Co. of America, possess certain features of considerable novelty. The armatures of the motors, which are bipolar machines, are mounted directly on the shaft, while the truck frame acts as part of the magnetic circuit, there being no special yoke. There are four pairs of motor wheels and two pairs of pony truck wheels, the total length of the wheel base being 27ft., and the length of the locomotive overall 37ft.; 4·4in. driving wheels are employed, and the driving axles are 8½in. in diameter. The locomotive weighs 190,000lb., and is so designed as to pass easily round a curve of 230ft. radius. Four 600-volt continuous-current motors each of 550 H.P. are fitted to the driving axles, but these will be able to exert 2,800 H.P. taken together, if desired.

Extension of the Shipley Electricity Works.—The demand for electrical energy, particularly for traction purposes, has recently increased in Shipley to such an extent that it has become necessary to increase the station capacity. During the year ended March 31, 1903, 470,530 units were generated (169,294 units being required for traction purposes), and the units generated in the following year amounted to no less than 926,244, of which 362,411 units were consumed by the electric tramway system. In order to meet the growing demand a 800 H.P. turbo-generator is to be installed, as also another boiler, fitted with a mechanical stoker and superheater. The switchboard is to be enlarged for three more electric generators. The premises at Dockfield have been extended, the new buildings covering 418 sq. yds. They comprise new offices, drawing room, battery room, stores and testing shops. These new buildings were officially opened on Tuesday, June 21st. At present the generating plant consists of three Parsons steam turbines, aggregating 1,100 H.P., directly coupled to three 240kw. generators, which supply energy at 460 volts.

A New Locomotive for the Jungfrau Railway.—In the *Schweizerische Elektrotechnische Zeitschrift* of June 18th Dr. Wrubel describes locomotive No. VI. of this railway. It differs in some important electrical details from the older locomotives (see *The Electrician*, Vol. XLI., p. 706), but the mechanical design has not changed. The locomotive weighs 16·8 tons and is equipped with two 150 H.P. 450 to 600-volt three-phase motors, running at 760 revs. per min. A speed of 5 miles per hour is maintained on both the up and the down journey. Special arrangements are provided for regulating the speed of the locomotive on the down grade—when disconnected from the line—between the normal speed and 5 per cent. of this. The motors of the new locomotive work as asynchronous motors on the up journey, but they can be connected up as self-exciting generators on the down run. They have three slip-rings on the one side and a commutator on the other. The three brushes belonging to the latter are automatically lifted off the commutator by a three-phase magnet whenever the line circuit is connected up to the motors. A substantial resistance, capable of absorbing 170kw. for a lengthy period, is used both for starting and for braking. The rheostat is cooled by a ventilator.

The Nickel-iron Accumulator of Dr. Jungner.—Herr M. U. Schoop, writing to the *Centralblatt für Accumulatoren* of June 15th, refers to the early experimental work done by Dr. Jungner, and concludes with some interesting information regarding the present state of development of the nickel-iron accumulator. According to Herr Schoop, Dr. Jungner commenced his series of experiments with accumulators having an alkaline electrolyte as far back as 1892, and he obtained a Swedish patent in 1901 (dated January 29th) for the combination of iron and nickel electrodes. In composition and design the present Jungner accumulator closely resembles that of Edison. The thickness of the positive electrode is 3·5mm., that of the negative electrode 2·5mm., and the distance between the plates is 2mm. In order to increase the conductivity of the active material, Dr. Jungner provides the graphite with a coating of metal deposited by an electrolytic process. Experiments are now being carried out for producing the outer case of the cell in one piece from a nickel-plated sheet of crucible steel 0·5mm. thick. The German firm of Gottfried Hagen of Kalk-Köln procured the patent rights of the Jungner accumulator last autumn, and it is stated that the process of manufacture has now been so simplified that nickel-iron cells can be made as cheaply as lead accumulators, having an equal capacity in watt-hours per pound. It is stated that the nickel electrode appears to have a somewhat longer life than the iron electrode, being quite indifferent to overcharges and reversals of current. With ordinary care, however, the iron electrodes also possess long life and give no trouble.

One-axle Bogies for Tramcars.—In order to secure a long wheel base for tramway cars which have to pass sharp curves, the Maschinenfabrik Augsburg und Nürnberg supply the cars with two bogies, having one axle each. Both bogies are connected by a link-joint which allows each one of them to take up a position in line with the radius of the curve through which it is passing. Each bogie is guided by means of rollers and segments, the latter being fixed to the car body. When entering a curve, the back axle tends to take up a radial position with regard to the curve, and, by means of the link-joint referred to, the front axle, too, is turned into a radial position. This action takes place against the pull of springs which tend to set the axles parallel to one another. The motors are suspended from the axles in the usual way, and the pull of the bogie is transmitted to the car by means of a stud, fixed to the body, and a metal plate on the bogie, in the circular slot of which the stud works. According to an article on this subject in *Elektrische Bahnen* it appears that curves down to 46ft. radius have been negotiated with cars having a wheel base of 10ft., and it is also stated that experiments on such cars running in Darmstadt indicate that there is—per ton-mile—a saving in current of 10 per cent. in favour of the new design. Some 60 cars have been built so far on these new lines. A few particulars of a set of two bogies for normal gauge and curves of 46ft. radius are: Wheel base 10½ft., weight of truck 4,900lb., weight of car 11,500lb., weight of car per seat 525lb.

Birthday Honours.—A number of gentlemen directly and indirectly connected with the electrical profession were included in the list of birthday honours published on Friday. Mr. George White, Chairman of the Bristol Tramways and Carriage Co. and of the Imperial Tramways Co. and also connected with the London United Electric Tramways, has been created a

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Baronet. Knighthoods have been conferred upon Prof. James Dewar, F.R.S., Mr. George Gibb, a member of the Royal Commission on London Traffic and General Manager of the North-Eastern Railway Co., and Mr. W. Lloyd Wise, who took a leading part in bringing about the legal recognition of patent agents in 1888, and has published books on patent law in connection with the electrical industry. Among the other honours are the following:—Companions of the Bath (Civil Division) (C.B.): R. A. Egerton, Secretary to the Post Office, Dublin; J. Lithiby, Assistant Secretary, Local Government Board; E. P. W. Bedford, Secretary to the Post Office, Edinburgh; and Lieut.-Col. H. A. Yorke, Chief Inspecting Officer of Railways, Board of Trade. Companion of the Order of St. Michael and St. George (C.M.G.) (Colonial Division): W. B. Spencer, President of the Professorial Board of the University of Melbourne. Knight Commander of the Order of the Indian Empire (K.C.I.E.): Col. J. W. Ottley, President of the Royal Indian Engineering College, Cooper's Hill. Companion of the Imperial Service Order: A. W. Heaviside, Superintending Engineer Postal Telegraphs, Newcastle-on-Tyne. The Imperial Service Order has also been granted. among others, to a large number of telegraphists and similar Government employés.

Wireless Telegraph Notes.—The President of the United States has appointed a Board of Naval and Military officials to enquire into the existing conditions under which wireless telegraphy is now being carried on, with a view to ascertaining the best system for adoption by the Government. It is also suggested that the committee is to make investigations regarding the extent to which wireless telegraphy should be under State control.

We learn that an arrangement has been arrived at by which the English de Forest Wireless Telegraph Co. will take over all the wireless telegraph patent rights of Mr. Nevil Maskelyne, and that the company will probably henceforth be known as the De Forest-Maskelyne Wireless Telegraph Co. It is not the intention of the company to attempt long-distance communications such as transatlantic work, nor will they undertake any inland work where wires are possible, but they will instal wireless telegraph apparatus where submarine cables are not feasible, owing either to the small amount of traffic or to natural conditions of the situation. In this way it is hoped that such installations will supplement the work of the cables by acting as feeders.

Invitations have been issued by the German Government to a second Wireless Telegraph Conference to be held in Berlin in the autumn of 1904, to continue the work of the Conference held in Berlin in August last, and to extend and complete, as far as possible, the set of draft rules and regulations which have been already submitted to the various Governments for consideration. It is considered probable, however, that, in consequence of the state of war in the Far East, the Conference will be postponed.

A New Slip-meter.—In a recent lecture before the "Elektrotechnischen Verein," Dr. G. Benischke described the following simple arrangement for measuring the slip of induction motors, the slip being defined as $(u_1 - u_2)/u_1$, where u_1 = the speed corresponding to synchronism and u_2 = the speed of the induction motor. Dr. Benischke fixes to the shaft of the induction motor a disc having a number of sectors alternately coloured black and white. Opposite to this, and at a short distance from it, is a second disc having a number of apertures of a sectoral shape and fixed on to the shaft of a small synchronous motor. A speed counter is also worked by this auxiliary motor, and it may be put into gear with the motor shaft or else disconnected from it by a lever. In looking from the rear of the synchronous machine through the apertures of its revolving disc, the sectors of the induction motor disc appear to rotate, the speed of rotation being obviously proportional to the slip. When taking a measurement, the speed counter is put into gear by depressing the lever, and the apparent speed of the induction motor disc is determined by counting the number of its sectors that pass a fixed point in space. This counting is continued until the speed gear is put out of action by raising the lever. The number of sectors that have passed during this interval is a measure of the difference in speed of the two motors due to slip—*i.e.*, $u_1 - u_2$, and the indication of the speed counter is a measure of the synchronous speed u_1. After reducing the two readings thus obtained with regard to the number of sectors on the one disc and the number of apertures on the other disc, the quotient of the two corrected readings will denote the slip. By suitably choosing the number of sectors and apertures, the reduction may be made very simple or may even be made altogether unnecessary.

Iron and Steel Institute's Visit to America.—Arrangements for the autumn meeting of the Iron and Steel Institute in the United States are now practically complete and for the reception of the Institute an influential committee has been formed in the United States. It is absolutely necessary that the number of members desirous of taking part, and the number of ladies accompanying them, should be known at once, as a limit may have to be placed on the number that can be provided for on one of the excursions. The following is the provisional programme:—

Most members will arrive in New York on October 21st, 22nd and 23rd. The headquarters will be at the Hotel Astor at 44th Street, and Broadway. On October 24th, there will be optional excursions to power houses, bridges, industrial establishments, universities, the navy yard, subway and other places of interest in New York during the morning and afternoon, with the opening of the annual general meeting of the Institute in the evening, followed by a reception. October 25th will be devoted to an excursion up the Hudson on a specially chartered Albany boat, stopping at West Point, where the United States Military Academy is situated. In the morning and afternoon of October 26th there will be two meetings of the Institute for the reading and discussion of Papers. In the evening the Institute will entertain the reception committee at dinner at the Waldorf-Astoria. The party will leave New York in the morning of the following day for Philadelphia, where October 28th will be spent. On October 29th special trains will leave for Washington, where there will be a reception in the evening by the President of the United States. October 30th will be spent in Washington, and October 31st, November 1st, 2nd and 3rd in Pittsburg. The main party will leave on November 4th for Cleveland, and spend Saturday and Sunday at Buffalo. Those who wish to stop at Albany to visit the General Electric Co.'s works, can do so, both parties arriving in New York on the evening of November 8th, in time for the steamer leaving for England on November 9th. During the stay in Buffalo the party will be taken to Niagara and given ample opportunity to see the Falls. The party travelling entirely by day, will only have to take two or three meals on the trains; and it may be estimated that the total cost for the main trip will be £25. For the convenience of members desirous of visiting the St. Louis Exhibition, arrangements will be made for a limited number to leave Pittsburg for St. Louis and Chicago, returning to New York in time for the steamer leaving November 12th. This trip will necessitate three nights being spent in sleeping cars, and the approximate cost will be £35.

A New Dynamo.—A dynamo of considerable interest is described by Herr W. Winkelmann in a recent issue of the *Elektrotechnische Zeitschrift*. The armature of the machine, which is made by Messrs. A. Leymann & Co., Schüttorf, according to a design patented by Herr Koppelmann, consists of laminated sectors, and resembles, therefore, a commutator, with the exception that the space between the sectors is not filled in with insulating material but with the armature windings. Each magnet pole of the ordinary type of continuous-current machine is replaced by a pair of poles of opposite polarity, so that the lines of force enter the armature at one end, then flow axially to the other end of the armature and from thence radially into the other field pole, thus completing the magnetic circuit. A number of such pole pairs are grouped around the armature, the polarities of the two poles forming one pair being reversed for alternate pairs. In order to get a summation of the E.M.F.s generated in the armature conductors, each conductor is laid along only one-half of the armature, and an E.M.F. is induced in this portion due to one pole only, which is, say, a north pole. In the centre of the armature the conductor is cranked, the cranked portion being laid in a peripheral groove in the middle of the armature, and leading to another pole in the next pair of the same polarity as before (*i.e.*, a north pole), and the second axial portion of the conductor, therefore, induces an E.M.F. of the same direction as the first. The winding is then continued in the usual manner, and it will be obvious, upon reflection, that the difference between this and an ordinary winding consists in the shifting of one-half the length of the armature conductors relative to the other half. Tests are given of a continuous-current machine, the principal dimensions of which are:—Diameter of armature 16¼in., double air-gap 0·354in., number of conductors 398, size of conductor 1·5mm. by 12mm., number of slots 100, number of pole pairs four, field ampere-

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turns 3,150 per pole, total weight 2,340lb., armature iron 322lb., and armature copper 128lb. When tested as a motor, with a current of 151 amperes at a voltage of 244·5 volts, a final temperature rise of 28·7°C. in the armature and 59°C. in the field coils was observed. The speed was 607·7 revs. per min. A separation of the various losses at full load resulted in the following figures:—Copper 2,160 watts, hysteresis 260 watts, eddy current 440 watts, friction 420 watts, excitation 601 watts, brushes 100 watts; total, 3,981 watts. The tests indicated an efficiency of 89·2 per cent. In consequence of the deep air slots, the self-induction of the armature winding is small, and the brushes were left in the neutral line, without sparking occurring at any load. The weight of the machine per kilowatt is 71lb., but, as the armature was not loaded up to the temperature limit, the author is of opinion that this figure might easily be reduced to 56lb.

Telephone Statistics of the United States.—Mr. W. M. Steuart, chief statistician of the Department of Manufactures in the Bureau of the Census, now part of the Department of Commerce and Labour, has just issued a preliminary report, of which the following is an abstract, on the telephone systems of the United States for the year ending December 31, 1902. This report, which is in line with those already issued in regard to street railways and the electric lighting industry, includes all commercial telephone plants, all mutual systems and all separate "farmer" or rural lines in operation during any portion of the year. It does not include, however, any single lines of an exclusively private character. According to the *Electrical World* of New York, the inquiry is the first of the kind as to the telephone ever undertaken in America, and has been extremely difficult on account of the rapidity of recent growth and the heterogeneous nature of the systems. The total assets of the entire American telephone undertakings reach $452,172,546.

Construction, Equipment, &c.	
Number of systems	4,151
Miles of single wire	4,350,486
Telephones of all kinds	2,315,297
Number of subscribers	2,137,256
Number of automatic pay stations	73,887
Number of all other pay stations	48,393
Number of party lines	258,166
Number of telephones on party lines	886,152
Number of public exchanges	10,361
Number of private branch exchanges	7,883
Manual switchboards, total number	10,842
Common battery system	837
Magneto system	10,005
Automatic switchboards	54
Messages or talks during year, total number	5,070,555,345
Local exchange	4,949,850,491
Long distance and toll	120,704,854
Total revenue	$86,825,536
Total expenses (including taxes and fixed charges except interest on bonds)	$61,152,823
Dividends paid	$14,982,719
Interest on bonds	$3,511,948
Net surplus	$7,178,046

In addition to the reports obtained from commercial and mutual telephone systems, the bureau secured reports of 4,985 independent farmer or rural lines having 49,965 miles of single wire and 55,747 telephones. These figures added to the totals for the commercial and mutual systems give a grand total for the continental United States of 9,136 systems and lines, 4,900,451 miles of single wire and 2,371,044 telephones. A number of commercial systems operate in rural districts, but combining the totals for farmer or rural lines owned by commercial systems, mutual systems and independent farmer or rural lines gives a total of 21,577 systems and lines, 259,306 miles of single wire and 266,968 telephones operated exclusively in rural districts. In addition to the statistics presented above for the continental United States, reports were received for one commercial system in Alaska and seven in Hawaii, having a total of 4,732 miles of single wire, 2,493 telephones of all kinds, 3,461,000 messages or talks during the year, $112,068 total revenue, $76,307 total expenses (including taxes and fixed charges) and $25,858 paid in dividends, leaving a net surplus of $9,903. The final report will contain an analysis of the above totals and present detailed statistics by States and for other phases of the industry. This report will be in the nature of a full discussion of the subject, in the manner of the reports that have been prepared and are also to be published in regard to electric lighting, street railways and electric manufacturing.

Electric Towing on the Teltow Canal.—A report has recently been issued by the management of the Teltow Canal (Germany) relating to trials of an electric towing locomotive. An abstract of the report appeared in *Elektrische Bahnen*, from which the following particulars have been taken. The experimental permanent way, 0·8 of a mile long, consists of rails weighing 45lb. to the yard, which are supported by iron sleepers, the gauge being 1 metre. Under the bridges the towpath is only 4ft. 11in. wide, but in the open the width increases to 6ft. 7in. The cross-section of the canal where the trials were carried out varied from 810 sq. ft. to 870 sq. ft. A small power station had been erected, which supplied the locomotive with continuous current at 550 volts by means of two trolley wires. The locomotive, built by the Siemens-Schuckert Company, has a bogie in front and one free axle at the back, each of the two axles of the bogie being driven through double gearing by an 8 H.P. series motor. In front of the bogie is the motorman's cab, totally enclosed but glazed on all sides. Just behind the cabin is a winding drum, by means of which the towing rope may be drawn in or paid out. This drum is not rigidly fixed to its shaft, however, but is connected with it through a friction coupling, which begins to slip whenever the pull on the rope exceeds 2,500lb. The drum is driven by a 2½ H.P. motor through worm gearing. From the drum the rope passes through an eyelet fixed to the top of an iron standard 8ft. 3in. high, placed directly over the free axle at the back of the locomotive. This standard is pivoted at its base and may be raised or lowered, with the pivot as the fulcrum, by a 1 H.P. motor; from the eyelet on the standard the rope passes to the barge. Of the total weight of the locomotive—*i.e.*, 6½ tons—5·6 tons are on the bogie. In certain trials which were conducted between October 14 and December 8, 1903, the following barges were used:—1. "Oderkahn," 176ft. long, 26·6ft. wide, weight empty 140 tons, draught, with a useful load of 440 tons, 5ft. 3½in. 2. "Berliner Masskahn," 163ft. long, 24·2ft. wide, weight empty 100 tons, draught, with a useful load of 320 tons, 4ft. 8¼in. 3. "Finowkahn I.," 131ft. long, 15·1ft. wide, weight empty 60 tons, draught, with a useful load of 190 tons, 5ft. 1in. 4. "Finowkahn II.," 132ft. long, 15·1ft. wide, weight empty 50 tons, draught, with a useful load of 154 tons, 4ft. 5in. When running alone the locomotive consumed 4·5 amperes at a speed of 3·1 miles per hour and 8·5 amperes at about 6 miles per hour, the voltage being 550 volts in both cases. Trials with empty barges were then carried out, and it was found that when the rope was fastened to a tow-mast on the first barge in the usual manner, the steering was not effective enough to prevent the barges from being drawn towards the bank. In the following tests the towing rope was about 260ft. long, and the tow-mast on the barge was 13ft. above the level of the water. Experiments were carried out with one barge alone and with groups of two, three and four barges. The mean values of the results are as follows:—At a speed of 2·48 miles per hour the tractive resistance was about 1·9lb. per ton of useful load or 1·33lb. per ton displacement. The locomotive absorbed 0·014kw. per ton of useful load or 0·0112kw. per ton displacement, and the energy required was 5·6 watt-hours per ton-mile of useful load and 4·4 watt-hours per ton-mile displacement. At a speed of 2·8 miles per hour the corresponding figures are: 2·3lb., 1·75lb.; 0·021kw., 0·0155kw.; 6·85 watt-hours, 5·4 watt-hours. At the still higher speed of 3·1 miles per hour the figures are: 2·98lb., 2·16lb.; 0·0284kw., 0·0209kw.; 4·02 watt-hours, 6·6 watt-hours. The locomotive efficiency at loads from 600 to 1,100 tons was about 65 per cent. It was observed that the tractive resistance increased by about 15 per cent. when the barges were near to the bank of the canal, while it decreased by about 10 per cent. when two boats passed each other at a speed of about 3·2 miles per hour. For shorter lengths of the towing rope than that adopted the tractive resistance increased and the steering difficulties were accentuated. The distance between the various barges did not appear to have any material bearing upon the tractive resistance.

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THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The ninth annual convention of the Incorporated Municipal Electrical Association opened in Derby on Wednesday. Yesterday the Association met in Nottingham, to-day (Friday) the meeting is in Sheffield, and to-morrow (Saturday) the business meeting will be held in Derby.

Wednesday, June 29th.

The Association was welcomed by the Mayor of Derby (Councillor C. Boam, J.P.) and the chairman of the Electricity committee (Ald. Butterworth). Mr. T. P. Wilmshurst, borough electrical engineer of Derby, who is president of the Association this year, then delivered his address. We give a verbatim report of the address on another page, and also comment upon it in our editorial notes. In the address, which was well received, Mr. Wilmshurst criticised the uncertain policy of Parliamentary Committees, advocated the organisation of a lamp department in connection with municipal electric supply works, and laid stress on the necessity of improving the daylight power load, pointing out that motors for miscellaneous power purposes gave an even better load-factor than tramways. His announcement that there were 250 single-phase motors at Derby, aggregating 1,300kw., and consuming 30 per cent. of the total units sold, was received with applause. Mr. Wilmshurst also called attention to the extraordinary divergence of practice of the various rating authorities, the item for "Rent, rates and taxes" in the costs sheet varying from 0·02d. per unit sold in one town to 0·7d. in another. The president concluded with an appeal to support the work of the Engineering Standards Committee "by judicious stifling of that natural desire for originality which smoulders in the breast of every well-regulated engineer."

A vote of thanks was proposed by Dr. J. E. Panton (Bolton) and seconded by Ald. G. Pearson (Bristol). Mr. Pearson cordially endorsed what Mr. Wilmshurst had said about the vacillations of Parliamentary Committees, and suggested sarcastically that in some cases the learned counsel engaged might just as well settle their differences by tossing up.

Mr. C. E. C. Shawfield (Wolverhampton) then read in abstract his Paper on the surface-contact system at Wolverhampton. He also explained the system with the aid of magic lantern slides, and showed on the screen some photographs of overhead wires evidently taken with the object of emphasising their unsightliness. The Paper is printed in full elsewhere in this issue. Mr. Shawfield's 2½ years' experience with the Lorain surface-contact system lead him to consider it even safer than the overhead trolley system, the only deaths resulting from live studs having been those of a sheep and a dog. The cost of maintaining the track is not excessive, and the main objection to the system, in Mr. Shawfield's opinion, is the extra consumption of energy required for working the circuit-closing mechanism in the stud and for carrying the extra weight of the skate and its accessories on the car; and, of course, the first cost of the line equipment is also far greater than that of the overhead system. The discussion was opened by Mr. J. H. Rider (London County Council tramways) who severely criticised the surface-contact system and the Paper in an amusing speech, and particularly criticised Mr. Shawfield's statements about the defects of the overhead system. He wound up by quoting a statement to the effect that Wolverhampton had the quickest service of tramways in the country, as the drivers of horse-driven vehicles were careful to keep clear of the track owing to the possibility of the contacts being charged, and repeated the fable of the tail-less fox, which he left Mr. Shawfield to apply as he would. Mr. Wetmore (of the Lorain Steel Co.) defended the surface-contact system, stating that the failures in Paris, which had given it a bad name were due to the use of mercury in the Diatto system employed there, and the insufficient strength of the top cover of the contact-box. Mr. F. C. Raphael protested against the exaggerated photographs of overhead work that had been exhibited. Mr. J. F. C. Snell (Sunderland) asked several questions, which were replied to subsequently by Mr. Shawfield. Finally, Mr. Stanley Clegg (Lincoln) stated that it had practically been decided to adopt the G.B. surface-contact system at Lincoln, in which old cathedral town there were æsthetic objections to overhead wires. Mr. Shawfield made a spirited reply to the discussion, showing considerable skill in meeting Mr. Rider's criticisms and reminding Mr. Rider that there was another fable about a fox in connection with certain unripe fruit. We report the discussion fully in another column.

A Paper by Mr. A. J. Cridge, assistant engineer at the Sheffield electricity works, on "The Organisation and Management of a Central Station Meter Department" was then taken as read. The Paper described the systems the author advocated in the work of a department for the testing, reading and maintenance of the meters, and also the testing of installations, lamps and instruments, and the replacing of fuses, which is apparently the work of the same department at Sheffield. The meters being single-phase, a 10kw. transformer supplies the current for testing, the arrangements being such that a large current at low pressure is passed through a number of meters in series, while the pressure coils of the meters are supplied from a separate pressure circuit. This, of course, means a considerable saving over the method still frequently employed for testing the meters with their actual full load. The number of revolutions of the meter disc are timed, the maker's figures for the gear ratio being accepted. The last part of the Paper dealt with the somewhat complicated organisation of the meter reading and consumers' accounts department, the methods adopted in inspecting house wiring, attending to complaints, and similar matters.

Mr. J. Christie (Brighton), who opened the discussion, considered the subject important, as the difference between the number of units generated and sold was far greater than could really be lost in the network. He disapproved of the meter department inspecting installations, and approved of the card system. Mr. J. Dick (Reason Mfg. Co.) deplored that there was no English book on meters, and emphasised the importance of meter accuracy, urging engineers to buy none but the best meters. Mr. Venner regretted that Mr. Cridge condemned meters with commutators, but pointed out that the prepayment meters alluded to in the Paper had commutators. Mr. Chamen (Glasgow) had found some difficulty in obtaining meters with cyclometer dials, although Mr. Cridge had referred to the willingness of makers to supply these. At Glasgow he preferred to employ meter readers distinct from the testing department. The gas department at Glasgow had had trouble on account of theft from prepayment meters, so he had thought it wiser not to make use of them. Mr. Cawthra (South Shields) said that he was not surprised at Mr. Cridge finding it necessary to employ a staff of 14 if he changed a consumer's meter every two years. Mr. Brydges (Eastbourne) had had trouble with prepayment meters with commutators, and described a compact portable accumulator battery for testing. Mr. G. Wilkinson (Harrogate) thought Mr. Cridge's meter department over-staffed. At Harrogate, 1,300 meters were looked after by a testing superintendent, two boys and a meter reader. Mr. Cridge then replied briefly, stating, in answer to questions, that his department dealt with about 2,600 consumers and 3,200 meters.

In the afternoon, excursions were made to Chatsworth House and Haddon Hall by the kind invitation of the mayor and Corporation of Derby. The weather was gloriously fine and the excursions were thoroughly enjoyed.

Thursday, June 30th.

After welcoming speeches by the Mayor of Nottingham (Councillor A. Page, J.P.) and Alderman Sir John Turney (Chairman of the Electric Lighting Committee), gracefully acknowledged by Mr. Wilmshurst, Mr. S. L. Pearce, the new city electrical engineer of Manchester, read in abstract his Paper on "Polyphase Sub-Stations." The author disclaimed any intention of putting forward original matter, but gave an interesting review of the subject, explaining the good and bad points of the various methods of sub-station design. Taking a 6,500-volt 220kw. machine as an example, the costs of an asynchronous motor-generator, a synchronous motor-generator and a rotary converter (exclusive of its stationary trans-

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formers) worked out to £6·1, £5·5 and £3·8 per kilowatt respectively, the floor space occupied by the rotary being also considerably less. Mr. Pearce also referred briefly to a modified motor-generator consisting of an induction motor whose rotor is connected to the armature of the continuous-current machine it drives—a device which, it is claimed, combines the advantages of the induction motor-generator and the rotary converter. A more detailed description of this machine would have been useful. The various types of stationary transformer and switchboard were also considered, and drawings and descriptions were given of the new motor-generator sub-stations in Manchester. Incidentally, Mr. Pearce raised the question as to whether separate high-tension lighting and traction 'bus bars were necessary, as he had found that the varying traction load did not interfere with the steadiness of the lighting voltage. After detailing the various methods adopted for starting rotaries and synchronous motor-generators, he described an alternative method in which a compensator is used to reduce the main voltage by 50 per cent., and the decreased voltage is employed for starting, the machine being switched over from the half-voltage to the full-voltage 'bus bars when it attains full speed. He also described the A.E.G. equaliser arrangement employed for balancing at Manchester. Summing up, Mr. Pearce recommended rotaries at 25 ~ for traction, synchronous motor-generators at 50 ~ for "mixed" lighting and traction, and for a continuous-current lighting and power system, as a rule, some synchronous and some induction motor-generators.

The discussion was largely directed to the relative merits of rotary converters and induction motors. Mr. E. T. Ruthven-Murray (Willesden) had come to the conclusion that the reputation for want of stability which had been given to rotaries was not justified. He himself had been running rotaries at 25 ~ for lighting for 12 months, passing 500,000 units through them without trouble. He also instanced the Isle of Thanet Tramways, where 50 ~ rotaries had been employed successfully for two or three years. Mr. J. H. Rider (L.C.C. tramways), on the other hand, far preferred induction motors, and dwelt on the difficulties with rotaries or synchronous motor-generators owing to having to stop all the machinery, re-start it and synchronise it if the supply were interrupted for half a second even. Mr. Ruthven-Murray also spoke on the methods of voltage regulation, and recommended cutting windings in and out of the transformer primaries rather than employing induction regulators He balanced by connecting to the middle wire the centre of the star-connected secondary feeding the rotary, and had thus dealt with 75 per cent. out-of-balance current on a 100kw. machine. Mr. S. Z. de Ferranti deplored the increasing complication in distributing systems as exemplified by the Paper, and once more expressed his devout belief that we should return to simple single-phase working. Mr. C. H. Wordingham expressed his surprise at the difference between the cost of using three single transformers and a three-phase transformer —viz., £1·4 per kilowatt in the former case and only £0·8 in the latter case for oil-cooled transformers. Mr. J. H. Highfield (Metropolitan Electric Supply Co.) supported Mr. Rider in putting reliability above everything, this being in his case particularly important, as he was competing with a company. Mr. Hadley (The Electrical Co.) spoke briefly, mentioning incidentally that an objection to induction motor-generators was their noise, a point to which Mr. Pearce, who uses motor-generators made by Mr. Hadley's firm, cordially agreed. Mr. V. A. H. McCowen (Belfast) asked what was the all-day efficiency of the sub-stations, and was informed by Mr. Pearce that it was from 75 to 76 per cent. In his reply to the discussion Mr. Pearce also stated that he had had no burn-outs due to supplying the stators of motor-generators at the unreduced high pressure, a fact which Mr. Ruthven-Murray had appeared to doubt, as makers showed some reluctance in supplying small motor-generators to take this high pressure. The discussion was very long, and raised a number of other highly-interesting technical points; we shall publish a full report of it in an early issue.

Mr. H. Faraday Proctor (Bristol) then read in abstract his Paper on the Bristol fire, briefly describing the circumstances, as already reported in our columns, and mentioning the safeguards which he was adopting in reconstructing the switchboard. Several hypotheses as to the cause of the fire were put forward during the discussion. Mr. H. Kilgour (Cheltenham) thought that it was occasioned by the machine fuse blowing. Mr. G. H. Cottam (Hampstead) had had experience of fires due to the fuse boxes not being full of oil, but Mr. Proctor assured him that in this case the boxes had been inspected before the occurrence and were quite full. Mr. L. Andrews did not believe in the electrostatic leakage explanation to which Mr. Proctor appeared to incline, and suggested that the first cause of the fire was a failure on a feeder outside followed by a dangerous arc on the generator fuses, and Mr. H. W. Clothier agreed more or less with Mr. Andrews. Mr. C. H. Wordingham emphasised the importance of not employing any inflammable material near the switchboard. He particularly objected to the use of an impregnated cover round the armouring of the cables, and suggested a copper instead of a lead sheath, as having a higher melting point. Councillor Irwin (Dublin) and Mr. G. Wilkinson (Harrogate) also spoke. Mr. Ferranti wound up the discussion by thanking Mr. Proctor and others for the generous attitude they had adopted towards his firm in the matter. He was quite prepared to believe that the fuses failed, and that this was the cause of the fire. He pointed out that the cellular form of switchboard was quite thrown away if there were combustible material near it, and suggested the use of compressed glass blocks as flooring instead of rubber mats. He mentioned that cellular switchboards had been in use in the sub stations of the London Electric Supply Corporation for 14 years, and that there had been no accident of any sort from them there. Mr. Proctor replied briefly, and the meeting adjourned.

In the afternoon visits were made to the Nottingham electricity stations and refuse destructors, Trent Bridge car depot and repairing shops and the Loughborough works of the Brush Electrical Engineering Co. The Association dinner, followed by a smoking concert, was held in the evening.

Accumulator Locomotives for Shunting Purposes.—According to Herr A. Passauer in *Elektrische Bahnen*, an electric locomotive built by Messrs. Siemens and Halske has been doing shunting work at the Oberhausen railway inspection works of the German State Railways since June of last year. The locomotive, which weighs complete about 26½ tons, rests on three pairs of wheels, the outer pairs of which are driven by series motors through a single-reduction gear of the ratio 1:4·5. The motors are guarded against excess currents by an automatic cut-out and fuses. When loaded with 72 tons, the locomotive attains a speed of about 10 miles per hour, and has, with the same load, an acceleration of about 0·46ft. per second per second. The complete motor equipment weighs just over 4 tons. The car body is built up entirely of steel, the motor man's cab being in the centre and the accumulator compartments being fore and aft of this. A battery of 200 cells, in boxes made of a special vulcanite is distributed in equal parts in the two compartments. Each cell has a capacity of 184 ampere-hours when discharged in two hours. Twenty cells, forming one group, are built into wooden boxes, which have a coating of an acid-proof insulating material. These groups are further insulated from one another and from the locomotive by porcelain insulators. Lead strips are used as connectors from group to group. In the cab is a small controller, by means of which the battery is split up into five parallel groups for charging. After this has been done from the 110-volt supply, the groups are again connected in series, the voltage of the battery then being from 360 to 410 volts. A set of voltmeters and amperemeters is fixed in the cabin, so that the process of charging, discharging and testing can be intelligently followed by the man in charge. The battery, which weighs complete 10 tons, is charged with constant current, the regulation being carried out by a variable series resistance. A hand brake and electric brake are provided, and the speed of the locomotive is governed by a series-parallel controller.

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THE NORTH-EASTERN RAILWAY AND CARVILLE POWER HOUSE.

Less than two years ago the North-Eastern Railway Co. invited tenders for the complete electrical equipment of about 37 miles of standard gauge railway, mostly of double track, in the neighbourhood of Newcastle-upon-Tyne; to-day a regular service of electric trains is running on the lines referred to. Although the railway is an old one, the directors have shown by their action that they are none the less fully alive to the advantages of electric traction, both from the point of view of the shareholders and the travelling public. Their decision has been hastened by the serious competition of electric tramways in and around Newcastle, and they have recognised that the only remedy was to fight the competition on its own grounds and with its own weapon. Hence the "electrification." The days of steam traction for local traffic are past and gone, as is also evidenced by the adoption of a petrol-electric motor coach running on a portion of the line which has not been "electrified."

The question of the supply of energy was very carefully gone into, and, after viewing the matter from every possible aspect, it was finally decided not to erect a separate power station but to purchase energy from the Newcastle-upon-Tyne Electric Supply Co. This company, in addition to supplying electric light in Newcastle, furnishes power to a large number of Tyneside factories, being, in fact, by far the largest electric power company in operation in this country. A full description of the company's works up to the summer of 1901 will be found in *The Electrician*, Vol. XLVII., pp. 319, 359 and 397. During the past three years the number of connections to the Newcastle Supply Company's mains has increased at a phenomenal rate, and although the plant at Neptune Bank has been again and again extended, yet the company soon perceived that it would be quite inadequate within a very short time. Added to the fact that their lighting and power load was being augmented week by week, there was the question of the supply to the North-Eastern Railway, this in itself being no inconsiderable undertaking. The result of this chain of circumstances was the decision to erect a large station on the riverside at Carville, and it is our present purpose to describe this station in some considerable detail, having regard to the fact that it possesses many features of originality, and may be looked upon as the newest, and perhaps the finest, specimen of electric power station design at present existing in this country. Although a certain amount of the energy taken by the North-Eastern Railway is at present supplied from Neptune Bank, which runs in parallel with Carville, the bulk of it emanates from the latter station, and we believe it to be the intention of the Supply Company to supply all traction current from Carville in the near future.

CARVILLE POWER HOUSE.

The buildings of the Carville generating station are constructed of steel framework filled in with corrugated iron, and are so designed that they may be extended, the temporary ends and sides being suitable for re-erection. On entering the engine room, one is struck by the very fine lighting effects which have been obtained. Doubtless this is due in some measure to the absence of tall reciprocating engines—a point that might be made more of by the advocates of turbines—but it is principally due to lofty construction and admirably-arranged glazing of the roof. The corrugated iron has been painted a yellowish white, and the front of the switchboard, which occupies one entire side of the engine room, is painted a pure white. It was not easy to make the boiler house lighting so great a success, and artificial illumination has had to be resorted to; it is proposed to paint the fronts of the boilers and all surfaces white, so as to effect some improvement in this respect. During the hours of darkness arc lamps are employed in both the boiler house and engine room, and incandescent lamps are also fixed in numerous positions.

Boiler House.—There are 10 boilers of Messrs. Babcock and Wilcox's marine type, fitted with chain-grate stokers. Each is capable of evaporating 20,000lb. of water per hour under normal conditions and 28,000lb. when forced. These figures hold good when the feed-water is at a temperature of 100°F. The working pressure is 200lb. per square inch above atmosphere, and steam at the turbo-alternator stop valve is superheated 150°F. Coal is taken directly to the bunker from the North-Eastern Railway siding by means of an electric locomotive running on an overhead siding. This locomotive takes continuous current from an overhead conductor by means of a bow collector; it is capable of hauling a load of 50 tons, exclusive of its own weight, up a gradient of 1 in 25 at a rate of 4 miles per hour, and is equipped with two 75 H.P. Westinghouse motors.

Before passing to the bunkers, the waggon carrying the coal has to pass over a weighbridge, which is operated electrically. This weighbridge is an exceedingly ingenious piece of apparatus; the waggon to be weighed is brought down by the locomotive to a small hut containing the steelyard and motor equipment, and on starting the latter quite a number of operations are performed automatically and simultaneously. A steel platform rises between the rails and, coming under the flanges of the wheels, lifts the waggon bodily from the rails and places it upon the knife edges. At the same time stops are caused to rise, thus preventing the waggon running off the platform in either direction, and a danger signal is hoisted on the roof of the hut. The weighing machine works on the ordinary steelyard principle, and may be operated by hand in the event of anything going wrong with the motor. By placing a card in a slot and pressing a handle the weight is automatically recorded. On reversing the motor, all the functions are carried out in the reverse direction—the platform sinks, the stops disappear and the danger signal changes to "clear."

After being weighed the truck is taken along a railway track which runs over the bunker and discharged. There is only one coal bunker, which is built up of steel plate, and is 95ft. in length by 22ft. wide and 14ft. deep. It is divided into five equal compartments by steel plate partitions, and has a capacity of 1,200 tons. The bottom plates of the bunker compartments are arranged to form hoppers, at the bottom of which cast-steel mouthpieces are provided. On passing from the bunker to the boiler stoker hoppers the coal is automatically weighed. The fuel now being used is Northumberland small coal, having a calorific value of about 11,000 B.Th.U. and the price paid for it is 5s. 9d. per ton.

Two main flues are supported above the boilers on steel girders, and each is capable of carrying off the products of combustion from five boilers. These flues carry the gases to a steel-plate chimney, 60ft. high above the flue level and 14ft. in diameter. Induced draught fans have been installed, but a natural draught by-pass is provided as a stand-by and for use when the fans are not demanded by the conditions of load. Under each boiler there is an ash-pit door which opens automatically and discharges ashes to the ash conveyor at regular intervals. The scrapers of the Green economisers are electrically driven.

At the end of boiler house next to the engine room there is a platform upon which are installed three boiler feed pumps of the Woodeson type, built by Messrs. Clark, Chapman & Co. Each is capable of delivering 150,000lb. of water per hour against the boiler pressure of 200lb. per square inch. The special feature in connection with the feed pumps is the fact that no oil is used for cylinder lubrication; no rings are fitted to the pistons. Although this is rather a wasteful arrangement as far as steam is concerned, owing to the clearance between the piston and the cylinder, yet the advantages gained by the resultant elimination of the oil outweighs any loss in economy. Moreover, it must be remembered that the main exhaust from the turbines is also free from oil, and hence there is no necessity for oil-separating apparatus. In fact, no cylinder or steam lubricant of any kind is used in any part of the works, the steam to the feed pumps being taken direct from the boilers by a special main as saturated steam

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without passing through the superheaters, in order that it may provide its own cylinder lubricant.

The exhaust from the feed pumps is taken through a spiral coil in the hot well, where it is condensed and taken to a drain tank into which all steam traps also discharge. The water from the drain tank, including, as it does, all drain water and the feed pump exhaust, is returned by a small centrifugal pump to the hot well. There is an overflow from the drain tank to a bilge tank, but normally the centrifugal pump is kept running constantly for the purpose of returning the contents of the tank to the hot wells, of which there is one to each unit. The feed pump suction is, of course, ordinarily taken from the hot wells, the water piping system is so arranged that the feed pumps may draw from four sources of supply—viz., the hot wells, the reserve feed water tank, the town mains and the river water tank. The reserve feed water tank has a capacity of 30,000 gallons, while the river water tank is about one-tenth this size. The latter is provided in order to secure a supply of water should the town supply fail for any length of time, and in order to provide water over the whole station for cleaning and washing-down purposes. For the water service to the station buildings there is a ring main from one tank to the other, so that either supply of water may be used for any particular purpose or for every purpose. Normally, the "make-up" water to the hot wells is taken from the town main through the reserve water tank, this arrangement being adopted to prevent, if possible, the ball valve freezing up in one position. In order that the engineer may know when the town supply fails, the make-up is ordinarily taken from a facing about 10in. below the top level of the water in the tank, but it may be taken from either the top or the bottom of the tank. By this arrangement there is always a full reserve feed tank of water to evaporate before adopting the alternative of using river water.

Each feed pump is sufficient for five boilers on one boiler-house section, so that there is one spare when both boiler-house sections are in full working order. As has already been mentioned, the pistons are solid and lubricated by saturated steam, and to ensure their proper working one man is employed exclusively for looking after them and observing the level of the water in the boilers. For this purpose, an iron gallery has been built all the way round the interior of the boiler house, so that the attendant may be able to observe the gauge glasses with a minimum of inconvenience. Four boilers are normally sufficient for a single generating unit, the fifth boiler of each section being spare, so that it is always possible to have a boiler laid off for cleaning and inspection. All steam pipes and bends are of solid drawn mild steel and the flanges of forged steel.

As will be seen from the plan of the buildings, the boiler house lies at right angles to the engine room, a separate chimney being used for each complete boiler house. With this arrangement long lengths of steam piping are avoided and each battery of boilers is arranged opposite the generating set which it feeds in the turbine room. The station is thus divided into what are practically complete and independent sections or units, each section or unit being capable of working independently of its neighbour, they being connected at only three points—viz., the coal bunkers, the main 'bus bars and the circulating water system. At present, however, the two batteries of boilers are connected by a ring steam main from which either saturated or superheated steam is taken to the turbines; but the batteries may be isolated from each other by means of valves.

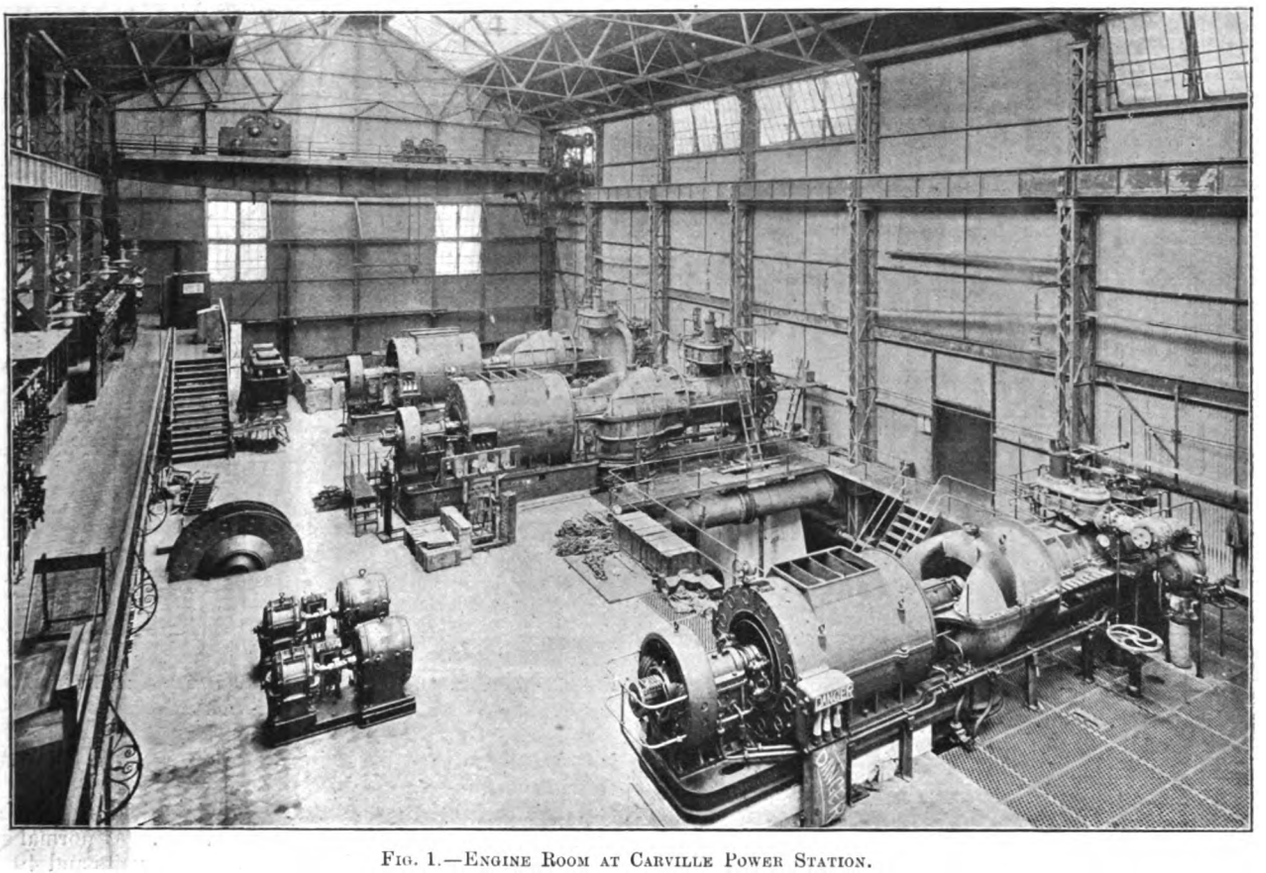

Fig. 1.—Engine Room at Carville Power Station.

Engine Room.—The present capacity of the engine room is 12,000kw., made up by two 2,000kw., and two 4,000kw. turbo-generators of Messrs. C. A. Parsons & Co.'s manufacture, the steam consumption being guaranteed less than 18lb. per kilowatt for the large sets and 19lb. per kilowatt for the small sets. These figures, it may be mentioned in passing, have actually been obtained under working conditions. Messrs. Parsons' latest improved type of turbines are installed, forced lubrication to the bearing being employed, with arrangements for water circulation. Mechanical governors are provided, which allow the normal speed (1,200 revs. per min.) at any load up to maximum load to be varied by 5 per cent. The adjustment of the governors may be effected either by hand at the turbine or by electric control at the switchboard. At present, the practice is to make preliminary adjustments on the

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machine and finally to bring it to exact speed by means of the electric control. This latter device was designed by Messrs. Parsons, the ratchet gear being operated by a solenoid, the current for which is taken from the station battery. The steady speed of the turbines is specified not to vary more than 3 per cent. between no load and normal load, and not more than 5 per cent. between no load and maximum load, and when running at maximum load the variation of speed

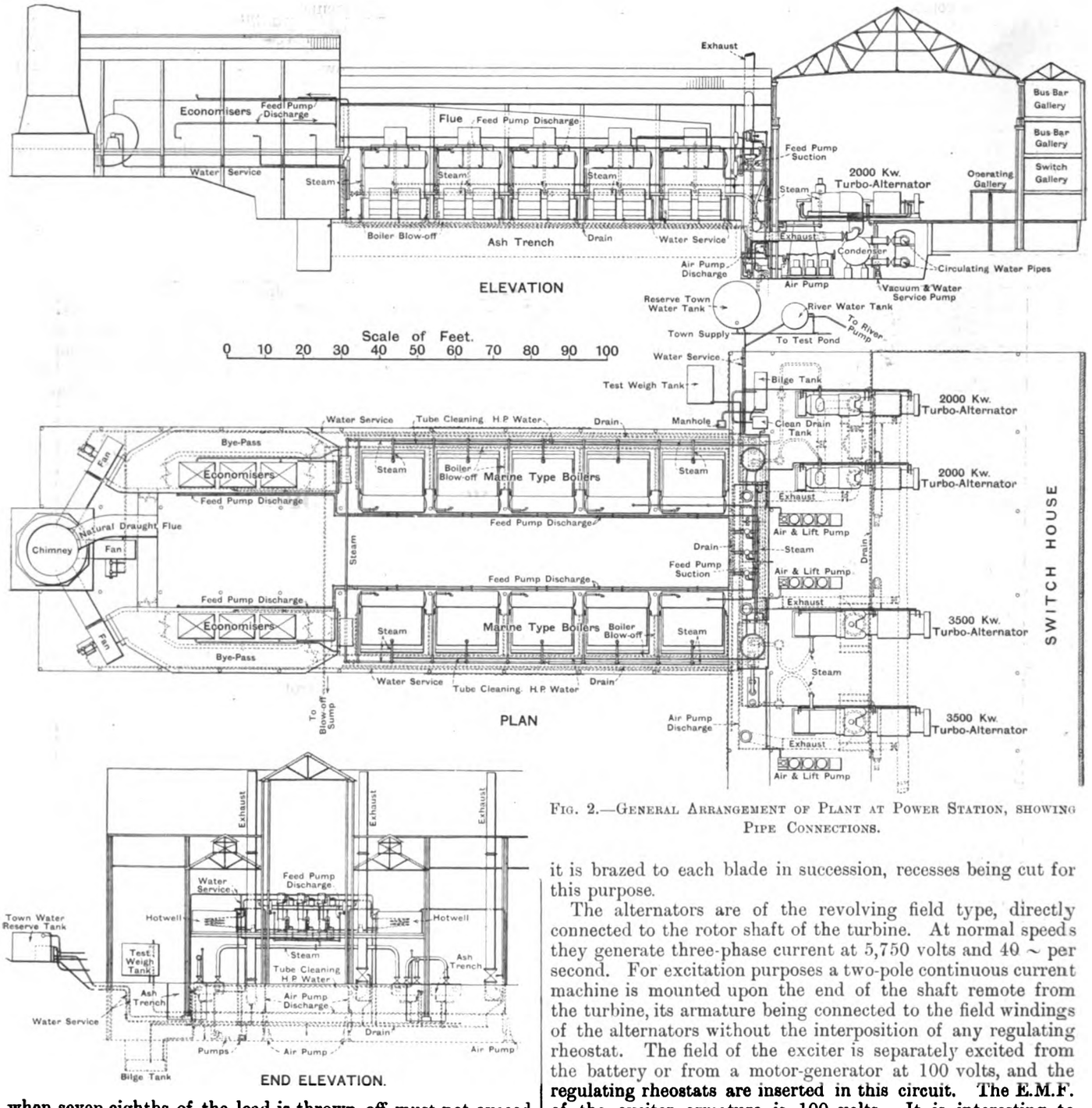

FIG. 2.—GENERAL ARRANGEMENT OF PLANT AT POWER STATION, SHOWING PIPE CONNECTIONS.

when seven-eighths of the load is thrown off must not exceed 6 per cent. Under ordinary conditions of steam pressure and vacuum the large turbines are each capable of dealing with 5,000kw. for one hour or 5,500kw. momentarily; the corresponding figures for the smaller machines are 2,300kw. and 2,500kw. In addition to the ordinary governors mentioned above, mechanical safety governors are provided, which cut off steam when the speed rises to 1,400 revs. per min., and these may be operated by hand both at the floor and basement levels.

Hitherto all Parsons turbines have been made with the blades laced together for mechanical strength in the low-pressure chambers only, but in the 4,000kw. sets at Carville it has been considered necessary to lace all the blades in the high as well as the low-pressure chambers and on both the stator and the rotor. In the case of the low-pressure blades, which are 8in. long, lacing is effected in the ordinary manner by means of wire at the ends and also half-way down the blade. The lacing of the other blades consists of a ring of metal of the same material as the blades brazed on to the blades. A cross-section of the ring measures $\frac{1}{8}$in. square, and it is brazed to each blade in succession, recesses being cut for this purpose.

The alternators are of the revolving field type, directly connected to the rotor shaft of the turbine. At normal speeds they generate three-phase current at 5,750 volts and 40 ~ per second. For excitation purposes a two-pole continuous current machine is mounted upon the end of the shaft remote from the turbine, its armature being connected to the field windings of the alternators without the interposition of any regulating rheostat. The field of the exciter is separately excited from the battery or from a motor-generator at 100 volts, and the regulating rheostats are inserted in this circuit. The E.M.F. of the exciter armature is 100 volts. It is interesting to observe that carbon brushes are employed on these exciters, and that, up to the present, they have not caused the slightest trouble. In the event of any exciter breaking down provision is made for exciting the fields of the main generators with current from a motor-generator. Regarding the alternators themselves, there is practically nothing to add to what has already been said, as they are machines of standard type, supplied under ordinary conditions as to regulation of voltage and temperature.

A special feature in the design of the turbine room is the arrangement which has been adopted whereby the overhead travelling crane may handle any portion of the main or

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auxiliary machinery although the condensers and air pumps are on a lower level than the main units. There is no basement, both main units and auxiliaries being placed on the floor which is level with that of the boiler house. The turbines are mounted on concrete blocks to allow room for the condensers below them and access is given by means of galleries. Thus everything is in daylight and within reach of the crane. This arrangement works admirably in practice and possesses the additional advantage of low capital cost. The steam piping calls for little comment except with regard to the extremely large bends by which the turbines are connected to the main steam range. These bends have a very large radius and have been inserted to prevent any strain on the turbines, which might have serious consequences, owing to the expansion and contraction of the pipe work. The plan of the station (Fig. 2) shows these bends very clearly.

Each turbine is provided with a surface condenser situated immediately beneath it, together with a "vacuum augmentor," an arrangement adopted by Messrs. C. A. Parsons & Co., by which the waters from the condensed steam and the suspended vapour are taken separately from the condenser chamber, thus enabling a slightly higher vacuum to be obtained (*The Electrician* of May 27th, p. 221). The air-pumps are of Messrs. Parsons' three-throw type, a plunger pump being fitted on the extension shaft of each pump for lifting the water from the air-pump discharge to the hot well. These are electrically driven by three-phase motors. An interesting point in connection with the condensing apparatus is the fact that the air-pump discharge may be diverted from the hot well to a weighbridge and tank. By this means the steam consumption of any generating set can be ascertained, without special arrangements, at a few moments' notice. Circulating water for the condensers is obtained from the River Tyne, a pump house being erected on a jetty at the riverside for this purpose. The present equipment of the pump house consists of two centrifugal pumps driven by three-phase motors, energy for which is conveyed to the pump house by means of an overhead line. Either of these pumps is sufficient for 8,000kw. of plant, so that a single pump is capable of supplying circulating water for the condensers of two generating sets. The discharge circulating water main is carried to the river and buried beneath low-water mark, so that advantage of the atmospheric pressure is obtained in lifting the condensing water. The power required in these circumstances is theoretically, therefore, only that necessary to overcome the friction of the pipes, without, as is usually the case when the outlet of the condensers is open to the air, having to lift the required amount of water in addition to the pipe friction.

In the engine room there is also a 40-ton overhead travelling crane by Messrs. Craven Bros. Provision is made for a clear lift of 40ft. and an auxiliary crab is provided capable of lifting 10 tons, it being possible for this to travel transversely independently of the main crab. The crane is driven by three-phase induction motors of the British Thomson-Houston Co.'s make and is operated by a single attendant from a cage fixed at one end of the cross girders. Blocks and hooks are fitted with ball bearings. All three motions of the crane are performed by the aid of a single motor, but the auxiliary crab is provided with a separate motor. The latter hoists at a speed of 25ft. per minute and the main crab at 4ft. per minute.

(*To be continued.*)

ELECTRICAL PLANT AT HEYSHAM HARBOUR.

(*Concluded from page 387.*)

Before entering into the details of the distributing system, we will describe the cranes and capstans employed. Fig. 10 is from a photograph of one of six 5-ton wharf cranes, which have been built by Messrs. Stothert and Pitt, as sub-contractors to the British Westinghouse Co., whose motors and switches are employed in them. Fig. 9 shows the gear of the crane in elevation and plan, the most interesting part of which is the lifting gear. For this Messrs. Stothert and Pitt's "free barrel" arrangement is adopted, in which the lifting barrel is not keyed directly to the shaft but runs loose upon it, being connected or disconnected by a "coil" friction clutch. By this means the lifting motor always runs in one direction and is never reversed. The barrel shaft carries the main spur wheel rigidly keyed on to it, and this spur wheel gears directly by single reduction with the pinion attached to the armature spindle of the lifting motor. The hand lever actuating the lifting controller also actuates an electric solenoid which controls the lifting friction coil clutch, the arrangement being such that on moving the lifting handle forward from the off position, current is switched on to the solenoid, the clutch is put into gear and the lifting motor started simultaneously; after the clutch is in gear, further movement of the lever cuts out resistance and speeds up the motor. There are only two working handles, one for lifting and one for slewing, and there is a treadle for the mechanical brake, so that the working of the crane is as simple as that of a steam crane.

One advantage of the "free barrel" arrangement is the large increase in speed of working, both in lifting and lowering, and also the reduced liability of accident to the motors owing to their being non-reversible and the impossibility of suddenly stopping the armature. In cranes with the barrels always in gear with a reversible motor, care has to be taken to check the lifting motor when the hook is a sufficient distance from the jib head, so that the momentum of the revolving armature may be absorbed before the hook is overwound on the jib pulley, with the possible result that the jib itself is lifted and the tie-rods bent. With the system described above, lifting can be continued at full speed and the load brought to rest instantly by pulling over the handle, the only revolving parts which have to be brought to rest being the barrel and brake drum, which have comparatively small inertia and do not revolve at an excessive speed. But the great gain in speed is in lowering, which can be performed at a vastly greater speed than is possible by a reversible motor, there being a perfectly free run out under the control of the foot brake. Moreover, lowering can be commenced instantly without perceptible pause from lifting at full speed; the lifting armature can continue to revolve with slackening speed during the period of lowering and then come to rest quietly without shock. A further advantage that will appeal particularly to the electrical engineer is that the motor does not take excessive current at starting, the curve of current being almost a horizontal line.

A no-voltage release is also added, so that the lifting drum is held and the controller thrown back should the supply fail for an instant. An over-travel device has also been fitted. The curved lever seen at the end of the jib in Fig. 10 is thrown back when the hook rises against it and a cord is pulled which releases a trigger and allows the weight to fall under the influence of a dash-pot, putting on the brake and stopping the lifting motor, leaving the load suspended. The brake also is interlocked with the controller so that current cannot be given to the motor until the brake is free. The gantries of the cranes are made with steel framings and hand travelling gear is fitted. The cranes revolve on rings of live rollers which run between cast-steel roller paths.

The cranes are worked by series motors of the traction type, a 40 H.P. for lifting and a 7 H.P. for slewing, and the speeds are 100ft. per minute for lifting and 400ft. per minute at the hook for slewing. Double the speed of lift for half the weight can be obtained by unshipping the snatch-block for double purchase and unslinging the hook at the end of the rope from its eye at the jib-head and so using it for lifting in single purchase. Double-reduction gear is employed for the slewing motion. Plug fittings have been placed every 40ft. to convey current to the cranes, and a round twin 98/20 flexible cable armoured with galvanised-iron wire is employed.

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A smaller wharf crane of similar design is also in use, being rated to lift 2 tons at 250ft. per minute with the same slewing speed as the larger crane. Its motors are rated at 40 H.P. and 4 H.P. respectively. On the platforms of the two goods sheds there are six 30 cwt. jib cranes. These are likewise of the two-motor type, being equipped with 12 H.P. motors for lifting at a speed of 80ft. per minute, and 3 H.P. motors for slewing at a speed of 250ft. per minute at the hook. One of these cranes is shown in Fig. 11. In addition to these cranes, two 30-cwt. cranes are to be placed in the fish dock, and there is also to be a 50-ton crane, the precise position for which has not yet been fixed.

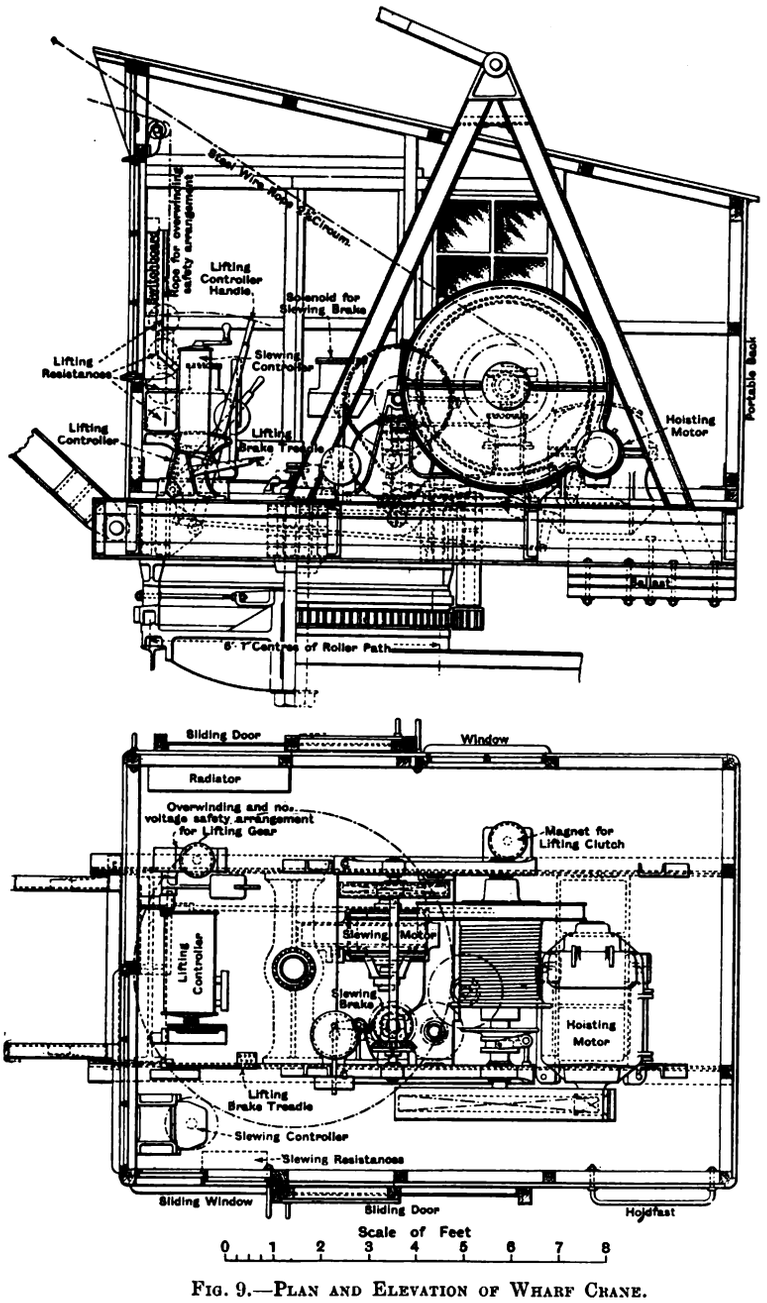

FIG. 9.—PLAN AND ELEVATION OF WHARF CRANE.

Twelve capstans have been erected in the harbour. There are two 1-ton capstans for ordinary work, and two 3-ton capstans for hauling ships, &c. These are provided with 20 H.P. compound-wound motors, and starting gear of a special design. Capstans are always controlled by a pedal gear, and, in consequence, the starting switch and overload cut-out arrangements do not present an absolutely simple problem. Fig. 12 shows the arrangement of the driving gear within the capstan box. The motor is placed so that its shaft is horizontal, and it drives an intermediate vertical shaft through bevel gear, this shaft being connected by single reduction spur gear to the capstan head itself. The controller is within the capstan box, and is worked by means of the foot plunger marked in Fig. 12. In Fig. 13, which shows the controller itself, the lever A is depressed by the treadle, and this connects the positive side of the main circuit, and also connects the positive main to the coil B (Fig. 14). Two subsidiary contacts on the same lever close the circuit of the

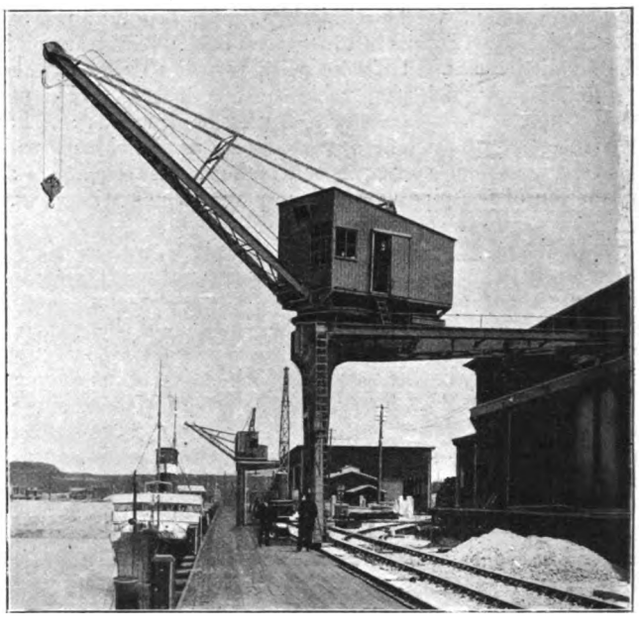

FIG. 10.—HALF-PORTAL WHARF CRANE.

coil of the snap-switch D, which, on coming up and making contact, forms the negative connection both of the main circuit and of the circuit of coil B. The coil B then moves the lever of the starting switch round until it is in the position shown in Fig. 13, starting the motor in the usual manner. When the

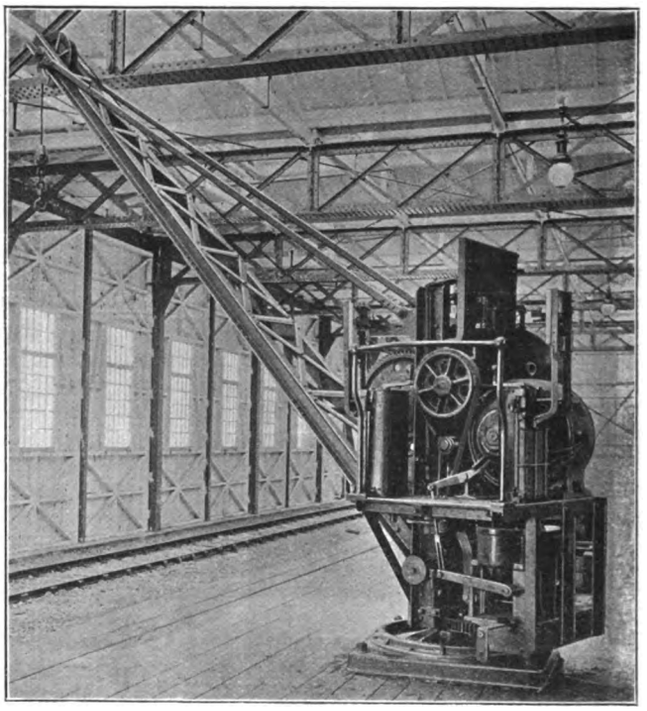

FIG. 11.—ONE OF THE PLATFORM JIB CRANES ON THE GOODS SHED PLATFORMS.

lever of the starting switch moves from the "off" position by leaving the two contacts there, it puts a resistance in the circuit of the snap switch coil and similarly on reaching the "on" position opens the contacts short-circuiting the lamp resistance C. These reduce current consumption and prevent heating. The function of the snap switch D is, by its making

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all connections to the negative main, to take all sparking on special contacts which it carries. With the main contacts on lever A which break *after* it owing to the subsidiary contacts which make its circuit being short, it also gives a double pole break. Before coming to its contact the main current passes through the "overload coil" (the resistances of the starting switch being on the positive side). Should the load on the capstan be too great, the "overload coil" is actuated, opening this circuit, the overload cut-off being retained in the off position by the catch F until the treadle is released. In this way, if the overload cut-off goes, the labourer working the capstan has merely to find what is obstructing the capstan rope, and then depress his treadle again; there is no cut-out for him to replace, and as the cut-off gear is contained within the capstan case he cannot wedge it up or tie it down to save trouble. The capstans have been made by Messrs. Stothert and Pitt, and the motors and controlling gear by the British Westinghouse Company, the controller connections having been worked out in detail by the Midland Railway.

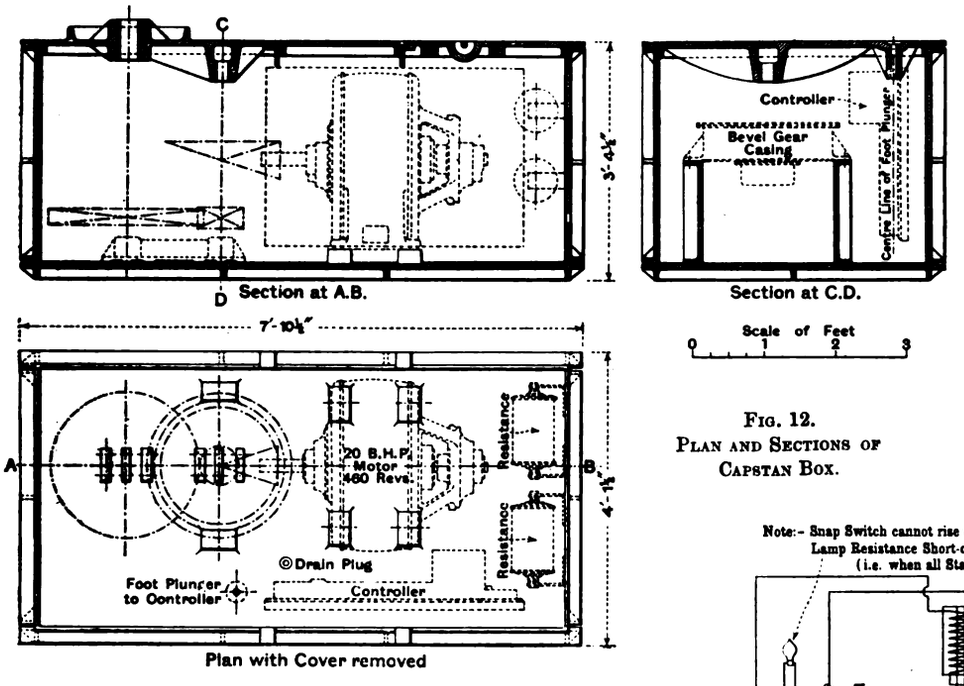

FIG. 12.
PLAN AND SECTIONS OF CAPSTAN BOX.

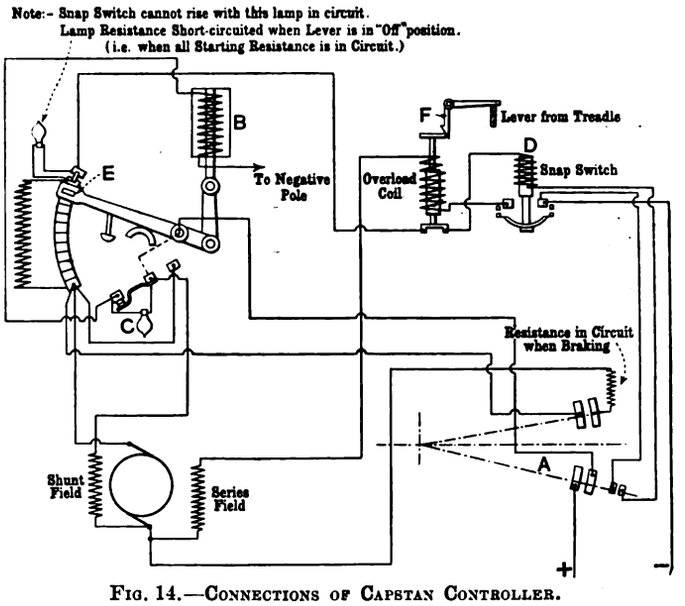

FIG. 14.—CONNECTIONS OF CAPSTAN CONTROLLER.

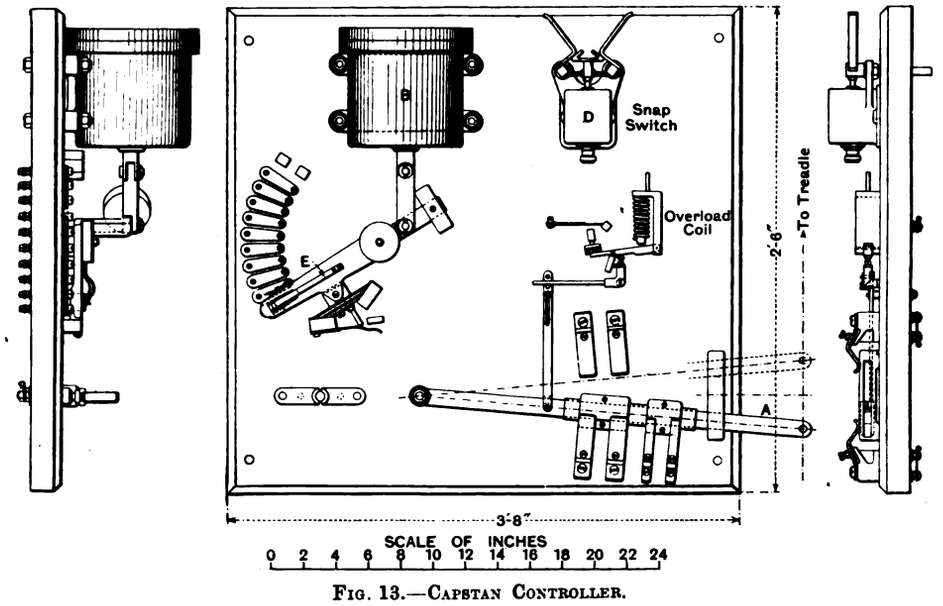

FIG. 13.—CAPSTAN CONTROLLER.

In consequence of the tidal rise, the two Waygood lifts which are provided for taking passengers and goods to and from the upper and lower landing stages, are provided with water-level cut-offs, so that it is impossible for the lift to come down to the lower-level landing stage when this is below water. Another special feature of the lifts, although not an electrical one, is that the cages are buoyant, so that no accident would occur if they travelled too far. In other respects the lifts represent standard practice, and are fitted with the usual car-switch control, over-travel cut-off, &c Each is driven by a motor of about 20 H.P. capacity.

These low-level landing stages necessitated special precautions being taken with regard to the lighting, fittings and wiring. Fig. 15 shows one of the passages leading to a low-level landing stage which is completely under water at high tide. The type of fitting adopted is shown in Fig. 17; it is seen that the lamp and holder are simply enclosed in a thick glass cover cemented into an iron ring, which is fixed in a watertight manner to the top of the fitting with the aid of a rubber ring.

All the wiring in these passages is drawn into heavy gauge galvanised tubing made by the Conduit and Insulation Co. The joints of the tubing are screwed. The main portion of the tubing is above high-water level, the only portion of the tubing which is covered with water being the down-comers to the fittings, which latter are also submerged twice a day. All the fittings and the tubing are painted with P. & B. paint. In the goods sheds the cable is run open on insulators, and in the other buildings it is drawn into tubing, as in the landing stages and the passages to them. Vulcanised rubber cable of the 2,500 megohm class (made by Messrs. Connolly Bros.) is employed for this, as well as in all the buildings.

Two sets of both power and lighting feeders are taken from the switchboard in the engine house through trenches and connected up to aerial cables carried on a double H 40ft. pole-line to sub-switchboards at three distribution points, one (Fig. 18) in the large goods shed (A), one in the small goods shed (B),

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and one on the north side of the harbour (C). The fourth distribution point, D, is in the engine room itself, for supplying within a radius of about 150yds. of the power house. All the poles are set in concrete, and the aerial cables, supplied by the British Insulated and Helsby Cable Co., are simply braided and hung by means of leather suspenders from No. 6 galvanised wire, which is made off at every pole on oil shackles (Fig. 16), supplied by Messrs. Johnson and Phillips. The power and lighting feeders A and B to the two sub-switch-

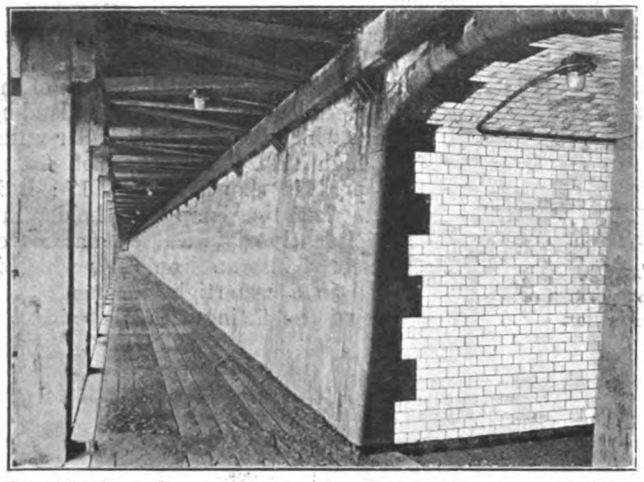
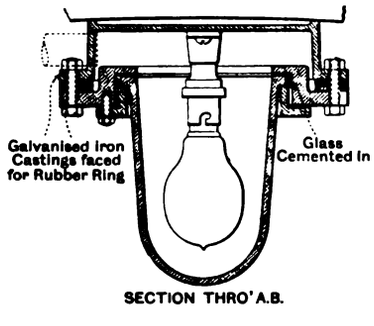


FIG. 15.—ELECTRICALLY-LIGHTED LOWER LANDING STAGE AND PASSAGE THENCE TO THE LIFT (on the right).
(Completely under water twice daily.)

boards in the goods sheds are separately boosted and the two pairs, one lighting and one power, are connected together by two balancing mains, which are connected to the feeding-point through a reverse-current circuit breaker at each end. Coupling switches for connecting the lighting feeders on the power 'bus bars, or vice versa, are also supplied, thus allowing each board to be fed wholly from either power or lighting feeders should a breakdown occur on either set. The feeders to C serve both lighting and power and are also boosted.

The reverse current circuit breakers (Fig. 19) as well as the remaining switches and fuses on the distribution board are of Messrs. Dorman & Smith's make. The reverse controlling gear of the circuit breakers is positive in its



SECTION THRO' A.B.

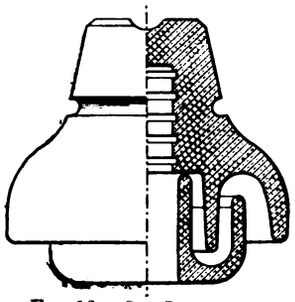


FIG. 16.—OIL INSULATOR.
(½ full size.)

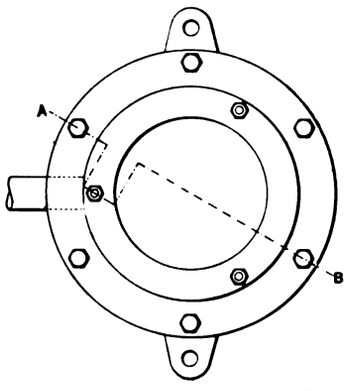


FIG. 17.—PLAN AND SECTION OF WATER-TIGHT FITTING. (½ full size.)

action, and is arranged in the form of a polarised relay, the polarised coils being controlled from the distribution 'bus bars so that on a reversal in the main coil a powerful electromagnetic tripping gear is operated, opening the switch. The switch can also be operated by hand if desired. The circuit is closed through the switch by two operations, the first operation closing the automatic switch and setting the electromagnetic controlling gear; a further operation completes the circuit through a pair of compact auxiliary contacts, so that the automatic switch is free to be instantly opened if there should be a reversal at the time the circuit is completed.

From the two distribution boards, feeders are taken to 20 100 ampere watertight plugs for supplying the seven wharf cranes, other feeders being taken away to supply the seven

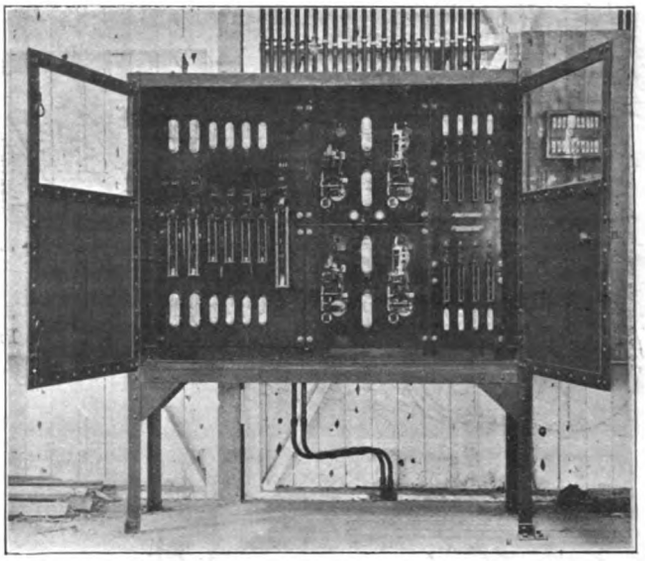


FIG. 18.—ONE OF THE DISTRIBUTION BOARDS.

platform cranes and the 12 capstans. A looping-in system of wiring is employed throughout. The lighting of the docks, including landing stages, cart roads, sidings, passenger station, large and small goods sheds, engine house and other buildings, is carried out by means of 106 4-ampere "Jandus" arc lamps, each fitted with "Siemens" raising and lowering gear; about 600 16 c.p. incandescents, 200 32 c.p., 150 50 c.p. and about 30 ½ and 1-ampere Nernst lamps. All the inside arc lamps are of the double-enclosed type, the outside arcs being of the new single-enclosed pattern.

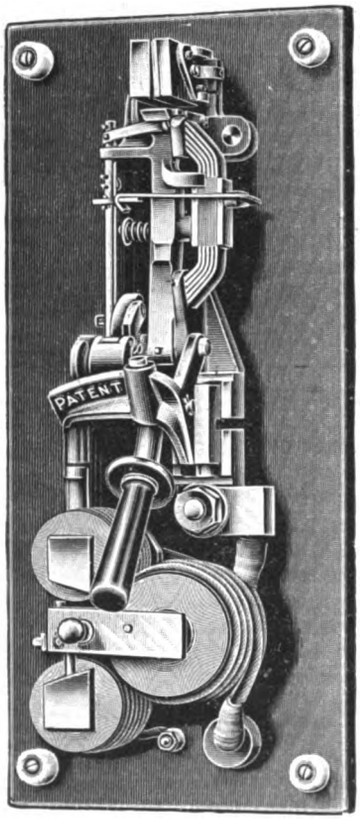


FIG. 19.—REVERSE CURRENT CUT-OUT.

The lighting of the quay side is carried out by means of two light fittings run on alternate circuits and carried in lanterns on 10ft. cast-iron pillars, spaced about 60ft. apart. The arc lamp wiring for the general lighting of the sidings, roadways, cattle pens, &c., is carried out by means of aerial cables run on oil insulators, carried by creosoted wooden poles set in concrete, to which brackets are attached for hanging the arc lamps.

The distance of the feeding points from the station is: A, 385yds., B, 385yds. and C, 650yds, and their sizes 19/12 with a 19/14 middle wire in the case of the lighting feeders.

Messrs. E. J. Eckersley & Co. have acted as sub-contractors for all the inside and outside wiring, the British Westinghouse

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Company being the contractors for the whole of the electrical work of the harbour.

The electrical and mechanical equipment of the harbour has been done in accordance with the specifications and under the supervision of the locomotive superintendent, Mr. R. M. Deeley. His assistants have been Mr. J. Dalziel, who has been responsible for the entire electrical equipment and allied matters, and Mr. Newbould, who supervised the construction and erection of the mechanical portions of the work. We desire to express our gratitude to Mr. Deeley for affording us every facility for the preparation of this article, and we are also much indebted to Mr. Dalziel, who showed us over the harbour, explaining every detail and affording us considerable assistance.

MERCHANT VENTURERS' TECHNICAL COLLEGE, BRISTOL.

On Wednesday the new laboratories and workshops of the Merchant Venturers' Technical College at Bristol were formally opened by Sir William White. The college was founded, under the name of the Bristol Diocesan Trade and Mining School, on March 28, 1856. In 1880 the Society of Merchant Venturers resolved to devote themselves to educational work, and, for this purpose, bought the premises in Unity-street, and erected the large building now standing on that site. In 1885 they took over the Trade and Mining School, with its students and staff, and transferred them to the new building. The Society secured in 1903 a house in Montague-place, Kingsdown (now known as the "Merchant Venturers' Preparatory School"), to which they transferred the youngest pupils attending the college, and a building in Rosemary-street which, with the aid of a grant from the Bristol Education Committee, has been equipped with workshops for artisans engaged in boot and shoe manufacture, plumbing, printing, bookbinding, painting and decorating. By the transfer of the classes forming the Preparatory School to Kingsdown, and by the removal of sundry workshops from the main college building and No. 8, Unity-street, considerable space was set free for the fuller accommodation of those adult day students of the college who are in training to become engineers, or are preparing for the B.Sc. degree of the University of London in applied science.

The new laboratories for mechanical engineering, electrical engineering and applied physics are more than twice as large as the corresponding laboratories were in 1903; new shops for carpenters, bricklayers and masons have been provided, and a special laboratory has been set aside for students engaged in research work. A reading room has also been opened. The number of individual day students in attendance in the several departments in May, 1890, and May, 1904, were 416 and 616 respectively. In the evening classes, the number of entries for the session 1889-1890 was 832; the number for the current session is 2,249, exclusive of 406 entries for the branch evening classes of the college held in the suburbs of Bristol and in Gloucestershire.

The engine house contains a new experimental steam engine, built by Messrs. Robey & Co.; it is of the horizontal compound condensing type, and has been designed to the specifications of Prof. Munro, in consultation with Prof. Ripper, of Sheffield; it enables students to carry out a large number of experimental determinations with great accuracy and upon a practical working scale. When working as a compound condensing engine it is capable of developing 60 H.P. at 140 revs. per min., but it can be uncoupled and the high and low-pressure cylinders worked separately as simple engines, either condensing or non-condensing. The cylinders are fitted with patent drop-valve gear and Corliss valve gear, to enable the relative merits of these appliances for the distribution of steam to be studied. The crankshaft is made in two parts, connected by a solid forged coupling, the flanges being drilled so that the angular relation of the cranks may be adjusted in eight different ways. Independent feed and circulating pumps are provided, together with the most modern form of surface condenser. The power developed is taken up either by friction brakes, or by dynamo machines. Steam for the experimental engine is obtained from a water-tube boiler built by Messrs. Babcock and Wilcox, and designed for a working pressure of 160lb. per square inch. By means of suitably placed stop valves the steam may be taken directly from the boiler, or it may first be passed through a superheating apparatus. The temperature of the flue gases is measured by an electrical pyrometer. A water-softening and purifying plant facilitates the study of the action of chemicals in the preparation of boiler feed-water from the ordinary hard water supplied by the Bristol Water Co. A complete equipment is provided for measurement of the indicated power for tests of mechanical efficiency, for

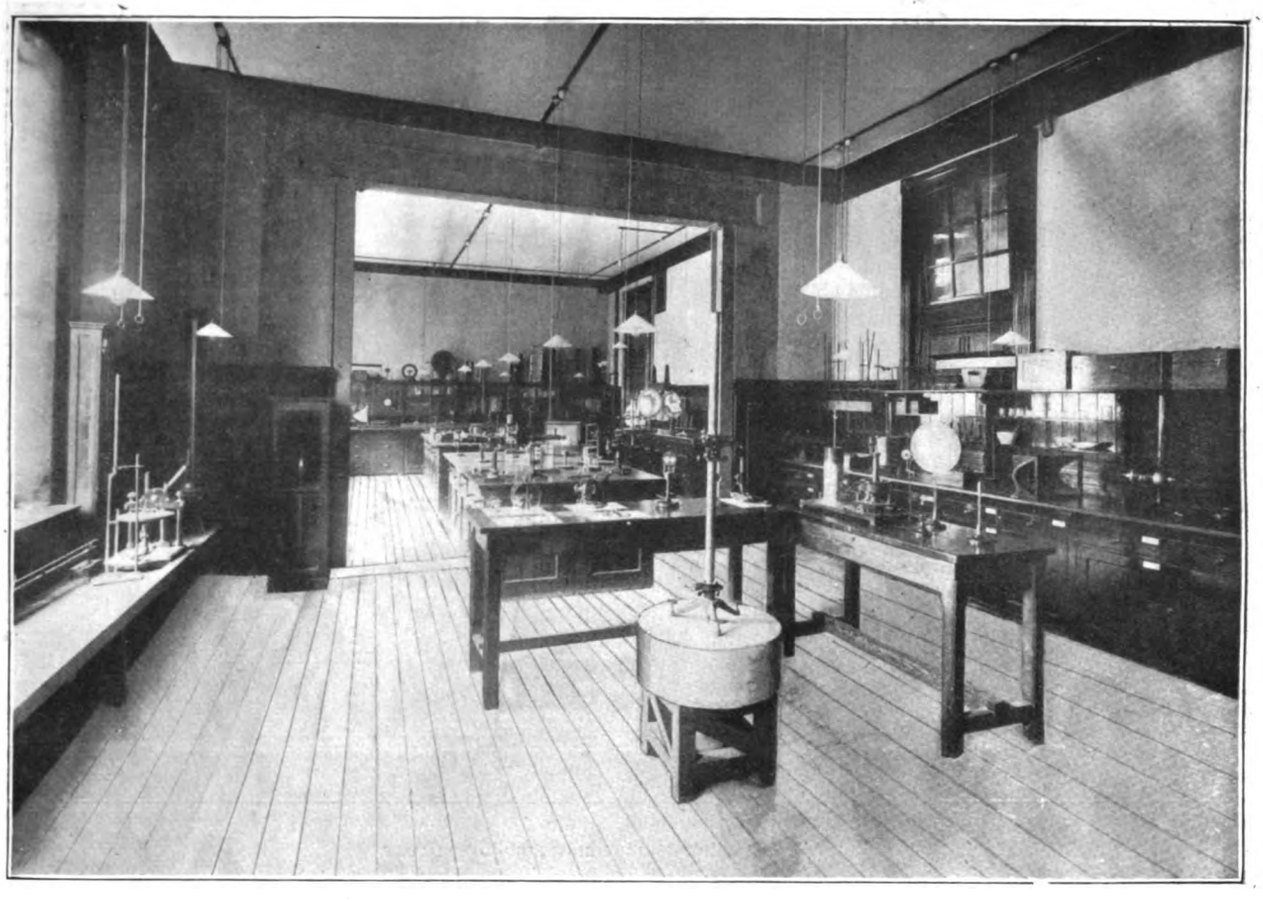

FIG. 1.—THE SENIOR PHYSICAL LABORATORY.

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measurement of the supply of steam, and for the estimation of the heat supplied to, and rejected by, the engine. In this room there is also a small experimental electric light and power station, the dynamos being driven by the steam engines, or by an Otto gas engine. They are connected, through a switchboard specially arranged for testing purposes, to the arc and incandescent lamps and electric motors, on which trials will be run during the session. The two belt-driven dynamos are by Messrs. Mavor and Coulson, and are designed for an output of 25kw. at 210 volts. All the energy can be absorbed by two large resistance frames, or part may be used by the installation of motors and about 140 arc and incandescent lamps. The machines can be run on separate circuits for lighting, motors, or testing at the switchboard, or they can be connected in parallel to all or any of these.

The mechanical engineering laboratory contains apparatus with which measurements can be made with extreme accuracy, in some cases to 0·00002in. It includes an extensometer for measuring very small elastic deflections; a tilting mirror apparatus for measuring the stretch modulus of fine wires; apparatus for measuring small torsional strains and the transverse coefficient of elasticity of iron and brass rods; apparatus for experiments on the principles which govern the balancing of revolving masses. There is also a testing machine by Messrs. Denison & Son capable of exerting a force of 6,000lb. for tensile, compressive or cross breaking tests; and also a deflectometer, reading to 0·001in., for experiments on beams and springs. There are, in addition, the usual apparatus for experiments on friction, stress and strain, composition and resolution of forces, moments, velocity, acceleration, kinetic energy, &c., and also for experiments on the velocity ratio, mechanical advantage, efficiency and friction of simple lifting machinery, of which a number of models are provided.

In the engineering workshop are some fine examples of labour-saving tools; the latest addition is a 6in. centre lathe, made by the American Tool Co., and fitted with a hollow spindle to allow the bar of metal from which objects are being made to pass freely through the cutting tools, which are held in a turret and are brought successively into action by an automatic arrangement which causes the turret to revolve. There are also a 7in. centre lathe, with plain and compound rests, and a 15in. shaping machine, fitted with the newest appliances for attaining quickness and accuracy of work, both made by the Hendey-Norton Machine Co; a modern 6in. centre screw-cutting lathe, and a drilling and boring machine, made by Messrs. Humpage, Jacques and Pedersen. The shop also contains one self-acting, sliding, surfacing and screw-cutting lathe, made by Messrs. Greenwood and Batley; one self-acting, sliding screw-cutting lathe, suitable for ordinary work; one wood-turner's lathe, and two lathes of simple construction, suitable for beginners; a planing machine, which has a self-acting feed motion; a double-geared milling machine; two drilling machines, with complete sets of twist drills; and one 14in. double-tool grinder. Power is supplied by an Otto gas engine. The fitters' benches have 34 parallel vices, and complete sets of hand tools. There is a cast-iron marking-out table, having a surface of 9 sq. ft. and provided with steel straight-edges, T-squares and scribing blocks. There are two pattern-makers' benches, and full sets of pattern-makers' and moulders' tools. The forge is fully equipped with all necessary appliances for the production of hammered iron work, and for making and dressing tools. The new senior physical laboratory (Fig. 1) is fitted for experiments on general physics, heat, light, sound and electricity. It is provided with a cathetometer, vernier, microscope, spherometer and micrometer, gauges, balances, volumenometer, air-pump, standard barometer and other measuring instruments. There are also sets of apparatus for experiments with Röntgen rays, Hertz waves, wireless telegraphy, radium, &c.

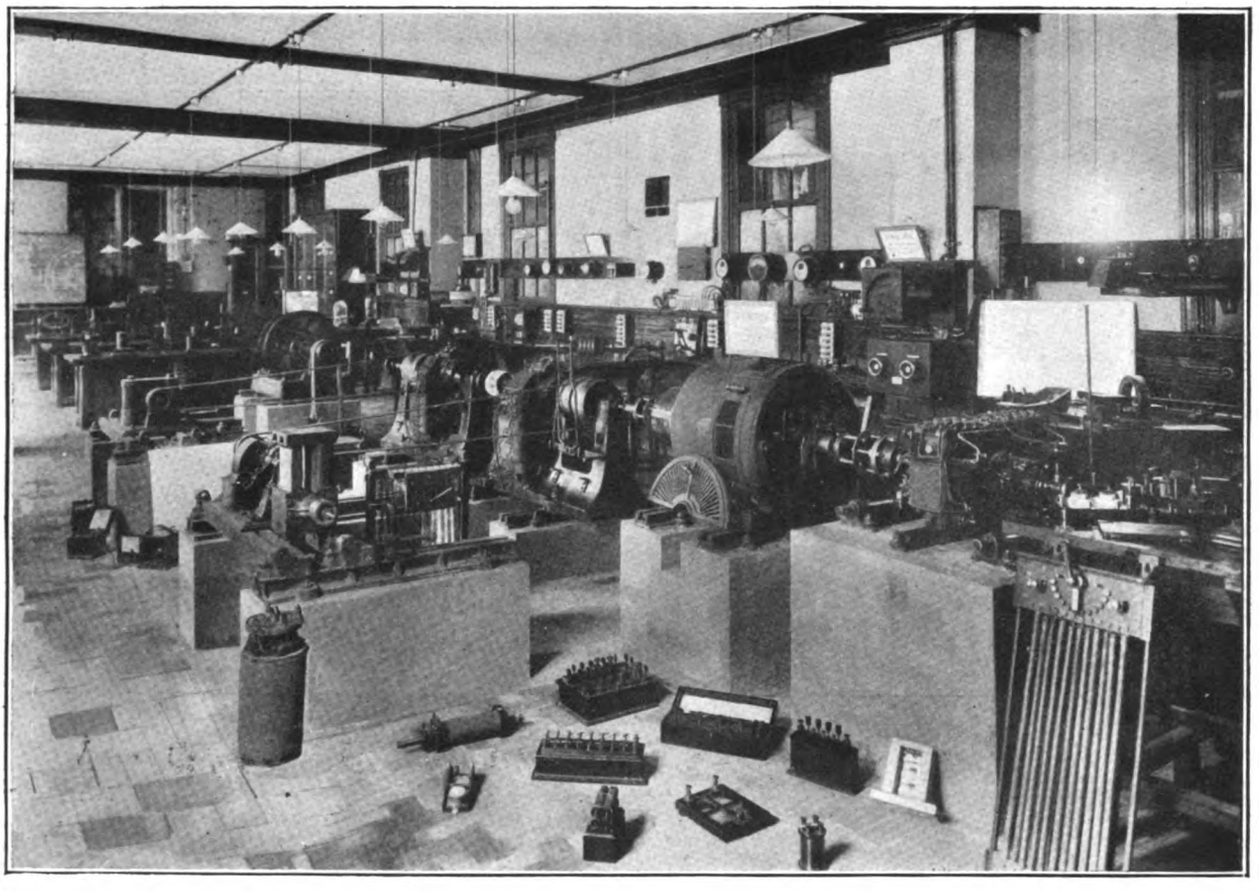

Fig. 2.—The Electrical Engineering Laboratory.

The electrical engineering laboratory (Fig. 2) has been considerably enlarged and entirely re-modelled. It has been equipped with a motor in place of the former gas engine, and the chief machines are now all set in line so that they can be coupled together mechanically. There are at present five continuous-current machines in this line, having outputs varying from 2kw. to 7½kw., and there is a gap left for an alternator. Two of the machines, Nos. 2 and 6, are run as motors from the city mains at 500 and 250 volts, while any of them can be run from the battery. The leading particulars of the machines are as follows:—No. 1 is a two-pole Manchester type machine, by Messrs. Mather and Platt, with compound-wound field magnets and smooth-core ring-wound armature. It has a rated output of 30 amperes at 65 volts and runs at 1,050 revs. per min. The shunt coils are wound in 10 sections connected to separate terminals on the top of the machine, so that many combinations are possible; the temperature at different depths can be explored, and several other special tests made. Three points on the armature winding are connected to slip-rings from which three-phase alternating currents can be collected. There are sufficient turns in the series coils to permit the machine being run as a series machine when desired.

Machine No. 2 is a four-pole enclosed ventilated motor by Messrs.

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Mavor and Coulson, with shunt-wound fields and slotted armature, having a two-circuit wave-wound drum-winding. The rated output as a motor is 10 B.H.P., taking 18 amperes at 500 volts and 850 revs. per min. This machine can be used to drive the others, the adjacent machines being connected by leather disc couplings when required. In order to allow a close adjustment of the speed to be made for testing purposes, there is a double field rheostat with coarse and fine adjustments by which the speed may be varied between about 850 and 1,200 revs. per min. The main switch, starting switch and resistance and field regulator are enclosed in separate cast-iron cases, and the main switch has a lock and key. An overload and no-voltage release is provided on the starter. The brushes, shunt coils, switches and starter are connected to a set of terminals in a metal case with glass front, to allow the parts to be got at separately for measuring purposes. So long as the main switch is kept off the whole apparatus is entirely disconnected from the 500-volt mains, and if the extreme terminals are then joined to the battery terminals close at hand, the machine can be run from the battery circuits without any other alteration to the connections. It will then give about 2 H.P. at a slow speed.

Dynamos Nos. 3 and 4 are bipolar over-type machines, by the Newton Electrical Engineering Co., with shunt-wound fields and smooth-core ring-wound armature. The rated output is 40 amperes at 105 volts, or 30 amperes at 150 volts and 950 revs. per min. No. 3 is used for charging the storage battery, being driven directly by No. 2. Each of the machines has two field regulators, a coarse one being fixed on the wall beside the switches, and a fine one, of the Ward-Leonard type, being connected up when required. The regulators are also available for other purposes in the laboratory. In charging the battery, however, no regulator is employed on the generator, but all the adjustments are made by altering the speed of the motor. There is one Sturtevant starter, with automatic release, which is used with either of these machines when run as a motor. No. 5 is a blank space, in which an alternator is to be placed afterwards.

Dynamo No. 6 is a four-pole open-type machine, by Messrs. Mavor and Coulson, with shunt-wound fields, and a two-circuit wave-wound drum armature, with slotted core. The rated output as a motor is 5 B.H.P. at 500 volts, or 2½ B.H.P. at 250 volts, the full-load current being 9 amperes. It can be run from the battery circuit if desired, and most of the special work is done under these conditions. This machine has been specially made for experimental purposes, and has a number of novel features. The four shunt coils are separately connected to a terminal board on the wall where they can be joined all in series, all in parallel, or in series-parallel, in order to get different speeds or to suit different pressures. The normal arrangement is to have them all in series on 500 volts, or in two parallels of two each on 250 volts, but the coils can be run with 250 volts on each without overheating. Six points on the armature winding are connected to separate slip-rings at the pulley end of the armature, and the brushes which bear on these are connected to a set of six terminals on the wall. The machine can thus be run as an alternate-current generator or as a rotary converter for either one, two or three-phase currents, the maximum frequency being about 40 ~ per second.

In order to be able to examine the distribution of the magnetic flux at each pole separately, a special search coil is wound, ring fashion, in the bottom of one of the slots and through one of the ventilating holes, and joined to another pair of slip-rings. The wave curve of the E.M.F. in this coil, which will show the distribution of the flux, or the wave curves for the currents or P.D. of any circuit on the A.C. side can be determined by means of a rotating contact-maker on the commutator end of the shaft. This consists of an ebonite disc with a strip of brass across it at one place, which connects two brushes once in a revolution. These brushes are carried on a rocker having an engraved scale by which the particular instant of contact can be adjusted at will. The commutator is made extra long, and a pair of small exploring brushes can be made to touch it between the lugs and the main brushes. These exploring brushes are carried by a holder on a large brass ring which is supported from the field magnet ring and can go quite round; their position is indicated on a scale on the ring. The distribution of the potential round the commutator can thus be explored and the mean flux distribution determined.

There are two testing beds in another line, with rails and cross-rails to which any other machines can be bolted and belt-driven from the above machines, or tested as motors. At present several old small machines are fixed on these beds, and are used for illustrating the effects of the various ills to which dynamo-electric machines are liable. All the beds have been raised a considerable height above the floor so as to allow ample room below the pulleys for brake tests. In arranging the connections of the machines the idea has been to facilitate as far as possible all the different connections required for experimental purposes and to allow each part to be easily disconnected from all the others for measuring purposes without interfering with the wires on the machines themselves. With this end in view the brush leads, field coils, switches, &c., have all been connected to separate terminals fixed on the wall near the machine, so that it is perfectly easy to trace out the connections. In each case, also, pilot wires have been provided connecting terminals on the wall to terminals on the machine, which can be used for special purposes. The terminals, which have been specially designed (see Fig. 3), are double-ended, and are fixed to porcelain insulators with bridges between the metal parts both in front and behind. The cables leading to the machines, &c., are sweated into a central socket at the back, and the front is thus left entirely free for making the connections between the several parts. Ammeters, voltmeters or regulators can thus be easily inserted wherever required, a board being fixed above to which those can be fixed which read in a vertical position. Instruments which are used in a horizontal position can be laid on the bench below the terminals. Each terminal has an ivorine label to indicate the part to which it is permanently joined.

Nos. 1 to 4 have been arranged on a uniform plan, the positive terminals always being placed to the right or top, with the pilot wires in the centre, the shunts next, then the armature, and lastly the switch and fuse connections. The terminals to which the outside circuit is to be joined form the extreme ends of the set. Nos. 1, 3 and 4 have single-pole switches and double-pole fuses placed at the ends of the rows of terminals, each connected between a pair of terminals in the row. No. 3 has also a four-way voltmeter switch, of which the second pair of contacts go to the extreme terminals for the outside circuit, the third to the armature terminals, and the fourth to the pilot wires. The first pair go to the two contacts of the switch in order that the voltmeter may be used to find whether they are at the same potential before switching

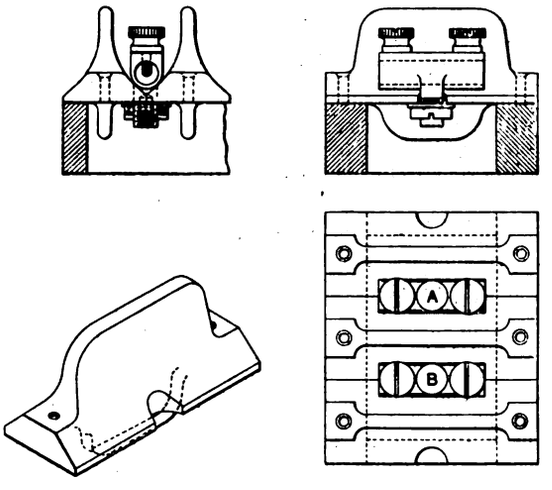

FIG. 3.—SPECIAL TERMINALS USED FOR MACHINES AND BATTERY IN THE ELECTRICAL ENGINEERING LABORATORY.

on. This is required in paralleling the machine with the battery to make sure that the fields have not become reversed, as this often happens with the currents used for testing.

There is a storage battery of 60 RG2 Chloride cells of 120 ampere-hour capacity and maximum discharging rate of about 30 amperes; also five E.P.S. cells of about the same size. These are all joined in series, but the latter are joined in through a set of terminals by means of which they can be paralleled for ammeter testing, &c., if required. A six-way double regulating switch is connected to every second cell at the positive end of the Chloride battery. From the two levers of this switch, from three other points on the same battery, and from the end of the E.P.S. battery, wires are taken through a six-panel distributing fuse-board to sets of six terminals at a number of points round the room, and at each of the central benches. The points of connection to the battery are so chosen that any multiple of five cells up to 65—*i.e.*, any multiple of 10 volts up to 130 volts—may be obtained at these places by merely connecting to the proper terminals. The terminals are lettered and ivorine tablets fixed beside them show which to employ for any desired number of cells.

Another set of six wires are taken from the fuse-board to a "distributor," to which pairs of wires from various other rooms in the college are brought, so that they can also be put on to any part of the battery, and to a similar distributor in the senior physical laboratory, from which pairs of wires lead to a number of points in that laboratory. Lastly, a circuit from panels B and E, between which there are 50 cells, is taken to the two physical lecture theatres, the optical laboratory and the large hall gallery for working electric lanterns.

The arrangements for the reflecting galvanometers are on an entirely novel plan. The galvanometers themselves stand on wooden turntables, with hole and slot on the top of blocks of stone

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which rest on rubber feet. This obviates all trouble due to vibration when the machines are running. The scales are engraved with 40 divisions to the inch on white tracing paper, which is placed between two glass plates in a wooden frame. The bottom half of the scale is covered on the front by opaque white paper to make the spot easily visible from the back side, while the other half is used for reading from the front, or side remote from the galvanometer. The frame is placed inside a mahogany box which shields off extraneous light, this box being open at both ends and carried on brackets hung by a geometrical method from bolts in the wall at such a height as to make the scale easily read by an observer standing. Thus there is ample room for the other apparatus below the scale box. Concave mirrors of about a metre radius are used on the galvanometers, and produce on the scale an image of an illuminated lens and cross-wire fixed to a lamp carriage which slides on the side of the scale box. The lens is illuminated by an electric lamp behind it, which also serves to light the table below. It has a shade to protect the eyes of the observer and throw the light down better. The lens can be adjusted in all directions relative to the lamp in order to get the best light on the scale, the image being focussed by sliding the carriage in or out, while the cross-wire can be rotated to get it parallel to the scale divisions. Two long screws support the lamp carriage, which give a fine adjustment for the height of the image, the zero being roughly adjusted by turning the turntable on which the galvanometer is placed, and a fine adjustment can be made by shifting the scale itself by a lever provided for the purpose. Inside the scale box, at one side, is a three-cornered block of wood, turning on a pivot, with "Too Large" and "Too Small" printed on two of its faces; this is used for zero tests, that side which reads correctly for the particular experiment being turned outwards. The galvanometer and scale being both close to the wall, the line of centres is inclined to it.

A 20in. bench is fixed nearly all round the room, and small, loose tables can be placed against it wherever required to increase the width. One of these tables is always placed below the scale stand, and the observer takes his position in the corner between it and the bench with his apparatus and scale all in front of him. When two work together, the other takes the other side of the table and can also see the spot from his side. There are also three benches in the middle of the room, at which many of the simpler experiments can be performed.

The laboratory is provided with a number of measuring instruments. Among them are the following:—Three moving-coil milli-ammeters with shunts and series resistances to measure current and P.D. throughout a wide range, Weston wattmeter, three Siemens dynamometers, numerous ammeters and voltmeters of the soft-iron type, Cardew voltmeter, Ayrton-Mather electrostatic voltmeter, moving-coil and moving-needle reflecting galvanometers, Post Office and Helmholtz tangent galvanometers, Crompton universal potentiometer, Nalder volt potentiometer, resistance boxes, bridges, rheostats and resistance frames, of which several have been specially designed, carbon rheostats, condensers, two quadrant electrometers, combined revolution counter and chronograph, stroboscopic tuning forks for exact speed measurement, magnetometers, &c.

We have to express our indebtedness to Prof. J. Wertheimer, principal of the college, for his courtesy in furnishing us with the above particulars.

MR. T. P. WILMSHURST'S PRESIDENTIAL ADDRESS TO THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.*

At the commencement of our ninth annual convention, it is with great pleasure that I am able to congratulate you on the continued growth in numbers and importance of our Association. When our first president, Mr. Arthur Wright, addressed you, he referred to the fact that our members controlled undertakings with a capital outlay amounting to £4,000,000. Within eight short years this has risen to £25,000,000, and, including the tramway undertakings with which many of us are connected, it may be safely said that our members control an industry with a capital of nearly £40,000,000. Before going further, however, I must refer to the grievous loss which we, and, in fact, the whole profession, sustained by the sudden death at an early age of Mr. Quin. For several years he served on our council: his opinions always commanded respect, and his abilities were such that all who knew him prophesied for him a brilliant career.

When reviewing the influences which affect for good or evil the undertakings we control, the attitude of Parliament and Parliamentary Committees cannot fail to have a great interest for us, since anything tending to unreasonable restriction cannot fail to have an adverse influence on our prospects. One cannot, therefore, view without a certain amount of uneasiness the want of continuity of policy in Parliamentary Committees. I will give you one or two instances. The Committee of the House of Commons which sat in 1900, under the chairmanship of Sir James Kitson, to consider the question of power schemes generally, laid down the following principle:—

A local authority which undertakes and is prepared to give a full and ample supply of electrical energy for all purposes to consumers within its district ought not, without its consent, to be required to give facilities for the supply within its district of electrical energy by other undertakers. But if a local authority is unable or unwilling to provide on reasonable terms and within a reasonable time a full and adequate supply of electrical energy for any purpose to any company or person applying for same within its district, such company or person should be at liberty, after notice to the local authority, to obtain their supply from other authorised undertakers, and the local authority should be required to give all necessary facilities for this purpose.

In other words, peaceable possession was to be given in return for good behaviour. This principle was adopted, and, in consequence, all important towns having electric supplies were excluded from the many power schemes which were promoted during the next two or three years. It was, therefore, a considerable surprise to us when another Parliamentary Committee reversed this principle and allowed the city of Bristol to be included within the area of a power company. In this case, at any rate, there was no question of an inadequate or defective supply being furnished by the Bristol Corporation; in fact, considerable expense had been incurred in providing special arrangements for the supply of electric power for local industries.

Another instance is the insertion in a bill of the famous—or infamous—"Bermondsey" clause, which might have been invented with the object of strangling an industry in its early days, while in other bills the clause has been refused; allied to this is the "Willesden" clause, which will be fresh in the minds of many of you. Yet another instance is the electrolysis clause which has been inserted in a number of tramway bills, while in other cases we have been refused this clause, but instead have been told to comfort ourselves with the assurance that we are amply protected by the existing Board of Trade regulations.

The recent decision of a Parliamentary Committee to grant to a company powers to run over the lines of the Newcastle Corporation tramways is a new departure, which, if confirmed by Parliament, will have far-reaching results. Another novel decision recently given is the case of a certain corporation, which, in promoting an omnibus bill, sought and obtained power to give a supply of electricity to a number of villages within its sphere of influence with the consent of the local authorities controlling these villages. The proviso was inserted, however, that the consent of the Corporation should not be required in the event of a certain power company also wishing to supply these villages.

I have said enough to show how injurious to us may be the effect of this unfortunate want of continuity of policy. We often hear the complaint that Parliament is overloaded with minor details, and that the consideration of purely local matters could better be left to certain decentralised bodies to deal with. A little consideration shows that this would prove an aggravation of rather than a panacea for our troubles. Obviously, these troubles arise from the fact that similar questions involving the same principles are dealt with by several different Parliamentary Committees, the members of which may hold widely divergent views on such questions as municipal trading. The only remedy that I can see is to delegate matters involving the same questions of principle to one committee or to a body of commissioners similar to that which adjudicates on light railway schemes or by conferring wider powers on the Board of Trade.

We have been accused in some quarters and occasionally in the technical Press of looking on the power companies as our natural enemies. This view is entirely wrong and somewhat unjust to us as engineers. We all recognise that power companies have a distinct sphere of utility in supplying the large and small industries outside the reach of the local municipal or company supply, and in giving the benefits of an electric supply to small towns which hesitate to lay down their own plant. I do not say for a moment that we welcome their competition in our towns—if we did we should probably not be believed—but what we most strongly object to is their attempting to obtain terms and exemptions which we are denied under the Electric Lighting Acts and our provisional orders. For instance, sec. 19 of the Electric Lighting Act, 1882, provides that the undertaker shall supply anyone who demands a supply, subject only to certain very limited safeguards; the power companies are, however (or seek to be) relieved of this obligation. In other words, while we are compelled to take the rough with the smooth, the power companies seek only the plums. Again, in a number of power schemes which I have had occasion to examine within the last few years, the promoters have made comparisons of the cost to the consumer under their scheme with the cost of the municipal supply, invariably to the disadvantage of the latter. Cross-examination, however, has usually brought out the fact that while the municipal supply is given at a pressure suitable for immediate use, in the rival scheme it is proposed to give the

* Delivered at Derby on Wednesday.

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consumer a supply at 5,000 to 10,000 volts, leaving on him the onus of providing his reducing and converting machinery. This comparision is as unfair as a comparison of the cost per ton of a finished article with that of the raw material from which it was made.

The growth of our business, as shown in the periodical returns which are available, is very satisfactory. It is advisable, however, to remember the great progress which is also being made by our competitors. In recent years the gas business has received an enormous impetus from the introduction of the Welsbach mantle, and it would be folly on our part to disregard their experience. Rather let us see if the methods they adopt cannot also be adopted with benefit to ourselves. When the old flat flame burner was in general use the burner was of the simplest possible character, and if kept clean would last an indefinite time without attention. The old order, however, changed with the extended use of the Welsbach mantle. This gradually deteriorates with use, and has to be replaced at more or less frequent intervals. Neglect of this results in discredit being thrown on the supply. Gas engineers have not been slow to see that for the credit of their undertakings some sort of supervision of the consumers' fittings is to the interest of both buyer and seller. We find, therefore, an increasing tendency for arrangements to be made whereby, for a small payment, a periodical inspection is given. Now, the position of the incandescent electric lamp is analogous to that of the mantle. It is a device requiring technical knowledge in its selection, so that lamps of reasonably high efficiency and long life may be used. Yet how many of our customers consider life and efficiency before first cost when purchasing? The result is, inefficient lamps are used and are allowed to burn beyond the "scrapping point," and heavy bills follow; the supply is blamed as "not being so good as it used to be," and strained relations arise between our consumers and ourselves. I believe, therefore, that if we wish to continue and increase our rate of progress, the following suggestions are worthy of consideration:—(1) The periodical renewal of consumers' lamps, free, or on easy terms; (2) the periodical inspection of consumers' lamps *in situ*; or (3) the free testing of and reporting on consumers' lamps.

I am aware there are deeply rooted objections to the first two courses. Many engineers (and their consumers) shrink from organised domiciliary visits and from interference of any sort beyond the meter. Another objection often urged is that we do not purvey light, but electrical energy, and consequently it is no concern of ours how that energy is used.

Though I have no sympathy with the principle of the municipality undertaking wiring or interfering with the legitimate business of the local contractor, I believe that only good can result from our selling lamps of good efficiency at the lowest possible price. The opponents of municipal trading will, I think, admit that this is germane to the business of electricity supply, and Parliament has recognised this by permitting in many local acts the clause authorising us to "sell, let on hire and otherwise deal with electric lamps, &c." Personally, I am strongly in favour of the policy of testing free of charge all lamps which the consumer likes to send us. The expense to us is very small, and there should be no difficulty in arranging for the tests to be carried out during the night shift or some other convenient time.

We are handicapped in the pushing of our business by the fact that our capital charges are so heavy as compared with our revenue. This is, I believe, largely due to the want of a cheaper and more efficient method of storage. As a matter of fact, the average percentage of our revenue to capital only amounts to 10 per cent., as compared with 24 per cent. in the case of gas undertakings. It is a sign of promise for the future, however, that the increasing use of power during the hours of daylight is helping towards the solution of the problem of this small percentage. This, however, should be sold at the lowest possible price and, if necessary, encouraged by letting out the motors on hire. The progress of power supply in many of our towns is so marked that I believe it is having and will have a distinct influence in those towns which wish to retain old and attract new industries. Just as in foreign countries we find new and thriving trades settling round the sources of cheap water power, so I believe the best industrial inducement we can offer to the manufacturers to settle within our boundaries will be the offer of cheap electric power. In our own town of Derby the progress of power supply has been most encouraging. Five years ago we gave a supply to 20 motors, aggregating 70kw. At the present time we have a total of 250 motors, aggregating 1,300kw., connected to our single-phase mains, while the percentage of units sold for power to total units sold amounts to 30 per cent. Allied to the foregoing is the vexed question of the proper apportionment of charges for energy for tramways between the two committees interested.

Many members of Tramways committees who have usually not had the opportunity of studying the considerations which underlie the costs of production, fail to see why they should be asked to pay, say, 1½d. to 2d. per unit, while smaller consumers of energy for industrial purposes only pay, say, 1d. to 1½d. per unit. A little consideration shows that there are at least two good reasons why this is so. The cost of producing electrical energy is independent of the purpose to which that energy is applied, and it depends chiefly on the rate of production; in other words, on the load-factor. Now, experience shows, contrary perhaps to what one would expect, that as a rule a motor load has a higher load-factor than a tramway load; quite frequently it is 10 to 15 per cent. higher, owing partly to the fact that the traction plant running has to be larger than the actual load. The second consideration is that in the case of the traction supply the energy must be taken from a separate plant to that supplying the lighting, and also a separate and distinct switch gear and set of mains must be provided, whereas the motor load is taken from the same machinery and mains as is supplying the lighting. For towns of moderate size I look to the battery and reversible booster as an important factor in reducing tramway costs. I do not, however, wish to trench further on the question, as you will have on Friday an opportunity of fully discussing it.

In our endeavour to improve our costs of production, I often think that we do not sufficiently consider the importance of the item "Rent, rates and taxes." From the fact that we have no hand in fixing the amount of our assessments, we are rather apt to dismiss the question of these charges as being unimportant, or, at any rate, as a burden to be borne with resignation, and, as engineers, we often know very little of the methods on which our assessment is based. I think this question of the equitable assessment of electricity works is one which our Association might profitably take up in the near future. To illustrate its importance, I need only say that reference to the columns of the *Electrical Times* shows that in five towns the rating is heavier than the coal bill, while in 20 towns it is over half the amount of the coal bill. It is only natural that in those towns where the rating of the works is low the engineer does not look too closely into whether the basis of his assessment is equitable, provided the amount of money which he has to contribute is reasonable.

There is a somewhat extraordinary divergence of practice in the methods adopted by the various rating authorities. In some towns it depends solely on the caprice of the assessment expert; in some an amount is arbitrarily fixed for a few years until it is seen what development takes place; in others it is based on the capital expended, while in others, again, it is based on the total horse-power installed. The result of such discordance is that this item in our cost sheets varies from 0·02d. per unit sold in one town to 0·7d. in another, and this can hardly be due to variation to this extent in the amount of the rates. The generally recognised custom seems to be to treat the undertakers as a "hypothetical tenant," deducting the working expenses from the gross receipts and making certain allowances for stock in hand, working capital and depreciation. As to whether this is the fairest method, I fear I am not competent to express an opinion, but if we could bring about greater uniformity in this matter, and so help some of our undertakings which are groaning under unduly heavy rating burdens, we should be worthily fulfilling one of the primary objects for which our Association was formed.

In conclusion, I would make an earnest appeal to all our members to do what in them lies to support the work of the Engineering Standards Committee. By more rigid adherence to standard designs and by judicious stifling of that natural desire of originality which smoulders in the breast of every well-regulated engineer, we shall be making an important step in the reduction of our capital expenditure.

I fear you will have found this address somewhat tedious by comparison with those of my predecessors in the chair, but I feel that the points alluded to are of some importance to us in the conduct of our concerns. I am glad to think that the Papers to be read at this convention are of an eminently practical character, and I venture to hope that your visit to the Midlands will not be without profit and pleasure to you all.

PHOTOMETRIC TESTS OF "LINOLITE."

Certain photometric experiments with the system of electric lighting known as "Linolite" have been carried out by Mr. J. S. Dow at the Central Technical College and the following is an abstract of his report. It will be remembered that the lamps are in the form of long narrow cylinders, and these are connected end to end. Fig. 1 shows the distribution of light in a horizontal plane, the lamp, and therefore the filament, being vertical—(*a*) when the reflector is removed; (*b*) when the nickel-plated copper reflector (pattern 35) is used; (*c*) when the polished aluminium reflector (pattern 20) is used; (*d*) when the white enamelled zinc reflector (pattern 5) is used.

To obtain (*a*), the full line curve, the lamp was placed in a vertical position opposite the photometer, the axis of the photometer intersecting the mid-point of the filament. The lamp was then rotated through a small angle about its filament, and the candle-power measured. The lamp was then rotated through a further

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angle, and another reading taken, and the process repeated till one complete revolution had been made. On these readings being plotted they gave the full line curve, which is approximately a circle. To obtain (*b*), (*c*) and (*d*) the procedure was the same, except that the nickel-plated copper, the aluminium, and the white enamelled zinc reflectors respectively were used. In these cases, of course, for rather more than 180deg., the light was completely cut off from the photometer by the reflectors. The difference in shape between the curves for the nickel-plated copper and aluminium reflectors may be due to some small difference in the curvature of the reflector, but it is probably the result of the fact that we get less of the irregular diffused reflection (such as occurs when light is reflected from any white metal surface) in the former case. For the same reason any "streakiness" in the appearance of the light, due to irregularities in the glass of the lamp, is accentuated with the nickel-plated reflector, and gives rise to the irregular "peaks" at the sides of the curve.

It will be seen that, in the case of the aluminium reflector, for an angle of 70deg. the light was 100 per cent. more than it was without the reflector, and for an angle of 100deg. it was 50 per cent. more. This is important, as it enables more light to be used for a lamp by itself. From these curves the mean spherical candle-power can be calculated. The chief object in getting the mean spherical candle-power is that the ratio of the mean spherical candle-power with one of the reflectors to the mean spherical candle-power of the lamp alone enables us to calculate the efficiency of that reflector. On doing this we find the efficiencies are as follows:—(1) Polished aluminium reflector, 81 per cent.; (2) white enamelled reflector, 79 per cent.; (3) nickelled copper reflector, 68 per cent. In addition to being the best reflecting surface, aluminium has the advantage that it does not tarnish like nickel or silver-plated metal does.

As the results of the experiments, there is no doubt that, where a strong illumination is wanted over a particular area, "Linolite" is much better than ordinary glow lamps without reflectors, and more often than not no reflectors are used with ordinary glow lamps. Indeed, very often shades are used which absorb a large amount of light. It is well known that with an ordinary glow lamp the light in the direction of the axis of the lamp (known as the "end-on" candle-power) is only 60 per cent of that marked on the globe, whereas with "Linolite" the light thrown forward over an angle of 70deg. is twice the amount marked on the lamps. Again, the

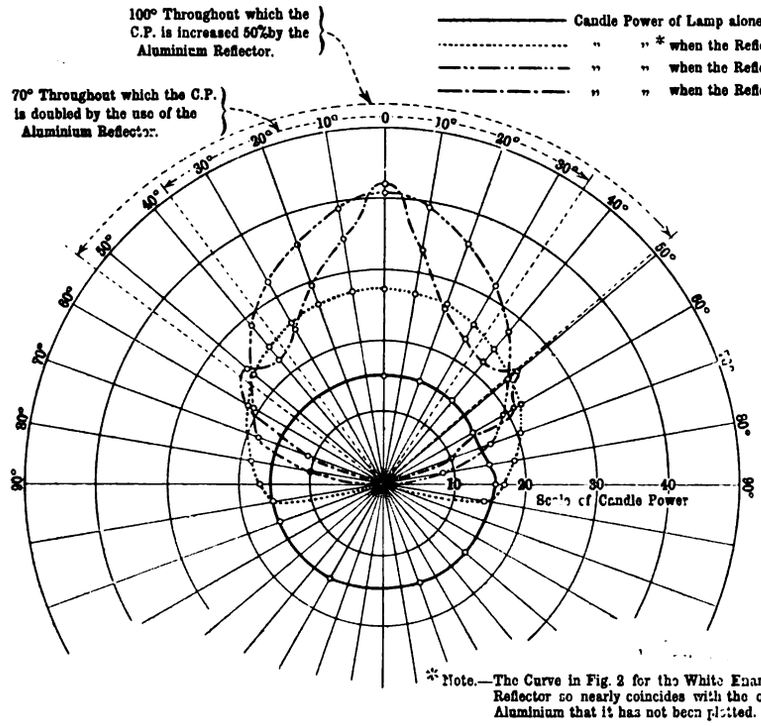
100° Throughout which the C.P. is increased 50% by the Aluminium Reflector.
70° Throughout which the C.P. is doubled by the use of the Aluminium Reflector.
Candle Power of Lamp alone.
" * when the Reflector is White Enamelled (Patt. 7)
" " when the Reflector is made of Aluminium (Patt. 20)
" " when the Reflector is made of Nickel-plated Copper (Patt. 35)
Scale of Candle Power
* Note.—The Curve in Fig. 2 for the White Enamelled Zinc Reflector so nearly coincides with the one for the Aluminium that it has not been plotted.

FIG. 1.—Polar Curve of Candle Power in the Horizontal Plane through the Centre of, and at Right Angles to, the Filament of the Lamp.

FIG. 2.—Polar Curve of Mean Candle Power for Planes at Different Angles to the Vertical.

given purpose. The distribution of the light by the aluminium reflector was also more uniform than was the case with the nickelled copper. In the direction of maximum intensity the light was increased from 15·7 c.p. to 40·8 c.p., or over 2½ times, by the aluminium reflector. The white enamelled zinc reflector gave a still more uniform distribution than the aluminium, but the increase of light in the direction of maximum intensity was only from 15·8 c.p. to 28·2 c.p., or less than double, and hence for many purposes it is not so suitable as the aluminium reflector, though the results of a later experiment show that the efficiency of the reflecting surface of white enamel is only 2 per cent. less than that of aluminium.

The curves in Fig. 2 show the mean distribution of light in any vertical plane through the filament, which is also vertical as before. The photometer was kept in one position and the lamp was placed first vertically and then tipped forward (bowing, so to speak, into five positions) towards the photometer, in the vertical plane containing the axis of the photometer, the fifth position being that in which one of the ends of the lamp pointed at the photometer. In other words, the axis of the photometer and lamp were then coincident. In each of the five positions the lamp was rotated by steps about its own axis (as in the case of the first set of curves) and readings were taken. In the case of the lamp by itself, of course the readings for each position were practically the same, but when the reflectors were used some readings showed there was no light—*e.g.*, when the back of the reflector was towards the photometer—and others showed the maximum quantity of light. The mean of these readings has been plotted for each position, and thus the curves in Fig. 2 were obtained for the various reflectors and the stretching out of the filament and the arrangement of the reflector, whereby practically every point of the filament is in the same relative position to the reflector, does certainly give a more diffused light while enabling the light to be easily sent into any required direction.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Electric Motors." By H. M. Hobart. (London: Whittaker & Co.) 12s. 6d.

"Electric Flashes, or the Systems of Wireless Telegraphy and Telephony." By A. T. M. Johnson. (London: Everett & Co.) 2s. 6d.

"Technological and Scientific Dictionary." Edited by G. F. Goodchild and C. F. Tweney. (London: Geo. Newnes. 1s.

"Proceedings of the Royal Society." No. 495. Vol. LXXIII. (London: Harrison & Sons.) 3s.

"Die Dampfturbinen, mit einem Anhange über die Aussichten der Wärmekraft maschinen und über die Gasturbine." By Dr. A. Stodola. 2nd edition. (Berlin: Julius Springer.) 10m.

"Das Elektrische Bogenlicht." Part I. By W. B. von Czudnochowski. (Leipzig: S. Hirzel.) 3m.

"Der Kaskadenumformer." By E. Arnold and J. L. La Cour. (Stuttgart: Ferdinand Enke.) 1.20m.

"Traité Général de L'Emploi de L'Électricité dans L'Industrie Minère," By N. Lapostolest. (Paris: Ch. Dunod.) 7.50fr.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Radium Emanation.—An important communication on the properties and transformation of the radium emanation is made by Sir William Ramsay. In collaboration with Soddy, he has succeeded in determining the amount of emanation given out by radium bromide in a given time, and in determining the position of its brightest spectrum lines. They dissolved 70mg. of radium bromide in distilled water, and found that the water was gradually decomposed, giving rise to an explosive mixture of oxygen and hydrogen, with the latter predominating. This explosive mixture contained a small quantity of emanation. By detonating it and then introducing the tube into a liquid air refrigerator, they succeeded in condensing the emanation. They then pumped away the hydrogen and obtained a small quantity of the pure emanation, which, after regaining the normal temperature and pressure, occupied a volume of one-fiftieth of a cubic millimetre. On gradually reducing the pressure, they found that the gas expanded, very nearly according to Boyle's law. The emanation, therefore, behaves like an ordinary gas. It emits sufficient light to read the time on a watch by. On observing the light with a spectroscope, the author found 18 lines, the strongest of which occurred at 5,595, 5,393 and 4,985. There were two fairly strong lines at 5,805 and 5,725 respectively, and another at 4,966, which, however, disappeared after a time. On keeping the emanation for a month, the luminosity gradually disappeared. On reducing the pressure and heating slightly, a gas having four times the volume was obtained, which showed the spectrum of helium. The emanation resembles the gases of the argon family, and its atomic weight is probably double its density. The latter is about 80, so that an atomic weight of about 160 would be indicated. That of radium being 225, it follows that one atom of radium cannot well give rise to more than one atom of emanation. Now, every gramme of radium gives 3×10^{-6} cubic mm. of emanation per second. Hence the amount of radium transformed into emanation in one year is about one-thousandth part of its weight. This would mean that the life of radium is about 1,000 years. The heat emitted by the emanation is three or four million times the amount emitted by an equal volume of an explosive mixture of hydrogen and oxygen during explosion. In consideration of the fact that the emanation is a gas of independent, though destructible, properties, the author proposes to call it "exradio."

[Sir WILLIAM RAMSAY, *Comptes Rendus*, June 6, 1904.]

Ionisation Recorder.—C. Nordmann has invented an instrument which he calls the "Ionograph," and which is intended to give a continuous reading and automatic record of the state of ionisation of the atmosphere and of gases. The gas to be studied is introduced between the armatures of a condenser. One armature is raised to a potential sufficient to produce the saturation current. The other armature is joined to an electrometer on the one hand, and to the earth through the intermediary of a very high resistance on the other. Under the influence of the field between the armatures, the second armature collects a certain quantity of electricity per second, such quantity being proportional to the number of irons produced per second between the armatures. If C is the capacity and E the potential of the second armature and its electrometer connections, its charge, CE, at the end of a time t equal Qt, less the quantity of electricity lost to the earth through the high resistance. By a suitable choice of the dimensions of the apparatus the readings for E may be made proportional to the values of the product QR, where Q is the quantity and R the high resistance. The best value of the high resistance is about 10 megohms. The registration of the actual ionisation is then completed in about half a second.

[C. NORDMANN, *Comptes Rendus*, June 6, 1904.]

Alternate-current Electrolysis.—A. Brochet and J. Petit have studied the solubility of various metals in a 4-gramme molecule solution of cyanide of potassium under the influence of alternate currents of various frequencies. They found that the popular impression of a uniform decrease of solubility with increase of frequency is incorrect. Platinum shows, in fact, a uniform though slight increase. Copper shows a well-marked and uniform decrease, whereas the metals of the iron group show a decided maximum at a frequency of 12 to 30 periods per second. The solution of lead in sulphuric acid shows a maximum at about 15 periods per second, and after that a slight decrease. The current density used was 20 amperes per square decimetre.

[BROCHET and PETIT, *Comptes Rendus*, June 6, 1904.]

Cathode Rays.—P. Villard has made some interesting observations with regard to those cathode rays which follow the lines of magnetic force. Broca and Pellat have shown that there exists a species of cathode rays which, if placed in a strong magnetic field, trace out the magnetic lines of force. Villard has photographed both kinds of cathode rays with one exposure, using oxygen as the gas, and obtained the ordinary cathode rays in the form of a screw about the magnetic lines of force, and the other rays, which he proposes to call the magneto-cathode rays, following the magnetic lines of force. He finds that they originate at a lower difference of potential than the ordinary rays. Their appearance is accompanied by a fall of potential at the electrodes, and a weakening or even an entire suppression of the ordinary cathode rays. For the magneto-cathode rays the field is not only directive, but also motive. If the discharge from the cathode is hindered by placing a small aperture in front of it, a discharge may be forced through the aperture by increasing the strength of the magnetic field. The author proves that the magneto-cathode rays have no electric charge. On repeating Perrin's experiment, in which the shadow of a wire exposed to cathode rays is enlarged on charging the wire negatively, no effect is produced. He describes an experimeut based on Faraday's ice-pail experiment, in which either ordinary cathode rays or magneto-cathode rays may be made to enter the enclosure. The former instantly produce a deflection of the electrometer corresponding to several hundred volts, while the latter produce no effect. The magneto-cathode rays are indeed deflected by an electric field, but in a direction perpendicular to the lines of force. There is, in fact, a perfect antithesis between the two kinds of cathode rays. The electric field acts upon one kind as the magnetic field acts upon the other, and vice versa. "I believe this is," says the author, "the first time that a Laplacian action of electric force has been realised."

[P. VILLARD, *Comptes Rendus*, June 6, 1904.]

Anæsthesia of Metals.—Since the researches of Jagadis Chunder Bose it is known that certain poisons, and especially anæsthetics, diminish the "electric response of matter," or the return to equilibrium after an excitation, either because they increase the viscosity or diminish the elasticity of the material. If that is so, it is intelligible that the matter affected should be unable to follow the extremely rapid vibrations which give rise to N-rays. J. Becquerel has therefore examined the action of anæsthetics in diminishing the transmission of N-rays and the response to their impact. He used a hollow cone of aluminium or copper, and placed the source of N-rays under its base. The sensitive screen was placed at the apex, and the whole enclosed in a vessel which could be filled with air or with the vapour of chloroform or other anæsthetic. It was then found that if the base was protected against the immediate action of the chloroform by means of a plate of thin glass, the rays passed in spite of the presence of the vapour if the source was enclosed in a box of glass, wood or cardboard; but all action ceased if the box was made of aluminium or copper. The author concludes that aluminium and copper lose their transparency for N-rays when the surface which receives the radiation (in this case the base of the cone) or the surface from which the rays proceed (in this case the box containing the source) is exposed to the action of an anæsthetic. Glass, wood and cardboard, on the other hand, always allow the radiation to pass. The author is inclined to believe that the N-rays consist of two different radiations, one of them traversing glass and other substances with the velocity of light, or nearly so, as shown by the index of refraction, and a form of energy which is only propagated slowly and which stops at the surface of chloroformed metals.

[J. BECQUEREL, *Comptes Rendus*, June 6, 1904.]

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THE MARYLEBONE SPECIFICATION.

One of the outcomes of the famous Marylebone electric lighting muddle is a specification for generating-plant, issued by the Council's consulting engineer, Mr. ARTHUR WRIGHT. It will be remembered that the arbitration resulted in the Metropolitan Electric Supply Co. obtaining a substantial sum from the Marylebone Borough Council for that part of the undertaking which lies in the Marylebone area, but the Council must necessarily erect a large new generating station, as Marylebone is at present supplied from the works at Willesden, which remain in the company's possession. In this connection it is interesting to observe that an entirely different system of generation and supply is to be adopted, continuous-current plant and three-wire mains being put down throughout. There is already a sub-station in North-street containing synchronous motor-generators having an aggregate capacity of 3,000kw., and therefore certain of the Marylebone consumers are now being supplied with continuous current; but the new scheme provides for direct generation and distribution. Specifications for the generating plant in the new generating station, which will be situated on the banks of the Regent's Canal, St. John's Wood, were issued last Saturday, June 25th, and tenders have to be in Mr. WRIGHT'S hands by July 6th. This is undoubtedly driving the matter rather close, and it would have been better for all parties concerned if either the specification had been available earlier, or the date for the delivery of the tenders had been fixed later, especially as the work set forth is of considerable magnitude, and will require exceedingly careful consideration.

Tenders are invited for four 500kw. steam turbines coupled to continuous-current generators, and for five larger turbine sets of 1,700–2,000kw., as may be most suitable to the maker's standards. Each set is to have its own condensing plant. The smaller sets are to be delivered, erected and running in the station by February 28, 1905, and the dates for the first four of the larger sets are as follows:—April 30th, June 30th, August 31st and September 30th. The fifth set is not to be built until instructions to that effect are received from the Council, as eventually it may not be required at all. One peculiar clause in the specification is to the effect that no guarantee will be given that the buildings will

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be complete in time for the reception of the machinery. The contractor is recommended to take this into account in tendering—if he can. Of course, it is quite possible that the buildings will not be complete, and contractors will be obliged to erect temporary covering for their plant and maintain it until such time as the building be complete. And they will have no permanent covering under which to carry out the work of erection of plant. There is no restriction as to the type of turbine to be installed—it may be either vertical or horizontal—and the tenders will, therefore, possess considerable interest from this point of view alone. The turbines are to be capable of supplying a 25 per cent. overload for one hour, and the variation of speed is not to exceed 3 per cent. when full-load is suddenly reduced to half-load, nor more than 5 per cent. from full-load to no-load Possibly as a precaution against blade-stripping, the clearance between cylinders and blades is to be large enough for working with steam superheated 200°F., but under normal conditions it will only be superheated 100°F. The steam consumption for the large sets is not to exceed 20lb. of steam per kilowatt-hour at the switchboard and 21lb. for the small sets. Mr. WRIGHT has fixed no vacuum, but has drawn the specification very broadly with regard to condensers, merely stipulating that these shall be suitable for maintaining continuously the specified efficiency. Perhaps he had the discussion on Messrs. PARSON and STONEY'S Institution Paper in mind when considering this question. In addition to taking the responsibility for fixing the vacuum, the contractor also has to state the steam consumption at three-quarter, half and quarter load, and the vacuum upon which those guarantees are based. The tops of the turbine cylinders are to be removable without necessitating the dismantling of the governors or valve gear; the dynamos are to be continuous-current machines, generating at 500 to 600 volts. There may be either one to each turbine, or two in tandem, but if the small turbines have each two generators in tandem, then one set must have its two dynamos each wound for 300 volts, evidently for balancing purposes. There must be no sparking, even on a 25 per cent. overload for one hour, and the temperature of the armatures and field windings must not exceed 45°C. after a six hours' run at full load. In order that a fixed point of commutation may be obtained, compensating windings must be employed, but either carbon or metallic brushes may be used. There is nothing calling for special comment in the payment clause: 50 per cent. of the contract price is to be paid on completion of each set ready for running, 30 per cent. on the preliminary test proving satisfactory, 10 per cent. on final test, and the balance within six months of completion.

So far, it will be seen, no unusual conditions or restrictions are imposed on the contractor. But Mr. WRIGHT'S specifications are seldom devoid of some sign of originality, and in this case the departure from customary practice is therefore not altogether surprising. Up to the present time the Council has not issued specifications for the electrically-driven overhead crane, switch gear, balancers, boosters and accessories, and cooling towers. These items are designated by the letters *e*, *f*, *g* and *h* respectively, and the following is an extract from the specification:—

The engineer will invite tenders separately for the plant included in sections *e*, *f*, *g* and *h*, and the contractor will be bound to take over the contracts for the supply and completion of all the works included in the sub-contracts at the figures quoted by the sub-contractors. The contractor must state in his tender the minimum percentage that he is prepared to add to the sub-contractor's quotation to cover his risk and expenses involved in dealing with the sub-contracts mentioned on the actual quotations received by the engineer and communicated to the contractor, except in the event of the main contractor being the selected sub-contractor for the supply of any one of the items *e*, *f*, *g* and *h*.

A similar clause is inserted in the boiler specification for a tube well and coal-conveying plant, the 10 boilers being of the water-tube type and four of them equipped with thermal storage cylinders. Thus it will be seen that the contractor has no voice whatever in the selection of the sub-contractor, and yet he has to be responsible for the latter's good behaviour and performance of contract. In order to make matters appear slightly better for the contractor, he is invited to " . . . state in his tender the minimum percentage that he is prepared to add to the sub-contractor's quotation to cover his risks and expenses . . . "; but there is an element of speculation in this sort of thing, which every contractor of repute will view with anything but favour. Firms are requested to state a figure which they must anticipate will be sufficient to make good any loss due to non-performance by a sub-contractor when they have not the remotest idea who that sub-contractor will be. We should imagine that the percentage will vary up to almost 100, according to the reputation of the sub-contracting firm. Why Mr. WRIGHT has not issued specifications for the entire plant in the usual way is possibly explicable by a desire to obtain the advantages of dividing up the contract without its disadvantages. Doubtless this will save considerable time and trouble to the consulting engineer, but the method is not an economical one for obvious reasons, and in the circumstances any tenders received cannot contain the most favourable quotations.

COMMERCIAL PRACTICABILITY OF ELECTRIC TRACTION BY SURFACE CONTACTS.*

BY C. E. C. SHAWFIELD.
(Borough Electrical and Tramway Engineer, Wolverhampton.)

Many municipalities contemplating the adoption of electric traction are making inquiries into the merits of that most abused of all methods of electric traction—namely, the surface-contact system. As the author has had charge during the past 2½ years of the only surface-contact system of electric traction in commercial operation in Great Britain, he has ventured to place some of his experiences and the conclusions he has deduced therefrom on record, in the hope that they may be of interest to the members of this Association, and they may give rise to an interesting discussion. It is not the intention of the author to discuss in this Paper the respective merits or demerits of the various contact systems now on the market, but rather to make certain comparisons between the overhead system, which is so universally adopted in this country, and the surface-contact system which has been under the control of the author at Wolverhampton.

The surface-contact system in operation at Wolverhampton was first introduced into England by the Lorain Steel Co. of America, who had previously experimented with the system at Washington. It was first brought before the notice of the Wolverhampton Tramways committee in March, 1901, and after lengthy negotiations a contract was entered into between the Corporation and the Lorain Steel Co. by which the latter were to equip about 11½ miles of single track with their surface-contact system, and allow the Corporation to operate the lines so equipped for a period of 12 months. It was a condition of the contract that if the system proved itself a commercial success during the period of experimental operation, the Corporation were to take over and pay for the same at an agreed upon rate, but if it failed to prove itself safe and reliable and commercially successful, the Lorain Steel Co. were to remove their apparatus and bear the whole cost of the experiment. The 12 months' experimental operation terminated on April 17, 1903, and although there was a great deal of difference of opinion in the Town Council as to the advisability of retaining the system, it was eventually decided on September 11th, by a large majority, that the system should be accepted. Shortly afterwards it was decided to proceed with the reconstruction of existing routes operated by horse traction and the construction of new routes, amounting in all to an additional 7 miles of single-track, and the Council decided that these extensions should also be equipped with the Lorain surface-contact system. About 5 miles of these extensions have already been completed, and it is expected that the remainder will be finished very shortly.

* Paper read before the Incorporated Municipal Electrical Association on Wednesday.

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The design and general arrangement of the Lorain surface-contact system has already been fully described and illustrated in the technical press,† and is probably well known to the majority of the members of this Association, and, therefore, the author does not propose in his Paper to give any technical description of the system itself. In comparing the respective merits of the overhead system and the surface-contact system, the author proposes to do so from the following standpoints, namely:—

1. Safety to human beings and animals.
2. Reliability of operation.
3. Cost of operation and maintenance.
4. Cost of installation.
5. Disfigurement of streets and obstruction to traffic.

Safety.

In any electrical or mechanical system, probably the most important point to be considered is the safety of the general public, and it is, doubtless, the appreciation of this fact that has led the legislature to impose stringent regulations and conditions upon the use of electricity for the purposes of tramway operation. In comparing the respective advantages from the point of view of safety of the overhead system and the surface-contact system, it is evident that only one source of danger need be seriously considered—namely, that of electric shock—as practically all other risks are common to all systems of electric traction. In the case of surface-contact systems it is evident that the only portion of the apparatus exposed to the public from which a shock could, under any possible conditions be obtained, is the metal stud in the centre of the track, and that this can only become or remain alive (except when it is covered by a car) in the event of some failure of, or defect in, or damage to the mechanism which operates it. The actual value of this risk may best be estimated in the light of actual experience, and the author has therefore analysed the records of defective boxes during the past 12 months, and has extracted threfrom the following particulars.

Table I.—*Defective Boxes found during 12 Months ended March 31, 1904.*

Quarter ending.	Cups damaged by short circuits.		Moisture in granite basin.		Total.		Average per mile of single track per annum.
	E.M.F. above earth, as shown on Weston voltmeter.						
	Volts. 10 to 49.	Volts. 50 to 500.	Volts. 10 to 49.	Volts. 50 to 500.	Volts. 10 to 49.	Volts. 50 to 500.	
June 30, '03	10	14	..	1	10	15	10
Sept. 30 „	14	23	..	2	14	25	
Dec. 31 „	12	6	2	..	14	6	
Mar. 31, '04	10	11	2	2	12	13	
Totals ..	46	54	4	5	50	59	..

It will be seen from the foregoing table that a total of 109 boxes were found more or less alive during the 12 months in question, 59 of which were alive at an E.M.F. of over 50 and under 500 volts. The author has divided the live boxes into two sections—namely, those under and those over 50 volts—as he had found by experiment that it is quite impossible for any person or animal to feel the slightest sensation of shock from a box which gives a reading of 50 volts or under, and it is only in rare cases that anything approaching a shock can be obtained from a box which gives a reading of less than 100 volts.

It will be noticed that out of the total of 109 defective boxes, in nine cases the trouble was due to moisture in the granite basin, that is, to the accumulation of water on the surface of the granite basin under the dope, which formed a leakage path to the top plate. This may be said to be due in every case to carelessness in fixing in the first instance, sufficient care not having been taken to see that the interior of the granite basin was thoroughly clean and well brushed over with a coating of hot dope before the remainder of the dope was poured in. The remaing 100 defective boxes were the result of damage done to the interior of the cups by heavy and repeated short-circuits. These short circuits are caused by pieces of scrap iron which are picked up by the magnet system and come in contact at the same time with the collecting skate and with a cross rail at junctions and turnouts. The effect of a number of short-circuits on any one cup is that the interior of the top half of cup becomes burnt and charred, and thus loses its insulating properties, consequently the top plate or stud becomes alive at an E.M.F, which may be anything from a few volts up to nearly the full line pressure.

In this connection it is interesting to note that recent experiments made by the author show that the degree of damage to the cup in the event of a short circuit entirely depends upon the time element of the circuit-breaker controlling the main feeder. When the traction switchboard was installed at the power station the possibility of the adoption of a surface contact system had not been considered by the Tramways committee, and the circuit breakers for the tramway feeders were specially designed to give a comparatively slow break, with the object of preventing the rise of pressure which is frequently caused by the sudden rupture of an inductive circuit. Experience has shown, however, that this is the very worst type of apparatus that could have been selected for use with the surface contact system, as it allows the heavy current due to a short circuit to flow for a sufficient length of time to give rise to a considerable amount of arcing or flashing between the carbon contacts inside the cup, resulting in the charring of the latter and sometimes in the fusion of the copper ribbon. The author is now replacing the original circuit breakers with others of a new type which give a more rapid break with magnetic blow-out, and as a result of experiment he has found that with the circuit breaker set to operate at 600 amperes the tramway 'bus bars may be short-circuited a large number of times in rapid succession through the contact-making mechanism of the cup without the latter receiving any appreciable damage, and he has every reason to believe that this alteration in the type of circuit breaker will very greatly reduce the number of defective boxes in the future.

It will be observed that instances of defective boxes due to short circuits are more frequent in the summer than in the winter months, the reason for this being that light pieces of iron or steel are more easily picked up by the magnet when the track is dry and dusty than when it is covered with wet and sticky mud.

The presence of a metallic stud in the street surface electrically charged at a pressure of 500 volts above earth would at first sight appear to constitute a grave source of danger, but the author would point out that in speaking of a stud being alive at 500 volts it does not necessarily imply that the stud is capable of transmitting a dangerous shock to any animal or person stepping thereon; as an actual matter of fact this is by no means the case, as owing to the comparatively high resistance of the conducting path formed by the charring of the interior of the cup, the *quantity* of current that can pass is exceedingly small, and in many cases the readings obtained from the same "live" stud by different voltmeters will vary enormously, a difference of 100 or 200 volts being by no means uncommon, this variation being simply due to the difference in internal resistance of the respective voltmeters.

In only one instance has the shock received from a "live" stud been attended with serious results, and this occurred on February 17, 1904, when a sheep and a dog were electrocuted through treading on a faulty box on the Tettenhall-road route. The accident was the result of a curious combination of conditions, the absence of any one of which would probably have prevented its occurrence. In the first place, the box had been improperly fixed, the vulcabeston cup was cracked, and the space around it was not properly sealed with dope. A car passing over the box picked up a large piece of scrap iron, causing a heavy short-circuit, which completed the fracture of the vulcabeston cup and separated the top half from the bottom. Secondly, owing to a heavy snowfall the track in the vicinity had been salted, and at that particular spot was more or less covered with a fairly strong solution of brine. Owing to the absence of the proper seal of dope, this brine found its way into the interior of the cup, establishing a low resistance connection between the "live" lower contact and the top-plate and causing the top-plate to become "alive" at practically full line pressure. Lastly, the animals to which the accident happened had been travelling for some considerable distance along the salted track, and their feet were saturated with brine solution, thus greatly reducing the resistance of their bodies to the passage of an electric current. Immediately after the accident to the sheep and the dog, and before any warning could be given, a horse attached to a butcher's cart stepped on the same box and was brought down by the shock. It got up again immediately, however, and when examined shortly afterwards by a veterinary surgeon was reported as being none the worse for its adventure.

As a result of actual experiments the author is inclined to believe that horses, in spite of the fact that they are shod with metal shoes, are much less sensitive to a shock sustained by *stepping* on a charged metallic substance than to a shock received from a live conductor falling on them from above. Several instances have occurred of horses stepping on boxes which, when tested with a Weston voltmeter, gave readings of 500 volts and over, and although in the majority of cases the animals were brought down, in no case was there any resulting injury from the shock. The author has on more than one occasion watched a pedestrian step on a box which he has known to be "alive" at a pressure of 500 volts, as recorded by a Weston voltmeter, but in all cases the individual was apparently quite unaware of the fact. The comparative harmlessness of the shock received from studs "alive" at the apparently high pressure of 500 volts is, of course, due to the comparately high resistance of the charred surface of the vulcabeston cup, and to the fact that there is never, under any conditions of breakdown or defect, any metallic connection between the top-plate and the supply main.

In the case of the overhead system it is evident that there is risk of electric shock from any one of three causes, namely:—A

† *The Electrician*, Vol. XLIX., p. 174.

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fallen trolley wire; a fallen telephone, telegraph, span or guard wire; a pole which has become alive through the failure of the insulators. Wolverhampton is situated in the midst of a network of tramways, all of which are operated on the overhead trolley system, and judging by the frequent occurrence of accidents due to one of the three causes mentioned above, the author is of the opinion that the risk of electric shock from one of these causes is at least as great as that arising from the occurrence of a "live" stud. The recent accident in a Midland town whereby three horses were killed and the man in charge thereof injured by a shock received from a tramway pole in the centre of the street, is a grim illustration of the fact that the dangers of the overhead system are by no means confined to falling trolley wires or charged telegraph wires.

On a large percentage of the tramway systems of this country centre-pole or side-pole bracket arm construction is largely used, and in accordance with the usual practice the poles are erected in concrete. It is well known that, under certain conditions which may frequently occur in practice, these poles are virtually insulated from the general mass of the earth, and can, therefore, become charged at a high potential relatively to the earth. When it is considered that in a very large number of cases single insulation only is used between the trolley wire and the bracket arm, it is evident that failure of the straight line insulator which supports the trolley wire—either from mechanical stress or other cause—may result in a pole becoming "alive" at an E.M.F. of anything up to 500 volts, and prove a source of very serious danger to human beings and animals in the vicinity.

It is evident, moreover, that the failure of an insulator under the conditions named would not be easily detected under ordinary service conditions, and there would be nothing to indicate the fact that anything was wrong until an accident had occurred. That instances of falling trolley wires and "live" tramway poles do occur with startling frequency in many districts where tramways are operated on the overhead system is undoubtedly true, and that these mishaps are not more frequently attended by injury to human beings or animals appears to the author to be largely due to the beneficent interposition of Providence. It must be remembered, moreover, that a shock received from a falling trolley wire or a live telephone wire is of necessity infinitely more dangerous than any shock which can be received from stepping on a "live" stud, as in the former case the shock is generally transmitted through the most sensitive part of the body, and there is much greater risk of the "live" substance coming in contact with bare flesh. In proof of this contention it is only necessary to refer to the files of the daily Press, from which it will be found that in nearly, if not quite, every instance where a shock has been received under these conditions, it has proved fatal in the case of animals, and has always been attended with serious and sometimes fatal results in the case of human beings.

In conclusion, so far as the question of safety is concerned, the author is of opinion that the balance of advantage lies with a well-designed and carefully-installed surface-contact system.

Reliability of Operation.

Of almost equal importance to the question of the safety of the public is that of reliability of operation, and no system of electric traction will ever have the slightest chance of success unless it can be regarded as thoroughly reliable under all conditions of service. Owing to the entire absence of any statistical information regarding the number of journeys lost through defects in or failures of the overhead electrical equipment on tramways where the overhead system is adopted, it is very difficult to institute anything like a comparison between the overhead system and the surface-contact system so far as reliability of operation is concerned. From the very commencement of the operation of the tramway system in Wolverhampton, the author has kept minute records of every delay that occurred on any route and the cause thereof, together with the number of journeys lost by the cars affected by such delay or stoppage. Thus, if an accident occurs causing a delay of 15 minutes on any one route the mileage lost is reckoned as the total mileage that would have been run by each car affected by the delay during the period that the stoppage occurred. The following table shows the total mileage lost due to faults in the electrical equipment of the Wolverhampton tramways during the 12 months ended March 31, 1904:—

Out of a total of 173 car-miles lost due to defects in the Lorain surface-contact equipment during the period covered by the abov table, it will be seen that only 27 are debited against the track equipment; these were due to the following causes: 3 car-miles were lost owing to a delay arising from an improperly-soldered joint in a cable terminal, the remaining 24 miles being lost owing to a top-plate situated very close to a cross rail being permanently earthed thereto by a piece of iron wedged between the plate and the rail, it being about 20 minutes before the source of the trouble was discovered. 146 car-miles lost due to defects in the car equipment may be classified as follows:—

Table III.—*Details of Miles Lost due to Faults in Lorain Car Equipment.*

——	June quarter.	September quarter.	December quarter.	March quarter.	Total.
Earthed magnets	22	21	16	20	79
Buckled skates	10	7	20	3	40
Battery faults.....	8	6	..	3	17
Other causes	3	5	2	..	10
	43	39	38	26	146

It will be seen that, during the period in question, the total number of car-miles lost due to defects in the electrical equipment of both cars and track averaged 8¼ car-miles out of every 10,000 run, and having regard to the fact that during the months of February and March there were frequent and heavy snowfalls, the author is of the opinion that this constitutes a record of regularity of service which it is difficult to surpass. In considering the car-miles lost due to the Lorain car equipment, it must be remembered that the defects which were the cause of the delays have a parallel in the case of the overhead system in respect of broken and damaged trolley wheels and trolley poles and in the earthing of the cables inside the trolley standard.

The first heavy snowstorm since the system has been in operation occurred on February 17, 1904, when about 6in. level fall of snow occurred in the early hours of the morning. The electrically-driven snow sweeper was at once put into service and the lines were kept clear without difficulty, and no delay of any kind occurred. It is noteworthy that although the snowfall in the surrounding districts, operated on the overhead trolley system, was not quite so severe as it was at Wolverhampton, yet considerable difficulty was experienced, especially in the early morning, in maintaining a regular service. Owing to an abnormal rainfall in the early part of September certain routes were flooded, and at one point the track was submerged for a considerable distance to a depth of nearly 2ft. No trouble, however, was experienced as regards the running of the cars, and no defects developed in the car equipments, in spite of the soaking to which they had been subjected.

In considering the respective liabilities to breakdown of the rival systems, it should be borne in mind that in the case of the surface-contact system as installed at Wolverhampton, any accident or breakdown can only affect one, or, in very rare cases, two boxes, and the momentum of the car is sufficient to enable it to coast over the short length of track thus disabled. Further, any faulty box can be removed and replaced by a new one in an average time of 15 minutes without any interruption of service. It may, in effect, be said that the surface-contact system is equivalent to an underground trolley wire divided into 10ft. sections, each of which is independent of the rest, and may be removed and replaced without interference with the efficient operation of the remainder. It is in this respect that the surface-contact system has, in the author's opinion, a distinct advantage over the overhead system, inasmuch as with the latter an accident of any kind to the overhead equipment usually means the putting out of service temporarily from a ¼ to ½ mile of route, and a total cessation of traffic along the section affected for a more or less lengthy period.

Another respect in which the surface-contact system possesses a marked advantage over the overhead system is that the conductors are free to devote the whole of their time to the collection of fares and to looking after the convenience and comfort of passengers. In nearly all of the tramway systems at present in operation in this country a considerable proportion of the conductor's time is occupied

Table II.—*Car-miles Lost due to Defects in Electrical Equipment of Track and Cars.*

Quarter ended	Miles of single track in operation.	Total car-miles run.	Total car-miles lost.	Total car-miles lost per 10,000 miles run.	Car-miles lost due to faults in Lorain system.			
					Lorain car equipment.	Lorain track equipment.	Total.	Total per 10,000 miles run.
June 30, 1903.....	11	139,563	177	12·7	43	..	43	3·1
September 30, 1903	11	131,805	172	13·0	39	..	39	2·9
December 31, 1903	11	122,576	147	12·0	38	27	65	5·3
March 31, 1904	11	121,434	248	20·4	26	..	26	2·1
Totals	..	515,378	744	14·4	146	27	173	3·3

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in nursing the trolley pole through frogs and crossings or round awkward curves on the overhead equipment, but in spite of the care which is taken in this respect interruptions of service are frequently caused through the trolley pole jumping and displacing a portion of the overhead equipment. Similarly also, no reversal of the collecting apparatus is required when changing the direction of running of a car, whether at a terminus or elsewhere on the line, and consequently there is no risk of an accident occurring through forgetfulness or carelessness on the part of the motorman or conductor.

One of the most attractive features of the surface-contact system as installed at Wolverhampton is that it is virtually "fool proof," inasmuch as it is practically beyond the power of the motorman to inflict damage thereon by careless or incompetent handling of his car, and in this respect it possesses an advantage which is not shared by any other system of electric traction. As a result of the 2½ years' experience the author has had of the operation of a surface-contact system, he believes that for reliability of operation it has many and noteworthy advantages over either the overhead trolley system or the conduit system.

Cost of Operation and Maintenance.

This question must always be a determining factor in the choice of a system of electric traction, as under the present régime of municipal control, with its attendant low fares and high wages, it is becoming an increasingly difficult matter in many cases to maintain a tramway system as a paying concern, and, consequently, it is of great importance that the system of traction adopted should be one that will require the minimum annual expenditure to maintain it in a safe and efficient working condition.

It must be admitted at the outset that from the point of view of cheapness of operation and maintenance, no system of electrical traction can rival the overhead trolley system.

The following statement shows the expenditure on the maintenance of the Lorain surface-contact system at Wolverhampton during the 12 months ended March 31, 1904:—

Table IV.—*Repairs and Maintenance Costs of Lorain System for 12 Months ended March 31, 1904.*

Track Equipment.

—	Total cost.	Cost per mile of single track.	Cost per car-mile.
	£. s. d.	£	d.
Repairs and maintenance of cups and top-plates	125 5 5	11·3	0·058
Raising top-plates	5 19 2	0·5	0·002
Miscellaneous repairs	12 2 1	1·1	0·005
Inspection and testing of track	94 15 6	8·6	0·044
	238 2 2	21·6	0·11

Car Equipment.

—	Total cost.	Cost per car per annum.	Cost per car-mile.
	£ s. d.	£	d.
Repairs and maintenance of magnet systems	72 13 2	3·0	0·033
Repairs and maintenance of switches and batteries, including charging	20 3 4	0·8	0·009
Repairs and maintenance of collecting skates	115 11 8	4·7	0·053
Inspection and adjustment of magnet systems and collecting skates	102 13 11	4·2	0·047
	311 2 1	12 9	0·144

The expenditure under the heading of track equipment the author considers to be very reasonable, and is of opinion that it will bear comparison with the cost of maintenance of any similar length of overhead equipment running in a busy manufacturing town.

The whole of the work of inspection and testing of the electrical equipment of the track, the removal and replacement of faulty boxes and the execution of all repairs of every kind required in connection with the maintenance of the electrical equipment of the 15 miles of single track is performed by two men, who are paid wages of 32s. and 28s. per week respectively. The working day of approximately 17 hours is divided into two shifts, so that there is only one man on duty at a time. Every box is tested once a week, and the boxes in the vicinity of points and crossings and other special track work where there is a liability to short-circuits are tested daily.

During the period covered by the foregoing statement of costs the average time required to test about 11 miles of single track was 10 hours, the apparatus used for testing consisting of a portable Weston voltmeter slung round the neck of the operator, the flexible leads from the voltmeter being attached to terminals on a pair of walking sticks, one of which was placed on the box to be tested and the other on the rail.

As this method of testing proved to be a slow process, the operator not being able to cover more than about 1 mile of single track per hour, the author has devised an arrangement by which a light trolley carrying a contact skate can be towed behind any car in service, and by this means every box on about 15 miles of track can be tested in 2½ hours. It is expected that this will result in a considerable reduction in the expenditure on inspection and testing of the track.

The expenditure on the inspection and maintenance of the car equipment has been rather heavy, the items relating to the magnet systems and batteries being, in the author's opinion, abnormal, and considerably in excess of what may be expected in the future.

It is impossible to obtain reliable figures as to the cost of inspection and maintenance of the trolley wheels, trolley poles and standards in the case of the overhead system, as records, apparently, are not kept separately of the expenditure incurred in these respects, but it is probable that the car equipment of the overhead system can be more cheaply maintained than that of a surface-contact system.

One of the most serious disadvantages of the surface-contact system is the increased consumption of electrical energy involved. The additional quantity required varies according to the type of surface-contact system adopted, but with practically every type of system there are three causes which must involve additional current consumption, and these are as follows:—

Firstly. The energy required to operate the circuit closing mechanism of the track equipment.

Secondly. The additional energy necessary for the propulsion of the cars owing to the extra weight of the special apparatus carried on the car.

Thirdly. The surface leakage from box to rail over the paving under each car on the track.

Of the above-mentioned sources of power waste the first two only need be seriously considered, as in the case of the third the amount of energy wasted by surface leakage is so small as to be negligible.

In the case of the Lorain system as installed at Wolverhampton, the current required for the operation of the circuit-closing mechanism in the track equipment, which is in this case the energy required for the excitation of the magnets, represents a power consumption of 670 watts per hour, which is equivalent under ordinary conditions of service to 0·11 unit per car-mile.

The additional energy required to propel the cars owing to the extra weight carried must, of course, vary in different localities, being obviously more in a hilly district than in a flat. It would also be affected to a certain extent by the type of rolling stock in use and the distance apart of the stopping-places. It is, therefore, impossible to give a general estimate as to the additional energy consumed under this heading.

In Wolverhampton the routes at present in operation include some rather severe gradients, and, owing to the fact that a large proportion of the road surfaces in the vicinity of the routes are macadamised, the track is always very muddy and greasy in wet weather and correspondingly dusty in dry weather. The tendency is, therefore, for the current consumption per car-mile to be rather heavy, the average during the past 12 months being 1·49 units.

The average total weight of a single-truck double-deck car, together with driver and conductor and an average number of passengers, but *exclusive* of Lorain equipment, is 8¾ tons. To this must be added the weight of the magnets, collecting skate, battery, cables and connections of the surface-contact apparatus, amounting in all to 1 ton.

The steepest gradient has a rise of 1 in 17, and there are a number of sharp curves varying from 40ft. to 37ft. 6in. radius.

Under these conditions the author has calculated that the additional current consumption due to the weight of the Lorain equipment is approximately equal to 0·13 unit per car-mile.

The *total* additional current consumption to be debited against the surface-contact system is in this case 0·24 unit per car-mile, or approximately 19 per cent. in excess of what would have been required by the overhead system.

Cost of Installation.

Although perhaps not of such vital importance as the cost of operation, yet, nevertheless, the capital cost of installation must weigh heavily in considering the merits of any system, and it is obvious, therefore, that any system of electric traction which desires to enter into competition with the overhead trolley system must be capable of being installed at a cost not very much in excess of the latter.

It is very difficult, if not impossible, to give a general figure for the difference in first cost of the overhead system and the surface-contact system, owing to the fact that whilst the cost of the former is practically the same for either double or single-track, the cost of the electrical equipment of the latter is obviously twice as much for double-track as for single. Consequently, the amount of the extra cost of installing a surface-contact system necessarily depends upon the proportion of double to single-track on the routes concerned.

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Speaking generally, however, it may be taken that first-class overhead construction costs from £1,500 to £2,000 *per mile of route*, whether double or single, whereas the cost of the surface-contact system will be from £2,000 to £2,500 *per mile of single track*.

Disfigurement of Streets and Obstruction to Traffic.

It seems at the present time to be almost an article of faith amongst those in charge of the promotion of tramway schemes that the adoption of electric traction must of necessity involve the disfigurement of the streets, either by the erection of tramway poles and overhead wires or by the construction of an open slot between the centre of each track.

It is true that great progress has been made in the direction of rendering modern overhead construction less unsightly and obtrusive than was the case formerly, but nevertheless it must be generally admitted that the introduction of the overhead system into towns like Manchester and Liverpool has to a very large extent spoilt the appearance of some of the finest streets and buildings in those cities. One has only to compare the present appearance of St. George's-square, Liverpool, or Piccadilly, Manchester, with what it was before the introduction of electric traction to realise the great disfigurement due to the erection of poles and wires along these fine thoroughfares.

The author was speaking, not very long ago, to a Liverpool photographer, who informed him that at the present time it is practically impossible to get a satisfactory photograph of St. George's Hall from any point of the compass, owing to the interposition of the network of overhead wires.

Where centre-pole construction is in use, there is, in addition to the unsightliness involved, another very serious objection—namely, the obstruction to traffic. There can be no doubt whatever that the introduction of centre-poles into a street of average width very largely reduces the accommodation for vehicular traffic, and materially adds to the congestion of the already overcrowded streets in many of our large towns.

Where side-pole construction is adopted, this inconvenience is not so marked, although the presence of a large iron pole with massive base every 40yds. along the side walk is not by any means conducive to the comfort and convenience of pedestrians.

It is claimed for the surface-contact system that it offers less impediment to the free use of the streets and side walks than any other system of electric traction in which the energy for the propulsion of the cars is collected from an external source, and the experience of the author in connection with the Wolverhampton tramways leads him to believe that this claim is justified.

It was anticipated when the system was first installed that trouble would be experienced through the metallic studs between the rails projecting above the normal level of the paving proving a source of danger to the ordinary street traffic, and to horses in particular, and that considerable expense would be occasioned through the extra wear and tear of the paving surrounding the studs.

During the 2½ years that the system has been in operation no complaint of any kind has been received as to any obstruction or inconvenience to traffic having been caused by the iron top-plates in the street surface, and, so far as the author is aware, no accident of any kind has ever been attributed to them. There is, moreover, no indication of any abnormal wear of the paving surrrounding the studs, neither wood nor granite paving in the immediate vicinity of the metal top-plates appearing to wear any faster than at other parts of the track.

On the score of appearance it may fairly be said that the surface-contact system is the least conspicuous and the least objectionable of any system of electrical traction; in fact, it is the author's experience that unless the track is abnormally clean and free from dirt it is very difficult to distinguish the studs from the remainder of the paving. During dusty or muddy weather it needs a close examination of the track to detect the exact whereabouts of the metal top-plates, and probably, owing to this reason, a very large proportion of visitors to the town go away with the impression that the electric energy for the propulsion of the cars is carried in storage batteries on the cars themselves.

There can be very little doubt that from the point of view of the property owner in good residential districts, the surface-contact system is distinctly preferable to the overhead system, as it is much less likely to cause depreciation in the value of the property adjoining the tramway routes.

To illustrate certain points raised on this question of disfigurement of streets and obstruction to traffic, the author hopes to be able to exhibit several lantern slides of streets in Wolverhampton where the Lorain surface-contact system is in use, and of similar streets in other towns where the overhead system is installed.

In considering the results achieved at Wolverhampton in the operation of tramways by a surface-contact system, it should be borne in mind that in many respects the local conditions at Wolverhampton are probably more unfavourable to the successful operation of a surface-contact system than in almost any other town in the United Kingdom.

Owing to the large number of factories in the town engaged in the production of stamped steel and iron articles, a very large quantity of scrap iron of all sorts and sizes is produced and has to be carted away from the various works. This scrap iron is usually very carelessly heaped in open carts, with the result that a considerable percentage of each load is scattered in the street, and it unfortunately happens that the principal repositories for scrap iron are situated on the busiest tramway routes. As previously explained, the presence of this scrap iron constitutes the most serious difficulty the system has had to contend with.

The heavy rainfall of the last two years, in conjunction with the very general use of macadam in the majority of the streets in the town, has resulted in a clean track being a luxury but rarely attained, the track being usually covered with a sticky mud, which an hour or two's wind and sun speedily converted into equally objectionable dust.

It should be pointed out, moreover, that in Wolverhampton the track is laid to a 3ft. 6in. gauge, and consequently the space available between the rails, and between the side frames of the trucks, for the reception of the surface-contact apparatus is comparatively limited, and the author believes that with the standard 4ft. 8½in. gauge many of the troubles experienced with the upkeep of the magnet and collecting skates would largely, if not entirely, disappear, and the arrangement of the track equipment at points, crossings, and other special track work would be considerably simplified.

The conclusions arrived at in the foregoing Paper may be briefly summarised as follows:—

A well-designed and carefully-installed surface-contact system is superior to the overhead trolley system in respect of the questions of safety, reliability, disfigurement of streets and obstruction to traffic.

The overhead system is considerably cheaper both as regards the capital cost of installation and the annual cost of operation and maintenance.

For tramway systems where low initial cost and low annual charges are the first consideration, and especially for light railways in thinly-populated districts, the overhead system is to be preferred.

In many of our larger towns, and especially at watering places and other pleasure resorts, the surface-contact system has many claims for serious consideration in preference to the overhead trolley system.

The author has made no attempt to treat this subject at all fully in the limited scope available in a Paper of this description, his object being merely to provide a basis for discussion of a subject which has previously been brought very little before the notice of tramway engineers as a body.

The following is an abstract of the discussion that took place in connection with the above Paper.

Mr. J. H. RIDER (London County Council), referring first to the pictures of the car sheds, which the author had shown, asked how access was obtained underneath the cars. The picture showed no pits, but car sheds should be practically all pits, and he did not see how there could be a properly arranged depot on the surface-contact system. On the overhead system there was no difficulty, and on the conduit system he diverted the conduit to the side track. Coming to the Paper itself, he thought safety should be the first consideration. In Table I. it would be seen that there was a list of 109 cases where boxes had been found more or less alive in 12 months. The average per mile of single track was 10, making 20 per mile of roadway. If there were any overhead system showing such a bad record it ought to be pulled down. If Wolverhampton suffered from scrap iron in the way described in the Paper, it was just the wrong place to put down the first surface-contact system. Everyone knew the trouble that had been experienced at Blackpool with the first conduit system, it being spoilt for many years on account of the sand and sea water getting into the conduit. Blackpool was the wrong place to start such a system, and Wolverhampton was the wrong place to start a surface-contact system. At the same time, however, all the more credit was due to Mr. Shawfield for his success. The following paragraph in the Paper was interesting:—"The author has on more than one occasion watched a pedestrian step on a box which he has known to be 'alive' at a pressure of 500 volts, as recorded by a Weston voltmeter, but in all cases the individual was quite unaware of the fact." This paragraph, he thought, should be read in conjunction with the following passage, which occurred later:—"That these mishaps are not more frequently attended by injury to human beings or animals appears to the author to be largely due to the beneficient interposition of Providence." He should not like to be in charge of a system where studs could get alive and where he should get so hardened as to view with unconcern a pedestrian walking on a stud alive with 500 volts. Metallic connection between the top plate and the supply main was surely something within the bounds of possibility. The Paper said that the contact was bound to fall because gravity was the most certain of all forces. But friction would very easily counteract gravity, and he could easily imagine that some day the stud would not fall. Then if a man stood on it he would not be unhurt. The danger of a trolley pole or bracket becoming alive was quite true, but it could be most readily guarded against. If every post of an overhead system, and every trolley mast and every car were properly earthed to the wheels from the rails there would be no danger. On the surface-contact system no similar precaution could be taken. There was no indication when a stud was alive, and therein lay the danger. In connection with the danger from trolley systems the following remark was also made:—"When it is considered that in a large number of cases single insulation only is used between the trolley wire

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and the bracket arm, &c. . . . ." He had seen a good many overhead systems, but he had never seen one yet which had single insulation, and if the engineer of such a system was present, he should be ashamed of himself for putting it up. The author concluded that the balance of advantage lay with the overhead system, and he cordially agreed. The pictures which were shown of certain overhead equipments were as seriously distorted as the view of the car taken from the car-pit. The following statement was worthy of reference:—". . . The momentum of the car is sufficient to enable it to coast over the short length of track thus disabled." In his opinion this was the one serious danger, because in the case of breakdown of the current there would be arcing inside the box and carbon vapour would be deposited which in time would make a contact. The reason the studs did not spark was that the skate was supposed to make contact with the preceding stud before it left the one behind. So long as this was carried out there could be no sparking in the stud, because there was no really broken contact, but if for any reason the switch in the stud was not pulled up, the driver did not know it. There was also nothing to show the staff which box was wrong, and in time trouble would happen. The only surface-contact system which he knew of that did not allow the cars to run with only one stud in contact was the Schuckert. Another point raised by the Paper in defence of the system was that the conductor was not called upon to nurse the trolley pole round corners. But he was prepared to state distinctly that if any system required this it was not a properly-designed system. The other day when he was in Wolverhampton he asked a gentleman how he liked the surface-contact system. He answered that he liked it very much, for the reason that the service was the quickest in the country, because all the horses and carts kept off the track. This carried its moral. There was a fox who lost his tail by accident, and he called together his brother foxes, told them how comfortable he was, and suggested that if they all cut off their tails they would be quite as comfortable. He left the application to the meeting.

Mr. WETMORE, European representative of the Lorain Steel Co., said he thought Mr. Rider's fable was to be taken very much in connection with the conduit system, because at a recent meeting of the Institution of Civil Engineers he stated that on one occasion half his cars were thrown out of work on account of moisture. He did not think that Wolverhampton was troubled with such difficulties. Also, if Mr. Rider had to contend with the same amount of scrap iron as they did at Wolverhampton, there would be a good many short-circuits and a good many delays in his operation. Wolverhampton was probably a town that had all the difficulties which could be thought of in connection with a surface-contact system, and this was one of the reasons why his company preferred to take such a contract, rather than one in a town or city where the conditions were more or less ideal. No other system was working upon such a commercial scale as the Lorain. He was quite sure that the Diatto system in France would have been a success from the first if it had been able to abandon mercury, and also make the details of their system sufficiently strong to withstand the heavy traffic of the streets. The top plate had been made too light on the Paris system. The chief danger of surface-contact systems was the use of solenoids in connection with the studs. It was well known to engineers that no solenoid could be depended upon to act always, especially if exposed to moisture, and this one objection alone would condemn their use. Mr. Rider had spoken to the effect that the armature of the Lorain system might not fall, and appeared to be under the impression that there was a considerable friction against the dropping of the armature. His company had been trying to overcome for years the difficulty of designing a system in which there was no friction in the movement of the armature, and he thought this had been accomplished. There was no case on record at the present time in connection with Wolverhampton in which the armature had stuck up. There had been difficulties at Wolverhampton during the first few weeks, but they were due to the great hurry in getting the lines open for the Exhibition, and some of the cups were broken in their own shops; but even under these conditions there was never an armature found to be stuck up through a bad contact. Mr. Rider also remarked that, if a box got out of order, the driver of the car did not know which one it was, and therefore this constituted a danger. But there was absolutely no danger in connection with such a case. In the first place, if the car went over a box that remained dead, the driver knew immediately, because the current was cut off from the car and he had to use his battery switch to get the current on again. If the armature did not come up in the cup, or the plate became alive as the car passed over it, there was no danger because there was no metallic contact between the upper and lower carbon. In connection with the nursing of the trolley poles round curves, from his experience of putting up trolley lines in this country during the last seven years he was sure that there were a great many systems not properly designed. It was well known that the trolley rope might be tied up provided the car did not run at excessive speeds, but it was also well known that on suburban lines the speeds exceeded the schedule limit, and round curves at this excessive speed no swivel head trolley would remain on the wire unless it was put there. It was recognised that this was a danger, because on many systems trolley boys were employed at curves for this purpose. If the cars ran slowly the trolley would remain on the wires in any well-designed system. He recognised that the extra ton in the weight of the cars was a disadvantage, but this weight was only in comparison with the overhead system. Compared with the conduit system the disadvantage was not so great, because of the weight of the plough, and it was reduced to about half a ton in comparison. In connection with the slides shown of overhead construction, he did not consider they were an exaggeration. They were taken in the streets on a Sunday by a professional photographer.

Mr. F. C. RAPHAEL, on the last point mentioned by Mr. Wetmore, said that a very large number of photographs of tramway lines passed through his hands, and he was of the opinion that those shown by the author were exaggerated. Usually it was very difficult to see the wires in such photographs at all, and it was not uncommon, when wishing to emphasise the details of any special work, to have to give instructions to the draughtsmen or engravers to work them up slightly. But even then results were never obtained similar to those shown by Mr. Shawfield.

Mr. J. F. C. SNELL (Sunderland) asked the author what was the average leakage current over the system, and how far it complied with the Board of Trade regulations. He would also like to know what were the total operating expenses, because after all these tramway systems had to be judged, not only from their engineering standpoint, but also from their commercial standpoint. He thought the Lorain Company was to be congratulated on the simplicity of the system and the absence of solenoids and a lot of auxiliary apparatus with which many of the surface-contact systems were infested. Another point upon which he would like information was whether in the cold weather there was a larger percentage of accidents due to the coagulation of the oil, for instance, and a less chance of the armature acting, at any rate with sufficient speed. Further, would the author tell him how long it would take, in case of accident, to take out a cable and a box and to make the repair. It seemed to him that a very considerable loss must take place there. It also appeared to him that trouble must be experienced from horses slipping on the boxes. He thought, however, that Mr. Shawfield was to be congratulated if Mr. Rider's story be true that the carts and vans in Wolverhampton kept off the track, as it must result in a very considerable saving in the cost of maintenance of the roadways. In Sunderland, one of the chief items of repairs was repaving not necessitated by the tramway traffic. Out of £74 spent per annum per mile of track upon repairs, £50 was due to this repaving. In fact, it might be that this would be a very considerable item towards meeting the capital charges on a more expensive system like the surface-contact system.

Mr. STANLEY CLEGG (Lincoln) said he was considerably interested in Mr. Shawfield's Paper because the Lincoln Corporation had practically decided to adopt a surface-contact system—viz., the Griffiths-Bedell (see *The Electrician*, Vol. LII., p. 456). He would, therefore, like to ask Mr. Shawfield one or two questions. Had he ever measured the drop in volts between the live cable and the nearest terminal of the motor? Mr. Rider had mentioned the question of sparking. Assuming that there were one or two dead studs, the sparking did not take place inside the box, owing to the fact that the two carbons were held together until after the collecting device had passed over the stud. The sparking took place on the surface of the road, and, therefore, would not damage the box. He had had occasion recently to make enquiries as to the cost of repairs with overhead equipment. From 30 towns he received figures varying between £5 and £95 per mile, and Mr. Shawfield, in Table IV., gave £20 per mile of single track, so that he was much below the average for the overhead trolley system. The surface-contact system certainly did not disfigure the streets as did the overhead system, and for old cities, such as Lincoln, there were æsthetic reasons for the adoption of such a system.

Mr. C. E. C. SHAWFIELD (Wolverhampton), in reply to Mr. Rider, said that the car depots at Wolverhampton had originally been designed for the overhead system, and consequently the amount of pit room was rather small—small even for the overhead system—but the new sheds which were now being constructed were being made all pits. The method adopted at present for moving the cars over the pits was simple—a wandering lead, which could be attached to various points in the car depot. It was found perfectly satisfactory, and involved no loss of time whatever. The access to the underside of the cars was, of course, somewhat impeded by the presence of the magnet equipments, but in actual practice no extra wages costs were incurred in connection with the ordinary nightly inspection of brakes and motors. With regard to the table of live boxes, he would like to point out that, although many of the boxes were shown at 500 volts by a Weston voltmeter, yet it was quite impossible for any pedestrian who tried it to get a shock. It was not an infrequent occurrence for defective boxes to be discovered by barefooted youngsters in the lower part of the town, who at once reported them to the car depot and received two coppers for their pains. If at any time these youngsters saw a short circuit under a car they immediately ran round the box to see if it was alive, and, if so, they ran to the car depot to report it. Mr. Rider had spoken of the difficulty of locating a live box. But his experience was that live boxes only occurred as the result of a short circuit. If a short circuit occurred under a car the driver pulled up, the conductor stepped off the car and touched the stud to see if it was alive, and, if it was not, the car went on.

Mr. RIDER: What is the death rate in Wolverhampton?

Mr. SHAWFIELD replied that it was nearly the lowest death rate in England. Continuing, he said he quite agreed with Mr. Rider that the poles of an overhead system could be made perfectly safe by earthing. But, unfortunately, there were very few so earthed. As to the point with regard to single insulation not being used, all he could say was that if Mr. Rider would look round the lines worked by the British Electric Traction Co. he would find more cases of single insulation than of any other construction. He was afraid Mr. Rider had gone astray somewhat on the question of breaking current inside the boxes. It was absolutely impossible under any conditions to break any current inside a box other than the leakage current between the box and the rail. If a box became dead from any cause—supposing the carbon broke and the car lost its current—inasmuch as the box which the car was leaving was made alive by the magnets, it was utterly impossible under any conditions for more than from $\frac{1}{10}$ to $1\frac{1}{2}$ amperes, which was the leakage current in very wet weather, to be broken inside the box. He admitted that the necessity for nursing the trolley pole through special work and round curves was evidence of bad construction, but if Mr. Rider could spare a day or two he could show him 50 miles of lines where the trolley had to be nursed in this way.

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Mr. RIDER: More B.E.T.?

Mr. SHAWFIELD: Yes. (Continuing): With regard to the extra weight of the equipment of the cars on the Lorain system he agreed that this was a serious disadvantage. But in this respect it was somewhat on a par with the conduit system, where there was the weight of the ploughs and the friction of the plough in the slot. It was true that on many of the Wolverhampton roads the carts kept off the track, but this was because such a quick service was run that they would be pushed off the earth if they did not keep clear. In the busiest parts of the town, however, the brewers' drays and railway lorries kept in the middle of the track for choice, and it was a serious inconvenience. With regard to the little fable which Mr. Rider quoted, he would remind him of another fox, which was not unconnected with sour grapes. Mr. Raphael had referred to the photographs being exaggerated. He had seen photos in *The Electrician* which were every bit as bad, and could show him the actual equipment, which was quite as bad. It was rather difficult to give the average leakage current asked for by Mr. Snell, because it varied very much with the atmospheric conditions. In dry weather it could not be detected. After heavy rain it was something under $\frac{1}{10}$ ampere, and in muddy weather it might rise to as high as 1 or $1\frac{1}{2}$ amperes per car. The actual current consumption per car-mile due to leakage over 12 months was 0·008 unit. The question of temperature had no effect upon the operation of the boxes, because there was no oil inside the cup at all. The time taken for actually removing a box and repairing it was a quarter of an hour. In a rush it could be done in 10 minutes. With regard to the location of a fault, this was very easy, because, by simply removing two boxes or one box, it was possible to test in either direction. Again, owing to the fact that the cable was very carefully laid "solid," if any fault did occur it would only be a small fraction of an ampere, and it could always be left until a Sunday morning or until after midnight, when the line was empty. He was sorry he could not give Mr. Clegg the drop in volts between the cable and the motor terminal.

A hearty vote of thanks was accorded Mr. Shawfield at the conclusion of the discussion.

A NEW DEMAND INDICATOR FOR "SUPPLY IN BULK" SCHEMES.

BY JOHN R. DICK.

There are two cases in the electricity supply business in which the tariff has to be fixed with great care. The first is that of the small electric lighting scheme, where the error of making the tariff too low may render the undertaking permanently unremunerative, as the extra amount of business attracted by the lowness of the price is not sufficient to diminish the cost of production to the degree expected. If, on the contrary, the rates are fixed too high, the development of the business is impeded, and the prospect of making a profit may be as remote as when the tariff is fixed too low. Thus, a differential tariff appears to be essential, if such small undertakings are to meet with success.

In the second case, which is that of a power scheme aiming at the distribution of electricity in wholesale quantities, the conditions are entirely different to those of the small electric lighting station. The greater part of the electricity sold is for power purposes, and the success of the undertaking is dependent not only on the absolute values at which the rates are fixed, but also to an equal degree on the ability to meet the competition of other methods of producing power.

The essential feature in any proposition which the manager of a power supply scheme may discuss with a prospective customer, is that the price to be paid shall be less than the inclusive costs of generation in the customer's own works. It is obvious that any comparison of the respective merits of the two alternatives must take into account the charges for supervision and the use of capital in the private plant, but this is often forgotten. Should the choice lie between installing a gas engine and taking a supply from the power mains, there should be included in the costs of the first system the loss entailed in the generation of electricity, as direct electric driving of all machinery and shafting is one of the strongest inducements to making any change at all. One of the chief reasons why a power distribution company can offer an attractive enough price for electricity to a manufacturer is that the variation in the individual requirements of the consumers produces a considerable diversity factor. This, in conjunction with the naturally high load-factor which characterises the demand for power in works situated in an active industrial district, enables the cost of electricity produced on a large scale to be brought down to an extremely low figure.

Up to the present, when large works have been connected to the mains of the ordinary electric lighting station, there has been too much of a tendency to fix the rate at a simple and pleasant figure, such as 1d. per unit or ½d. per unit, in accordance with the engineer's idea of the desirability of the big customer. It also just as often depended on the customer's capability of driving a good bargain with the supply authority; but when large investments are made in the establishment of electricity stations for the express purpose of competing with other kinds of motive power, it is necessary to fix rates with a higher degree of scientific accuracy. The only system which can be universally applied in doing this is the "maximum demand" system. Its utility is clear, as it enables the supply undertaking to determine very closely its actual costs under any given conditions, and thus enables the selling price to be fixed at the lowest possible figure consistent with the certainty of earning a dividend.

To illustrate numerically the importance of that part of the total costs which is dependent only on the capital and other fixed charges, we may assume a load-factor of 25 per cent. as a probable figure for a genuine power business. The average cost of producing electricity with such a load-factor may be roughly stated as follows:—

Charges for interest and depreciation	50	per cent. of total cost.
Other fixed charges independent of output	25	,, ,,
Net running costs	25	,, ,,

It will be at once seen that the charges for the use of capital are by far the most important item in framing a tariff that is generally applicable. As it is the peak of each consumer's load which controls the amount of capital that has to be invested on his behalf, this has to be determined with considerable accuracy.

Wright's well-known instrument does this admirably for the ordinary lighting consumer where the peaks of his load are not naturally very acute. For motor loads the instrument has to be made specially sluggish in order to avoid the registration of an unjustifiably large demand. In practice the character of a power load may be intermittent, or steady with occasional peaks, or it may consist of a succession of peaks. The load curve of a December day illustrated in Fig. 1 shows, however, that the resultant peaks are not exceptionally acute.

In the actual measurement of the demand, it must be borne in mind that the vital point is to arrive at exact data for apportioning to the customer his just share of the capital costs. Thus the problem presents itself of how sluggish ought the instrument to be

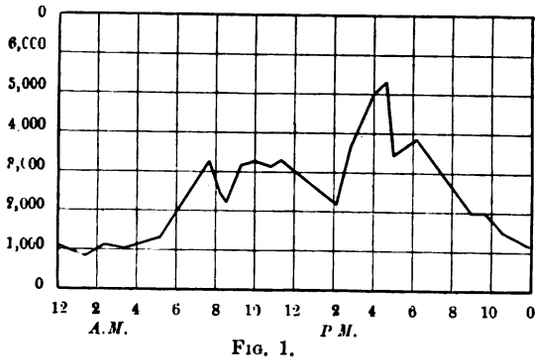

FIG. 1.

to secure this, and at the same time to avoid the registration of accidental peaks which do not appreciably affect the generating plant. An instrument peculiarly suitable for this purpose has been devised by Mr. C. H. Merz, and is manufactured by the Reason Mfg. Co. It is arranged so as to integrate the load curve during a given period, then to be re-set to zero, and to repeat the process of integrating the next element of the load curve.

The registering dial is provided with an index which shows the maximum of these integrated values. To express it algebraically, the instrument records the maximum value of $\frac{1}{T}\int_0^T P dt$, where P is the varying value of the power and T is the interval of time between each re-setting to zero. The same result would be laboriously obtained by observing an ordinary meter and noting the amounts of energy recorded in each consecutive hour. The maximum reading in any one hour would then be a measure of the maximum demand, and the instrument would have a time-lag of one hour in its registration. Before proceeding to describe Mr. Merz's instrument, in which these operations are done simply and automatically, it will be well to examine the conditions which decide what the period of the successive integrations or time-lag ought to be. This will be seen at once to depend on the relation which the capital charges for supplying any consumer bear to the *duration of his maximum demand*, and this is intimately related to the effect of overload on the various classes of generating plant.

To begin with the boiler house, it is well known that a heavy load is felt there sooner than in any other part of the system, and the number and capacity of the boilers put down must take into account the intermittent peak loads. In the engine room the effect is not felt so rapidly, as most prime movers are now designed to stand large overloads for periods up to one or two hours a day. More especially is this the case with steam turbines, which, by the use of a by-pass to the high-pressure section, may be overloaded with safety to the extent of 50 per cent., though with some loss of efficiency. With electric generators of modern design large overloads even for one or two hours are permissible. As it is almost

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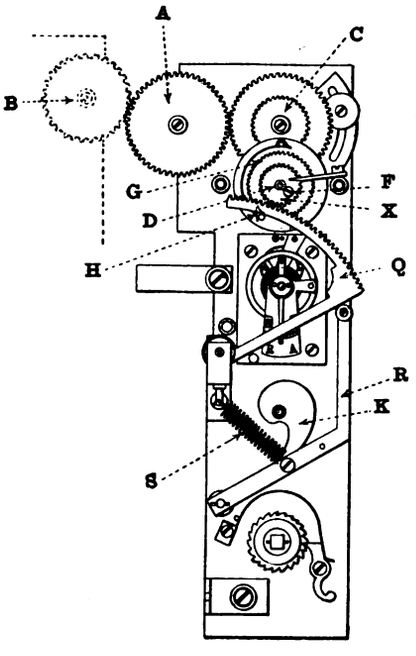
entirely a question of the rise in temperature, the provision of overload capacity does not appreciably affect their initial cost.

When we come to mains, transformers and switch gear we find a greater increase of load may be allowed without any probability of injury resulting. In view of these facts, we may safely assume that if a consumer has an occasional peak 50 per cent. higher than his average load, and that its duration is less than half an hour, his part of the capital cost will not be increased by anything like 50 per cent. In all probability, as the individual peaks do not coincide, the capital cost would not be increased by as much as 10 per cent. over that of a system which had no such peaks to deal with. Thus the proportionate capital cost of supplying a consumer might be based on the integrated value of his load curve during any one hour in the day. The integration being carried over this lengthy period has the effect of smoothing out the effect of the peaks, and the consumer does not have to pay a disproportionate rental on their account.

The above argument is not affected by the system adopted for the rating of the plant. Whichever method is used, if the station load is, say, 5,000kw., with a certain possible overload, exactly double the plant will have to be installed when the load is 10,000kw. under the same conditions of rating, and, therefore, all the arguments as to the distribution of the extra capital charges due to increase of load are perfectly applicable.

To return to the description of Mr. Merz's apparatus, we may state that it is an auxiliary attachment to an ordinary motor meter, either ampere-hour or watt-hour. Its chief parts are a pointer, driven by the meter train, an indicating dial and a clock for periodically re-setting the driving mechanism to zero. The first



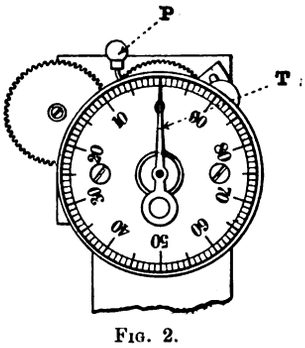


FIG. 2.

wheel, A, of the mechanism is geared to a convenient part of the ordinary train B, and, by means of a suitably-chosen ratio wheel, C, turns a spindle, D, through a given angle in the period between each re-setting to zero. The ratio wheel is so selected as to give nearly a complete revolution of the pointer should full-load be maintained on the meter for one hour. This driving spindle serves to turn a sleeve on the same axis through the medium of a simple form of clutch—usually a ratchet, G, and pawl, H. A toothed wheel on the sleeve carries the driving pin F, which actuates another pin on a toothed disc mounted on the same spindle as that to which the pointer is attached. A little pawl, P, on the toothed disc retains the pointer T in its maximum position, and prevents it being reset to zero by the automatic action of the mechanism. At the end of each month the meter reader does this simply by releasing the pawl and pushing the pointer back to its zero stop. The toothed wheel X on the sleeve gears with a rack in the form of a quadrant, Q, which is, of course, moved through a certain angular distance in accordance with the movement of the meter. At the end of each hour it is pushed back to its initial position, carrying with it the toothed wheel and driving pin, by a re-setting arm, R, on the clock. This arm in its turn is actuated by a spring, S, and a cam, K, forming part of the clockwork, the cam releasing the arm and spring every hour. The clock (which usually goes for eight days) is so arranged that it always keeps the re-setting arm just a little ahead of the fastest possible movement of the quadrant, so there is no friction whatever between the recording and re-setting parts of the mechanism.

We may now briefly recapitulate the complete series of operations. The toothed wheel carrying the driving pin F is driven from the meter train by a clutch; it turns round a ratchet disc set coaxially with it by means of another pin. The ratchet disc with its attached pointer is retained at the position of maximum angular movement by a pawl which can be released by hand and allow the instrument to return to zero after its reading has been noted. The automatic re-setting to zero of the toothed wheel carrying the driving pin is effected by means of the quadrant worked from the clock. If after any re-setting, the load on the meter increases, the toothed wheel and pin will move further round before the re-setting arm again works, and thus the pointer will give a higher reading. It may be added that the re-setting movement is almost instantaneous, and introduces no error in a one-hour registration. It will be seen, therefore, that if the meter is connected to a fluctuating load for a week the dial will record the maximum consumption per hour during the week. It is not the instantaneous load that is measured, nor the maximum average load for a minute or two, but the maximum load averaged over one hour, which we have seen is the most useful period in the fixing of an equitable rate.

As the instrument is an attachment geared to the meter, it does not necessitate the use of extraneous apparatus. It has theoretically and practically the same curve of accuracy as the meter itself, and it may be designed entirely by calculation based on the constant of the meter without the need of any experimenial calibration. Owing to the skill required in fitting the Merz mechanism it is somewhat expensive, so that it hardly lends itself for ordinary use in small installations, but it should prove highly serviceable in the large power installations. As the extra work the meter has to do in driving the indicating train is so slight, its accuracy is not at all affected.

In the case of power supply on three-phase circuits this form of demand indicator offers exceptional advantages, as the one moving spindle of the meter integrates correctly the power of all three circuits, even when they are out of balance. If Wright's demand indicator were used on such an unbalanced installation, three instruments would be necessary.

For power schemes it is most convenient that the instrument should record in kilowatts, as the tariff found most generally useful is in the form of a rental charge per kilowatt of maximum demand and a low price per unit. If desired, however, the scale may be made to indicate units to be paid at a higher rate, just as in the original Brighton system. Even should the contract with the customer be made on purely competitive and less exact conditions—*i.e.*, a low flat price—it is very useful to be able to check what the price ought actually to have been. Frequently it is necessary for the company to guarantee that the price should not exceed a certain figure, and at the same time to promise a rebate should the customer prove entitled to it. The upper limit of price can easily be calculated from the amount of plant installed and the declared number of working hours, while the rebate (if any) is determined exactly by the Merz indicator.

CORRESPONDENCE.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Until reading the astonishing communication in your columns of June 3rd, purporting to be signed by myself, I was entirely ignorant of its existence. Nothing is farther from my intention than to pose as arbiter in the discussion of priority in patent matters involving Braun, Marconi, Stone and Fessenden. I most emphatically disclaim any such opinion as the ingenious author seeks to express above my signature. The first disclosure of an oscillating circuit for use in wireless telegraphy, including inductance and Leyden jars, as auxiliary to radiating antennæ, was certainly due to Lodge in 1897, although he did not broadly claim the principle. From Lodge's disclosure it may be held no invention was required to attain the forms of apparatus used by the others since that date. The shameless forgery in question bears on its face very plain evidence of its real source, although it is not clear why so unexpected a modesty should impel its author to hide his identity behind my name. I must request you to send me the original of the letter, that its real author may, if possible, be determined.—Yours, &c., LEE DE FOREST.

St. Louis, June 16.

A FERRARIS FIELD DETECTOR OF HERTZIAN WAVES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Prof. Arnó's Paper, published in *The Electrician* of June 3rd, it is to be regretted that he, like most Continental scientists, does not subscribe to the American scientific journals, and is, consequently, unacquainted with the work done on that side of the ocean.

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Detectors of the type described by Prof. Arnó have now been in use for three or four years in America, the first one having been built in 1900 or 1901. Figs. 1 and 2 of United

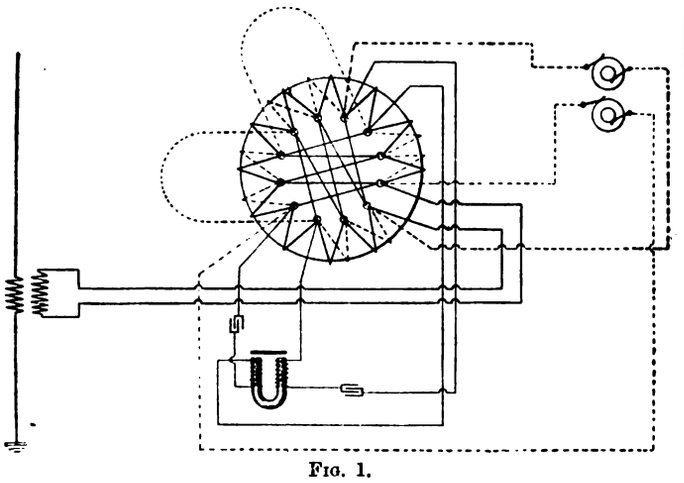

FIG. 1.

States patent No. 715,043, filed August 27, 1902, and issued December 2, 1902, show forms in which changes of hysteresis by Hertz waves in a rotating magnetic field are caused to effect electrical and also mechanical changes. It may, perhaps, be worthy of note that some of the claims of this patent cover also the Ewing magnetic detector.

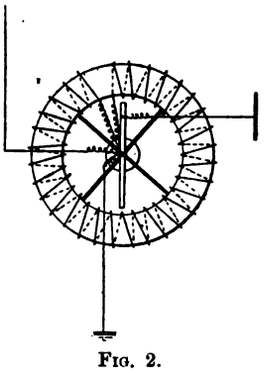

FIG. 2.

It should be mentioned that a good deal of work has been done in the United States with reference to the effect of electrical oscillations on hysteresis, beginning with the work of Henry, who was the first to apply the method to the detection of high-frequency currents. A considerable number of hysteresis phenomena are treated of in Prof. Fessenden's Paper in the *Physical Review* for January and March, 1900.—Yours, &c.,

NATIONAL ELECTRIC SIGNALLING CO.

Washington, June 14. H. J. Glaubitz, Manager.

PARLIAMENTARY INTELLIGENCE.

A SUBSTITUTE FOR THE "BERMONDSEY" CLAUSE.

ELECTRIC LIGHTING PROVISIONAL ORDERS CONFIRMATION BILLS, NOS. 2, 3 AND 6.

The Committee of the House of Lords, presided over by His Grace the Duke of Northumberland, met on Tuesday for the purpose of considering the clause which was ordered to be drafted in substitution of the "Bermondsey" clause, as reported on p. 399 of our last issue. It was announced that the parties had not come to a general agreement, and that a decision would have to be given by the Committee.

Mr. VESEY KNOX, for the Maidenhead Corporation, submitted the following clause:—

1. The undertakers shall, so soon as the annual statement of accounts of the undertakings under this order, and under the Maidenhead Electric Lighting Order of 1898, shall be filled up in the form prescribed by the Board of Trade under the Electric Lighting Act, 1882, publish in a newspaper circulating in the borough, a notification that such statement of accounts has been filled up and that copies of it can be obtained at the offices of the undertakers at a price not exceeding 1s. per copy, and such publication shall be in addition to, and not in substitution for, any publication prescribed by the Board of Trade under the Electric Lighting Act of 1882.

2. The undertakers shall, on the expiration of the third complete financial year after they have commenced to supply electrical energy under this order,* and on the expiration of each third succeeding year, reconsider, and, if necessary, revise, so far as reasonably practicable, the scale of prices charged for electrical energy under this order and under the Maidenhead Electric Lighting Order, 1898, respectively, so that in the judgment of the undertakers no rate will be required for the purpose of defraying the future expenses of the said undertakings during the next three years; provided, nevertheless, that

(*a*) The prices to be charged shall not exceed the maximum charges which may be charged under this order and the Maidenhead Electric Lighting Order, 1898, respectively;

(*b*) The scale of prices so reconsidered and revised may be from time to time in like manner reconsidered and revised by the undertakers.

3. Nothing in this section contained shall prevent the undertakers from entering into contracts for periods which may extend beyond the periods at which any revision may take place under the provision of this section on special terms under special circumstances not applicable to ordinary consumers, but, save with the consent of the Board of Trade, each such contract shall provide that the price to be charged for energy to be supplied under such contract shall either (*a*) be subject to revision at the next triennial revision provided for under this section, or (*b*) vary in the same proportion as the prices charged to ordinary consumers.

Provided that the undertakers shall not, without their consent, be required to accept any prices lower than the minimum prices mentioned in such contracts.

Discussing sec. 1, he said that the gas companies wanted to have the whole of the accounts published in a local newspaper, but this, he contended, would put an unnecessary burden upon an undertaking, because the rates for such insertions in local newspapers were very heavy, and would probably amount to £30. Sub-sec. 2, he ventured to think, carried out the wishes of the Committee. With regard to sub-sec. 3, he drew attention to the words "save with the consent of the Board of Trade," because there were special very desirable contracts, such as contracts with tramway companies, which, if they could not enter into for long periods, they would lose, much to the detriment of the undertaking. Tramway companies were the best possible consumers, because they desired a large amount of energy over a large portion of each day, but if they could not definitely fix up with the local authority a price for electricity before they put down their lines, they would erect their own works, and the local authority would lose the custom.

The CHAIRMAN pointed out that the clause allowed that in the case of anyone who wished to take a large supply, the local authority might go to the Board of Trade for consent to a special contract.

Mr. VESEY KNOX agreed, but the number of such consumers was rapidly diminishing. Only consumers requiring a very large amount of energy would think of putting down their own plant. It was only with exceptionally large consumers that the question would arise.

The CHAIRMAN: But would not a tramway company have to go to Parliament for an act.

Mr. VESEY KNOX replied that it was not absolutely necessary to proceed in this way. If they proceeded under the Light Railways Act, the Commissioners would have no power to authorise the local authority to enter into a long contract. The promoters were extremely anxious not to lose these contracts. With the exception that this point had been brought into the clause, he maintained that the clause followed out the decision of the Committee last week.

Mr. PADDON, for the Maidenhead Gas Co., said he disagreed entirely with the clause above printed, inasmuch as it only reflected in a certain colourless way the principle of the decision of the Committee. Therefore, he submitted the following clause:—

1. Within one month of the date in which the undertakers shall make up their annual statement of accounts in pursuance of sec. 8 (9) of the Electric Lighting Act, 1882, they shall in each and every year publish such statement of accounts in the same form and the same shape made up as aforesaid by inserting such accounts in each of two succeeding weeks in a local newspaper circulating in the district.

In case the undertakers make default in complying with the provisions of this sub-section, they shall be liable to a penalty not exceeding 40s. for each day during which such default continues.

2. The undertakers shall, at the expiration of the period of three years from the date of the passing of the act confirming this order, and thereafter at the expiration of every further period of three years, revise, fix, and thereafter maintain the prices to be charged for energy to be supplied by them during the ensuing three years (but not exceeding the maximum prices specified in this order) so that as far as reasonably practicable there shall be no deficiency of income to be charged upon or be paid out of the local rates as defined in the schedule to the Electric Lighting Act of 1882, and so that the annual revenues of the undertaking shall not be less than the annual expenditure (which expression for the purpose of this section shall include charges for revenue account and charges for interest on moneys borrowed, and instalments of principal and sinking fund) and in estimating the expenditure for any such period after the first revision of prices under this section, the undertakers shall take into account and provide for any deficiency of income in any former period of three years.

3. In every year after the expiration of one year from the date of the first revision of prices under sub-sec. 2 of this section the auditor prescribed by the Electric Lighting Act of 1882 in respect of the undertaking shall, within 14 days of the completion of the audit in each year of the accounts of the undertaking, report to the Board of Trade whether the undertaking during the year to which such audit relates has been carried on so that there was no deficiency of income for such year to be charged or chargeable upon the local rates as hereinafter defined, and whether the prices current at the date of such audit are sufficient to make the annual revenue of the undertaking equal to the annual expenditure. And if such auditor report that such current prices are not sufficient for such purposes, the Board of Trade shall fix the prices to be charged by the undertakers for any energy to be supplied by them during the remainder of the then current period of three years so that, as far as reasonably practicable, the annual revenue of the undertaking shall not be less than the annual expenditure.

* In the case of the Maldon and Coombe, Tamworth, Eastleigh, Hanwell and Bath Orders, these being new undertakings, this period has been fixed at five years—see below.

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4. Nothing in this section shall prevent the undertakers from entering into contracts for periods extending beyond the period to which any revision may take place under the provision of this section on special terms under special circumstances not applicable to ordinary consumers, but each such contract shall provide that the price to be charged for energy to be supplied under such contract shall either (*a*) be subject to revision at the periods of revision provided for under this section or (*b*) vary pari passu with any variation of prices charged to ordinary consumers made during the existence of such contract. Provided that the undertakers shall not, without their consent, be required to accept any price lower than the minimum price mentioned in such contract.

5. Subject to the provisions of this section, the undertakers may, if they think fit, at the end of each year revise their prices (other than the prices fixed by the Board of Trade) to be charged for energy to be supplied by them.

6. There shall not be made against the district rate, or any other rate, for energy used by the undertaking for its lighting or any other purpose a charge at a higher price than that charged to consumers using energy for similar purposes and for the like hours of supply.

He maintained that it was not a hardship for the local authority to publish the whole of the accounts in a local newspaper. He was informed that it would only occupy 132 lines, and the expense was only once a year. With regard to sec. 2 of the promoters, they quite took all efficiency from the clause, and, therefore, his sec. 2 should be adopted, because the object to be attained was to prevent the local authority being extravagant during the first three or five years, as the case might be, and they not being answerable for it in any way. In other words, any loss in one period should be carried on to the next, and the prices raised to meet it. Taking up sec. 3, he said that this merely provided the machinery for seeing that the principles of the previous section were carried out.

The Hon. T. H. W. PELHAM, of the Board of Trade, said that municipal auditors were not appointed by the Board of Trade.

Mr. PADDON said that whoever the official in question was, his functions were perfectly clear. Continuing on the question of contracts, he said that if a person had a contract with a definite minimum before him, there was no injustice if subsequent adjustments were made by virtue of general commercial changes, and he did not see any necessity for the consent of the Board of Trade. Sub-sec. 6 simply carried out the provisions that the price for street lighting and other municipal purposes should not exceed that charged to private consumers.

The Hon. T. H. W. PELHAM asked that the views of the Board of Trade should be heard before any decision was come to.

Mr. VESEY KNOX, in reply to Mr. Paddon, pointed out that the portion of the clause relating to the price for public lighting was not asked for in the petition of the gas company. If the gas company was of the opinion that the promoters' clause did not sufficiently guarantee that the provisions of it would be carried out without a penalty, he reminded the Committee that a mandamus could be obtained against the Corporation.

The Hon. T. H. W. PELHAM, on behalf of the Board of Trade, said he did not wish to express any opinion upon the clauses generally, but only so far as it was suggested to impose duties upon the Board of Trade. In the first place the Board of Trade did not appoint auditors, except for companies. There were officers appointed for the borough, or there were district auditors appointed by the Local Government Board. Sub-sec. 3 of the gas company's clause seemed to make the revision annual instead of triennial. He was not interested in this however, but he objected very strongly indeed to the suggested duty to be imposed upon the Board of Trade. The Board had no staff for this purpose. It would be necessary to hold a local inquiry into all the circumstances of each case and it would be a very expensive and troublesome duty, which the Board of Trade would be quite unable to undertake. It would not only affect electric light, but it would form a most dangerous precedent for other things. The Board of Trade had never been called upon to fix actual prices although sometimes they fixed maximum prices. It was impossible for the Board of Trade to know the exigencies of local trade and it would be a very complicated matter, which, he was authorised to say, it would be impossible for them to undertake. The only remark he had to make objected to the duty imposed upon them in respect of contracts. It would result in their having to decide contracts for every cotton mill or works which decided to take current.

Mr. PADDON said he would be prepared to alter the wording of the clause so that the Board of Trade merely appointed an arbitrator.

Mr. WEDDERBURN, K.C., said that the clause proposed by Mr. Vesey Knox in the case of Maidenhead was accepted by the promoters of all the other opposed orders. If the Committee would indicate which of the two clauses they would take as a basis, it might save time.

The CHAIRMAN said the Committee would take that proposed by Mr. Vesey Knox.

Speeches for Mr. Knox's clause were then made in respect of all the other orders, and replies in favour of the Maidenhead Gas Co.'s clause by counsel for the opposing gas companies.

After consultation, the CHAIRMAN said the Committee had adopted Mr. Knox's clause, with the following alterations:—In the early part of section 2 the words "and thereafter maintain" would be inserted after the word "practicable"; a little further on in the same clause the words "in the judgment of the undertakers" would be deleted; in section 3 the words "save with the consent of the Board of Trade" would be left out, and in (*a*) of that section the words "at the next triennial revision" would be omitted.

With regard to sub-sec. 6 of the gas companies' clause relating to street lighting, several applications were made for this, but the Chairman refused to go back on his decision given on p. 400 of our last issue.

with regard to the clause submitted by the promoters was that the Board

[It is understood, of course, that in the case of new undertakings the first revision under the new clause will not take place until the end of five years. The three years applies only to extension orders.]

LIGHT RAILWAYS BILL.

In the House of Lords on Thursday last week,

Lord WOLVERTON moved the second reading of the Light Railways bill, saying that it was precisely the same measure as that which passed through the House of Lords last year, and was then abandoned.

The second reading was agreed to.

The text of the bill is as follows:—

1. The powers of the Light Railway Commissioners under the Light Railways Act, 1896 (in this act referred to as the principal act), shall continue until Parliament otherwise determine.

2. (1) If any order under the principal act is not confirmed by the Board of Trade on the ground that the proposals of the promoters ought to be submitted to Parliament in pursuance of sub-sec. 3 of sec. 9 of the principal act, the Board may, if they think fit, submit the proposals to Parliament by bringing in a bill for the confirmation of the order.

(2) If, while a bill confirming any such order is pending in either House of Parliament, a petition is presented against the order, the bill, so far as it relates to the order, may be referred to a Select Committee, or, if the two Houses of Parliament think fit so to order, to a Joint Committee of both Houses, and the petitioner shall be allowed to appear and oppose as in the case of private bills.

(3) On bringing in a bill under this section for the confirmation of an order, the Board of Trade shall make a special report to Parliament with respect to the order.

3. This act may be cited as the Light Railways Act, 1904, and shall be read as one with the principal act, and the principal act and the Light Railway Commissioners (Salaries) Act, 1901, and this act may be cited together as the Light Railways Acts, 1896 to 1904.

METROPOLITAN DISTRICT RAILWAY BILL.

A Select Committee of the House of Commons, of which Sir Lewis McIvor is Chairman, considered this bill on Wednesday. It has already passed through the House of Lords, and full details of it were given in *The Electrician* of April 29, p. 65.

Mr. FREEMAN, K.C., for the promoters, asked for an extension of time to 1908 for the completion of the authorised deep-level line between Earl's Court and the Mansion House.

Mr. R. W. PERKS, chairman of the Metropolitan District Railway Co., stated that the company was not prepared to undertake the deep-level line until electric traction was established on the existing line, as they had no idea as to what the effect of the increase of trains would be on the upper line.

Questioned by the Chairman, Witness said the electric service would probably be commenced shortly after Christmas.

Mr. COWARD, K.C., for the London County Council, asked for a zone of 1d. fares and a provision for workmen's trains on the deep-level line, which would be used for express service, with possible stoppages at Charing Cross and Victoria.

After arguments by counsel on both sides, the Committee found the preamble of the bill proved.

ELECTRIC LIGHTING (LONDON) BILL

The preamble of this bill was found proved on Friday by the Select Committee of the House of Commons presided over by Mr. Bousfield.

OTHER ELECTRICAL BILLS.

The *Southport and Lytham Tramroad (Extension of Time) Bill* came before the Unopposed Committee of the House of Commons on Friday last, when the preamble was found proved. The bill provides for an extension until 1907 for the reconstruction of the Southport-Lytham tramroad authorised in 1900. It was stated that the capital for the first portion of the work had been found and that the work would be started upon at once.

The *Belfast and North-East Ireland Electricity and Power Gas Bill* came before the Unopposed Committee of the House of Lords last week, Lord Balfour of Burleigh presiding. The bill authorises the company to supply electrical energy and power gas in portions of the counties of Londonderry, Antrim, Down, &c. The capital of the undertaking is £1,500,000. The preamble of the bill was found to be proved.

In the House of Commons on Thursday last week the *Preston, Chorley and Horwich Tramways Bill* was read a third time.

The *Rotherham Corporation Bill* was before the Police and Sanitary Committee of the House of Commons last week. Among a number of things, extensions of the municipal tramway system was sought and some further provision with regard to the electricity undertaking. The former were unopposed and were sanctioned by the Committee. With regard to the electricity undertaking, it was sought to make discounts up to 10 per cent. to consumers who paid their account within a certain time. The Committee, however, refused to allow a higher maximum than 5 per cent.

In the House of Lords on Monday the *Manchester Corporation Tramways Bill* was read a third time.

The *Leicestershire and Warwickshire Electric Power Bill* was read a third time in the House of Commons on Monday.

In the House of Lords on Tuesday, the *Bristol Tramways (Extensions) Bill* and the *Baker Street and Waterloo Railway Bill* were read a third time and passed.

The *Light Railways Bill* came before a Committee of the House of Lords on Tuesday, and the preamble was found proved.

In the House of Commons on Tuesday, the *Derbyshire and Nottinghamshire Electric Power Bill* was read a third time.

In the House of Commons on Wednesday the *Saddleworth and Springhead Tramways Bill* was ordered for a third reading.

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MUNICIPAL TRADING.

In the House of Commons on Tuesday, Mr. LONG, in answering Sir W. Houldsworth, who asked whether any steps had been taken for the summoning of a conference of the Institute of Chartered Accountants and other societies, referred to in sec. 9 of the report of the Joint Select Committee on Municipal Trading, said that he had been giving attention to the practicability of a standard form of accounts of local authorities being prescribed, and was disposed to think that the best course would be to appoint a Departmental Committee to inquire into the system upon which the accounts should be kept.

RAILWAYS (ELECTRIC POWER) ACT, 1903.

In the House of Commons yesterday (Thursday),

Mr. CHANNING asked the President of the Board of Trade what orders, if any, had been made by the Board under sec. 1, sub-sec. (*g*) of the Railways (Electric Power) Act, 1903, for securing the safety of the public; whether such orders include adequate protection from contact with a live rail; and whether any of the fatal and other accidents which have occurred from contact with live rails have been found to be due to the neglect of the companies to comply with the terms of orders of the Board, or to neglect of other precautions. He further asked what steps the Board were now taking or would take effectually to prevent recurrence of such accidents.

Mr. GERALD BALFOUR: No orders have yet been made under the act.] Inquiries are being held into two recent accidents that occurred through the electrical working of railways, and when the reports are received the question of the precautions to be taken will be fully considered.

TELEPHONE FACILITIES IN IRELAND.

In the House of Commons yesterday (Thursday),

Mr. O'DOHERTY asked the Postmaster-General when telephonic communication between Ballymena and Londonderry, including branches to Limavady, Coleraine and Portrush, would be established, and when subscribers in those towns would be connected with Belfast.

Lord STANLEY said applications for a telephone service had been received from several other towns in the North of Ireland, and he had found it necessary to obtain further estimates in order that when the scheme now under consideration was put into execution it should be as comprehensive as possible. He hoped shortly to be able to announce that the work would be put in hand when the requisite support was forthcoming.

LEGAL INTELLIGENCE.

Poole and District Electric Traction Co. v. Bournemouth Corporation.

ARBITRATION.

(*Continued from p. 404.*)

Friday, June 24.

Mr. J. E. WALLER was further cross-examined by Mr. C. A. CRIPPS, K.C. He said that when he was promoting the rival scheme for Mr. Murphy in 1897 he gave it as his opinion that the loop line by Parkstone would pay. He said the same now, had the two lines been constructed together; but having constructed one line and made it pay, it would obviously deplete it of some of the traffic if the loop were now constructed. In this way the two lines together would not show the same profit as the one line showed now. In estimating his depreciation of the undertaking he had taken the cost of the construction of the line as shown by the balance-sheet, and he calculated the sum which should be set aside at £448·9 per mile of route per annum, as against £362·3 given by Mr. Sellon.

Mr. CRIPPS: But in estimating the depreciation and renewal you should take the cost of the reconstruction of the line and not the cost of the original construction?—I cannot agree, because you would then be going behind the balance-sheet, which you say we should not do.

You have given certain figures which you say shows that the line had more or less reached its maximum in 1903?—Yes.

Do you really say that a line that has only been in operation for three years is likely to get to its maximum in that time in a district of this kind?—Yes, I think it is reasonably near it; but I have allowed a further extension by allowing 360,000 car-miles per annum, whereas you only ran 338,000 car-miles in 1903.

But would you really take one statistic of this sort to base your view that there will be no increase in the future?—That is one of the elements. Another reason is that being a pleasure line you would get the full use of it from the visitors from the very first.

Do you not think that the pleasure traffic increases with the population?—No, I do not.

You also say that the Christchurch concession is worth nothing?—Yes.

And you proceed on the same sort of basis as in connection with Parkstone—viz., that 6 per cent. would be required for the money?—Yes, and I have taken the same proportion of business traffic that you now get between Bournemouth and Poole.

And on that basis you allowed for 603,115 passengers going between Bournemouth and Christchurch?—From the business point of view, and then I allowed the same percentage of business traffic as upon the Poole line.

You have made no allowance for the running powers?—Yes, I consider the difference between the 338,500 car-miles which you actually ran in 1903 and the 360,000 which I have allowed, sufficient to cover any advantage from running powers.

But I put it to you most distinctly that you included nothing, and did not intend to include anything for the running power?—I had not the question of running powers in my mind at the time, but I consider there is sufficient margin.

Saturday, June 25.

Mr. WALLER was briefly re-examined, but made no new points.

The UMPIRE: If you were a free man, would you advise anyone to construct the Parkstone line?—No, I would not, because the traffic to be obtained upon it would not repay the capital which it would cost to construct.

Mr. E. M. LACEY, the consulting electrical engineer to the Bournemouth Corporation, examined by Mr. LLOYD, K.C., said that in ascertaining the fair market value of the undertaking he felt himself entitled to take into consideration certain matters outside any particular figure in the balance-sheet, and especially did he think that a purchaser should see if any proper provision had been made for maintaining the earnings of the undertaking. He did not consider the permanent way was of substantial construction. In fact, it was of the cheapest possible construction. The tar macadam with which the space between the rails was paved was full of holes, and the lines of granite setts outside the rails were very unstable. This necessarily affected the wear on the rails, and from careful measurements he had ascertained that the wear on the rails since the opening of the tramways was $\frac{5}{32}$in., which would give a life of about 12 years. The points and crossings were very old-fashioned, and where ordinarily the life of these would be about seven years, he should say that the ones on the Poole line would have a very considerably less life. In fact, some of them needed renewing at once. The overhead equipment and the feeder cables were in fair condition, but the rolling stock had not been maintained in a proper manner. Originally, also, the rolling had not been first-class, and the general appearance of the tramway showed that it had not been maintained properly. The accounts confirmed this statement. In 1901 the amount set aside for renewals was £331. 4s., or 0·036d. per car-mile; in 1902 £1,363, or 0·990d per car-mile, and in 1903 £1,631, or 1·156d. per car-mile. There were very good reasons why in the first year the maintenance charge should not be a large one. In his opinion, however, after the first year a proper sum to be set aside for renewals would be £2,071 = 1·465d. per car-mile, and this was based upon the 1903 figure of 338,500 car-miles. In addition to this, also, a sum should be set aside for depreciation and his estimate for this was £1,598 per annum. In arriving at a valuation of the undertaking, he had first taken the balance-sheet for 1901 without correcting it for 12 months, as he contended that nothing in the agreement bound him to take anything but the balance-sheet. On this basis he arrived at a figure of £63,534 upon a 6 per cent. take and a purchase period of 16$\frac{1}{2}$ years. Taking a twelvemonth's valuation, his net figure was, using the 1903 balance-sheet, £61,582, both these items being the capital value of the existing line. This was after deducting three years' maintenance and depreciation at the rates mentioned above. With regard to prospective profits, he pointed out that notwithstanding the car-mileage and passengers increased in 1903, the profits were actually less than they were for the nine months of 1901. Another factor to be taken into account was that the company had been paying less for their electrical energy than the Corporation would have to pay under the agreement with the supply company which had to be taken over. Taking all these things into consideration, he had arrived at the conclusion that the undertaking had practically arrived at its maximum earning capacity, and therefore he had allowed nothing for increased future profits. He felt convinced that the car-mileage which the company now ran would provide for the requirements of the districts for a very long time. Throughout his calculation he had assumed that the gross receipts would be a little over 11d. per car-mile, which was a very good result, and no injustice was being done to the company by assuming that they would continue to earn that sum. With a turn-out system such as this, a six minutes' service, which was the one now given, was the maximum that could be given with the existing limits of speed. In fact, as showing the difficulty which was experienced in maintaining even this service, he said he knew, from his own knowledge, that on some sections of the line the cars ran at 18 miles an hour. He also agreed with Mr. Waller that the possible electrification of the local railway lines in the future must be taken into account. Coming to the Parkstone line he placed no value on this for the same reasons that Mr. Waller had given. The value of the running powers he had valued at £159 per annum or a capitalised sum of £2,650. To earn this, however, there would have to be an expenditure of £2,350 upon the cars in adapting them to the double working upon the trolley and conduit systems. He placed no value upon the Christchurch lines, and he would not recommend the Corporation to construct any lines in Christchurch if they could advoid it. The Poole Quay line and the Canford Cliffs line he could not bring himself to consider seriously.

Cross-examined by Mr. BALFOUR BROWNE, K.C.: As to the repair of the line, is it in any worse repair than the Winton line of the Corporation, which is of precisely the same construction?—I have not been on that line recently.

You have estimated renewals at 1·465d. per car-mile?—Yes.

Tar paving and road paving you have put at 1s. per yard super?—Yes.

Am I right in suggesting that instead of 1s. per yard super, in all books on the subject you will find it is given at 2d?—I do not know what you find in books.

It is done in Liverpool at 2·009d., and if it is done there surely it can be done here?—Perhaps.

Is not then your figure much too high?—It is ridiculous to say that 4 miles of macadam road can be maintained for £100 a year, which is practically what you say.

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Granite paving you have put at 5s. per yard super. Am I right in supposing that ½d. per yard per annum is sufficient?—Oh, no.

In Liverpool it is done for 0·54d.?—Well, I give you my figures.

Yes, I know you do, but they are wrong.

Further cross-examination: He had taken 11·75d. per car-mile as the average earnings upon the line. It was quite true that on some of the Corporation lines the earnings were as high as 2s. 2d. and 2s. 3d. per car-mile and that the average was 16d., but there were a large number of lines feeding the main line which accounted for this. Another reason was that the population was more dense in the centre of Bournemouth than upon the Poole line.

What determined your multiplier of 16⅔ years?—I regard an undertaking of this kind as a 6 per cent. investment.

Does not the multiplier depend entirely upon the security?—Yes.

Is a tramway purchasable at the end of 21 years as good a security as one that is not purchasable under 35 years?—No.

Again, is a tramway purchasable as "old iron" as good a security as one purchased as a going concern?—Certainly not.

In this particular case the line is not purchasable until after 35 years and then it is to be purchased as a going concern?—Yes.

Then what would be your multiplier under the 21 years' purchase clause of the Tramway Act of 1870?—About 14½ years, and I should regard it as a 7 per cent. investment.

That only makes a difference of 1 per cent.?—That is a considerable difference.

You include nothing for prospective value, nothing for the Christchurch rights, nothing for the Parkstone extension, and you give nothing for other circumstances, such as feeding?—Certainly not.

And, leaving all these things out, your valuation practically comes to £5,000 more than Mr. Waller's?—Yes.

Continuing: He had taken off depreciation from the 1901 balance-sheet, and then deducted the other two years from the 1902 and 1903 balance-sheets.

Re-examined: He had treated depreciation from the point of view that the company should have had three years' depreciation in their pockets to hand over to the Corporation. But this not being so, he had deducted it.

Mr. F. W. LACEY, the Bournemouth Corporation engineer and surveyor, agreed with the last witness as to the bad state of repair of the permanent way of the Poole line, and estimated that the cost of repairing it would be £2,815. The increase of passengers, as shown by the 1902 balance-sheet over the 1901 balance-sheet, was not due to the normal development of the district, but to the fact that there were large contracts of various kinds being carried out in Bournemouth, and the majority of the workmen found it cheaper to live near Poole than in Bournemouth. The increase in 1903 was due to the opening of the Corporation tramways. He also agreed with the previous evidence as to the value of the Parkstone line, and with regard to running powers, he thought the only value of them would be to the company, because the Corporation had never intended to run any of its cars to Poole. But before the company could realise any benefit from the through running, a large amount of money would have to be spent upon their cars, as stated by Mr. E. M. Lacey, which he himself put at £3,975. A half-hourly service would be sufficient. Therefore, on the basis of the additional 1d. per car-mile, which, it was stated, would be earned by the running powers, he calculated the net profits at £392 per annum, a sum which, capitalised at 16⅔ years, would amount to £6,530, from which would have to be deducted the £3,975 already mentioned. He also considered the Corporation should be compensated for the inconvenience to the existing service in Bournemouth. Therefore, his total valuation of the undertaking over 16⅔ years was £65,379. He had taken no account of the same items as the other witnesses.

Mr. ALFRED BAKER, manager of the Birmingham Corporation tramways, said his valuation amounted to £58,947. 8s. 10d. net. In arriving at this he had adopted the profit for the nine months as shown in the 1901 balance-sheet, and added to that the profits for the first three months, working of 1902, in order to arrive at a twelvemonth's working. On this basis the total gross profit for the year 1901 was £6,441. 18s. 7d. Against this, however, had to be charged maintenance and depreciation. In respect of the former he did not quarrel much with the amounts set aside in 1902 and 1903, but in 1901 another £500 should have been spent. For depreciation he felt justified in deducting £2,024, and this left the net profit for 1901 at £3,917. He had also assumed 350,000 car-miles and an average speed of 7 miles per hour. Allowing 11d. per car-mile receipts and 7·02d. per car-mile for expenses left a sum which, capitalised for 16⅔ years at 6 per cent., gave a total valuation of £65,019. 8s. 10d., and a net sum, after deducting depreciation, &c., of £58,947. 8s. 10d. As did the previous witness, he placed no value upon the Parkstone line, the Poole Quay line, nor the Christchurch lines; but with respect to running powers he had added ½d. per car-mile to the earnings, otherwise he would have taken 10½d. per car-mile. With regard to Canford Cliffs, unless a person wanted to get rid of his money, he saw no reason for its construction. To accommodate a four-minute service throughout the day the Poole line would have to be doubled throughout, and under these conditions the car-miles run would be 475,020. But this would make it impossible to keep the receipts at 11d. per car-mile. They would drop to 10d., with the result that the profit would be about the same as at present. Therefore, it did seem that the undertaking had reached its maximum earning capacity.

The proceedings were then adjourned.

Claim for Commissions.

In the City of London Court, on Friday last, Judge Rentoul, K.C., heard a claim by Mr. H. Cohen, commercial traveller, for £5. 18s. 1d., commission on sale of electrical goods, from defendants, the Union Electrical Co. Plaintiff's case was that defendants agreed to give him 10 per cent. commission on the sale of a motor car on their behalf. He introduced the matter to Messrs. Watson & Co., who did not buy the motor car, but afterwards bought electrical goods to the amount of £118, and plaintiff claimed commission of 5 per cent. on these goods, contending that he was entitled to commission on any goods sold to Messrs. Watson & Co., although he had not been actually instrumental in selling these goods.

Defendants said they had never agreed to give plaintiff any commission for selling electrical goods. The mere fact that plaintiff had introduced Messrs. Watson & Co. did not justify plaintiff in claiming a commission on goods which Messrs. Watson & Co. had purchased.

Mr. WATSON said he had known defendants for a long time by reputation, and had corresponded with them about the motor car through plaintiff. That transaction fell through. Later he bought some arc lamps. He knew there was a new lamp that had been brought out by defendant company, but he had not seen it. It was a little different from the ordinary arc lamp, because it was a different coloured light and it was what he had been looking for. He happened to tell plaintiff that he wanted a lamp of that description, and plaintiff then said he could see one if he went to the Agricultural Hall, London. He went, saw the lamp, and bought £118 worth. He would not have bought them if they had not been satisfactory, nor would he have gone to Islington but for the introduction of the plaintiff. If the plaintiff had never introduced the lamp to him he believed he would have bought it, as the lamp had since become better known, and in that way it would have come to his knowledge.

Judge RENTOUL: If a firm agree to give a commission for a specific business, is the party entitled to commission on everything else that comes along through that introduction? The point is certainly a very interesting one.

Mr. KAYES: Three months elapsed between the two transactions. We are not bound for ever, surely, to pay Mr. Cohen a commission on everything that Messrs. Watson buy. If the Court finds for plaintiff we shall certainly have to do so.

Judge RENTOUL: Not after notice has been given. The plaintiff is a commercial traveller, and it is his business to obtain commissions on introductions he effects. The agreement is not very clear; it is a case for compromise. Defendants would not have heard of Messrs. Watson but for plaintiff's introduction. Having regard to these circumstances, I find for plaintiff for £3 and costs.

Statutory Tramway Fares.

A test action as to the right of tramway owners to charge 1d. for a distance of less than 1 mile was recently brought by the Perth Corporation against Mr. Charles Craig, county assessor, who had in effect challenged the plaintiffs to take such action by travelling a portion of and to the end of the 1d. stage at Lower Scone and refusing to pay an additional 1d. when travelling from that point a distance of less than 1 mile to the end of the route at Upper Scone. Defendant's contention was that the second 1d. ticket, taken at Lower Scone, would not enable him to ride 1 mile.

Sheriff SYM decided last week in favour of plaintiffs, who, in his view, had the right to charge 1d. for 1 mile and a further 1d. for any addition to the first mile, and he disagreed with defendant's argument that a ticket from Fitzroy-terrace to the end of the journey could not legally be given for the second 1d. because, according to defendant's case, a portion of that journey—viz., from Fitzroy-terrace to Lower Scone—had already been covered by the first ticket.

Ferranti Limited. (Petition of Estler Bros.)

This matter came before Mr. Justice Buckley on Tuesday.

Mr. BUCKMASTER, K.C., said the late Mr. Justice Byrne had appointed a provisional liquidator. The debenture-holders had got possession and there being contracts which were liable to forfeiture an order was made giving effect to an arrangement between the debenture-holders and creditors. The matter stood over from time to time pending the completion of a scheme of reconstruction, which was still under consideration.

Mr. HENDERSON stated that the amount to be received in respect of the valuable orders to be carried out by the provisional liquidator was about £70,000. After paying everybody there would be about £25,000 working capital, and this was considered sufficient.

His Lordship granted a further adjournment to Aug. 2 to allow of the perfection of the scheme.

Workmen's Tramway Fares.

At Sunderland Police Court on Tuesday a clerk named Cockburn was summoned by the Corporation tramway department for having refused to pay his full fare on the electric tramways.

Mr. J. R. STOREY (for defendant) said the point for decision was whether or not a clerk was a workman.

The TOWN CLERK (Mr. F. M. Bowey), who prosecuted, said there was no decision on the point. He explained that, on June 10, the conductor of a workmen's car, going round to collect fares, asked defendant, a passenger on the car, for his fare. Defendant asked for a "transfer," a form of ticket which enabled workmen to travel any distance on the system for 1d. The conductor said as he was a clerk he could not have a workman's ticket, but would have to pay the ordinary fare. Defendant refused, and gave his name and address. He (Mr. Bowey) understood that it would be argued in the defence that defendant had previously been supplied with a workman's ticket; but that did not justify him in pursuing that course. The object of the Corporation was not to exact a

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severe penalty under the bye-law, but to dispel any notion there might be that anyone who chose to do so was entitled to take the benefit of the workmen's cars when they were not workmen within the section. The section relating to workmen's cars conferred benefits exclusively upon artisans, mechanics and daily labourers.

Defendant said he had always had workmen's tickets. He had travelled on the same route, and been given a workman's ticket since the summons was issued.

The CHAIRMAN: The decision of the Bench was that they were quite satisfied the fare demanded should be paid, and that the defendant was not a workman nor a mechanic, but a clerk. As defendant had gone to some expense, he would simply be fined 1s., to include costs; but any repetition of the offence would be severely dealt with.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Council of the University of Birmingham, invite applications for a chair of electrical engineering. Stipend £1,000 per annum, with liberty to undertake certain consulting work. Particulars from the secretary (Mr. Geo. H. Morley), to whom applications by Aug. 1. See advertisement.

London County Council require a rolling stock superintendent in their tramways department. Salary £400. Applications by 16th inst.

A lecturer and chief assistant (£150 to £200 per annum) and an assistant lecturer and demonstrator (£100 to £125) are wanted for the Glasgow and West of Scotland Technical College mechanics department.

An executive engineer is required for the construction of hydraulic works in connection with the electric lighting of Kuala Lumpor (Malay States). Salary £420 per annum. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., by 9th inst.

West Ham Corporation require a lecturer in electrical engineering for the Municipal Technical Institute. Commencing salary £200. Applications to the principal by noon July 7.

A demonstrator in chemistry is required at Heriot-Watt College, Edinburgh. Salary £125. Applications by Oct. 1.

An assistant lecturer and senior demonstrator in chemistry is wanted for the University College of Wales, Aberystwyth. Applications by July 9.

A science master (to teach physics and mathematics) is required for Accrington Municipal Technical School. Salary £140, rising to £185. Applications by 9th inst.

A physics master is wanted for Chesterfield Grammar School.

There are vacancies for five switchboard attendants with previous experience in three-wire continuous-current system and accumulators for Londonderry electric light and power station; also for one fireman and for a smart man capable of being trained to duties of dynamo attendant and lamp-switch man. Applications to the borough electrical engineer (Mr. R. V. Macrory) by July 16.

Brighton General Purposes committee decided on Thursday last to recommend the appointment as town clerk (in succession to the late Mr. F. J. Tillstone) of Mr. Hugo Talbot, the present deputy town clerk, who is a qualified solicitor and a son of Mr. W. H. Talbot, town clerk of Manchester.

Mr. Withycombe, clerk of works to West Ham electrical undertaking, has been promoted to be superintendent of the tramways overhead equipment.

Mr. J. H. Shaxby, B.Sc., has been appointed demonstrator and assistant lecturer in Physics at the University College of South Wales and Monmouthshire, Cardiff.

Mr. Reginald W. Ferguson, B.Sc., A.R.C.S., senior science master at the Intermediate School, Newport, Mon, has been appointed principal of the Municipal Technical School, the Gamble Institute, St. Helens.

EDUCATIONAL NOTICES.

City and Guilds of London Institute.—Particulars of the courses of instruction for the session 1904-5 at the Institute's Central Technical College, Exhibition-road, London, S.W., and at the Technical College, Leonard-street, Finsbury, in the engineering and chemistry departments, are set out in an advertisement on another page. The entrance examinations to both colleges are held in September, and particulars can be obtained at either of the colleges or from the head office of the Institute, Gresham College, Basinghall-street, London, E.C.

Goldsmiths' Institute.—At a meeting of the Senate of the University of London on Wednesday, it was decided to accept the offer of the Goldsmiths' Company to transfer the New Cross Institute to the University. It is proposed to use the buildings for the training of school teachers, and, if funds permit, to carry on the higher part of the work of a polytechnic, and also to continue the art school.

Acton.—An inquiry was held recently by Mr. H. Ross Hooper into the application of the Council for sanction to a loan of £54,091 for electricity supply. It is proposed to take supply in bulk from the Metropolitan Company from Jan. 1 next. The cables from the company's station to the Council's transforming station will be laid by the company and become the property of the Council without purchase if the company continues the supply for 27 years, but the Council will pay a proportion of their cost if they exercise their right to terminate the contract after nine or 18 years.

The public library is to be lighted electrically.

Acts of Parliament.—On 24th ult. the Royal assent was declared to the following new Acts of Parliament:—

Electric Lighting Order Confirmation (No 1).
Great Northern and City Railway.
Metropolitan Railway, 1904.
West Metropolitan Railway (Abandonment).
Govan Electric Lighting (Further Powers).
University of Leeds.
Chesterfield Corporation Tramways and Improvements.
St. Marylebone Electric Lighting.
South Staffordshire Mines Drainage.
Lancashire Electric Power.
Preston, Chorley and Horwich Tramways.

Amble (Westmorland).—The Council (as stated in our issue of May 27) have asked Broomhill Collieries (Ltd.) for a supply of electricity, and the company have replied that arrangements for supply in bulk might be come to, but that they cannot enter into negotiations until the Northern Counties Electricity Supply Co. (who hold an order for the district) have indicated ther intentions.

Barcelona.—Permission has been granted by the authorities for the conversion of the short Barcelona-Tarria railway line into an electric tramway. This undertaking belongs to a Belgian syndicate, the Société Générale Chemins de Fer Economiques of Brussels.

Bath.—In addition to increasing the salary of the city electrical engineer (mentioned in our last issue), the Council have increased the salaries of Mr. F. Hale, station superintendent, from £150 to £175 per annum; of Mr. C. S. Walker, shift engineer, from 40s. to 45s. per week; of Mr. D. T. Miles, mains superintendent, from £3. 5s. to £3. 10s. per week (and an honorarium of £25 in respect of extra duties during the past two years); of Mr. Nethercote, head of the clerical department, from £150 to £160, and of Mr. Shapley, from £150 to £175.

Birmingham District Tramways.—The Pershore-road tramway (Birmingham to the Cotteridge, King's Norton) was formally opened on Thursday last week. The line is 3 miles in length and forms the first portion of 9½ miles of tramways to be constructed by the King's Norton and Northfield District Council, and leased to the City of Birmingham Tramways Co.

Bishop Auckland.—The Urban Electric Supply Co. have secured a site for an electricity generating station.

Boness.—The Secretary for Scotland has now sanctioned the borrowing of £25,000 by the Town Council for the erection and equipment of electricity works by the National Electric Construction Co., who have agreed to pay 6 per cent. per annum for the redemption of the capital expenditure, and to supply current for public lighting at 2½d. per unit.

Bridlington.—When electricity supply is available the Council will charge 5d. per unit for lighting and 3d. for heating and power.

Brighton.—The section of the Corporation electric tramways between the Aquarium and the north-western boundary of the borough was opened on Sunday.

Bury (Lancs.)—The Council have fixed the following scale of charges for current:—Places of worship, banks, offices, &c., flat rate of 5d., instead of 6d. and 3d. on the maximum-demand system; shops 4½d; public houses, private houses, &c., 4d. and 3d. per unit. For power up to 1,000 units per quarter, 3d. per unit and 1d. in excess of that quantity.

Cadiz.—Reporting upon the trade of Cadiz district for the year 1903, Mr. Consul Keyser states that there is a market in the Cordova district for electric lighting plant, for tools, turbines and motor vehicles. At the port of Seville the imports of machinery for 1903 were 2,935 tons, a large increase over the two previous years, mainly represented by electrical machinery from Germany.

Chertsey.—The Council will ask the Board of Trade to revoke the Staines, Egham and Chertsey electric lighting order granted to the Thames Valley Electric Supply Co. in 1900.

Chesterfield.—The Council on Monday considered tenders received for the construction of electric tramways.

The Electric Tramways committee recommended that the tenders set out on another page be accepted. The committee also recommended that Thos. Nash & Sons (Sheffield) be appointed to inspect rails and fish-plates at the works of the makers at a fee of 1s. per ton, and points and crossings at a fee of 2s. per ton; and that the committee be empowered to accept tenders for ironwork, &c., in connection with the construction of the car sheds. The committee further reported that three firms of repute

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in the tramway world sent in tenders somewhere near each other in amount. The British Insulated Co. was the only one with which the committee had done business, and their tender was lower by £2,000 than the others. The contractors undertook to complete the system within three months from time of commencing work, and to commence within three weeks of the date of receiving order.

The Mayor said the Council's estimate for the part of the work covered by the British Insulated Co.'s tender was £49,291.

Ald. Wood asked if special terms had been given to outsiders or not, and whether the British Insulated Co. proposed to use British-made goods. He also required details as to the weight, strength and design of materials used, and the design of the cars. He thought there should have been a report from the committee furnishing all these particulars and moved that they be furnished before the tenders were accepted.

Councillor Jacques said all the information which had been asked for had been published in the minutes of the Council during the past 12 months. The rails would weigh 95lb. per yard. The cars would be similar to those in use at Nottingham, and would each hold 57 passengers.

The amendment was lost, and the resolution for the acceptance of the tenders was carried.

The length of line covered by the tenders is about 3½ miles in length.

Colliery Exhibition.—But little flourish of trumpets has heralded the holding of the second International Colliery Exhibition at the Agricultural Hall, Islington, London, this week. But this notwithstanding, an excellent show is made, and the exhibition, which remains open until to-morrow (Saturday), is well worthy a visit for its electrical interest alone, to which we may refer in more detail in a subsequent issue. The exhibitors include a number of leading electrical engineering firms, whose stands are as instructive as any in the exhibition.

The British Westinghouse Co., at stand No. 44, have a good show of electrical apparatus specially designed for use in collieries. Brockie-Pell Arc Lamp (Ltd.), at stands Nos. 71 and 72, show their well-known arc lamps and arc lamp accessories. Callender's Company have a fine show of electric cables, including vulcanised bitumen cable specially manufactured for colliery work. Single conductor, twin and three-core samples are shown, each as unarmoured, single-wire armoured, and double-wire armoured. This company's patent fall-resisting colliery cable, armoured with locked coil wires, is on show. On this cable, after the armouring, a single galvanised steel wire is wound on in the form of a close helix and at high tension, so that it is impossible to displace the wire of the lock coil armouring. Trailing cables, shot-firing and signalling cables, and a special display of insulating materials will also be found at this stand. On the stand of the Electrical Co. (No. 50) photographs and plans of colliery plants which have been laid down by the company are shown. At stand 91 the General Electric Co. make a good show in the form of plant specially designed or specially suited for colliery work, including a main-and-tail portable type hauling gear, single drum portable hauling gear, and portable pumps driven by three-phase motors; switchboards and fuseboards in watertight iron cases, mining telephones, bells and keys, enclosed arc lamps, mining fittings, magneto exploders, &c. Messrs. W. T. Glover & Co., exhibit a general assortment of electric cables and accessories, having special reference to use in colliery working. These include fire-resisting cables, leather-braided, rubber, paper and bitumen cables, joint boxes, &c. The Lahmeyer Electrical Co.'s stand (No. 48) is mainly devoted to photographs and drawings of electrical installations for coal mines, electricity generating stations, &c., hauling and winding gear, electrically-driven pumps, &c. At the stands of the St. Helens Cable Co. (Nos. 17 and 18) a fine show of cables for all classes of work is made, the most notable items being an example of "Dialite" cable working in boiling water, electric current for the lighting of the stands passing through this cable. Besides electric cable exhibits there is an excellent show of steel hauling ropes and guide ropes, rubber tiling, mats, matting, &c., and various other mechanical rubber goods used in collieries. The steel ropes manufactured by this company have been in use for nearly a century, and are recognised as being of the highest class of manufacture. At Messrs. Witting, Eborall & Co.'s stand (No. 63) a good assortment of standard type electric motors for direct, single-phase and polyphase currents is shown, as well as standard types of controllers, switch gear, &c. There is also a large number of photographs and drawings showing the company's plant as adapted to mining work. An example of a compounded alternator on the Heyland system is also shown. Other exhibitors of electrical plant are Messrs. Bruce Peebles & Co., John Davis & Son, Ernest Scott and Mountain, Fuller MacLeod & Co., F. A. Glover & Co., Mavor and Coulson, Monté Callow & Co. and J. A. Rowcliffe.

Engineering exhibits are an important class, both for quantity and quality, and among the firms making conspicuous exhibits may be mentioned the following:—Messrs. Babcock and Wilcox, a model of their famous water-tube boiler, fitted with steam superheater, and their chain grate stoker, of which a large number are in use in electricity stations. There is also a model of the Guttmann water softener, and specimens of wrought steel steam piping, of which this company make a speciality. Hadfield's Steel Foundry Co., at stand No. 37, have an interesting display of articles used in colliery work in which the company's patented form of manganese steel enters largely in the manufacture. There is a working demonstration of a patent tub controller, as well as stone breakers, screen bars, coal cutter wheels, bearings, wheels, &c., of toughened cast-steel, and colliery sundries of various kinds. The Hardy Patent Pick Co. show a large range of mining tools and machinery and a number of models of coal washers, screens, and screening machinery employed on the pit bank. This firm occupies a front place in the supply of tools of all kinds for colliery working. The "Hardy" heading, undercutting, and nicking machine, just placed on the market, is claimed to be the lightest mechanical coal cutter obtainable. At the stand of the Pulsometer Engineering Co. (No. 53) the well-known Pulsometer pumps of the type specially suited for colliery work are shown, together with pulsometers for coal washing and other items of the company's manufacture which have particular interest for colliery owners and managers. At the stand of the Triumph Stoker Co. a mechanical stoker of the sprinkler type is shown, which comprises a hopper with automatic feed, a thrower for distributing the coal, and moving self-cleaning fire-bars. A full description of this stoker has been given in our columns, and it only remains to be stated that the latest improved type of this apparatus is exhibited here. Messrs. Cochran & Co. show (at stand No. 60) one of their patent multitubular boilers. This boiler is of standard type 5ft. diameter, having 220 sq. ft. of heating surface, and is complete with all fittings and mountings ready for work. The internal construction of the boiler is admirably demonstrated by means of electric illumination inside. A ladder is arranged giving access to top of boiler, and the view obtained through the manhole is certainly instructive, owing to the absence of stays and general accessibility. For small electrical installations Messrs. Cochran inform us they have supplied a number of their boilers with eminently satisfactory results.

This brief description by no means exhausts the many interesting and up-to-date examples of machines and apparatus on show at Islington, but may serve to direct our readers' attention to the exhibition.

The Institution of Electrical Engineers paid an official visit to the Exhibition yesterday (Thursday,) and at the invitation of Mr. H. Greville Montgomery attended a luncheon. In the unavoidable absence of the president and president-elect, Mr. Gavey replied to the toast of "The Institution," which was proposed by the host, and referred to the increase in the number of electrical exhibits as compared with those of last year's exhibition. Not only had the number increased, but the quality was also superior, and he expressed extreme gratification at the way in which electrical engineers had been welcomed by the colliery industry. Mr. Patchell, in proposing the health of the chairman, echoed Mr. Gavey's remarks, and said he was sure there was a great future for electrical work in connection with collieries.

Cotteridge Tramway Extension.—On Thursday last week the Cotteridge extension of the Birmingham tramway system was formally opened. The line is about 3 miles long, and is a single line with a number of crossing places. It is leased to the British Electric Traction Co. until 1911, when the lease of the Bristol-road route also expires.

Derelict Tramways in London.—Col. Yorke has reported to the Board of Trade that the London, Camberwell and Dulwich tramways, which have been disused for many months, are dangerous and beyond repair, and should be completely reconstructed or removed. Camberwell Borough Council have asked the Board to order the removal of the rails.

Dorking.—The District Council have decided to advertise for tenders for public lighting.

Electricity in Building Operations.—The builders of the new Glasgow University extension (Alex. Muir & Sons) have installed an electric motor to drive a large mortar mill, and have also erected an electric derrick crane capable of lifting 5 tons at a speed of 170ft. per minute and of covering a radius of 75ft. Current is obtained from the Corporation supply inside the University grounds, and is transmitted about 250yds. The electric plant has been supplied by J. D. Mackenzie & Co., and the crane by Butters Bros.

Elton (N.B.)—A company, who have submitted proposals, are to be invited to introduce electric lighting at their own risk.

Epsom.—The Council have decided to increase the salary of their chief electrical engineer (Mr. H. F. Foster) from £225 to £250 on Oct. 1, and that of the chief assistant engineer (Mr. A. C. Gilling) from £104 to £120. The Council adopted the recommendation of the Lighting committee to postpone the question of the reduction of charges for electric current until the connections reach the equivalent of 7,000 8 c.p. lamps. The number is now 5,548.

Factory Lighting, &c.—Babcock and Wilcox are supplying boilers and the British Thomson-Houston Co. the electrical plant for the lighting and driving the new works of the Asbestic Brick and Tile Co. at Regent's Park, London.

Falkirk.—The accounts of the electricity undertaking to May 15 last show capital expenditure £25,370, an increase of £4,340 for the year.

The revenue was £2,146. 13s. 5d., including £1,482. 8s. 1d. from private consumers, and £663. 5s. 4d. from public lighting. Working expenses were £1,095. 4s., leaving a gross profit of £1,051. 9s. 4½d. The net result (after payment of interest and sinking fund charges) was the reduction of the deficit of £201. 15s. 1d., which existed at the beginning of the financial year, to £163. 11s. 11d. 128,855 units were sold. There is the equivalent of 7,931 8 c.p. lamps connected, and there are applications to date (exclusive of the new poorhouse) for 9,183 8 c.p. lamps.

Farnworth.—The Electricity and Tramways committee recommend the reduction of the price charged for current for private lighting from 5d. to 4½d. per unit.

Fatalities.—A boy, named Whitehead, 11 years of age, was killed on Wednesday evening near the St. Peter's station on the electrified section of the North-Eastern Railway between Newcastle and Tynemouth. Death resulted from contact with the live rail.

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At an inquest held on Tuesday at Hightown, on the body of Private Collins, Royal Welsh Fusiliers, the evidence showed that deceased was found dead on the Southport Electric Railway on Saturday evening last, but how he strayed on to the line the evidence did not show. A comrade stated that deceased was the worse for liquor and suddenly disappeared. Both he and his comrade were fully aware that the lines were dangerous, as every man in the regiment had been warned to that effect. Deceased appeared to have fallen on the line, and was cut to pieces by a passing train. In the opinion of Mr. Percy Slattery, a switchboard assistant at the L. & Y. Railway power station at Formby, death was due to the train passing over the body, but the medical evidence was to the effect that death was due to electric shock. A verdict of accidental death was returned.

Fraud.—At the Preston Quarter Sessions on Wednesday, Arthur Britch, described as an electrician, of Manchester, was sentenced to nine months' imprisonment for obtaining by false pretences large quantities of electric cables from Liverpool and Manchester firms. The chief constable of Blackpool (Mr. Derham) said prisoner had for years carried on bogus companies at Nottingham, Leeds, Manchester, Bradford and Liverpool, and had made a living by obtaining by false pretences electric cables for which he never paid but which he sold to engineers.

Fulham (London).—The Council is now supplying current to the Grand Theatre at 4d. per unit up to 4,000 units, 2¾d. for the next 20,000 and 2½d. for any further quantity. The Council will construct and equip a transforming station at the theatre.

Halifax.—The Tramways committee recommend the Council to proceed with the extension to the tramways from Brighouse to Bailiffe Bridge (1¼ miles double-track) at a cost of £10,000.

Hampstead (London) —The Council decided last week to construct an additional sub-station at Kilburn at a cost of £356. Application is to be made for sanction to a loan of £25,856 to cover the estimated capital expenditure of the current year.

High Wycombe.—The Corporation are considering an offer from the local electric lighting company to submit revised terms for public lighting.

Holyhead.—The Council are applying for sanction to a further loan of £1,000 for extensions of the electricity undertaking.

Hull.—Messrs. Reckitt & Sons have agreed to take supply of electricity from the Corporation on the terms and at the price mentioned in our issue of June 10 (p. 326).

Inquiry.—A Board of Trade inquiry was held on Monday at Liverpool by Major Druitt and Mr. A. P. Trotter into the cause of recent accidents on the Southport Electric Railway.

Ipswich.—The receipts of the electricity department for the six months ended March were £2,441, including £1,686. 10s. 7d. from the tramways department. Working expenses were £2,109, showing a gross profit of £353. 12s. 4d. After providing £2,517. 4s. 10d. for interest and sinking fund charges, there is a deficiency of £2,163. 12s. 6d.

The tramways have earned £5,637 during the same period, and the working expenses were £6,091, a loss of £446. 17s. 9d. Interest and sinking fund absorbed £1,472. 14s. 5d., total deficiency £1,919. 12s. 2d. Expenditure, however, included a portion of the non-recurring item of purchase-money, and the period covered by the accounts was the lighter half of the year.

Islington (London).—The revenue account of the electricity undertaking for the year to March 31 last shows a surplus of £1,054. 1s. 8d., against a deficiency of £1,496. 3s. 7d. for 1902-3.

The chief items of expenditure during 1903-4 were: Fuel, £12,294. 17s. 6d.; interest, £12,180. 9s. 8d.; repayment of loans, £6,172. 16s. 9d.; wages at generating station, £3,166. 1s. 8d.; repairs to buildings, boilers, machinery, &c., £2,842. 17s. 6d.; salaries, £2,627. 7s. 1d.; rates and taxes, £2,059. 15s. 2d.; wages (other than at generating station) and repairs and maintenance of public lamps, £2,033. 18s. 7d.; oil, waste, water and engine-room stores, £1,662. 17s. 11d.; general establishment charges, £967. 7s. 9d. Receipts from sale of current were £48,352. 5s. 2d., £32,704. 18s. 3d. from private consumers. Outstanding loans amount to £379,618. 6s. 8d.

Lancaster.—The electricity department accounts for the year ended March show capital expenditure of £5,399. 16s. for the year, making the total capital expenditure to date £60,595. 11s.

The year's income was £9,065. 15s. 1d., including £8,271. 9s. 5d. from private consumers, £660 from public lamps and £370. 11s. 3d. from sale and repair of apparatus. Generation expenses were £2,665. 15s. 7d., distribution costs £902. 11s., management £742. 11s. 1d., other charges bringing the total working expenses to £5,033. 9s. 5d., leaving gross profit £4,032. 5s. 8d., from which £796. 1s. was applied for debt redemption, dividends £706. 9s. 4d., interest £1,023. 4s. 7d. Of the balance, £756. 10s. 9d. has been placed to reserve and £750 to the borough fund. 680,480 units were generated. 65,438 were supplied to public lamps, 333,834 to private consumers and 205,676 to the tramways department. There are 34 arcs and the equivalent of 35,000 8 c.p. private consumers' lamps connected. The maximum supply demanded was 460kw. for lighting and 200 for tramways. The capacity of the plant is 1,000kw.

In the tramways department £2,210. 12s. 4d. has been spent on capital account during the year, making the total £27,206. 13s. 5d. The year's income was £4,687. 10s. 5d., and the net result, after providing £4,653. 14s. 2d. working expenses and £2,866. 19s. 7d. for interest and debt redemption, a deficit of £2,833. 3s. 4d. This deficit is, however, entirely due to heavy payments for interest and redemption in respect of capital for extensions which have not yet been, but will shortly be, revenue earning.

Limit of Liability for Tramway Accidents.—Councillor Muir Wilson, with a view to testing the right of Sheffield Corporation to limit their liability to £25 compensation for injuries received by passengers on their tramcars, recently refused to take a ticket upon paying his fare when travelling on a Corporation car, as an intimation of his refusal to agree to this limitation, and refused to pay a second time. He has been summoned (1) for not showing his ticket, and (2) for not paying the fare on the second demand.

The question of the limitation of the Corporation's liability is also to be tested shortly by means of an action to recover £50 for injuries received.

The summonses against Mr. Muir Wilson were originally fixed for hearing yesterday (Thursday), but, on the request of the Corporation's counsel, have been postponed to a day to be fixed later.

Liverpool.—The statement on the Corporation's financial position at December last shows that the total debt was £13,593,967. 7s. 7d., including £1,696,917 borrowed for the tramway department and £1,386,845 for electricity supply, both of which undertakings yield profits in aid of the general rates.

London County Council.—At Tuesday's meeting loans for electric lighting were made to Fulham (£25,000) and Hampstead (£4,300).

Tramways.—It was agreed that application be made to Parliament in 1905 for powers to enable the Council to construct tramways from the terminus in Westminster Bridge-road, across Westminster Bridge and along the Victoria Embankment and the portion of the subway authorised by the London County Council (Subways and Tramways) Act, 1902, from the Victoria Embankment to the north side of the Strand, with a connection between the proposed tramways and the tramways in Lambeth Palace-road.

The Highways committee reported that the arbitrator had awarded £91,363 to the London, Deptford and Greenwich Tramways Co. for the acquisition by the Council of their undertaking, and the committee recommended the expenditure of £95,500 on capital account in connection with that purchase.—Agreed.

The Highways committee also reported having considered the question of modifying the system of electric traction in connection with the first sections of the northern tramways. On the southern system it provides for a slot ⅜in. in width for the passage of the car-plough. They now proposed to increase the width of the slot to 1in., which is the width on the Bournemouth tramways, and on several American systems. The advantages to be derived from such a modification of the slot as is suggested are (says the report) twofold. In the first place, the greater width reduces the danger of using paving materials of a character liable to expansion, and the Council would thus be enabled, to a much greater extent than hitherto, to meet the views of the local authorities and of the public as to a more general use of wood paving, or some similar material, in front of churches and public buildings. In the second place, if the slot width were increased, it would be practicable to make certain slight alterations in the type of plough at present used, which would, the committee think, result in greater efficiency in the working of the tramways.—It was decided to submit the proposals to the Board of Trade.

London United Tramways.—Middlesex County Council have decided to advertise for tenders for the construction of the track of the tramway (2½ miles in length) between Acton and Willesden, which is to be taken over and worked by London United Tramways (Ltd.).

Marylebone (London).—At a special meeting of the Council held on Tuesday, the necessary sanctioning resolution for the Finance committee's recommendations with regard to the temporary loan of £1,300,000, set out in the last issue of *The Electrician*, p. 406, was passed unanimously, as was also a resolution that the treasurer be ordered to pay by cheque on June 30 the following sums due to the Metropolitan Electric Supply Co. (Ltd) in accordance with a judgment dated August 7, 1903, and other orders of the Court:—

Metropolitan Company or order	£1,088,347	13	7
Metropolitan Company or bearer	150,000	0	0
Paymaster-General or bearer.....	10,000	0	0

making a total of £1,248,347. 13s. 7d.

It will be seen that, including the £50,000 due to be paid into Court, as ordered by Mr. Justice Buckley, the total payment to be made is £1,298,347. 13s. 7d.

Dr. Leaf, chairman of the Finance committee, explained, with regard to the first two items, that the amount to be paid direct to the company had been divided in this way to meet the wishes of the Metropolitan Company as the £150,000 to be paid by bearer cheque covered the interests of the debenture-holders in the company. With regard to the third item (£10,000), this had to be paid into Court to cover any outstanding expenses with regard to title and adjustment that may have to be made on these accounts, the company undertaking to repay any amount that may be found on readjustment to be overpaid.

Melton Mowbray.—The Council have accepted the tender of the local electric lighting company for the public lighting for five years at £325 per annum.

Metropolitan Railway.—Mr. C. T. Yerkes anticipates that the conversion of the Metropolitan Railway to electric traction will be completed and the line ready for working by Jan. 1 next.

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Municipal Telephony.—Some weeks ago we announced that the Telephone committee of Swansea Corporation were taking counsel's opinion as to the liability of the National Telephone Co. to allow subscribers to the municipal telephone service to have inter-communication facilities. Counsel, it is stated, have advised the Corporation to demand the desired facilities without affording the company inspection of their books, and this advice is, we understand, being considered by the committee.

Municipalities and Tramway Compulsory Running Powers.—On Monday a meeting of the executive committee of the Municipal Tramways Association was held at Westminster Palace Hotel, London, to discuss the precedent created by the passing of the Tyneside Tramway Co.'s Bill.

Representatives of Glasgow, Manchester, Newcastle, London (County Council), Sunderland, Cardiff, &c., were present. Reports were submitted showing the action taken by the committee since the last meeting and promises of support received from members of Parliament to secure the rescission of the compulsory running powers over the Newcastle Corporation tramways which have been granted to the company. A circular letter to be sent to members of the House of Commons was approved.

A general meeting of the Association was held at the same place on Wednesday, when the Manchester officials present included the Lord Mayor (Councillor T. T. Shann), the chairman of the Tramways committee (Mr. D. Boyle) and the tramways manager (Mr. J. M. McElroy), who is also secretary and treasurer of the Association, other representatives (mayors, chairmen of tramway committees and town clerks) were also present on behalf of Warrington, West Ham, Halifax, Newcastle-on-Tyne, Bolton, Oldham, London (County Council), Leeds, Ayr, Chester, Portsmouth, Wigan, Preston, Nottingham, Sunderland, Bradford, Southampton, Lowestoft, Cardiff, Bury, Ashton-under-Lyne, Hull, Croydon, Glasgow, King's Norton and Northfield. A resolution approving the proposal to be submitted to the House of Commons by Sir James Woodhouse for the recommittal of the Tyneside Company's bill was approved.

A Parliamentary deputation waited upon Mr. G. Balfour on Tuesday with the object of presenting the views of the local authorities upon this question before the Board of Trade.

Neepsend Electricity Station (Sheffield).—The new electric generating station of Sheffield Corporation situated at Neepsend was formally on Monday.

Newport.—Receipts from sale of current during the year ended March last were from private lighting £12,047, power £778, traction £3,479, public lighting £1,565 (less £550 for maintenance), meter rents £381, and motor hire £126 (less £49 for maintenance), total £18,167.

Total works costs were £7,228, management and general costs £1,383, total working expenses being £8,796. 6s. 1d., leaving a gross profit of £9,370. After paying interest (£5,812. 10s. 10d.) and sinking fund instalment £3,782. 18s. 6d., there was a deficiency of £225. Prices received for current were 4·29d. per unit for private lighting, 1·71d. for public lighting, 1·62d. for power and 1·50d. for traction, and the total cost was 1·10d. per unit.

The total revenue of the tramways department was £23,540. Working expenses were £15,419. 15s. 9d., leaving £8,119. 16s. 8d. gross profit. £4,360 was required for interest, and £3,359. 9s. 6d. sinking fund, leaving £399. 17s. 9d. net profit. 4,473,411 passengers were carried, and 635,000 car-miles run. The revenue per car-mile was 8·94d., total costs 5·86d., gross profit 3·08d., and net profit (after deducting interest and sinking fund charges) 0·17d.

New Submarine Telegraph Cables in the East.—The agreement recently entered into between the Governments of Holland and Germany for the working of submarine cables between the Dutch and German possessions in the Far East has been amplified by the addition of France, whose Government has entered into an agreement with the Dutch Government under which a French cable from Saigon is to be connected with the Dutch cable between Pontianak, Billiton and Batavia. This agreement is awaiting the approval of the Dutch Lower Chamber, and provides that all differences which may arise in regard to the arrangement shall be settled by the Hague Court of Arbitration in the event of diplomatic measures proving unsuccessful. A similar clause is, we understand, contained in the Dutch-German agreement.

Personal.—Mr. George Hunter Robertson, a director of the National Telephone Co. and of the Liverpool Overhead Railway Co., was suddenly taken ill on Sunday and underwent a serious surgical operation on Monday. We learn that the operation was successful and that the patient is progressing as well as can be expected.

Port Elizabeth (S. Africa).—Of the loan recently floated by Port Elizabeth Municipality £100,000 is to be applied to the installation of electricity supply. The London agents of the Municipality are Messrs. Davis and Soper, 54, St. Mary Axe, E.C.

Prompt Repairs.—The City of Birmingham Tramways Co. have trained their employés on their electric cars to deal expeditiously with breakages of electric wires, prizes being offered every three months.

Provisional Order Application.—Surbiton District Council are applying to the Board of Trade to extend the area of the Council's electric lighting order to include Tolworth and Hook.

Pudsey.—The Council will shortly discuss the question of tramway facilities in the borough.

Retford.—The Board of Trade threatens to revoke the Council's time-expired electric lighting order unless steps are taken to fulfil its provisions.

Rosherville.—Gravesend Electric Lighting committee and Northfleet Lighting committee are to confer on the subject of the lighting of Rosherville.

Sheffield.—The annual summary of the past year's working of the tramways system shows that the gross profit was £79,578. 17s. 5d., against £71,957. 5s. 9d. in the previous year. £32,874 was absorbed by interest and £19,394 by instalment of sinking fund leaving a net profit balance of £27,309 to be carried to accumulated surplus account.

Income from all sources was £235,981, against £216,308 in the previous year. Working expenses were £156,402, compared with £144,351 in the previous year. 61,450,993 passengers were carried, an increase of 4½ millions; 5,768,231 car-miles were run, an increase of 842,148. There are 1,396 employés in the department, including 23 inspectors, 360 motormen and 378 conductors. The total amount contributed to relief of rates since electric traction was adopted in Sheffield in 1897 is £50,620. 10s. 8d. The amount expended on renewals during the year was £3,771 and it is proposed to set aside £33,771 out of the unappropriated surplus towards the renewals fund. The accumulated surplus amounts to £143,369, having been augmented during the year by the net surplus £27,309, balance in hand from contingencies fund £5,125, and balance in hand from renewals fund £50,000. After deducting various grants in aid (amounting to £42,020) there is a balance of £101,349. The average number of cars running daily was 167·49 at an average fare per passenger of 0·907d. Working expenses per car-mile were 6·507d., total expenditure per car-mile 8·682d., while the total revenue per mile run was 9·818d. The percentage of total expenditure compared with total income earned was 88·427.

It has been decided to provide 30 additional cars with top deck covers.

Shipley.—The accounts of the District Council's electricity department for the year to March 31 last (second year of working) show a small deficit of £125, compared with a deficit of £447 for 1903.

Electricity supply was started at Shipley in July, 1901, and electric traction in May, 1902. The total capital expenditure at March 31 was £43,794, an increase on the year of £13,054. The total revenue for the year was £5,210, compared with £2,723 the previous year. Total costs were £3,137, compared with £1,909. The gross profit was £2,072. Interest absorbed £1,532, and the sinking fund instalment £665, the financial result being, as stated above, a small deficit. The equivalent number of 8 c.p. lamps connected was 18,098, an increase of nearly 10,000 lamps for the year. The total number of units sold was 608,524, compared with 301,369 in the previous year. Of these, private consumers took 190,113, public lighting 56,000, traction 362,411. The average price obtained from private consumers was 2·14d. per unit, against 2·16d. in the previous year, and for public lighting and traction in both years 1·25d. and 1 75d. respectively. Works costs were 0·788d. per unit, compared with 0 98d. in the previous year; total costs 1·014d. per unit, against 1·32d.

The through service of tramcars over the lines of the Mid-Yorkshire Tramways Co. and Bradford Corporation (from Thackley to Nab Wood) has been discontinued.

Southend.—The Council have decided to increase the salary of the borough electrical engineer (Mr. W. E. J. Heenan) from £350 to £400.

Mr. Roberts, in proposing this increase, spoke of the improvement Mr. Heenan had effected in the condition of the electricity undertaking. The generation costs were now 17½ per cent. less than at the time he took over the management.

It has been decided to lay an additional feeder cable at a cost of £195 and to purchase a motor waggon at £350.

Spain.—A correspondent informs us that a notable industrial feature of the present time is the large amount of Belgian and German capital which is being invested in electrical undertakings in Spain.

Spanish-Moroccan Submarine Telegraph Cables.—The Spanish Government Posts and Telegraph Department recently invited tenders for the laying of new submarine telegraph cables, and the repair of exisiting cables, between the Canary Islands, Palma and Barcelona, but we understand that no tenders were received in response to this invitation, the conditions presumably being unacceptable.

The prolonged interruption of the Spanish Tangier-Tarifa submarine telegraph cable (since January last) forms the subject of adverse comment in several of the Spanish journals, one of which recently stated that the calculated loss to the Spanish Treasury owing to the interruption of these cables has amounted to not less than 145,000 pesetas.

"Split Turns" on Tramways.—The vexed question of the continuance of the system, arranged by the Leeds Corporation tramways manager (Mr. B. Hamilton), of taking certain cars off the road during quiet periods of the day, necessitating a break in the employment of some of the motormen and conductors, and thus somewhat lengthening their working day, has not yet been settled,

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as the Tramways committee last week, while making concessions on some routes, resolved to remain firm as to the general principle.

Stockholm.—In 1903 the Swedish Parliament was applied to for permission to experiment with the electrification of the short lines of railway between Stockholm and Järfva and Stockholm and Wärtan, and the scheme appears to have been favourably entertained. In addition to this, there is a proposal before the Government for the electrification of all the State lines of railway at an estimated cost of between £5,000,000 and £6,000,000. It is proposed, in this project, to adopt water-power for the generation of current, and it is stated that this power is available for use in connection with the majority of the lines. The increased price of imported coal into Sweden is an important factor in connection with this scheme.

Stockport.—The Corporation have increased their offer for the purchase of the local tramway company's Hazel Grove tramways from £21,500 to £23,000. The company ask £25,000.

Stockwell Orphanage (London).—The managers of this institution (founded by the late Rev. C. H. Spurgeon) are desirous of obtaining funds to provide an electric lighting installation. About £1,400 is required.

Swansea.—The Corporation electricity department give notice that on the 19th, 20th and 21st inst. (the period of His Majesty's visit) demand indicators will be short-circuited and current supplied at 2d. per unit to persons who apply for supply of current for "illumination" purposes.

Tamworth.—The Corporation intend to apply for a provisional order to supply electricity in Wigginton, Bolehall and Glascote.

Telegraph Engineer Volunteers.—The formation of a field telegraph detachment by the Leeds engineers has been authorised. The full establishment is 101, including mounted officers and non-coms., with 26 draught horses.

Telephone Operators' Dispute.—Much has been made by some of the daily papers of the dispute between the National Telephone Co. and some of their London female operators. On Monday, however, as the result of a conference between Mr. W. E. L. Gaine (the general manager), Mr. C. B. Clay (the metropolitan superintendent) and Mr. R. A. Dalzell (Western London district manager) an amicable arrangement was come to.

Tewkesbury.—The Chepstow and Ross Electricity Co. intend applying for a provisional electric lighting order.

Transvaal Imports.—The imports into the Transvaal of electric cables, wires and fittings during the three months ended March 31, 1904, were valued at £19,000, compared with £15,000 for the same three months of 1903.

Tunbridge Wells.—The accounts of the electricity undertaking for the year ended March show total capital expenditure £74,442. 16s. 10d., an increase of £2,976. 19s. 10d. for the year.

The year's income included £9,954. 3s. 10d. from sale of current to private consumers at prices ranging from 6d. to 3d. per unit, £2,537. 2s. 5d. for public lamps, and meter rents, &c., brought the total to £12,896. 2s. 7d. Generation expenses were £4,983. 16s. 2d., and distribution costs £480. 3s. 11d., rents, rates, taxes and insurance £381. 13s. 6d. and management expenses £1,298. 1s. 3d., the total being £7,808. 14s. 4d., leaving £5,087. 8s. 3d. gross profit. Dividends to stock-holders and redemption of stock absorbed £4,375. 1s. 5d., and interest on and instalment towards repayment of loan £339. 15s. 10d., the net profit being £372. 11s. 1,005,210 units were generated compared with 892,712 in the previous year, 337,653 supplied to public lamps (against 264,187) and 515,646 sold to private consumers (against 475,961). There is the equivalent of 52,404 8 c.p. lamps connected (against 49,878) and the capacity of the plant at the works is 596kw. (against 579kw.)

Ware (Herts.)—The North Metropolitan Electric Power Supply Co. have approved the draft agreement for taking over the Council's electric lighting order and establishing electricity works.

West Ham.—The Corporation are charging for water from the municipal artesian well at Canning Town for the new electricity generating station as follows:—Under 2,000,000 gallons per quarter, 6d. per 1,000 gallons; over 2,000,000 and under 3,000,000 gallons, 5½d.; over 3,000,000 gallons, 5d.

The electrical engineer (Mr. W. J. W. Bullock) has advised, in view of the prejudice against the present arc lighting rates, and to induce shopkeepers and others to adopt this form of lighting more widely, that the minimum charge of 17s. 6d. per lamp per quarter, plus 2d. per unit for current be reduced to 15s. plus 2d., the Corporation to have the right to increase the fixed charge where larger lamps than 500 watt are used. This was approved.

The electrical engineer is to report as to the disposal of the old generating station, &c., and the three Lancashire boilers there.

Mains extensions estimated to cost £1,271 have been authorised.

Application is to be made to the Board of Trade for sanction to the borrowing of the sums required for the electrification of the High-street, Romford-road and Leytonstone-road lines.

Workhouse Lighting.—Hammersmith Guardians received 14 applications for the appointment of consulting electrical engineer to prepare specifications and superintend the carrying out of the electrical installation at the workhouse and infirmary now in course of erection at Wormwood Scrubbs. Messrs. J. and J. S. Enright were appointed.

Wrexham.—The Corporation have received sanction to a loan of £5,600 for extensions of the electric lighting cables.

Marriage.—On June 16, at St. George's, Hanover-square, London, Mr. Charles Richard Delebere, youngest son of Mr. G. E. Pritchett (Messrs. Pritchetts and Gold, Ltd.), was married to Miss Jacintha Muriel Laura, youngest daughter of Mr. James Arrowsmith, of Buxton. A reception was held at the Langham Hotel, after which the happy couple departed for Guernsey for the honeymoon.

Outing.—On June 25 the second annual outing of the staff of Stepney electricity department took place. Although the day was not an ideal one as to weather, the journey to Margate and the sojourn for the day proved very enjoyable, and the dinner at Munn's Hotel was a success. In the unavoidable absence of Mr. W. C. P. Tapper (the borough electrical engineer and manager), the chair was taken by Mr. W. Young, supported by Mr. A. J. Somerville.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Bristol Corporation Electrical committee invite tenders for (*a*) H.T. switch gear, (*b*) water-tube boilers, (*c*) two 1,000kw. three-phase E.H.T. turbo-alternators, (*d*) two 500kw. induction type motor-generators, E.H.T. to D.C., (*e*) E.H.T. cables, (*f*) E.H.T. transformers, (*g*) E.H.T. switch gear. Specifications, &c., from Mr. H. Faraday Proctor, city electrical engineer, after July 4, and tenders to Mr. Proctor, city electrical engineer's office, Temple Back, Bristol, by 10 a.m. July 15. See also advertisement.

St. Pancras (London) Borough Council invite tenders for supply and erection of main switchboard at the King's-road power house, Camden Town, N.W. Specifications, &c., from the electricity department, 57, Pratt-street, N.W. Tenders to the deputy town clerk (Mr. H. T. Richards), Town Hall, Pancras-road, N.W., by noon July 19. See also advertisement.

Rochdale Corporation invite tenders, in connection with their electricity works extensions, for (contract No. 7) the supply and erection of (*a*) two steam turbines direct-connected to two three-phase alternators or (*b*) for alternators connected to high-speed triple expansion engines; also (contract No. 8) for one motor-driven three-phase alternator. Specifications, &c., may be seen at the offices of the engineers (Messrs. Lacey, Sillar and Leigh), 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester, and can be obtained at the former office. Tenders by 18th inst. to the town clerk (Mr. James Leach), Town Hall, Rochdale. See also advertisement.

Rochdale Corporation also invite tenders (by 5th inst.) for tramway feeder cables, pilot cables, conduits, &c. Tenders to Mr. Leach.

Dublin Corporation require tenders for the supply of 100,000 pairs arc lamp carbons. Specification from the secretary (Mr. Fred. J. Allan), 3, Cork-hill, Dublin, where tenders (addressed chairman of Lighting committee) by 9th inst. See also advertisement.

Messrs. Wm. Lee, Son & Co. (Ltd.) invited tenders for an electrical installation at their cement works, *Halling*, near Rochester. Further particulars can be obtained of the manager of the works. See also advertisement.

St. Marylebone (London) Borough Council invite tenders for supply and erection of constructional steel work and buildings for generating station also for steam generating plant, steam turbines, electric generating plant and cables. Tenders to the town clerk (Mr. James Wilson), Town Hall, Marylebone-lane, W., by noon July 6.

Handsworth District Council invite tenders for water-tube boilers, engines and dynamos, hand-travelling crane, storage battery, arc lamps and posts, switchboards and boosters. Tenders to the clerk (Mr. H. Ward), Council House, Handsworth, near Birmingham, before noon July 11.

Tenders are invited for telephone and fire alarm installation for the Angelton and Parc Gwyllt Asylums, *Bridgend*. Tenders to the clerk (Mr. W. E. R. Allen), County Council Offices, Cardiff, by noon July 6.

Penrith District Council invite tenders for supply and erection of two oil or gas engines and dynamos, switchboard and boosters, storage battery and mains. Tenders to the clerk (Mr. G. Wainwright) by 10 a.m. July 5.

Stepney (London) Electricity committee invite tenders for ampere-hour meters, demand indicators and arc lamp carbons. Tenders by noon July 4.

Belfast Harbour Commissioners invite tenders for two portable electric gantry cranes. Tenders to the secretary (Mr. W. A. Currie), Harbour Offices, Belfast, by July 11.

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Felixstowe District Council invite tenders for extensions to feeders. Tenders to the chairman of the Council, Town Hall, Felixstowe, by noon July 9.

Stourbridge District Council invite tenders by noon 8th inst. for supply and laying of mains (paper-insulated preferred).

Aston Manor Corporation want tenders by noon 18th inst. for pipework, &c., for the electric supply department.

Warrington Corporation require tenders by 12th inst. for steel poles, trolley wires, &c.

Leicester Tramways committee invite tenders by 5th inst. for machine tools for car depot and fitting shop.

Glasgow Corporation require tenders by 10 a.m. 14th inst. for fuel for Pinkston power station, &c.

Middleton Corporation require tenders by 11th inst. for 12 months' supply of coal to their electricity works.

Derby Corporation invite tenders by noon 13th inst. for electric light installation at the sewage works pumping station.

Whitby District Council require tenders by 10 a.m. 18th inst. for distributor and street lighting cables and network and service boxes.

Batley Corporation invite tenders by 16th inst. for 350kw. steam dynamo and switchboard extensions for same.

The "Madrid Gazette" for June 21, 23 and 26, contains particulars of a number of tenders required for electric lighting and electric tramway material, telephone concessions, &c., in Spain.

TENDERS RECEIVED AND ACCEPTED.

Hammersmith (London) Council have accepted the tender of Richardsons, Westgarth & Co. for a turbo generator at £7,270 and two condensers at £3,200; that of the British Thomson-Houston Co. for a turbo-generator at £7,272. 10s. and exciter plant at £740.

There were 13 tenders sent in from 11 firms, ranging for turbines (two) from £12,008 to £15,186, for condensers from £2,072 to £3,251, and for exciters from £740 to £1,046. In addition, there were 14 tenders from 14 firms for alternative plant—viz., two slow-speed generating sets (without condensers), ranging from £20,525 to £25,899.

Chesterfield Corporation have accepted the tender of the British Insulated and Helsby Cables (Ltd.) for permanent way, overhead equipment and underground feeders and conduits for their tramways at £41,257. 15s. 4d.; of the British Westinghouse Co., for electrical equipment of cars at £2,640; and of the Brush Co., for car-bodies and trucks at £3,960 (or, if fitted with radial trucks, £360 additional).

Belfast Gas and Electric committee have decided to accept the following tenders:—

Lancashire Dynamo and Motor Co., for 5 and 7½ H.P. motors; Electromotors Limited, for ½, 1 and 4 H.P. motors; Bruce Peebles & Co., for 2, 10, 15 and 25 H.P. motors; British Westinghouse Company, for 3 H.P. motors; Fairbairn, Lawson, Combe and Barbour, pipe work; and M'Dowell, Leathem and Fraser, gangways.

Blackburn Electricity and Tramways committee accepted the following tenders for supply of various stores:—

L. Andrew & Co. (insulating materials), Sunbeam Lamp Co. (incandescent lamps), British Thomson-Houston Co. (incandescent lamps), Ferranti Limited (alternating and continuous-current meters), Siemens Brothers & Co. (rubber cable), Reason Mfg. Co. (fuse boxes), General Electric Co. (switches, &c.), British Westinghouse Co. (motors and motor-starting switches) and D. McNaughton (carbons).

Poplar (London) Council have accepted the tender of Croggon & Co. for the ironwork of a temporary annexe at the generating station (to accommodate a switchboard and a motor converter), at £180.

The Waipori Electric Power Co., who are about to establish a 3,000 H.P. water-power plant on the Waipori River, near Dunedin (N.Z.), have placed orders with the General Electric Co. (New York) for generators, and with the Pelton Water Wheel Co. for turbines.

Brighouse Corporation have accepted the tender of W. T. Glover & Co. for the laying of cables in the borough, including supply, delivery and erection of all materials and accessories therefor.

Sunderland Corporation have accepted the tender of the Electrical Co. (central station and tramway department) for the supply of indiarubber-covered cables from April 1, 1904, to March 31, 1905.

The following orders have recently been secured by Cowans Limited:—

Ealing, H.T. feeder board and extension to generator board; Acton, extra H.T. main switchboard; Cardiff, main L.T. switchboard; Bristol, arc lighting switchboard; Royal Courts of Justice (London), main switchboard; Poplar (London), L.T. switchboards for motor-generators, &c., five extra H.T. main switchboards.

Southampton Corporation have accepted the tender of J. R. Wood & Co. for 12 months' supply of small coal to the electricity works, at 10s. 9d. per ton.

The Metropolitan Water Board have placed an order with the Magneta Co. for the installation of electric clocks at the new central offices at £180.

Bristol Electrical committee have accepted the tender of Siemens Brothers & Co. for cables for extensions.

Middlesex County Council have accepted the tender of the Electric Construction Co., at £892, for dynamo and engines for Napsbury Asylum.

West Ham Corporation have accepted the tender of the District Electric Co., Wolverhampton, for electric wiring and fittings at West Ham Park School at £320.

Walthamstow Council have not found it necessary to rescind the British Westinghouse Co.'s contract for the supply of tramcars, as the company have, it is stated, agreed to the Council's terms.

Cardiff Corporation have accepted the tender of Mirrlees, Watson & Co. for condensing plant for Canton power station at £2,127.

Faversham Council have accepted the tender of H. S. Tett & Co. for electric bells at the electricity works at £14. 19s. 6d.

Leicester Tramways committee recommend that 40 additional cars be ordered from Dick, Kerr & Co. at £510 each.

Metropolitan Asylums Board have accepted the tender of James Keith, Blackman & Co. for an electric ventilating fan at £22. 10s.

BUSINESS NOTICES.

Mr. George F. Mackay, hitherto manager of the electrical department at Wm. Harvie & Co.'s works, Glasgow, and Mr. Grier, late secretary and a director of the same company, have joined Mr. Maxwell Telford, electrical engineer, &c., in forming a joint-stock company under the style of Telford, Grier and Mackay (Ltd.) at 220–222, Broomielaw, Glasgow, where special attention will be given to the applications of electricity to power, mining and ship lighting and ventilating. The new company wish to receive trade catalogues and terms.

Messrs. H. Turner and C. R. D. Bearcroft, electrical engineers, 15, New Broad-street, London, E.C., have dissolved partnership. Debts by Mr. Bearcroft.

The Glasgow address of Johnson and Phillips has been changed from 108, Argyle-street to 59, St. Vincent-street.

BANKRUPTCIES, LIQUIDATIONS, &c.

A receiving order has been made against Henry Binko, electrical engineer, 34, Leadenhall-street, London, E.C. The first meeting of creditors takes place on July 7 and the public examination on July 27 at Bankruptcy-buildings, London, W.C.

A first and final dividend of 2s. 6¾d. is payable at 34, Fisher-street, Carlisle, in the failure of G. Jackson and David Smith, electrical engineers, Annetwell-street, Carlisle.

The Reliance Electric Co. (Ltd.) is to be wound up voluntarily. Mr. E. W. Bundy, 85, Philip's Park-road, Bradford, is liquidator.

The Thames Valley Launch Co. (Ltd.) has gone into liquidation. Mr. F. J. Saffery, 14, Old Jewry-chambers, London, E.C., is liquidator.

Sales by Auction.—Messrs. Wheatley Kirk, Price & Co. will sell by public auction, in one lot, at 10 a.m. on Tuesday next, July 5, on the premises, the freehold engineering works known as Hythe Works, Hythe-road, Willesden Junction, London, N.W., and at 10:30 for 11 a.m. on the same and following day (July 5 and 6), piecemeal, the whole of the contents of the works, including high-class lathes, milling, drilling, shaping, emery-grinding, screwing and other machines, electric power installation, accumulators, electric-plating plant, &c. Catalogues from the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester. See also advertisement.

Messrs. Fuller, Horsey, Sons and Cassell, in conjunction with Mr. C. P. Whiteley, will sell by auction, at the Crypto Works, 29, Clerkenwell-road, London, E.C., on July 12 and 13, at 11 a.m., a quantity of engineers' machine tools, including lathes, drilling, profiling, shaping and slotting machines, plating plant and dynamo, smiths' forges, brazing hearths, gas engines, &c., and the stock and stores. Further particulars are given in an advertisement. Orders to view and catalogues (when ready) may be had of Messrs. Wilsons, Bristowes and Carpmael, solicitors, 1, Copthall-buildings, E.C.; of Mr. C. P. Whiteley, 82, Queen-street, Cheapside, E.C.; or of the auctioneers, 11, Billiter-square, E.C.

Sale by Treaty.—Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., have for sale by private treaty the works, roads, lands and water power owned by the Royal Ballincollig Gunpowder Factories, which it has been decided to close. The waters of the River Lee give a reliable 400 H.P. continuously. Some further particulars will be found in an advertisement on another page.

Sale by Tender.—Owing to change of system and closing of their old electricity station, Exeter Corporation have a quantity of plant for disposal, particulars of which are set out in an advertisement. Schedule and form of tender from the city electrical engineer, Mr. H. D. Munro, to whom tenders by 12 noon, July 15.

Plant for Sale.—A small electric lighting plant suitable for hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 30, Birley-street, Blackpool.

There is advertised for sale on another page, by Mr. A. Underwood, of 3, Queen-street, London, E.C., a complete set of electrical plant.

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Premises to Let.—A large light ground floor is to let. Particulars of Messrs. Marshall & Co., Campbell Works, Stoke Newington, London, N. See advertisement.

In the important business district of Tabernacle-street, Finsbury, London, E.C., Messrs. B. Brampton & Co., Finsbury House, Finsbury-square, E.C., have to let two floors in eligible warehouse premises.

Land to be Let or Sold.—Messrs. Walfords, 29, Bolton-street, Piccadilly, London, have for sale land at Stamford, Lincs., specially adapted for general engineering construction works. An advertisement contains some additional particulars.

New Cable Factory.—Messrs. Johnson and Phillips have recently completed large extensions to their cable department. In the new shops has been installed the latest type of equipment for the manufacture of dry-core telephone cables, for which an order is in hand for the Post Office for 730 miles. The new machinery is of Messrs. Johnson and Phillips' own design and manufacture, and the motors and electric power plant used in the factory has also been designed and manufactured on the spot. This extension of the cable works has necessitated the organisation of a construction and cable-laying department, and we are informed that this branch is now fully employed on Admiralty contracts for Portsmouth and Pembroke Dockyards, and on work under contract for Handsworth, Weymouth, Birkenhead and Ipswich Corporations. A further extension will be made at the end of the year, when a vulcanised bitumen shop will be opened and wire-drawing plant will be laid down to enable this important branch of work to be carried out on the premises.

Hydraulic Tests for Cables.—Messrs. W. T. Glover & Co. forward us a copy of a letter from Messrs. Mordey and Dawbarn describing some hydraulic tests made by that firm of the lead covering of electric cables. Messrs. Mordey and Dawbarn's report is to the effect that the experiments show that, besides being much quicker, the hydraulic method patented by Messrs. Glover is more searching than the usual 24 hours' immersion in open tanks. Not only does the hydraulic method show the presence of holes or cracks in the lead covering, but it breaks down incipient faults which, under ordinary conditions, would probably not be revealed until after the cable was laid. By the patented hydraulic process the cables are immersed for a few minutes in an enclosed water tank, a considerable pressure being applied to the water. In the tests made by Messrs. Mordey and Dawbarn the pressure was 100lb. per square inch for a period of five minutes.

Holiday Sailings.—Mr. Effingham Wilson, of Royal Exchange, London, is publishing "Robinson's Handbook of Holiday Sailings," price 6d. net. The book, which is in its third year of publication, contains a list of all the pleasure sailings in the United Kingdom, and those of our readers who are on the look-out for a pleasant holiday on the water will find it useful.

Catalogues, &c.—A well-got-up catalogue of the "Highfield" patent automatic and semi-automatic booster is issued by the Chloride Electrical Storage Co., Clifton Junction, Manchester. In addition to information concerning the theory, use and application of the booster in electric tramway, electric railway and electric lighting work, and a detailed description of the special merits of the Highfield boosting system, of which the company are the owners, the catalogue contains a list of installations where these machines are applied. There is also a series of actual load curves and voltage and current diagrams, which gives graphic illustrations of the advantages of booster installations in electric light, power and traction work.

A pamphlet descriptive of the Cape Town Industrial Exhibition, which will be opened in November and will remain open for three months, is just issued, and gives interesting information concerning the exhibition buildings, &c.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from June 22 to 28, with the ports of destination:—

Africa—Alexandria, £78; Algoa Bay, £75; Cape Town, £31,143 (including £30,960 telegraph cable); Delagoa Bay, £450; Durban, £2,514 (including £97 telegraph material); East London, £139; Port Elizabeth, £1,244; Sekondi, £12. *Australasia*—Adelaide, £189; Fremantle, £40; Hobart, £16; Melbourne, £95; Perth, £37; Sydney, £245; Wellington, £50 (telegraph material). *Belgium*—Ostend, £8. *China*—Shanghai, £703 (including £73 telegraph material); Tientsin, £17. *Germany*—Hamburg, £135 (including £120 telegraph material). *Greece*—Piræus, £100. *Holland*—Amsterdam, £91; Flushing, £29. *Hong Kong*, £33. *India*—Bombay, £767 (including £40 telegraph material); Calcutta, £618; Madras, £79 (telegraph material). *Japan*—Yokohama, £44. *Mauritius*, £38. *Norway*—Christiana, £15 (telegraph material). *Portugal*—Lisbon, £653. *Straits Settlements*—Penang, £150; Singapore, £404 (including £384 telegraph material). *Zanzibar* £58 (telegraph material). Total £40,269, against £5,521 in the corresponding week last year (June 24 to 30).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

April 14, 1904.

8,548 H. ROTTENBURG and A. BARKER. Cambridge. Devices for clamping wires or cords.
8,549 J. HOUSTON and J. ERSKINE, jun. Glasgow. Electric ship's telegraph.
8,555 E. TWEEDALE, S. TWEEDALE and J. SMALLEY. Castleton. Electric stop-motions for drawing, slubbing and similar machines for preparing and spinning fibrous materials.
8,556 K. WOLF. Berlin. Call receivers and repeaters for telegraph stations.*
8,575 W. BENICKE and H. WESTERBECK. Electrical device for shifting type carriers, as well as paper carriers, for typewriters, type telegraphs and the like.*
8,590 B.T.-H. Co. (G.E. Co., U.S.). Brush holders for dynamo-electric machines.
8,591 B.T.-H. Co. (G.E. Co., U.S.). Switches.
8,608 F. W. YOUNG. Commutators for dynamo-electric machines. (Date applied for, May 22, 1903, date of application in U.S.)*
8,612 J. S. RICHMOND. Transmissions of electrical impulses.*
8,620 T. VON ZWEIGBERGK. Electric motors.
8,621 A. FOWLER. Rails for electric tramways and for like purposes.

April 15, 1904.

8,632 W. KENYON. Sheffield. Decoration of articles by electro-deposition of metals.
8,642 A. G. LIVESAY. Leeds. Trolleys for overhead electric tramways.
8,656 F. PROCTOR. Arc lamps.
8,657 J. D. WHITE. Printing telegraph receivers.
8,663 H. G. JEKEN. Leeds. Switches for electromotors.
8,669 D. GILLIES. Sunderland. Insulator.
8,686 P. DELAFON. Galvanic battery.
8,693 GANZ & Co., EISENGIESSEREI-UND MASCHINENFABRIK A.G. Arc lamps. (Date applied for, May 9, 1903, date of application in Germany.)*
8,694 GANZ & Co., EISENGIESSEREI-UND MASCHINENFABRIK A.G. Alternating-current arc lamps. (Date applied for, July 24, 1903, date of application in Germany.)*
8,699 B.T.-H. Co. (G.E. Co., U.S.). Windings for dynamo-electric machines and methods and apparatus for forming same.
8,702 C. A. WRIGHT. Mercury interrupters for use with X-ray induction coils and other like purposes.
8,703 R. ZWACK and L. KOTTMAIR. Switches.
8,714 H. J. GORE. Switches.
8,715 W. P. THOMPSON (Charles Johnston and Claude Johnston, U.S.). Liverpool. Electric circuit cutouts.*
8,723 E. L'B and A. FEIGELBERG. Preventing snow settling on conductors.*

April 16, 1904.

8,731 H. SWANTON. Automatic circuit-breakers.*
8,737 H. OPPENHEIMER (A.G. Mix and Genest, Germany). Mechanically-replaced annunciator movements for telephone switchboards.
8,745 G. A. BINNS. Halifax. Trolley pulleys of electric tramcars.
8,777 J. S. W. THOMAS and J. NORTHWOOD. Brierley Hill (Staffs.). Attachment of globes or shades to electric lamp fittings.
8,802 J. B. WILLIS. Construction of rotary magnets.
8,819 S. LÖTI and R. LATZKO. Incandescent lamp fittings.*
8,826 SIEMENS BROTHERS & Co. (Siemens and Halske A.G., Germany). Safety appliances for electric circuits.*

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1903.

3,876 DE FOREST. Methods and apparatus employed in wireless signalling
3,876A DE FOREST. Methods and apparatus employed in wireless signalling. (Date applied for, Feb. 18, 1903.)
11,145 CALANDRI. Accumulator electrodes.
11,299 SCHÜLER and FERRANTI LIMITED. Alternating-current motors.
11,378 EVERSHED AND VIGNOLES and EVERSHED. Electric testing apparatus and dynamos therefor.
11,730 CAROLAN (G.E. Co., U.S.). Systems of electric motor control.
11,900 RIDINGS. Arc lamps.
12,311 CAROLAN (G.E. Co., U.S.). Electric steering gear.
13,074 HEINZE. Coin-freed electric shocking machines.
14,295 EDISON ORE MILLING SYNDICATE (Edison). Electromagnetic separators.
15,591 CAROLAN (G.E. Co., U.S.). Preventing arcing between commutator brushes.
15,595 CAROLAN (G.E. Co., U.S.). Arc lamp hanger and switch.
17,073 HAMILTON-ADAMS. Arc lamps.

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21,493 SIEMENS BROTHERS & Co. (Siemens and Halske A.G.). Apparatus for perforating the type bands for automatic telegraph transmitting apparatus and the like.
21,793 TUTERS. Valve and brake controlling mechanism for electric windings or hoisting engines.
28,780 EIMER. Electric furnaces or oxens. (Date applied for May 22, 1903.)

1904.

1,242 DEAN. Party line telephone systems. (Date applied for, June 15, 1903.)
2,273 HADFIELD. Manufacture of magnetic material. (Date applied for, June 12, 1903.)
2,420 DAGGETT. Trolley arms for electric cars.
2,766 IRVING. Electric light fittings.
3,912 SOC. ANON. L'INDUSTRIE VERRIÉRE ET SES DÉRIVÉS. Regulating the intensity and heating effect of electric currents. (Date applied for, Feb. 18, 1903.)
4,866 TRICK. Electric furnaces.
4,869 MARCONI. Wireless telegraphy. (Date applied for, Oct. 13, 1903.)
5,799 LELARGE. Electrical apparatus for separating coke and other electric conductors from cinders and other substances.
6,132 CONTAD. Accumulators. (Date applied for, March 24, 1903.)
6,936 PFANHAUSER. Voltametric balances.
8,234 BLOXAM (Goffin). Telegraphic signalling apparatus.
8,332 VAN MORSE. Spark plugs.
8,608 YOUNG. Commutators for dynamo-electric machines. (Date applied for, May 22, 1903.)
8,715 THOMPSON (Johnston and Johnston). Cutouts or switches.
8,826 SIEMENS BROTHERS & Co. (Siemens and Halske A.G.). Safety appliances for electric circuits.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

AMALGAMATED DRY BATTERIES (LTD.) (81,316.)—Reg. June 22, capital £20,000 in £1 shares, to adopt an agreement with B. Sherman and to carry on business of manufacturers and vendors of electric dry batteries and other articles, &c. First directors, F. E. de Mattos and B. Sherman (managing).

T. H. P. DENNIS & SON (LTD.) (81,314.)—Reg. June 21, capital £30,000 in £1 shares, to acquire the business of wholesale and retail ironmongers, electrical and mechanical engineers and general merchants, and to carry on this business and that of makers and dealers in magnetic, telegraphic, telephonic and other apparatus and appliances, ornamental ironworkers, &c. First directors, T. H. P. Dennis and F. H. Dennis. Reg. office, 20 and 21, High-street, Chelmsford.

SYKES AND SUGDEN (LTD.) (81,328.)—Reg. June 22, capital £6,000 in £1 shares, to acquire business of an electrical engineer and steeple jack carried on by A. Sykes at Huddersfield, and to carry on business of electricians, electrical and mechanical engineers, suppliers of electricity for light, heat, motive power or otherwise, steeple jacks, erectors of lightning conductors, &c. First governing directors, A. Sykes (chairman) and A. Sugden. Reg. office, Spring-place Works, Springwood-street, Huddersfield.

MORTGAGES AND CHARGES.

BROMLEY (KENT) ELECTRIC LIGHT AND POWER CO. (LTD.)—Acknowledgment of indebtedness under seal, dated June 8, creating £20,000 further debenture stock (making £70,000, and being supplemental to a trust deed dated July 7, 1902), has been registered. Property charged, the company's undertaking and property, present and future, including uncalled capital. Trustees, F. T. Medcalf and W. R. Davies.

BRITISH ELECTRIC CALIBRATED FUSE CO. (LTD)—Issue of June 6 of £300 debentures, part of series authorised Dec. 4, 1903, securing £3,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holder, J. Lang. No trustees. Previously issued of this series, £1,350.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26⅛d. per oz. (June 30). Consols 90⅜—90½ for money, 90⅜—90¾ for account; 2½ per cent. annuities 89⅝—89⅞ (June 30). Consols Pay Day, July 1; Stocks and Shares Continuation Days, June 27 and July 12; Ticket Days, July 13 and 27; Pay Days, July 14 and 28; Mining Share Carry-over Days, July 11 and 25.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The directors' report for the year to March 31 last states that the total for appropriation, including £24,912. 11s. brought forward, is £274,730. 4s. 2d. Premiums (£30,042. 15s.) received on debenture stock issued during the year have not been brought into account, but are carried direct to reserve. Interest has already been paid or provided for on the 5 per cent. perpetual and 4½ per cent. second debenture stock, as well as for the dividend on the 6 per cent. preference shares and for an interim dividend at the rate of 6 per cent. per annum on the ordinary shares for the half-year to Sept. 30, 1903, leaving as balance £78,138. 15s. 9d. The directors now recommend a balance dividend at the rate of 6 per cent. per annum on the ordinary shares for the half-year to March 31. £38,148. 9s. 9d. is carried forward. During the year £232,407 5 per cent. perpetual debenture stock has been issued and £250,000 4½ per cent. second debenture stock. The net premiums received in respect of these issues was £38,042. 15s., which has been added to reserve. Since the closing of the books arrangements have been made with a syndicate for the sale of £50,000 5 per cent. perpetual debenture stock and for an advance to the company of £550,000 by instalments, to develop and complete the undertakings in hand, and an option has been given by the company to the syndicate to call for allotments at any time before Dec. 31, 1905, of debenture stocks and shares, the proceeds of any of such allotments to be applied, in the first instance, to repayment of the above advances, with interest at the rate of 4½ per cent per annum. Since the issue of the last report 33·65 route miles of new or reconstructed tramways and light railways have been opened by the company or its affiliated companies for traffic by electric traction on the overhead system. Airdrie and Coatbridge 3·4 miles, Auckland, New Zealand, 1·8, Barrow 3·5, Birmingham District 7·6, Gateshead 1·75, Potteries 1·9, Worcester 4·9, Yorkshire Woollen District 8·8. The total mileage in operation by the company and its associated companies, by electric traction, steam, and horses, at Dec. 31, 1903, was 327·44, against 288·77 in the previous year; and the mileage of omnibus routes 68·87, against 71·62. The total number of passengers carried on the lines open for traffic in 1903 was 219,714,189, an increase of 29 per cent. for the year; and the total traffic receipts were £1,162,005, an increase of 26 per cent. The total amount received for electricity sold by the associated Electric Power and Lighting Co.'s in 1903 was £40,345, an increase of 50 per cent.

Further progress has been made by the Metropolitan Electric Tramways (Ltd.) with the important scheme of tramways in North London, and light railways in Middlesex and Hertfordshire, and the first section of about 6 miles will, it is expected, be opened for traffic on the overhead system in a few weeks. The Metropolitan Electric Tramways Co. has also purchased from the British Electric Traction Co. all the shares in the North Metropolitan Electric Power Supply Co., which owns Acts of Parliament giving the right in perpetuity to supply electricity in bulk over an area of about 325 sq. miles north of London.

The company has obtained an Act of Parliament authorising the conversion to electric traction of the Brighton and Shoreham Tramways and the extension of these lines to Worthing, and a company has been formed to work the lines Acts of Parliament have been obtained authorising the construction of tramways in the neighbourhood of Croydon, and it is proposed to transfer these powers to the County of Surrey Electrical Power Distribution Co. (Ltd.), whose title it is proposed to alter to the South Metropolitan Electric Tramways and Lighting Co. (Ltd.).

The company's Yarmouth undertaking is likely to be purchased by the Corporation under the Tramways Act, 1870, the company having failed to come to an arrangement with the Corporation in regard to extension of tenure and electrical conversion.

The directors have given attention to the question of motor haulage and motor omnibuses, and have entered upon several experimental enterprises, but, so far, without satisfactory results.

No return has yet been received on the ordinary shares held by the company in the Brush Electrical Engineering Co., in which the company is now largely interested.

The British Electrical Superannuation Fund and the British Electrical Friendly Society continue to make steady progress.

The board having decided that the business of the company necessitates more than one managing director, Mr. Raworth was appointed in 1901 an additional managing director, with the title of technical director. Mr. Raworth having resigned this position as from April 1 last, while retaining his seat on the board, Mr. Hilton and Mr Madgen, who have during the past few years acted as executive directors, have been appointed managing directors jointly with Mr. Garcke.

CAPE ELECTRIC TRAMWAYS (LTD.)—An interim dividend of 5 per cent. (tax free) has been declared.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The following dividends have been declared "on account" of the distribution for the year ending Dec. 31, 1904:—Preference shares, 6s. per share; ordinary shares 5s. per share. Payable, less tax, on July 14.

COMPANIA ALEMANA TRANSATLANTICA DE ELECTRICIDAD (BUENOS AYRES).—The gross profits for 1903 were 4,153,326m., against 2,504,374m. in 1902. A dividend of 6 per cent. has been declared.

EASTERN EXTENSION AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—An interim dividend has been declared for the quarter ended March 31 last of 2s. 6d. per share (tax free), payable July 15. The share register will be closed from July 7 to 14 inclusive.

ELECTRICAL POWER STORAGE CO. (LTD)—The directors have decided to recommend the payment of a dividend of 6 per cent. on the ordinary shares for the year ended May 31 last.

ISLE OF WIGHT ELECTRIC LIGHT AND POWER CO. (LTD.)—A meeting of this company was held at Ryde on Friday last, when Mr. F. E. Gripper, who presided, said during the past year the company had supplied current to East and West Cowes, and had established new works at Ryde. During the first four months of 1904 they had made connections or had received applications amounting to the equivalent of between 7,000 and 8,000 8 c.p. lamps. They had made a profit of £5,640, and had expended about £46,000 in Ryde and St. Helens and about £28,000 in Cowes.

LEEDS COPPER WORKS (LTD.)—The fourth annual report of this company (to Dec. 31 last) states that the net trading loss for 1903, including interest, was £13,886. This loss is attributed to the following causes:—(1) The prejudice which has undoubtedly existed in England against electrically-deposited copper. This is being steadily overcome. (2) The difficulty of obtaining really efficient management for a business

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which is, at present, the only one of the kind in England. This is being dealt with, as explained below. (3) The unsatisfactory results of a part of the arrangement with other houses in the trade. Steps are being taken to modify this. The company's process (the report proceeds) is undoubtedly an economical one when carried out on a sufficiently large scale; at the same time it is exceedingly delicate, and requires most careful supervision by a competent staff. The works are extensive, and ultimate success must be largely contingent on increasing the sales to a figure which will bring down the heavy standing charges to a reasonable rate on the output. The directors have confidence that when this is attained satisfactory results will be achieved. Special attention has been given to the re-arrangement of the management. The directors being satisfied that it is not practicable to obtain full efficiency through a general manager not resident in Leeds, have appointed Mr. J. C. Jobling, late managing director of a well-known shipyard on the Thames, to replace the late general manager and works manager, with direct charge of the works, and to reside on the spot. Considerable economies have been and are being introduced. Mr. Jobling is also already widening the field of the company's operations and increasing the volume of business. Thanks to some of the directors and principal shareholders, who have accepted personal responsibility in the matter, the board has been able, without recourse to any permanent issue of debentures, to arrange the finances on a sound basis, and on moderate terms.

At the meeting on Monday, Mr. J. H. Duncan presided, and said he wished the shareholders to realise what their business consisted of. They manufactured shells, which were either sold in that form or finished into tubes, and in the manufacture of tubes they had a large amount of scrap, which was a burden on the business. In selling this scrap for its weight in copper, not only did they not receive the full market price, but it was usually sold at a small loss. But they had now discovered a means of turning this scrap to account in the manufacture of brass tubes, and had been adding plant to their business with this object. Certain trade arrangements which had been made had hampered their proceedings, and, in spite of the quality of their goods, they had secured less trade. The directors anticipated considerably improved results from the change of managership, and were hopeful that they had passed through the worst they had to face. The company had a large quantity of land and buildings, of which they were hopeful of disposing at an enhanced value. This represented a large amount of working capital that ought to be utilised in the business. Their main requirement was a larger volume of business.

MEXICAN RAILWAY CO. (LTD.)—The directors are seeking powers to extend the company's field of operations by acquiring and working tramways, motor cars and electrical works, &c.

NEW GENERAL TRACTION CO. (LTD.)—The directors' report for the period from March 23, 1903, to March 31, 1904, states that, after paying £3,272. 9s. 1d. for general expenses, salaries and fees, £9,294. 14s. 7d. for debenture interest and £3,511. 13s. 1d. for interest on loans, there was a loss for the year of £6,659. 18s. 10d. Bringing forward the balance to credit of profit and loss (£14,183. 3s. 11d.) and deducting this £6,659. 18s. 10d. loss, there is a credit of £7,523. 5s. 1d., which the directors recommend should be transferred to special reserve. With regard to the company's Philadelphia undertaking, it is anticipated that the whole of the line will soon be open for traffic. A contract has been entered into for the construction work of the Coventry tramways which is being carried out by this company, and it is expected the new extensions will be finished before the end of the year, and the relaying of a portion of the existing old track shortly afterwards. Out of an issue of £80,000 4 per cent. prior lien debentures £60,000 has been subscribed and allotted at 97½ per cent.

Coventry Electric Tramways Co.—The accounts for the year 1903 show the net profits to be £4,642. 10s. 3d., against £4,067. 14s. 7d. in 1902. Deducting interest, there is a balance of £3,562. 10s. 3d., which, added to £400. 10s. 3d. brought forward, gives £3,963. 0s. 6d. for distribution, and the directors recommend a dividend of 2½ per cent. for the year, less tax, the balance (£1,502. 10s. 6d.) to be carried forward.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered a further issue of £116,353 4 per cent. redeemable mortgage debenture stock of the *British Westinghouse Electric and Mfg. Co.* (*Ltd.*) to be quoted, and have been asked to appoint a special settling day in 6,315 £1 fully-paid ordinary and 33,000 £1 fully-paid vendors' ordinary shares of the *Rhodes' Electrical Mfg. Co.* (*Ltd.*).

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LTD.)—An interim dividend of 12s. per share has been declared.

THOMAS PARKER (LTD.)—The directors' report for the year to April 30 states that after writing off various depreciations the balance standing to credit of profit and loss is £1,410. 3s. 9d. The directors propose to carry this amount forward. The diminished profits are the result of the general depression in trade and the recent fierce competition in the electrical industry. Large economies have been effected during the year in the methods of construction and works management and the improved designs have met the requirements of the market. The result is that the works output has been considerably increased, but these advantages are more than counterbalanced by the reduction in prices necessary to secure orders. The works are full of orders and the shops are in good position to take full advantage of any improvement in trade.

J. G. WHITE & CO. (LTD.)—At a meeting of this company on Monday, Mr. J. G. White presided, and said, as compared with former years, the results for the last year might appear unsatisfactory. This was due to special causes, chiefly bad weather during the summer and autumn of last year, and various unsatisfactory general conditions and sundry complications in connection with the carrying out of certain contracts. In one particular instance the estimated cost of carrying out a certain contract was increased by £13,000 from these causes. Considerable difficulties were also met with owing to delay by manufacturers in the delivery of material, resulting in increased cost of working to the extent of some thousands of pounds. But, on the whole, the general position was satisfactory.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	June 26	1,584	+ 287	4	6,021	+ 1,157
Airdrie	,, 17	221	...	19	3,656	...
Ayr Corporation.....	,, 25	392	+ 24	6	1,978	- 26
Barnsley	,, 17	166	+ 4	24	3,929	- 285
Barrow	,, 17	166	+ 158	19	2,997	+ 1,862
Bath Electric Trams, Ltd.	,, 22	645	...	25	14,886	...
Bexley District Council.....	,, 23	242	...	37	6,559	...
Birkenhead	,, 26	1,061	- 50	...	...	...
Birmingham Corporation...	,, 25	‖834	...	24	‖7,098	...
Birmingham Tramways Co.	,, 25	5,479	+ 119	25	138,167	+ 8,084
Blackburn Corporation.....	,, 24	920	+ 11	18	12,380	+ 899
Blackpool Corporation	,, 23	857	- 159	12	10,484	+ 531
Blackpool and Fleetwood...	,, 25	690	+ 6	26	9,464	- 771
Blackp'l,St. Anne's&Lytham	,, 23	456	- 23	24	8,205	+ 5,645
Bolton Corporation	,, 26	1,855	- 82	18	23,795	- 186
Bournemouth Corporation..	,, 22	1,050	+ 118	‡12	18,162	+ 756
Bradford Corporation	,, 25	4,506	+ 549	12	56,300	+ 9,724
Brighton Corporation	,, 26	979	+ 82	12	11,476	+ 52
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage...	,, 24	5,201	+ 108	5	26,839	- 1,891
Buenos Ayres & Belgrano...	May 29	3,891	- 314	6	20,202	+ 224
Burnley Corporation.....	June 25	986	+ 194	13	13,550	+ 3,313
Burton Corporation	,, 26	841	...	¶12	4,240	...
Calcutta Tramways Co.....	,, 25	a36,345	+a6,659	26	a389,578	+a110,463
Camborne-Redruth	,, 27	110	- 57	8	944	- 101
Cardiff Corporation	,, 25	2,095	+ 35	12	25,258	+ 985
Carlisle Tramways Co.	,, 25	201	- 20	25	4,702	+ 268
Central London Railway ...	,, 25	6,621	- 488	26	178,840	- 3,245
Chatham & Dist. Lt. Rys....	,, 23	665	+ 75	25	18,894	+ 2,065
City & South London Rly..	,, 26	2,552	+ 108	26	76,671	- 2,543
Cork Electric Trams Co. ...	,, 23	585	- 81	25	10,831	- 834
Darwen Corporation	,, 24	225	- 9	12	2,842	- 181
Devonport & Dist. Trams...	,, 17	567	+ 132	24	11,968	+ 1,902
Dover Corporation.....	...	...	...	...	...	...
Dublin & Lucan Railway...	...	...	...	...	...	...
Dublin Southern District...	,, 24	1,135	+ 148	¶26	118,114	+ 3,140
Dublin United.....	,, 24	4,274	+ 100			
Dudley—Stourbridge.....	,, 17	888	+ 87	24	19,538	+ 722
Dundee Corporation	,, 22	851	- 16	...	...	...
East Ham Council.....	,, 25	781	- 23	12	9,502	+ 988
Gateshead & Dist. Trams...	,, 17	945	+ 49	24	21,135	+ 1,026
Glasgow Corporation.....	,, 25	14,220	+ 307	†4	54,308	- 1,476
Glossop.....	,, 25	105	...	26	2,576	...
Gravesend—Northfleet.....	,, 17	283	+ 64	24	5,720	+ 70
Gt. Northern & City Rly....	,, 25	873	...	19	17,532	...
Greenock & Port Glasgow..	,, 17	634	+ 17	24	12,506	+ 641
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 17	825	+ 60	24	6,500	+ 643
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 25	2,152	+ 289	12	26,178	+ 2,959
Ilford District Council	,, 25	519	- 46	18	6,098	+ 593
Ilkeston Corporation.....	,, 22	148	- 49	...	...	...
Ipswich Corporation.....	,, 25	525	...	12	5,969	...
Isle of Thanet Co.	,, 26	998	+ 9	...	...	...
Kidderminster & District...	,, 17	151	- 14	24	2,711	- 123
Kirkcaldy Corporation	,, 22	218	- 34	25	5,393	...
Lanarkshire Trams Co.....	,, 23	714	...	25	15.303	...
Leeds Corporation.....	,, 25	5,781	- 230	14	75,863	+ 4,017
Leicester Corporation ...	,, 18	1,148	...	6	6,753	...
	,, 25	1,097				
Liverpool Corporation	,, 18	10,857	+ 1,189	25	248,238	+ 5,685
Liverpool Overhead Rly. ...	,, 26	1,721	+ 61	26	41,220	+ 43
*London County Council ...	,, 18	12,488	+ 8,892	§11	130,202	+ 22,131
Lowestoft.....	,, 18	200	...	¶48	9,897	...
	,, 25	207				
Manchester Corporation ...	,, 25	12,112	- 157	12	146,901	+ 3,460
Mersey Railway	,, 25	1,904	+ 418	25	37,563	+ 7,611
Merthyr	,, 17	207	+ 12	24	4,791	+ 175
Middleton	,, 17	401	+ 111	24	7,822	+ 156
Nelson Corporation	,, 25	116	+ 46	13	1,487	+ 650
Newcastle-on-Tyne Corp....	,, 25	4,989	+ 657	25	90,340	+ 11,297
Newport (Mon.)	,, 25	515	+ 118	12	6,566	+ 1,575
Oldham, Ashton & Hyde ...	,, 17	566	+ 62	24	12,774	- 693
Oldham Corporation.....	...	...	...	...	...	...
Perth (W. A.) Elec. Trams.	,, 24	1,204	+ 89	25	33,586	+ 4,413
Peterborough	,, 17	151	+ 29	24	3,227	- 160
Poole and District.....	,, 17	301	+ 42	24	6,521	+ 2
Portsmouth Corporation ...	,, 23	2,313	- 28	†13	23,960	+ 2,170
Potteries	,, 17	1,730	+ 309	24	40,326	+ 3,303
Reading Corporation.....	...	...	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 17	170	- 12	24	1,952	+ 4
Salford Corporation	,, 27	4,060	- 99	13	51,627	+ 4,493
Sheerness	,, 15	78	+ 6	24	1,238	- 870
Sheffield Corporation	,, 26	4,659	- 98	§13	61,778	+ 1,916
Southampton Corporation ...	...	...	...	...	...	...
Southend Corporation	,, 22	891	+ 59	12	8,756	+ 297
Southport Tramways	,, 17	848	+ 55	24	7,072	+ 377
S. Staffordshire Trams. ...	,, 17	759	- 69	24	18,704	- 942
Stockport Corporation.....	,, 25	566	+ 243	12	7,168	+ 3,058
Sunderland Corporation ...	,, 26	1,961	- 44	12	15,630	+ 313
Swansea Trams	,, 17	592	+ 63	24	12,120	+ 816
Taunton Trams	,, 17	55	- 2	24	1,244	- 87
Tynemouth and District ...	,, 17	327	+ 29	24	5,964	- 232
Tyneside Trams Co.	...	...	...	...	...	...
Wallasey District Council..	,, 25	766	+ 27	§13	8,977	+ 415
Walsall.....	...	...	...	...	...	...
Warrington Corporation....	,, 23	316	+ 10	12	3,788	+ 68
West Ham Corporation ...	,, 23	1,182	...	17	12,115	...
Weston-super-Mare	,, 15	139	+ 38	24	1,473	- 37
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District ...	,, 17	406	+ 57	24	8,939	- 221
Worcester	,, 17	329	+ 140	19	5 488	+ 2,303
Wrexham.....	,, 17	111	- 7	24	2 631	- 280
Yorkshire Woollen Distric:	,, 17	640	+ 347	24	13,760	+ 5,952

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days
‖ These are net figures after deduction of amount due to City of Birmingham Tramways Co.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., June 29.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business, Week to June 29. High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	5 —5⅛	4 15 3	April, Oct	5⅛	5 1/16
St.	6%	† Do. Permanent 6% Deb. Stock	132 —137	4 7 6	..	..	..
St.	5%	†Auckland Elec. Trams 5% Deb. (red.)	98 —100	5 0 0	..	101⅜	..
10	6%	Barcelona Tramways Ord.	7⅞—8⅛	3 10 8	..	..	..
10	5/0	† Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	93 —98	4 13 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 —100	5 2 0	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	⅜—⅞	..	..	..	..
1	..	Do. 5% Cum. Pref.	⅝—1	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	..	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Prov. Certs.	96 —101	4 9 3	..	96¾	..
10	8%	Bristol Tramways and Carriage Ord.	18½—19½	4 2 1	Feb, Aug	..	..
10	4%	† Do. Cum. Pref. (fully paid)	10 —10½	3 16 2	..	..	..
St.	4%	† Do. 4 per Cent. Debs.	106 —108	3 15 3½	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100 —103	5 16 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	98 —101	4 19 0	..	100	..
10	5/0	Do. 5% Cum. Perp. Pref.	10¾—11½	4 8 10	..	..	..
40	4¼%	† Do. 4½ per Cent. 1st Mort. Debs.	103⅝—105⅞	4 6 2	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	100⅜	..
10	6/0	British Electric Traction Ord.	9⅜—10½	7 16 1	..	10⅜	9 15/16
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—11½	5 6 6	Feb, Aug	10½	10 1/16
St.	5/0	Do. 5 per Cent. Perpetual Debs	116 —119	4 6 3	..	117	116
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	95 —98	..	..	97	..
5	3/0	Buenos Ayres and Belgrano Ord.	2⅞—3⅛	4 16 0	..	3 1/16	2 15/16
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼—5⅝	5 4 4	..	..	..
5	3/0	Do. "B"	5 —5⅛	5 9 1	..	..	..
St.	5%	† Do. 5 per Cent. Debs.	105 —108	4 12 8	..	..	..
St.	5%	† Do. 5% 2nd Deb. Stock Prov. Certs.	101 —104	4 16 6	..	104½	..
St.	5%	†Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	94 —99	5 1 0	..	..	..
5	3/6	Calcutta Tramways	7 —7⅛	4 0 0	..	7 1/16	7⅛
100	4½%	† Do. 4½% 1st Deb. Stock (red.)	105 —108	4 3 3	..	..	..
1	1/0	Cape Electric Tramways Shares	1⅞—2⅛	8 0 0	..	2	..
St.	4%	Central London Ordinary Stock	90 —93	4 6 0	June, Dec	94	91
St.	4%	Do. 4 per Cent. Pref. Stock	101 —104	3 18 5	..	..	..
St.	4%	Do. Deferred Stock	79 —82	4 17 7	..	81	..
100	4%	Do. 4 per Cent. Debs.	113 —116	3 10 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2%	City and South London Rly. Con. Ord.	47 —49	4 16 11	Feb, Aug	49⅛	46⅞
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —126	4 0 0	Feb, Aug	..	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	121	120
St.	4%	Do. 4 per Cent. Perpetual Debs	106 —109	3 13 5	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 10	..	..	..
10	6 0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8⅓	Gt. Northern & City Rly. Prf. Ord. (4%)	5 —6	5 0 0	..	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	† Imperial Tramways Ord	18 —19	5 5 3	Mar, Sept	..	..
10	6%	†‡Do. 6 per Cent. Pref.	13⅞—14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡Do. 4½ per Cent. Debs.	106 —108	4 3 4	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	3 7/16	3 7/8
St.	4%	† Do. 4 per Cent. Deb. Stock	88 —91	4 7 11	..	..	..
10	1½%	Liverpool Overhead Railway Ord	3¾ —4	3 8 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	100¼—102½	3 19 6	Jan, July	..	..
10	5/0	†London United Trams. 5% Cum. Pref.	11⅜—11½	4 8 10	..	..	..
St.	4%	† Do. 4% 1st Mort. Deb. Stock	102 —104	3 16 11	..	..	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅜—½	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	..	⅞	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 5 0	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 —2	..	May	..	..
St.	5%	†Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99—102	4 18 1	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	..	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	April, Oct	..	..
St.	3%	Waterloo and City Ord.	89 —92	3 7 11	Jan, July	..	..
					June, Dec	91½	91
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 6	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	12/6	Anglo-American	46 —49	5 18 0	F,My,Ag,N	47	46
St.	25/0	Do. Preferred	91 —93	6 3 6	F,My,Ag,N	92⅜	91½
St.	2/0	Do. Deferred	6⅛—7	1 8 7	F,My,Ag,N	6⅜	..
100	£2	†Commercial Cable Capital Stock	170 —190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	93 —95	4 2 6	Jn Ap,Jy,O	94⅜	..
10	5/0	Cuba Submarine Ord.	7 —8	7 10 0	Feb, Aug	7 1/16	..
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100⅝—103⅞	4 9 0	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10½	6 4 0	Ja,Ap,Jy,O	10 1/16	10⅛
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —103	4 9 0	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	126 —131	5 7 0	Ja,Ap,Jy,O	131	127
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —90	3 17 9	Ja Ap,Jy,O	89½	88½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 6	May, Nov	106½	105½
10	6/6	Eastern Extension	11¾—12¾	5 14 0	Ja,Ap,Jy,O	12¼	11 13/16
St.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 15 0	Feb, Aug	107¼	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	99 —102	3 19 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞—102⅞	3 18 9	May, Nov	..	..
10	20 0	Great Northern (of Copenhagen)	25/8—26⅜	5 13 2	Jan, July	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 —103	4 9 0	June, Dec	..	..
25	37/6	Indo-European	42 —45	5 11 2	May, Nov	..	..
100	4%	Pacific&Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..
10	6/0	†West African Telegraph Shares	6 —7	5 14 3	..	6⅞	..
2½	..	West Coast of America	1/16—3/16	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 10	Jan, July	..	..
10	..	West India and Panama	⅝—½	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 7	May, Nov	6 3/16	..
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 18 4	Jan, July	102	..
10	3/0	†Western Telegraph	12½—13	5 7 8	Mr,Jn,O,D	13	12 13/16
100	5%	* Do. 5% Debs. (2nd Series, 1906)	102 —105	4 17 4	June, Dec	..	..
St.	4%	† Do. 4% Deb. Stock (red.)	99 —102	3 18 5	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	†Elec. & Gen. Investment 6% Cum. Pref.	4⅜—5½	5 14 4	..	5	..
10	5/0	Globe Telegraph and Trust	8¾—9½	5 19 0	Ja Ap,Jy O	9	8 13/16
10	3/0	Do. 6 per Cent. Pref.	13 —13½	4 8 11	Ja Ap,Jy,O	13¼	13 1/16
8	4/0	Reuter's	6½—7½	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	118 —123	4 18 9	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed., June 29.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business, Week to June 29. High-est.	Low-est.
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	4½—5¼	5 14 3	August ..	..	..
1	7½	Monte Video Telephone Ord.	⅜—½	..	..	..	..
St.	6%	National Co. Pref. Stock	104 —106	5 13 3	..	105	104
St.	5%	Do. Def. Stock	84 —87	5 17 4	..	85⅜	85
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 —13	4 12 4	Feb, Aug	12½	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5¼	4 15 3	Feb, Aug	5 1/16	5 1/16
St.	3¼%	*†Do. Deb. Stock 3½ per Cent. (red.)	99 —101	3 10 6	June, Dec	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock (red.)	101 —103	3 17 8	..	..	104⅛
		Do. Do. Prov.Certs,70%tobepd.	29 —31	..	..	..	..
1	0/8⅜	Oriental	1/16—1 1/16	6 6 3	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1½	6 4 6	..	..	..
5	5/0	United River Plate	5⅜—6½	6 9 0	July.....	6⅜	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	June, Dec	5 1/16	..
St.	5%	*†Do. 5 per Cent. Deb. Stock (red.)	102 —105	4 15 3	June, Dec	..	..
		ELECTRICITY SUPPLY.					
		Blackheath & Gr'nwich. Dist. Ord. (f.p.)	⅜—⅝	..	..	..	..
1	0/8⅜	Do. 7% Cum. Pref.	1⅛—1⅜	5 1 9	..	..	..
St.	4¼%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	120 —125	3 12 0	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12¾	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9⅛—10¼	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10⅜—11½	5 4 4	..	..	..
St.	4¼%	† Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	102¼
5	..	Bromley (Kent) El. Lt. & Power Shares	5⅛ — 6	..	..	..	..
St.	4¼%	Do. Do. 1st Debs	100 —103	4 7 5	..	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord	10⅜—11¼	4 8 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10¼—10⅜	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7 —7½	4 13 4	..	7¼	7 1/16
10	4/6	Central Elec. Sup. Co. 4% Guar. Db. Stock	105 —108	3 14 1	..	..	106¼
10	6/0	Charing Cross & Strand Electric Sup.	7⅛—8	5 0 0	Feb, Aug	7⅜	..
5	2/3	Do. 4½ per Cent. Pref.	5⅛—5⅜	4 3 6	Feb, Aug	5⅜	..
5	2/3	† Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	..	5⅜	..
5	2/3	† Do. Do. (19.3)	4¾—5	..	..	4 15/16	..
St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 0	..	..	..
5	3/6	Chelsea Electric Supply Ord.	6⅛—6¾	4 1 6	March ..	6 1/16	..
St.	4¼%	*†Do. 4½ per Cent. Deb. Stock (red.)	108 —109	4 2 6	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	11 —11½	4 7 0	Feb, Aug	11⅜	11½
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St.	5%	*†Do. 5 per Cent. Deb. Stock (red.)	120 —125	4 0 0	Jn, Dec ..	..	..
St.	4¼%	† Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	..	..
10	4/0	County of London Elec. Supply Ord.	7⅛—8⅛	4 14 3	..	7 1/16	7⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	11 1/16	11
St.	4¼%	† Do. 4½% Deb. Stock (all paid) (red.)	104 —107	4 4 0	..	108	..
St.	4¼%	Do. Second Deb. Stock Prov. Certs.	100 —103	4 8 0	..	..	..
St.	5%	†Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	89 —93	5 7 6	..	..	..
5	3.6	Folkestone Electricity Supply Co. Ord.	5⅛—6	4 11 8	..	5⅜	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 8 0	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
5	5.0	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
St.	4½%	I of W. Elec Lt. & Power 4½% Db. St (red.)	101 —103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	3/32—1/32	..	..	..	..
5	7/0	Kensingtn & Knghtsbdge Ord.	12 —13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	..	..
3	..	London Electric Supply Ord.	1½—1¾	..	..	..	..
5	3/0	Do. 6 per Cent Pref.	4¾—5¼	5 14 6	..	5 3/32	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	93 —96	4 3 4	Mr,Jn,S,D	..	..
10	9 6	Metropolitan Electric Sup. Ord.	19½—20½	4 5 6	April, Oct	20⅜	20
5	2/3	† Do. 4½ per Cent. Cum. Pref.	5⅛—5½	4 1 10	..	5½	..
St.	4¼%	† Do. 4½ per Cent. Deb. Stock 1st Mort.	108 —112	4 0 4	Jn, Dec ..	..	..
St.	3½%	† Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 —99	3 10 6	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
10	6/0	†Notting Hill Electric Ord.	13 —14	4 5 8	March ..	..	..
5	4.0	Oxford Electric Ord.	5⅛—6	5 8 4	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 3	..	..	..
1	..	Rand Electric	1 —1½	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 —103	4 7 9	April, Oct	..	..
5	9 6	St. James' & Pall Mall Elec. Ord.	14½—15½	4 13 7	Feb, Aug	15	..
5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	8 1/16	8¼
St.	3¼%	† Do. 3½ per Cent. Deb. Stock (red.)	96 —99	3 10 6	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2⅜—3½	6 3 1	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
£	3/0	South London Electric Supply Ord.	3¾—4½	3 10 7	..	4⅛	4
5	2/6	Urban Electric Supply Ord.	4½ 5	5 0 0	..	4⅝	4 1/16
5	2/6	Do. 5% Cum. Pref.	4½—5	5 0 0	..	..	..
5	7/0	Westminster Electric Supply Ord.	12⅜—13½	5 0 0	Mar, Sept	13⅜	12 15/16
5	2/6	Do. 5 per Cent. Cum. Pref.	6⅛—6¾	3 14 0	..	6 1/16	6⅛
		ELECTRIC MANUFACTURING &c.					
1	..	Aron Elec. Meter 6% Cum. Pref.	⅛—⅜	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5½—6	6 13 4	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5½—6	5 0 0	Jan, July	5 3/32	..
St.	4½%	† Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 7	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	3¼—3⅜	8 0 0	..	2⅜	2 1/16
St.	4%	† Do. 4 per Cent. Mort. Deb. Stock	86 —89	4 9 11	..	..	..
½	..	Brush Electrical Engineering	½—1	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	¾—1½	9 12 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	† Do. Perpetual 2nd Deb. Stock	71 —76	5 18 4	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½—10½	5 14 3	Jan, July	..	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	5¼—5⅜	4 6 11	Jan, July	..	..
St.	4½%	† Do. 4½ per Cent. 1st Mort. Debs. (rd.)	101 —104	4 6 7	Nov, May	..	..
1	2½d.	Castner-Kellner Alkali Co. (fully paid)	⅞—1	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¾—2¼	6 13 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95 —98	5 4 6	Jan, July	97½	..
5	..	Dick, Kerr & Co. Ord.	8 —8½	..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
St.	4½%	† Do. 4½% Deb. Stock	103—105	4 5 9	..	..	..
1	..	Edison & swan United("A"Sh.)(£3 pd.)	⅝—⅞	..	Feb, Aug	..	..
1	..	Do. (£5 paid)	1 —2	..	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	76½	76
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	75 —79	6 11 8	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5⅜—6	5 16 8	H'lf-yearly	5 15/16	5⅞
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅝—5⅞	5 2 6	..	5 31/32	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106 —109	4 4 0	..	108½	108½
2	1/2½	Electric Construction Co.	1⅝—1⅞	7 2 10	Jan, July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2¼—2½	5 2 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	†General Electric (1900) 5% Cum. Pref.	9 —9½	5 5 3	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	11½—12⅜	6 0 0	Feb, Aug	11⅝	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..	..
10	5/0	†India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 6	Feb, Aug	19½	19
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 —103	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	36/0	Telegraph Construction & Mainten'ce.	36 —39	6 3 0	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
5	..	Willans and Robinson Ord.	2¼—3½	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3½—4½	..	Apr, Oct	3⅜	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	85 —90	4 9 6	May Nov	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

THE fact that a Committee of the House of Lords found last night that the preamble of the Electricity Supply Bill was proved by no means implies that the Committee stage of the Bill is concluded. Almost every clause is to be argued upon and amended, and the proceedings in Committee may last many days yet. Then there is opportunity for further opposition when the Bill comes up for third reading in the House of Lords and in every stage in the Commons, so that with the present congestion of business in the Lower House it is very unlikely that the Bill will be passed this session. This is most unfortunate, for it cannot be denied that the measure is a most reasonable one, its object being to remove some of the obstacles which are still hampering the development of the electric light and power industry, and that its main provisions would be advantageous to municipal as well as company enterprise. From the report which we publish elsewhere in this issue, it will be seen that the opposition is largely directed to preventing the substitution of Provisional Order procedure for the procedure by Special Act in the case of many requirements for powers that were not contemplated in the original Electric Lighting Acts of 1882 and 1888. As the grant of powers by Provisional Order requires subsequent Parliamentary sanction, it is difficult to see the reason for opposition of this nature. The result will be, as we have said, that the Bill will not get through Parliament this session, and the present opportunity for effecting the much-needed revision of the law of electricity supply will thus be lost.

IN this connection we may refer to the remarkable conference at St. Pancras, arising out of the recent actions for an injunction against electricity undertakers with respect to nuisance from vibration. The power to acquire land compulsorily by Provisional Order is really all that electricity undertakers want in order to remedy the present condition of affairs in this respect, and this power would be granted if the new Electricity Supply Bill were to become law. Yet, instead of deciding to do its utmost to further the Bill, the conference has resolved itself into what may be considered an organised committee to oppose it, in order to obtain wider powers for local authorities and narrower powers for companies than would be granted if the Bill passed as it stands. It is hardly to be wondered at that some of the company delegates have retired from the conference in indignation.

A PAPER by Mr. C. E. SKINNER, read before a recent meeting of the National Electric Light Association of America, deals at considerable length with the uses to which oil may be put in connection with transformers and switches. The oil trade will probably suffer by the increasing employment of steam turbines, but it will profit to an almost equal extent by the extended use of oil in transforming and switch gear. Some interesting data concerning the effect of water in oil are brought forward by the author. One thirtieth of one per cent. of water in oil brings about an alarming drop in its specific resistance, but the drop in resistance does not increase in proportion to the percentage of water present. For instance, on testing samples of dry oil, the author found that 9,500 volts were required to bridge a gap of 1·9mm. between brass balls 1·25cm. in diameter. So small a quantity of water as one-fiftieth of one per cent. mixed with the oil brought down the rupturing voltage to 5,000, or very little more than one-half. But on increasing the proportion of water to one-fourth of one per cent. the voltage then required to bridge the gap was 3,600. Obviously, then, the state of affairs to aim at is not to have as little water as possible in the oil but to exclude it altogether. This is

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not difficult in the case of transformers working continuously, owing to the heat developed driving off any water present, but it is clear that the time at which an oil-cooled transformer is most likely to break down is immediately after a long rest, when a certain amount of aqueous vapour must have condensed and become mixed with the oil. The same applies to a lesser extent to switches, because these are usually designed so as to prevent heating to any appreciable degree.

REGARDING the inflammability of oil, the author is, perhaps, not quite so happy in his deductions. He scorns the "popular" idea that oil is highly inflammable, and instances the case of a blazing transformer being dropped into an oil tank to extinguish the fire. He asserts that, in bulk, oil is almost like water in its non-inflammability, and that it is only when spread out into thin layers, readily capable of being heated to the burning point, that danger is present. This is true enough, but it is extremely difficult to confine oil to bulk proportions—it persists in creeping and forming thin layers, which he admits are dangerous. If oil could be relied upon always to retain its bulk form without creeping or leaking, and if all sparks could be warranted to occur within the bulk, and not in proximity to "thin layers" or in highly-inflammable hydro-carbon vapours, then oil would be almost an ideal insulator. But the worst feature of all is the difficulty of extinguishing oil once it is alight. It will not always be feasible to drown the flames in an oil tank, as the author has done in the case of his burning transformer.

THE high-tension switchboard, which is now in use at the Carville power station, a description of which appears in this issue, is practically the first example in this country of a type of switch gear which will almost certainly become common practice in the future. An ordinary oil switch rated from 50 or 100 amperes 6,000 volts three-phase, and having all three poles in one oil tank is, if carefully designed, an excellent piece of apparatus when placed at the end of a feeder supplying transformers or rotary machinery on an ordinary power or lighting load, But with the larger generating units at Carville, Mr. MERZ realised that a switch designed on these lines would be quite unsuitable, owing to the fact that it has to open on a heavy fault with the whole power of the station behind it. Especially is this the case when, as at Carville, a railway is to be supplied on which heavy short-circuits occasionally occur. The Carville switch gear and connections for the various units and for the outgoing circuits are kept as separate from each other as possible; the different phases of each circuit are separated; the connections are thoroughly fireproof; each portion of the switch gear is arranged so that it can, in case of breakdown, or for the purpose of overhaul and repairs, be isolated from the rest of the apparatus; and provision is made for easy extension of the switchboard.

IN order to arrive at these conditions, it was necessary that the circuits should all run parallel to each other and perpendicular to the 'bus bars, and the 'bus bars themselves had to be absolutely safe, as a breakdown on any circuit which could not be readily isolated would affect the whole station, and not one feeder or generator cable only. Naturally, these conditions involved the use of a considerable amount of space, and it will be seen from our photograph that the switchboard occupies an entire side of the engine room. Switch gear such as this cannot conveniently be operated directly by an attendant, and it therefore became necessary to adopt some system of remote control, either electrical or mechanical. Electrical control has been adopted at Carville, owing chiefly to the fact that, when acting as a cut-out, the switch gear has to be operated electrically by means of the automatic gear, and it is, therefore, considered to be a simplification to adopt electric control throughout.

IN the House of Commons on Thursday of last week there occurred an event of considerable importance to tramway undertakings, whether working under municipal or company control. It is ancient history now that the Newcastle Corporation and the Tyneside Tramways and Tramroads Co., after negotiations, failed to arrive at an agreement with regard to running powers, and that the latter finally sought the aid of Parliament. After passing through Committees of both Houses, their Bill was referred back in respect of the compulsory running powers clauses on coming up for third reading in the Commons. While it is to be deplored that legislation has to be resorted to, and, it appears, unsuccessfully, in order to effect an arrangement which is for the benefit of the public at large, yet it is still more regretable that Parliament has seen fit to give its approval to the one-sided policy adopted by the Newcastle Corporation. From the evidence before the Committees, and from our own personal knowledge of the situation, we have no hesitation whatever in saying that an exchange of running powers would be of considerable benefit, not only to the Company, as alleged, but also to the Corporation, and, what is more important, to the public.

ANOTHER stage in the proceedings was reached on Wednesday when the Bill again appeared before the House of Commons Committee, which adjourned until July 19th in order that negotiations, with a view to amicable settlement, may be carried on between the two parties. Failing some satisfactory arrangement, the Chairman intimated that the Corporation would have to be prepared with evidence against the compulsory running powers clauses. Counsel for the Corporation pleaded that his clients were too busy to give the matter their attention immediately, but the Chairman very properly pointed out that they had had plenty of time to prepare their case and that there should be no delay. In spite of this ruling, however, it is to be feared that the Bill will not now get through this session.

ONCE more, a tramway accident has been attributed to the motorman losing his presence of mind and not to any fault of equipment. Major DRUITT, in reporting on the Dewsbury accident, lays particular stress on the fact that more highly-trained men should be employed to work electric brakes than those who only have to operate hand brakes—that is to say, a more intelligent and skilled driver is required in districts with heavy gradients. In connection with man

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electric tramways there is a training school for motormen, and this should be the general rule. It is essential that the driver should know which levers to move, and the direction and order in which to move them; but he should also be familiar with the precise effect of each brake, knowing exactly which ones are liable to lock the wheels and the time that elapses for the other brakes, with which the car is equipped, to take effect.

THE accounts of the London County Council tramways for the year ended March 31, 1904, show that the total receipts amounted to £536,239 and the working expenses £441,786, the balance of £94,453 appearing as profit on the year's working. But this does not allow for payment of interest and sinking fund (£100,537) nor for income tax (£2,200), and when these items have been deducted there is a deficiency of £8,284 to be carried to appropriation account. This is accounted for, to a certain extent, by the cost of energy, the supply being only of a temporary nature; but when permanent arrangements are made it is hoped that the balance will be on the right side. The total number of passengers has increased considerably, the average fare remaining the same, and the number of car-miles run is nearly a million and a-half in excess of the previous year's total. On the whole, the financial result is more favourable than might have been expected for an undertaking of this magnitude in its first year of partly "electrified" working, especially when the disadvantages of the temporary arrangements for supplying current are taken into consideration. In fact, if the greater part of the new lines had been equipped on the overhead instead of on the conduit system—as might well have been the case—the new undertaking might almost have shown a profit. A lengthy abstract of the report will be found in another column.

Personal.—The honorary degree of Doctor of Science has been conferred upon Mr. Ludwig Mond, F.R.S., by the Victoria University of Manchester.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Dakar—Konakry	May 13, 1904
Chio—Tenedos	June 21, 1904

Royal College of Science.—Science scholars selected from the whole of Great Britain for their ability and promise, maintaining themselves on 17s. 9d. a week, were, in 1903, saved from much privation by secret gifts of small bursaries, amounting, for the year, to £240. Grants were thus made to 51 students. Prof. Perry says that he has no right to ask for help from the generous men who assisted him last year, but adds he has "all the sturdiness of a chartered beggar"—he asks in a good cause.

A New Application of Electricity.—We quote the following amusing "fishing story" from *Motoring Illustrated*:—

The whalemen of Nantucket, U.S.A., have an ingenious motor whale-boat, which is destined to revolutionise the industry in which they are engaged. The boat has an electric motor driven by accumulators. When the whale is harpooned he dashes off at full speed, drawing the boat after him. The electric current is at once shut off from the accumulators, the pressure of the water on the screw drives the propeller shaft, which is coupled to the motor. The armature of the motor rotates and generates electric energy which charges the accumulators. When these are charged the captain sends an electric current through the wire harpoon rope, and this electrocutes the whale. . . . Three electric whale-boats are in service at the Siasconset station in Nantucket, and three more are to be installed at New Bedford.

An Electric Service Launch.—The Temple Back and Avonbank generating stations of the Bristol Corporation both being situated on the banks of a canal, and the distance between them by water being ⅓ mile less than by road, an electric launch has been purchased capable of carrying a load of 2 tons or about 20 passengers. It is driven by a Newton motor and 35 E.P.S. accumulators. An average speed of about 6½ miles per hour is attained over the mile which separates the stations. A considerable saving in time and money is effected, as it was formerly the custom to hire a cab. The launch affords no protection from the weather, but this defect will be remedied shortly. It was purchased from the Thames Valley Launch Co.

Electricity Supply in Mirfield.—By the agreement which the Mirfield Urban District Council have just made with the Yorkshire Electric Power Co., the former have decided to purchase their electricity in bulk, so that all they have to do is to retail it to customers, and not to generate it. They have been guided in this matter by Mr A. B. Mountain, Corporation electrical engineer to Huddersfield, who has acted as their consulting engineer. Mr. Mountain went carefully into the relative merits of a small generating station and a supply from the power company, and his recommendation was in favour of the latter course. As Mr. Mountain is an acknowledged champion of small generating stations, this decision speaks well for the lowness of the company's prices. The agreement is of a somewhat novel character, for the Council have arranged to deal with the lighting supply only, and have left the company to deal with the large users of power direct. This arrangement has been decided upon for two reasons: the first, because a much smaller capital expenditure will be involved, and the second, because the Council are anxious that their undertaking should pay its way from the commencement. Negotiations of a somewhat lengthy character have been carried on by Mr. E. B. Wilson (the clerk to the Council) and Mr. W. B. Woodhouse (the chief engineer of the Yorkshire Electric Power Co.). Electrical energy is to be generated by the company at their Thornhill station, and transmitted at 10,000 volts by underground cables to the Council's sub-station at Mirfield, where it will be reduced to a pressure suitable for lighting. We understand that a supply will be available in Mirfield in December next. Various other district councils in the West Riding are considering the same problem to which the Mirfield Council have just found a solution.

Machine for Loading Wheelbarrows or Cars.—The practice of loading wheelbarrows, ore buggies, cars, &c., by hand shovelling is often followed in cases where the amount of work, or continuous work, would make it more economical to employ power machinery. A machine designed for such a purpose is described in a recent issue of *Engineering News* of New York. It consists of an inclined steel frame with a trough around it, in which travel the blades of a conveyor. At the lower end the trough is flattened out like a scoop, and at the upper end there is a hole in the bottom, with a chute through which the material is discharged. The frame is 13ft. long, 5ft. 3in. wide, and can be tilted at varying angles, with a maximum height of 7ft. for the discharge end. The weight is about 3 tons. It is mounted on a two-wheel truck with broad-tyred wheels or flanged wheels, and is driven by a 10 H.P. electric motor; when the machine is to be moved forward or from place to place, the motor also serves to propel it by means of a link-belt gear to the axle. One of the wheels can be disconnected from the axle by a clutch, so that the machine can be swung easily to set it in any desired position. A lever handle at the side controls the scoop-driving mechanism, and another actuates the clutch of the propelling gear. The vertical screw in front is for regulating the inclination of the conveyor, and a long handle is provided for steering the machine when travelling. The trough in which the arms travel is 18in. wide, with a depth of 16in. at the inner side. In operation the machine is run up to the ore or coal pile, gravel bank, &c., so that the lower end or scoop of the conveyor trough will be fed by the material. The conveyor is then started, and the travelling arms carry the material to the upper end of the conveyor, whence it falls into the wheelbarrows or cars, or into an auxiliary portable belt conveyor to reach a greater elevation than

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that of the machine, as, for instance, in loading large railway cars. The arms travel at a speed of 60ft. to 80ft. per minute, and the average capacity of the machine in handling loose material is about 90 cubic ft. per minute. The machine has been tried with success in loading ore from stock piles into the blast furnace charging buggies at the South Works of the Illinois Steel Co., South Chicago, Ill. It has also been used in loading gravel, coal, stone, salt and other materials.

Laying the Track on the Brixton–Streatham Tramway.—Messrs. J. G. White & Co., contractors to the London County Council for the conversion of the Streatham line of cable tramways to the electric conduit system, send us the following interesting particulars with regard to the carrying out of this work. The contract for the 3¼ miles of double line in question was allotted on March 2nd, with the stipulation that the work was to be completed by July 1st.

Mr. I. Fisher, who had already constructed some 30 miles of conduit in South London for Messrs. J. G. White & Co., broke ground on April 6th. For lifting the wheel rail Barrett jacks were used, as on the first Tooting track; but in order to save time in starting the operation a jaw was fitted around the head of the rail, and this jaw was raised by two jacks mounted on iron wheels. In this manner the necessity of breaking up the roadway at each fresh start was obviated. In order to avoid the tedious process of unbolting the slot rail from the yokes, wedges of varying thickness were driven into the slot whereby the slot rails were forced apart, carrying the shoulders of the yoke with them. The concrete enclosing the old cable tube was found to be very hard and difficult to remove, but after the first 10 days it was discovered that by driving the wedges (four men to a wedge) a certain distance back on either side of the tube a seam was opened up. The finding of this seam enabled the concrete to be taken out in large blocks. During the first week the number of men employed was increased daily until some 1,600 men were at work, and such progress had been made that on May 18th a car was run over the double line from Kennington Gate to Water-lane, a distance of 1¾ miles. The Board of Trade inspection on this first part of the route took place on May 20th, five weeks before the contract time. The average of progress by all the gangs was 1,000ft. of single track per day which is believed to constitute a record for this kind of work. The whole work was completed on June 13th, and the first car ran to the terminus on the 15th. The Board of Trade inspection was held on June 18th and the line was thrown open for traffic on June 19th, 17 days ahead of the stipulated date.

Mr. Maurice Fitzmaurice, engineer to the Council, made several alterations in the original construction of the track as carried out on the first Tooting line, and described in *The Electrician*, Vol. XLIX., p. 624 and Vol. L. p. 9. The rail length was increased from 30ft. to 45ft. On the Tooting line the rails were laid with "Dicker" joints without any provision for anchoring. On this road, the anchor rail joints were used; the rails were also anchored between joints. The position of the sumps was also changed from the margin to the centre of the track and the sumps were spaced 140ft. instead of 180ft as formerly. The conduit tubes discharge directly into the sumps, so that the difficulties found in keeping clear the pipe connections from tubes to sumps are avoided. At insulator pockets paving plates were inserted, carried between yoke and stirrup support in panel. For slot switches in the special work Hadfield's design was adopted. The castings were supplied by the Anderston Foundry Co., the tie-rods by Messrs. Bayliss, Jones and Bayliss and the cement by the Associated Portland Cement Manufacturers (Ltd.). The whole of the work was executed under the supervision of Mr. A. N. Connett, chief engineer to the contractors.

St. Louis International Electrical Congress. — We are informed that a number of national electrical societies have already arranged to co-operate in the International Electrical Congress at St. Louis. In America, a number of these co-operating bodies are to hold simultaneous conventions in St. Louis during the congress week, and to hold joint sessions with specified sections of the congress on definitely appointed days. Other bodies are not going so far as to hold simultaneous conventions and joint sessions, but have accepted invitations to send delegates to the congress. The following have promised to hold simultaneous conventions and joint sessions:—The American Institute of Electrical Engineers, the American Electrochemical Society, the American Physical Society, the International Association of Municipal Electricians, and the American Electrotherapeutic Association. The National Electric Light Association and the Association of Edison Illuminating Companies have promised to send delegates to the congress. In Europe, the following have promised to send delegates to the congress:—The Société Internationale des Electriciens and the Sweizerischer Elektrotechnischer Verein. It is expected that the Institution of Electrical Engineers of Great Britain and the Electrotechnischer Verein of Berlin will also send delegates. The delegates accredited to the congress from various co-operating bodies are not expected to be called upon to vote upon any questions of national importance. All matters concerning units, standards, &c., will lie within the province of the Chamber of Government Delegates. All delegates of the co-operating bodies are invited to read Papers before any section of the congress they select. Such Papers will be printed in the Congress *Transactions* as being offered by the delegate on behalf of the co-operating body. The Paper and discussion thereon will subsequently be offered by the congress to the co-operating body for incorporation in its own *Transactions* if desired.

The delegates of the American Institute of Electrical Engineers and their Papers to the congress are as follow:—Mr. Ralph D. Mershon, Section D, "The Maximum Distance to which Power can be Economically Transmitted." Prof. M. I. Pupin, Section A, "Electrical Impulses and Multiple Oscillators." Prof. C. P. Steinmetz, Section D, "The Theory of the Single-phase Motor."

The delegates of the U.S. Electrochemical Society and their Papers to the congress are as follow:—Prof. W. D. Bancroft, Section C, "The Chemistry of Electroplating." Prof. H. S. Carhart (with Dr. G. A. Hulett), Section C, "The Preparation of Materials for Standard Cells and their Construction." Prof. L. Kahlenberg, Section C, "The Electrochemical Series of the Metals."

The delegates of the National Electric Light Association and their Papers to the congress are as follow:—Mr. George Eastman, Section E, "Protection and Control of Large High-tension Distributing Systems." Mr. G. Ross Green, Section E, "American Meter Practice." Dr. F. A. C. Perrine, Section D, "American Practice in High-tension Line Construction and Operation."

The delegates of the Association of Edison Illuminating Companies and their Papers to the congress are as follow:—Mr. W. C. L. Eglin, Section E, "Rotary Convertors and Motor Generators in connection with the Transformation of High-tension Alternating Current to Low-tension Direct Current." Mr. L. A. Ferguson, Section E, "Underground Electrical Construction." Mr. Gerhard Goettling, Section E, "Storage Batteries as an Adjunct to Station Equipment." The delegates and Papers of the other co-operating bodies have not yet been appointed.

In response to invitation, the following foreign Governments have appointed delegates:—Switzerland, Prof. Ferdinand Weber and Prof François Louis Schule; Norway and Sweden, Prof. G. Arrhenius; India, Mr. J. C. Shields; Mexico, Mr. Rafael R. Arizpe. Appointments from Great Britain, France, Germany, Austria-Hungary, United States, Belgium, Italy, Denmark, Spain, Portugal, Australia, Japan, China, Brazil, Chili and Peru have not yet been made.

The following are the programmes of Papers promised for Sections F and G of the congress. Similar programmes of Sections A, B, C, D and E have already been published in *The Electrician*, May 6th, June 10th and 24th.

Section F.—Electric Transportation.

Mr. Ernst Danielson, "Theory of Compensated Repulsion Motor"; Mr. Philip Dawson, "Electrification of British Railways"; Herr F. J. Eichberg, "Single-phase Electric Railways"; Prof. Dr. F. Neithammer, "Alternating versus Direct-current Traction"; Prof. Dr. Rasch, "The Puffer Machine in Railway Service and its most suitable Control"; Mr. A. H. Armstrong, "The Electrification of Steam Lines"; Mr. B. J. Arnold, "Electric Railways"; Mr. Louis Duncan, "General Review of Railway Work"; Mr. J. B. Entz, "The Storage Battery in Electric Railway Service"; Mr. C. O. Mailloux, to be announced; Mr. E. H. McHenry, "Some Qualifications of Electric Railway Equipment for Trunk Lines"; Mr. R. A. Parke, "Braking High-speed Trains"; Mr. W. B. Potter, "Electric Railways"; Mr. F. J. Sprague, "The History and Development of the Electric Railway"; M. L. B. Stillwell, "Notes on the Electrical Equipment of the Wilkesbarre and Hazleton Railway Co."; Mr. H. G. Stott, "Central Station Economics and Operation"; Mr. W. J. Wilgus, "Equipping the Central Terminal."

Section G.—Electric Communication.

Senor Don Julio Cevera Baviera, "Electric Communications in Spain"; Dr. J. A. Fleming, F.R.S., "The Present State of Wireless Telegraphy"; Mr. John Hesketh, "A New Danger to Lead-covered Aerial Telephone Cables"; Herr Joseph Hollos, "Simultaneous Telegraphy and Telephony"; Mr. Saitaro Oi, "Telephony and Telegraphy in Japan"; Herr V. Poulsen, "System for Producing Continuous Electrical Oscillations"; M. G. de la Touanne, "Questions connected with Rates and Management in a Telephone Exchange"; Mr. J. C. Barclay, "Printing Telegraph Systems"; Dr. Albert C. Crehore, "Rapid Telegraphy"; Dr. Lee de Forest, "Wireless Telegraph Receivers"; Mr. Patrick P. Delany, "Rapid Telegraphy"; Mr. Hammond V. Hayes, "Telephony"; Mr. Franz. J. Dommerque, "The Telephone Problem in Large Cities"; Prof. Reginald A. Fessenden, "Wireless Telegraphy"; Mr. J. C. Kelsey, "Features of Two-strand Common Battery Systems"; Mr. Kempster B. Miller, "Problem. Automatic versus Manual Telephone Exchange"; Mr. F. A. Pickernell, "Telephony"; Mr. Louis M. Potts, "Printing Telegraphy"; Col. Samuel Reber, "Military Use of the Telephone, Telegraph and Cable"; Prof. George F. Sever, "Electrolysis of Underground Conductors"; Mr. L. W. Stanton, "Economical Features in Modern Telephone Engineering"; Mr. John Stone Stone, "The Theory of Wireless Telegraphy."

The chairmen of the respective sections are Dr. Louis Duncan and Mr. F. W. Jones, and the secretaries are Mr. A. H. Armstrong and Mr. B. Gherardi.

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THE NEW TWO-PHASE STATION AT SHEFFIELD.

Electricity works nowadays follow one another largely on the same standard lines, and, therefore, descriptions of them are apt to form wearisome reading unless the stations possess some particular new feature of interest. In the case of the new electricity works at Sheffield this special feature is the arrangement of the boilers and their furnaces, a "regenerative" system of induced draught being employed, from the use of which considerable economy is not unreasonably anticipated.

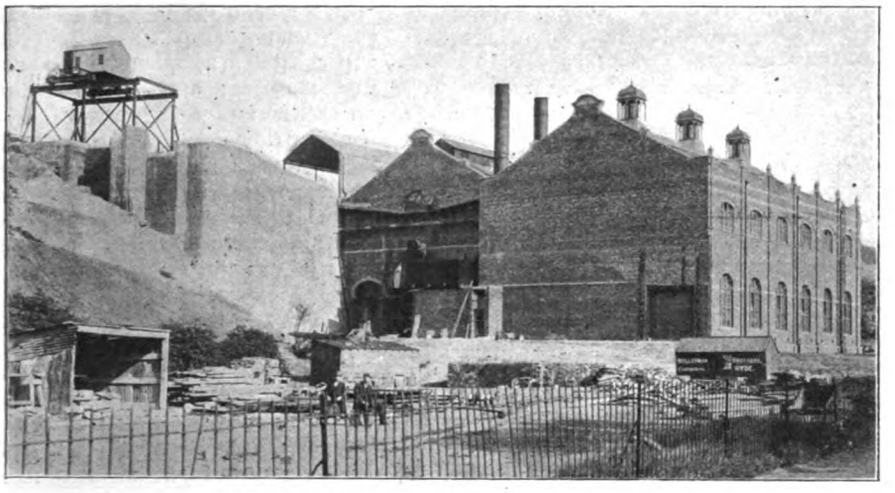

FIG. 1.—GENERAL VIEW OF THE NEEPSEND WORKS.

The electricity supply undertaking in Sheffield is one of the oldest in the United Kingdom. The Sheffield Electric Light & Power Co. was formed in 1892, but some years before his undertaking developed into a company Mr. John Tasker had been supplying electric light to some outside consumers from his factory in Sheaf-street, where, subsequently, a larger generating station was built. In 1897 the Corporation bought the electricity works from the company, paying a large premium for the undertaking, the sum being so large that it still represents a considerable portion of the capital expenditure of the concern, as is seen by the analysis given later in this article. Although the old generating station was situated in the centre of the city, the area being a large one, the usual practice of the time was followed and a single-phase system adopted. For the electric tramways, which were opened in 1899, a separate department was formed and an independent power house built. In 1900 it was decided, in view of the large outlet for electric power supply in Sheffield, to change over the system from single-phase to two-phase, and this work has been gradually completed while the new works at Neepsend were in course of erection. The generators at the old works have been re-wound for two-phase supply, and the new generating plant at the Neepsend station is, of course, two-phase.

The site chosen for the new works at Neepsend is about 2 miles from the centre of the city, and is an ideal one from the point of view of coal and water supply. It is situated on the banks of the Don at a point above the town where a sufficiency of clean water can be obtained for condensing purposes, and the site sloped upwards from the river bank to the Great Central Railway, leaving just the right amount of room for the works between the river and the railway. To build the works, however, a considerable amount of excavation was necessary, about 40,000 tons of earth and rock being removed, and a high retaining wall (see Fig. 1) had to be built against the railway siding. Some of the cost of this was saved, however, by erecting brick works on the spot and thus making a certain proportion of the bricks required for the buildings and the retaining wall. As seen in the plan (Fig. 3), the present buildings are large enough to accommodate four sets of 1,500kw. capacity, but there is sufficient land to allow of enormous expansion at a future date. The buildings are wide and high—unnecessarily so for the class of plant adopted—and extremely well lighted by a glazed roof and large side windows, and the bright white tiles with which the engine room is lined assist materially in thisdirection. In fact, the cost of the buildings must have been a large proportion of the whole cost of the new works Messrs. Wellerman Bros. were contractors for the buildings, Messrs. Mellowes & Co. being sub-contractors for the plumbing and glazing and patent roof glazing.

After passing the weighbridge, seen to the right in Fig. 1, the coal waggons can be run into the coal store, or the waggons may be shunted under a Chatteris travelling crane worked by hand and capable of lifting and traversing loads of 20 tons. By this means, goods can be picked out of the railway trucks and lowered down to the system of tramrails which runs through the station yard, boiler and engine houses and to the ash elevator. The present coal store can accommodate 1,000 tons. The coal is discharged from the railway trucks or trimmed from the store directly into the steel coal shoots, which are fitted with breeches pipes and measuring chambers, through which the coal falls by gravity into the hoppers of the Bennis stokers. By an arrangement of valves each charge is automatically measured, and the amount of coal registered on counters. The valve arrangement is such that it is impossible for the attendant to obtain coal without due registration, as the indicator must register before the coal valve is opened, and, conversely, the outlet valve must be closed before the feed valve is opened. The ashes from the boilers are wheeled out in dumping cars, running in a tunnel

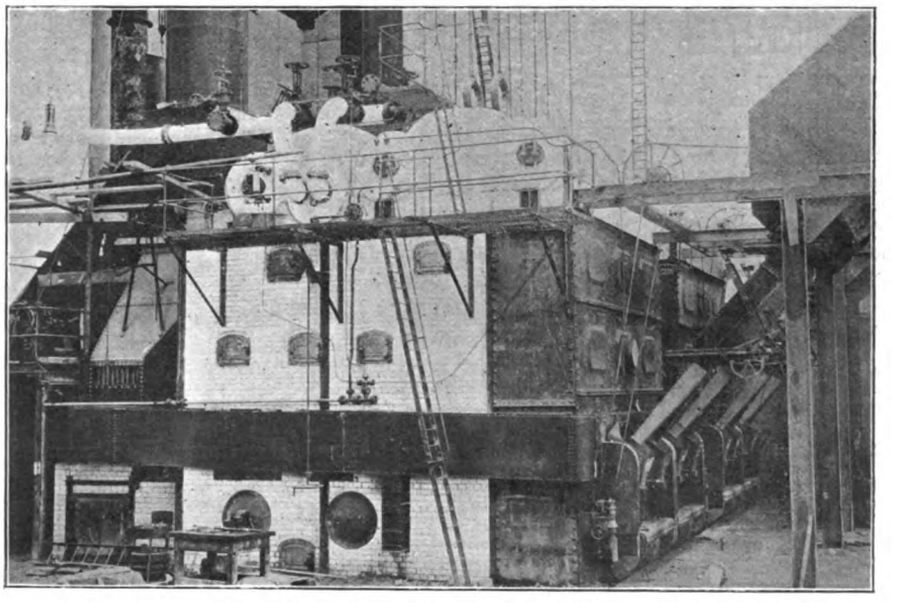

FIG. 2.—GENERAL VIEW OF BOILER HOUSE.

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below the firing plates, and deposited upon a grid covering the elevator hopper. They are then lifted by a bucket elevator into a storage chamber, from which carts or trucks can be loaded. The elevator is driven by a 7 B.H.P. two-phase motor.

Two Stirling boilers have been put in, each fitted with a superheater, and two more of the same type and size are on order. Each boiler is rated to have an evaporative capacity of 30,000lb. per hour and a guarantee of 80 per cent. efficiency is given. Although among the largest that the Stirling Company has built, the boilers are of their standard pattern, with three steam drums above and two mud drums below connected by four banks of tubes slightly sloping from the vertical. The boilers and their fittings have been constructed under the supervision of the National Boiler and General Insurance Company, and have been designed for a working pressure of 200lb. per square inch.

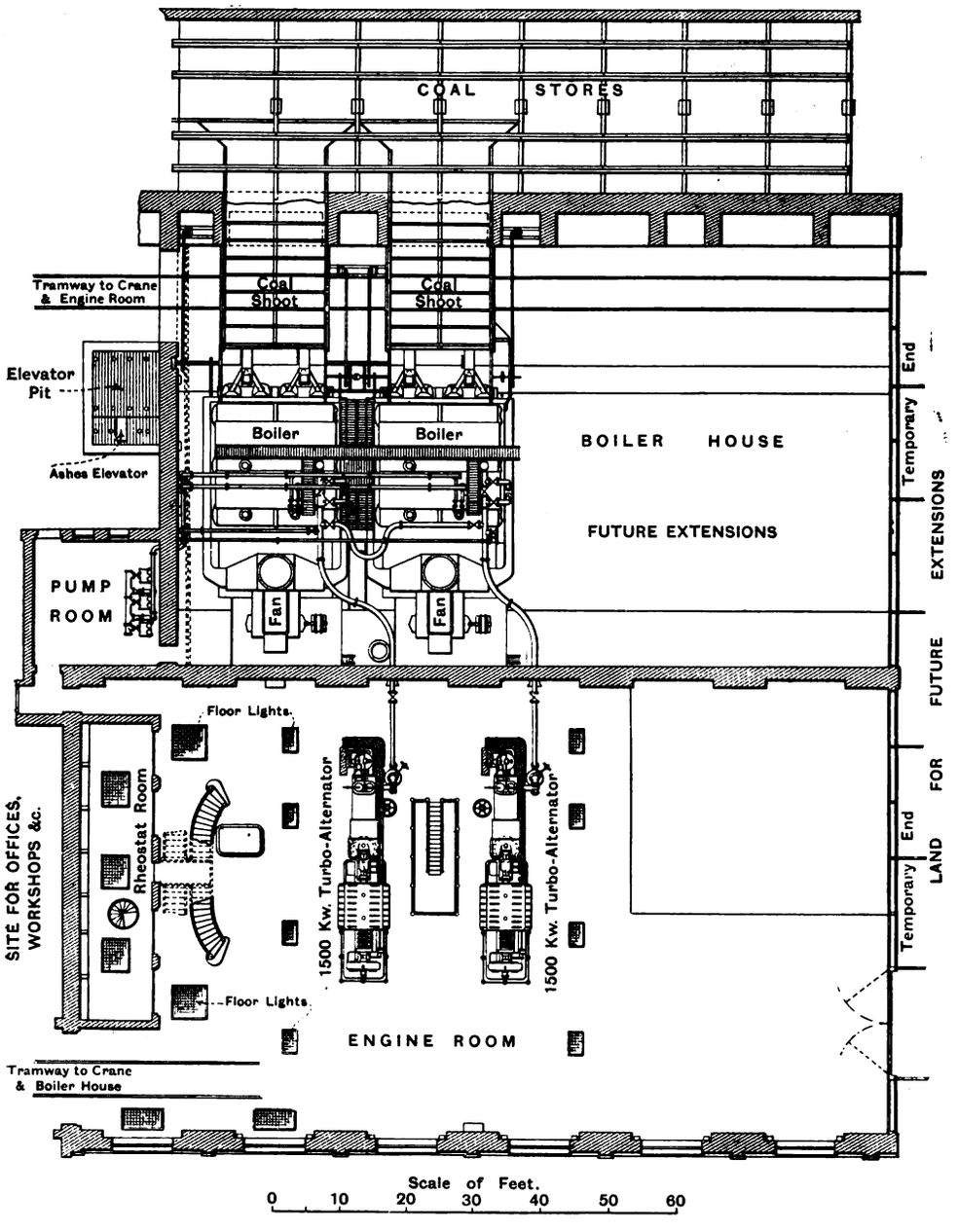

FIG. 3.—PLAN OF THE NEEPSEND GENERATING STATION.

Each boiler is fitted with Bennis quadruple machine stokers and compressed air furnaces, each arranged with strong cast-iron side bars, and seven compressed air bars. The front of the bars is carried on strong iron stretchers and rollers, the back ends being supported on a substantial cast-iron bearer; and the backs of the furnaces are sealed with brickwork carried on a cast-iron bridge, below which is fixed a cleaning-out door. The stoker and furnace mechanism is carried on substantial cast-iron fronts, box shape, and fitted with bafflers, cast-iron jambs, &c., suitable for the induced regenerative air system employed. The two outside furnace fronts of each machine are provided with a seating for carrying a gear box. This latter gives all the motion to the furnace bars and mechanical stokers, and is fitted with claw clutches for disengaging the bars or boxes or both at will. Each of the mechanical stokers or throwing-out boxes is mounted on a seat provided on the furnace front. These boxes are of pneumatic type, each fitted with reciprocating feed cams, which allow of a wide variation in the feed of fuel to the furnaces. Opposite each compressed air bar a $\frac{1}{16}$in. diameter steam jet is arranged, the steam used for these jets being superheated in a copper coil arranged in the ashpit; a valve is provided on each jet pipe for regulating or shutting down. Each furnace front is fitted with a fire door to allow of hand-firing if necessary. The driving of the stokers is effected by means of two 3½ B H.P. two-phase electric motors per boiler through counter-shafting by means of raw hide belts. Each section of counter-shafting is provided with a coupling so that one motor may run two sections in the event of breakdown.

The most interesting part of the boiler plant, however, is the system of induced draught already mentioned, and for working in conjunction with which the Bennis stoker appears to be particularly well adapted. The system is a development of the Ellis and Eaves system of induced draught as manufactured by Messrs. John Brown of Sheffield, who have fitted the system at the old electricity works as well as the new one which we are now describing. Certain improvements due to Mr. Fedden, the electrical engineer to the Sheffield Corporation, have been embodied in the system. The general arrangement is seen in the views of the boiler house (Figs. 2 and 4) and in the detailed drawing Fig. 5. The flue gases are drawn from the boiler by a fan, passing through a group of 423 2$\frac{5}{4}$in. air-heating tubes on their way to the fan and the chimney. These tubes are seen to the left in Figs. 2 and 4, and also in Fig. 5. The air supply passes around the tubes and along flat air ducts at the side of each boiler (one of which is also clearly seen in Fig. 2) and part of the air passes into the furnace between the bars of the Bennis stoker, while part is led into the boiler at the side, near the back of the furnace, the position of this second inlet being clearly seen in the Figs. 2 and 5. The air here passes into the furnace through 24 openings 3in. by 2in. The fan for each boiler is capable of dealing with 45,000 cubic ft. of air per minute, and is driven at 580 revs. per min. by a 35 B.H.P. two-phase motor, the motor being provided with a speed-regulating rheostat by means of which it may be driven at five lower speeds when required. By-pass flues are provided, so that natural draught can be used should the induced-draught plant be disabled through any cause. There is a separate steel chimney for each boiler, 60ft. high by 5ft. diameter, and the dimensions of the chimney bases are 15ft. 5in. high by 5ft. 5in. square.

Each boiler is connected to its engine by a 7in. wrought-

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steel lap-welded steam main, with bends of large radius, as seen in Fig. 3. In addition, there is an inter-connecting main of the same size, which can be employed for cross-connecting a

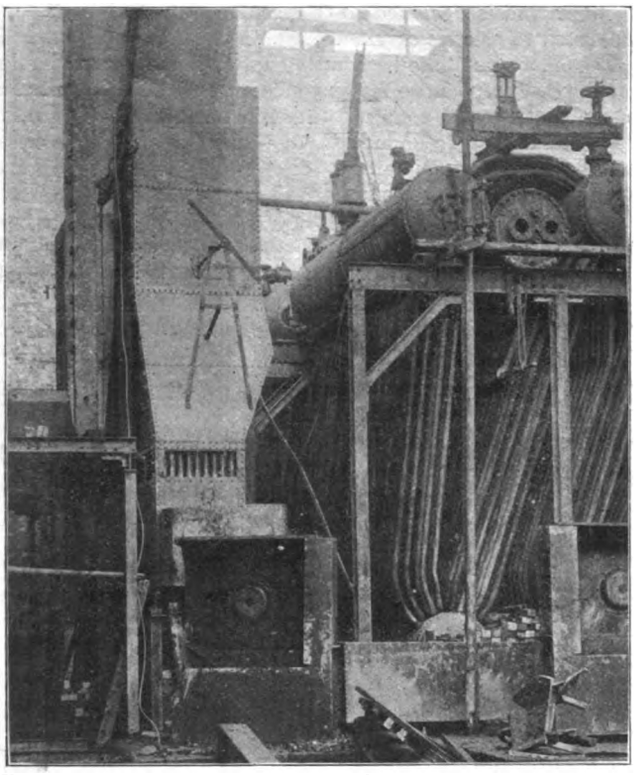

FIG. 4.—ONE OF THE BOILERS UNDER CONSTRUCTION, SHOWING THE AIR-HEATING BOX AT THE BASE OF THE CHIMNEY.

boiler to another engine if necessary. This main has a large steel expansion bend. The feed range is a ring-main, however, consisting of 4in. pipes with large copper expansion bends. The pipework has been supplied partly by Tasker's Engineering Co., and partly by the Sir Hiram Maxim Electrical and Engineering Co, and it is covered with the United Asbestos Co.'s material.

Three feed pumps of the Worthington long-stroke vertical double-acting type have been put in. They draw their water from an overhead tank above the pump room, which is divided into three parts, with a total capacity of 20,000 gallons, the suction piping being so arranged that any of the pumps can draw from either of the sections of the tank. The make-up water is taken from the town mains.

In the engine room (Figs. 3 & 6) there are two Parsons turbines, each of 1,500kw. capacity, and designed for steam with 150deg. of superheat. These run at 1,500 revs. per min., and are directly coupled through flexible couplings to the two-phase alternators. The alternators are four-polar, and have fixed magnets and revolving armatures, supplying current at from 2,100 to 2,200 volts and 50~ per second. Each set has its own surface condenser in the basement, but no "augmentor." Cooling water for the surface condensers enters from the river through strainers and controlling shuttles to a concrete chamber, from which it flows through a 36in. cast-iron main to an 8ft. by 4ft. culvert in the basement of the engine bay. Iron-flanged pipes of 11in. bore lead from this culvert to each condenser, and the water is returned through 14in. pipes to a common main which discharges it lower down the stream. The air pump discharge can be measured by a Glenfield and Kennedy hot water meter, arranged with a by-pass.

The circulating and air pumps are motor-driven, the speed of the motors being regulated in all cases by resistances in the rotor circuits. A 30 B.H.P. motor is provided for each circulating pump, and an 11 B.H.P. motor for each of the air pumps.

The following tests of the turbo-alternators were made at the makers' works last November:—

1,500kw. Turbo-alternator, No. 846, 1,500 revs. per min.

—	Pressure. Lbs. per sq. in.	Superheat deg. F.	Vacuum in in.	Load in kw.	Steam used per hour.	
					Lbs.	Lbs. per kw.
No load ..	148·7	38 4	28·57	..	2,878·0	..
¼ full load..	145·0	1'0·0	28·14	529·9	11,453·0	21·58
½ full load..	131·0	123·6	27·52	1,070·9	19,591·5	18·24
Full load ..	128·5	125·3	26·76	1,584·65	27,855·0	17·61

Average drop in volts from no load to full load, 3·15 per cent.
Average full load excitation, about 0 5 per cent.

Oil coolers are erected in the basement below the turbos, through which the lubricating oil for the turbos is passed, and cooled by means of a cold-water circulation. This water is obtained from the condensers, and, after passing through the coolers, is led into the circulating discharge pipe. For use in the event of the plants running on atmosphere at any time, a pipe from the town's main is also connected to these coolers. These coolers are in the form of cast-iron cylinders, containing copper pipes.

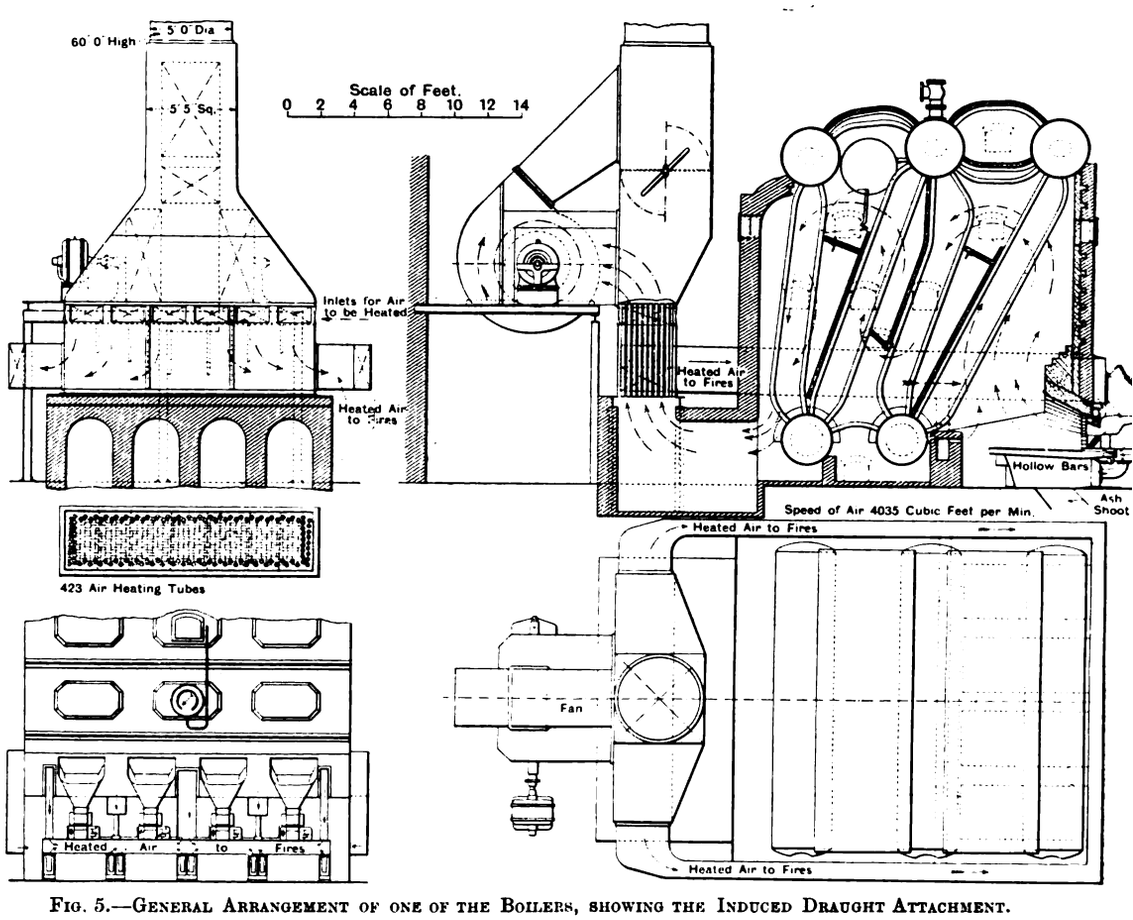

FIG. 5.—GENERAL ARRANGEMENT OF ONE OF THE BOILERS, SHOWING THE INDUCED DRAUGHT ATTACHMENT.

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A B.T.-H. high-tension switchboard is placed on a high gallery at the left-hand end of the engine room, as viewed in Figs. 3 and 6. The cables come up through connectors designed by the Sheffield mains department and shown in Fig. 7. The inner of the concentric passes straight through the connector, and the outer is simply clamped by the conical arrangement seen in the figure, without being soldered. The stoneware pot surrounding the whole is then filled up with compound. The instrument transformers and the oil switches are at the back of the switchboard, only the handles and the release coils of switches being on the front, together with the horizontal edgewise instruments, &c. Above the board, and out of reach, are the isolating switches. In the basement at the same end of the engine room as the switchboard there is a sub-station for the works lighting at 100 volts, and the motors driving the auxiliaries at 200 volts. The wiring of the station circuits is drawn in "Simplex" screwed conduit, and a battery is to be provided (charged by a motor-generator) on to which the chief station lighting circuits can be switched in the event of a breakdown of the generating plant.

From the Neepsend works to the old Sheaf-street station in the city, two trunk feeders have been laid, consisting of two pairs of 0·5 sq. in. concentric cables. They are of Messrs. W. T. Glover & Co.'s make, and are insulated with "diatrine paper" and lead-covered. The cables have been tested to 10,000 volts for 15 minutes between the conductors and 5,000 volts between the outer and lead. Sample lengths were then bent six times in alternate directions round a drum 12 times the diameter of the cable, and successfully withstood 20,000 volts afterwards. The two concentrics are used one for each phase, and the outers are earthed at Neepsend, so that the switch gear is all single-pole. They are drawn in to 4in. cast-iron pipes.

Owing to the 'bus bar volts being varied with the load in the station it is necessary in order to keep the pressure constant at the distributing centres in the city, to feed the local transformers through variable boosters, by means of which the working voltage in the station can be kept at 200. These transformers are of the Burnand type and are wound in sections and connected up to multiple contact switches, which are interlocked with reversing switches in the shunt winding. By manipulating these, a boost of 150 volts in 15 steps of 10 volts can be made either up or down on the primary transformer feeding cables. The primary of the boosting transformers is bridged across the main 'bus bars and the secondary is in series with the main circuit.

The engine room crane, supplied by the Chatteris Engineering Works, is constructed to deal with daily working loads of 20 tons, and is designed so that at any future date it can be converted to electric driving.

The old single-phase distributing network has been maintained unaltered, except in so far as concerns the changes to the arc lamps, meters and some of the transformers in view of the reduction of the frequency to 50~ per second, and a certain amount of rearrangement to circuits so as to divide them equally over the two phases. Some new sub-stations have, of course, been added, and some of the old ones enlarged, and two-phase current is taken to the power consumers by means of cables independent for the most part of the old single-phase lighting circuits. Fig. 8 shows the large sub-station at Cammell's rolling mills, supplying a large number of motors, some as large as 80 H.P., and running night and day. There are four Burnand transformers, each of 100kw., connected two on each phase, and, owing to the continuous running, it has been necessary to instal a Sirocco fan to keep the sub-station cool, although the magnetising current is said to be only 0·5 per cent. of the full-load current.

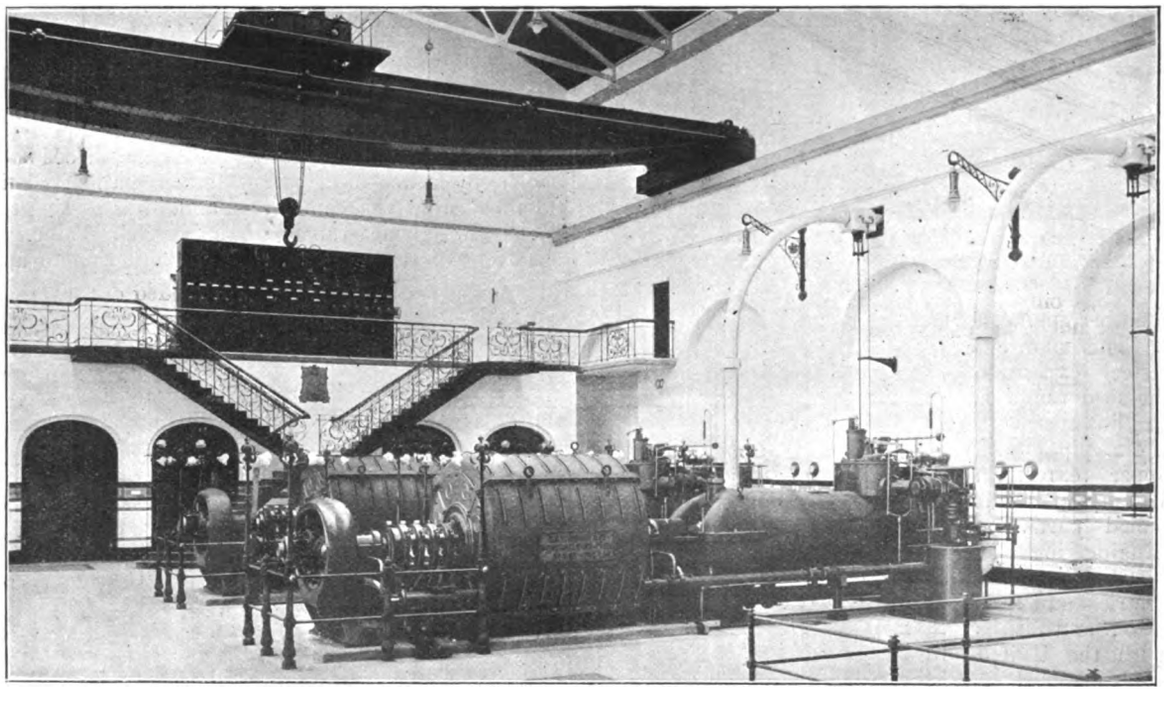

FIG. 6.—VIEW OF ENGINE ROOM.

It may be mentioned that the Sheffield electricity department makes its own transformers under the Burnand patents. A well-illustrated description of the Burnand transformer appeared in *The Electrician*, Vol. XLIX., p. 862, and the transformers made at Sheffield are of the same pattern, except that the sandwiching of the four sections of the core is done every few laminations instead of every 75 or 100, as was the practice originally. This, we understand, reduces the iron losses to a considerable extent, and has been adopted by the Burnand Company also at Mr. Fedden's suggestion. A useful portable sub-station has also been made, consisting of transformers and switch gear contained in a covered horse-drawn trolley, and this has proved of considerable service, having in some cases been in use for months in one position during the building of permanent sub-stations.

The accounts for the Sheffield undertaking for the year 1903-4 have just been issued, and show a considerable improvement in the works costs, due to the changes made at the old station, although the new works at Neepsend were not yet in operation. No fewer than 3,980,049 units were sold, as against 2,919,722 of the year before; and the respective total

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costs of generating and distributing these amounted to £12,955 in 1903–4 and £12,067 in 1902–3. These figures, which do not include "management charges," interest, sinking fund, &c., show that the works costs per unit were 0·78d. in 1903-4 and 0·99d. in the previous year. Of course, it must be borne in mind that there is no public lighting whatever in Sheffield,

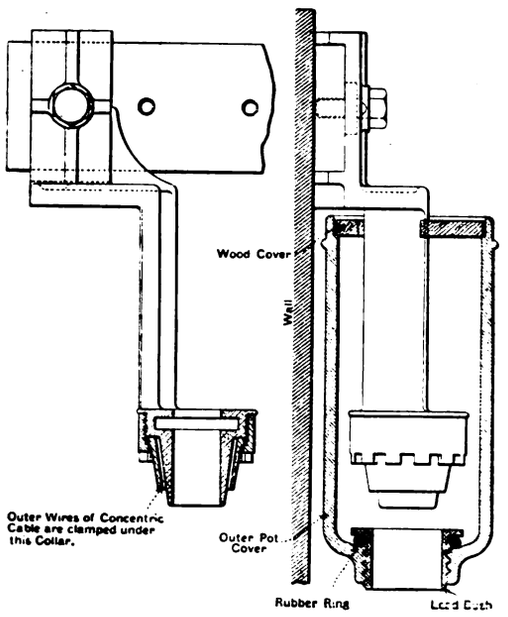

FIG. 7.—SECTIONS OF CABLE CONNECTOR.

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and no traction load, as the tramways are supplied from a separate department, and that, owing to the old single-phase system, which has only recently been replaced by two-phase, the motor load is not so large as it might be. In the following table, which gives the comparative figures of the last two years for the various items, it will be observed that there is no

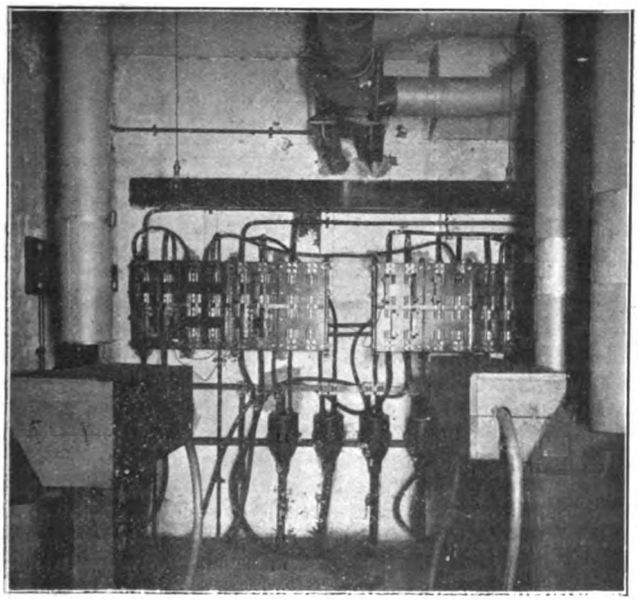

FIG. 8.—SUB-STATION WITH FAN VENTILATION AT CAMMELL'S ROLLING MILLS.

figure set down opposite "Wages" under "Distribution costs," these being presumably included under other items. It would have been interesting, also, if separate accounts were given to show the turnover and profit of the Corporation's "Installation" and "Manufacturing" departments.

The actual maximum supply demanded has increased from 2,797kw. to 3,740kw. in the 12 months, but the plant capacity

—	Year ended March 25, 1903.	Year ended March 25, 1904.
Total units sold	2,919,722	3,980,049
GENERATING COSTS—	pence.	pence.
Coal	0·44	0·36
Oil, waste, water and stores	0·04	0·02
Wages at stations	0·22	0·17
Repairs and maintenance	0·20	0·13
	0·90	0·68
DISTRIBUTION COSTS—		
Wages	..	..
Repairs of mains	0·05	0·05
,, transformers, &c.	0·04	0·05
	0·09	0·10
Total works costs	**0 99**	**0·78**
MANAGEMENT CHARGES, &C.—		
Rates and taxes	0·16	0·14
Salaries, stationery and establishment charges, &c.	0·15	0·12
	0·31	0·26
Interest	1·53	1·36
Redemption fund	0·50	0·70
Total Costs	**3·33**	**3·10**

still remains the same—viz., 5,125kw. From these data and the units sold as given in the above table, the load-factor works out at 12·15 per cent. for the year ended March 25, 1904, and 11·92 per cent. for the year ended March 25, 1903. This increase in load-factor is quite in keeping with the greater number of equivalent 8 c.p. lamps connected, which has increased from 212,722 to 275,363, and the number of consumers from 2,100 to 2,477. In the following table there is given an analysis of the capital expenditure, showing the amount per kilowatt installed expended on the various items, together with the percentage which each item represents on the whole capital expenditure. The large item under "Miscellaneous" includes £143,685 "Premium account," which presumably represents the premium paid to the old company on taking over the undertaking, and amounts almost to one-fifth of the total capital, or £28 per kilowatt installed up to March, 1904.

Account.	Total, March 25, 1904.	£ per kw.	Per cent. of total.
Land	£18,928 13 9	3·68	2·56
Buildings and foundations	39,745 12 1½	7·74	5·38
Machinery	158,606 17 11	30·83	21·44
Mains and services	283,554 17 8	55·33	38 24
Tranformers, motors, &c.	26,466 7 3	5·16	3·57
Meters	17,001 17 2	3·32	2 29
Electrical instruments and tools	1,587 10 3	0·31	0·22
General stores	9,261 11 9	1·81	1·25
Office furniture	1,835 18 0½	0·36	0·25
Miscellaneous	183,953 17 9	35·81	24·80
	£740,943 3 8	144·35	100·00

Summarising, the works costs for the year 1903-4 were £12,955, to which must be added £2,336 for rates and taxes, £1,943 for management charges, &c., thus making a total of £17,234. This, of course, represents working expenses, and as the sale of electricity, meter rents, &c., have brought in £56,876, there is a balance of £39,642, to which must be added £18,432, being the balance from last account, making a total of £58,074. This has been disposed of as follows:—To interest on mortgage, stock and bank charges, £22,608: to sinking fund, £11,604; to suspense account, £2,860; to balance carried forward, £21,002.

In concluding this article we desire to express our acknowledgments to Mr. S. E. Fedden (the general manager and engineer) and Mr. J. W. Beauchamp (the deputy manager) for permitting us to inspect every detail of the works and for placing all information at our disposal. The formal opening of the new works by the Mayor of Sheffield took place on Monday, June 27th.

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THE NORTH-EASTERN RAILWAY AND CARVILLE POWER HOUSE.

(Continued from page 427)

Switch Gear.—The Carville switchboard occupies four galleries outside the crane stanchions, and extends the whole length of the engine room, a basement being provided below the bottom gallery which is level with the engine room floor. The two uppermost galleries contain the two sets of 'bus bars, the main oil switch and the operating panels are placed on the next gallery, while the ground floor is occupied by the instrument transformers, &c. All cables, whether outgoing feeders or those from the generators, are brought up through the ground floor immediately below their respective sets of switch gear, and from this point until they reach the 'bus bars run as nearly perpendicular as possible, so that there are no cases of high-tension leads crossing or running under ceilings or false floors; in fact, each set forms a complete and independent panel through all the floors throughout the height of the building. These panels are built up of concrete slabs, cast into shape before erection, and are so constructed and assembled that when complete they constitute a wall running down the centre of the galleries and extending vertically from the ground floor to the top of the building. On one or both sides of this wall, as required, vertical projecting partitions 3in. in thickness are

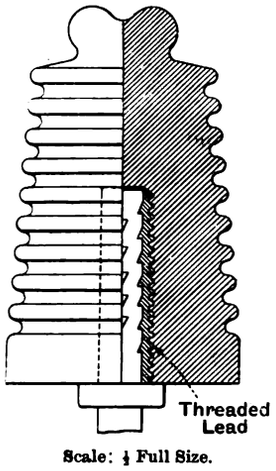

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FIG. 3.

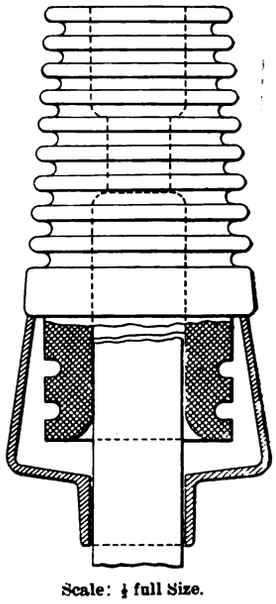

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FIG. 4.

provided, and at other points small enclosed chambers are built up for isolating certain pieces of the apparatus. The partitions on the wall are so arranged that the apparatus and connections of each phase are contained in a separate compartment throughout. Unlike other boards of this type, no brickwork is used, the chambers and partitions being entirely constructed of moulded concrete, which has been found equally satisfactory and less costly than the former. All the concrete work is painted with white enamel paint, which not only gives a pleasing finish but serves also to prevent dust, which would otherwise arise from the concrete. In the separate compartments, however, red, white and blue square patches have been painted on both sides of the board and on every gallery. This facilitates the tracing out of a cable, and constitutes an easy method of identifying different feeders and generator cables, as each patch bears a distinctive number corresponding to its particular cell or compartment.

Referring to Figs. 10 and 12 of Mr. Merz's Paper on Power Station Design on pp. 136 and 137 of *The Electrician* for May 13, in which the general arrangement of the concrete work is seen, it will be noticed that on the engine room side all apparatus on the switch and 'bus bar galleries is entirely enclosed, whilst, by providing doors placed at the ends of the concrete work, access is prevented to the portions at the back where live metal is within reach. Owing to the fact that the generator panels are, in many respects, similar to feeder panels, it may be as well to describe the latter first and then point out in what respects they differ. The feeder cables are laid on the solid system quite up to the switchboard. Outside the station they are laid in wood troughing filled in with pitch and covered with 3in. tiles, made specially heavy to ensure efficient protection. When once they enter the station, however, the wood troughing is abandoned and iron troughing, with iron covering, substituted for it. This troughing was designed by Messrs. Siemens Brothers to Mr. Merz's specification, and consists of seamless wrought iron ¼in. thick stamped out of sheet material. The ends of the lengths are so fashioned as to fit into one another, and the joints of the covers occur at intervals not coinciding with the joints of the troughing itself. Not more than one

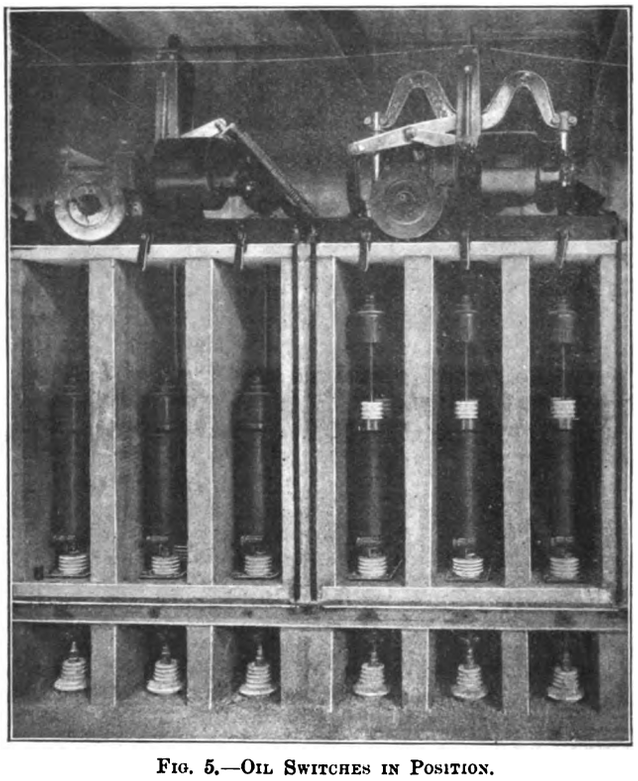

FIG. 5.—OIL SWITCHES IN POSITION.

cable is laid in each trough, except in the case of pilots and telephone wires, which have been laid together, and the arrangement, therefore, forms a very admirable protection against damp and rough usage. All the feeder cables come in at one end of the basement and are laid side by side, in the iron troughs, along the concrete floor. Each cable is then taken up vertically through the ceiling directly on to the particular panel of the board which has been provided for it. The iron troughing is continued vertically quite up to the ceiling and fastened, so that it supports the cable to a large extent. In spite of the fact that the troughing is of ¼in. wrought iron, all bending was done on the spot and no difficulty whatever was experienced in this respect. Up to the present time, the cables in their troughs simply lie on the basement floor with no further covering, but it is proposed to cover them in with sand and then a thin layer of concrete, which may be easily broken in the event of an accident occurring—a very unlikely contingency.

The cables themselves are three-core paper-insulated lead and copper-sheathed; immediately above the gallery floor they terminate in a cast-iron dividing box (seen in the front elevation, of the figures mentioned above) in which the cores are jointed to three short single-core lead-covered cables. These are just long enough to reach into the separate phase compartments, where they terminate in end sealing bells, from which the bare core projects and is

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connected to a pair of isolating switches. These consist of ordinary lever switches mounted on porcelain insulators; they are not provided with handles, but the blade is drilled so that it can be operated by means of a hook on a long insulating handle. These isolating switches really perform three functions: supposing it to be necessary to clean or overhaul the main apparatus, such as connections, oil switch, &c., corresponding to a particular feeder, the left-hand blades of the switches of that feeder would be withdrawn, and everything on the side of the oil switch remote from the 'bus bars is immediately made dead. It is important, however, although a feeder may be disconnected, that the voltage may be known and that the cable itself may be protected from surgings and dangerous rises in voltage.

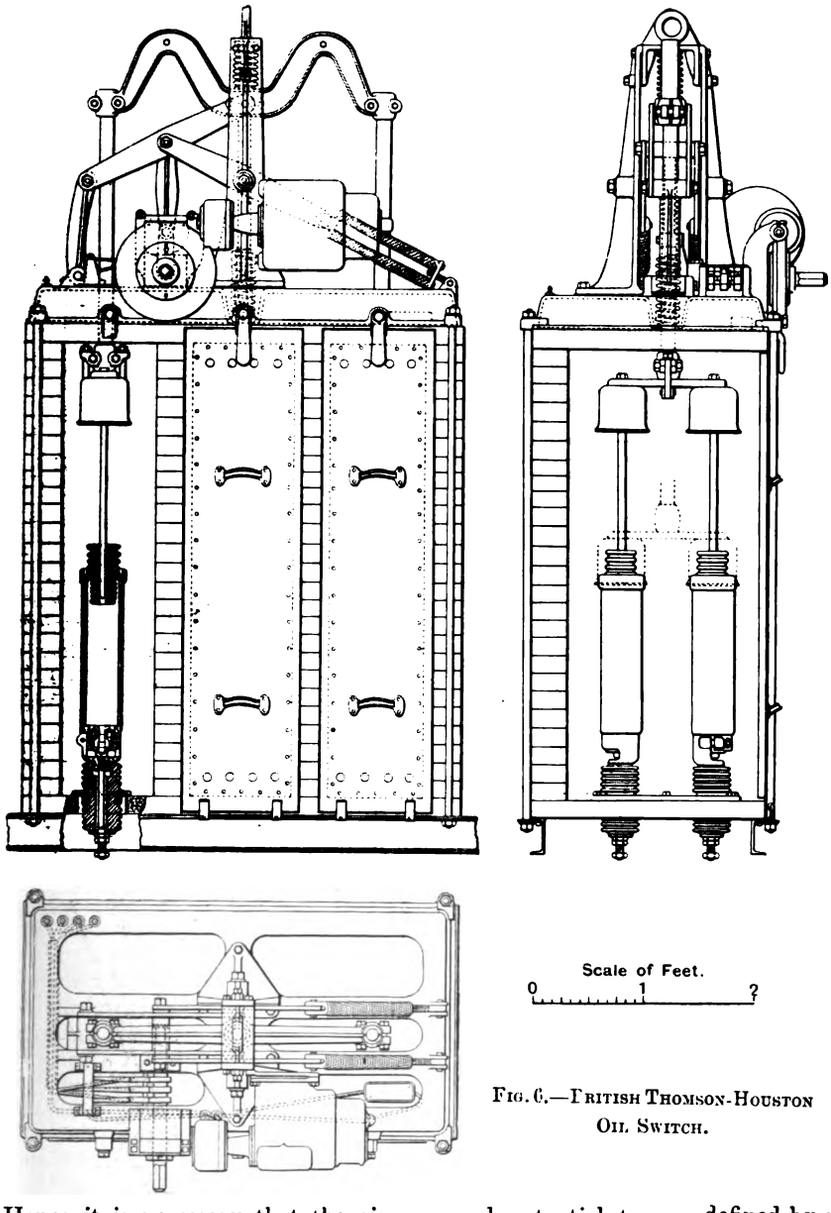

FIG. 6.—BRITISH THOMSON-HOUSTON OIL SWITCH.

Hence it is necessary that the air-gaps and potential transformers should remain connected, and this is effected by means of the cross connection from the lower left-hand terminal to the upper right-hand terminal. But it may be necessary to cut out the air-gaps and potential transformers while the feeder is working, and this can be done by pulling out the right-hand blade of the isolating switch without in in any way interfering with the ordinary working of the feeder. Naturally this arrangement is not required on generator cables, as when once the oil switch is opened and the turbine shut down there is no possibility of the cable or connections becoming alive. It also follows that no air-gaps are necessary on generator panels. The section of the feeder panel in the illustrations mentioned shows clearly how connection to the potential transformer is made through the concrete partition. The transformer itself is situated in a small compartment at the back of the board, and is protected by high-tension fuses. A stout sheet-iron cover is placed over the front of the compartment, and it is therefore impossible for any person to come in contact with high-tension connections; and if a breakdown of the transformer occur it is perfectly isolated from any other apparatus. Although the isolating switches are intended to be operated while alive, they are not intended, of course, to be opened when any energy is flowing through them.

Above the main isolating switches are the series transformers for operating the ammeters and relays, and from the tops of these transformers connections are taken up through the floor to the bottom of the main oil switches. All the connections between the various pieces of high-tension apparatus consist of rubber-covered cable supported on porcelain insulators. The rubber insulation, though guaranteed by the makers to withstand the full working pressure, is intended as a safeguard only, sole reliance for insulation to earth being placed on the porcelain insulators. These are corrugated, and have been specially designed to give a very long leakage surface. Fig. 3 shows one of these insulators, to the extreme end of which the cable is tied by means of cord. Where connections are taken through the concrete floors or partitions hollow porcelain insulators with corrugated ends are used. These are similar in many respects to the insulator shown in Fig. 4, which illustrates the type used for bringing the cables out of the three-way dividing boxes. In this insulator the mouth of the sealing chamber is bored to fit the lead covering of the cable, and after the latter has been bared and passed through the insulator, compound is poured into the sealing chamber and the insulator pushed home. The compound then hardens, and owing to the taper of the sides of the chamber and the corrugations of the lower part of the insulator, a very sound job results. The final operation is the pouring of compound into the top of the insulator, so as to fill in the annular space between the cable and the inner walls of the insulator. The insulators for the Carville board have been specially designed to fulfil the required conditions, and have been supplied by English makers.

After passing through the isolating switch, the feeder goes through the current transformer, and thence to the main oil switch which is on the floor above. As a matter of fact, this floor is occupied entirely by oil switches, which, extending side by side down the whole length of the engine room, form quite an imposing array. Here a digression may be made in stating that the dimensions of the oil switches are the most important factor in determining the amount of space to be occupied by each panel, whether feeder or generator. If cables are not to cross, it is obvious that each oil switch must occupy just the same fractional length of the board as the three sections forming one panel; and this is the case on the Carville board, and it may be remarked that separate panels are defined by painting a vertical black line on the edge of every third concrete partition. The oil switches, which are of the British Thomson-Houston type, are shown in Fig. 5, and their construction is clearly shown in Fig. 6. The switch mechanism consists of a strong iron cross-piece, from which hang three wooden rods, carrying the moving contacts of the switch. This cross-piece is supported on a parallel link motion which gives it a vertical travel and from which it is driven. Connected to a crank on the driving spindle is the link motion, so arranged that when the switch is in its open position this crank is on its top dead centre, and when the switch is in its closed position the crank is on its bottom dead centre. The spindle also carries a worm wheel which is driven through a worm shaft by the operating motor. Between the motor and the worm, however, is a friction clutch, so arranged that the switch mechanism

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can run faster than it is being driven by the motor, but cannot lag behind it. By this means a very quick break is obtained on the switch, since, as soon as the motor has started the crank over the dead centre, the mechanism travels rapidly and free of the motor under the influence of springs which are in compression both in the full-open and full-closed position. As the crank nears the other dead centre, and begins to slow down, the clutch again grips, and the motor forces it right up to the dead centre, at the same time compressing the springs ready for the next operation. On the same spindle as the crank are three contact pieces which close against contact fingers as required and operate the signal lamps which show whether the switch is open or closed, and also bring the motor to rest at the end of its run. The spindle has a square end to which can be fitted a large ratchet spanner for operating the switch by hand. For each phase the switch has a pair of brass oil pots supported on insulators. These oil pots form the main contacts On closing the switch, the metal cross piece carrying a pair of copper cups descends, and the cups, gripping the tops of the pots, make a good contact in air for carrying the main current. The oil break is obtained by means of copper rods which project downwards from the centre of the copper cups and pass through corrugated insulators let into the top of the fixed oil pots which act as a guide and enable the rods to engage with auxiliary contacts below the oil. On opening the switch these rods do not break circuit with the auxiliary contacts until after the main contacts have opened, and similarly, on closing the switch, the contact under the oil is made before that in air. The switches are operated by small continuous-current motors, and are all situated within sight of the operating panels.

On leaving the main oil switch, it will be seen that a cable for each phase is taken through to a vertical compartment at the back of the board, where it is connected, just below the ceiling, to another pair of isolating switches which are used as 'bus bar selector switches. After leaving the oil switches, all cables are rubber covered, and, in addition, are supported by insulators as previously mentioned. From the selector switches there are, of course, two cables to each phase, but being of the same polarity and voltage they are run in the same compartment. They pass through the floor of the next gallery and one is then connected to a lower 'bus bar, through an isolating switch, leaving the other to pass through the floor of the top gallery and make connection with the corresponding 'bus bar of the upper set, also through an isolating switch. By means of this arrangement of selector, or change-over, and isolating switches, it is possible to connect the cable on to either set of 'bus bars or on to both; it is also possible to disconnect any cable between the 'bus bars and the oil switch for purposes of repair or cleaning. These isolating switches are in every respect similar to those previously described.

(To be continued.)

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Report by Board of Trade (Labour Department) on Strikes and Lockouts in 1903." (London: Eyre & Spottiswoode; Edinburgh: Oliver & Boyd; and Dublin: E. Ponsonby.) 7d.

"Science Abstracts." June. Part 6, Vol. VII. Section A: Physics. Section B: Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

"Les Accumulateurs Électriques." By L. Juman. (Paris: Ch. Dunod.) fr.29.

"Consono-Vowel Vocabulary, for Code Telegraphing." By James Nicolson, A.M.I.E.E. (London: Whitaker & Co.)

"Jahresbericht des Physikalischen Vereins zu Frankfurt am Main für das Rechnungsjahr 1902-1903," with a supplement.

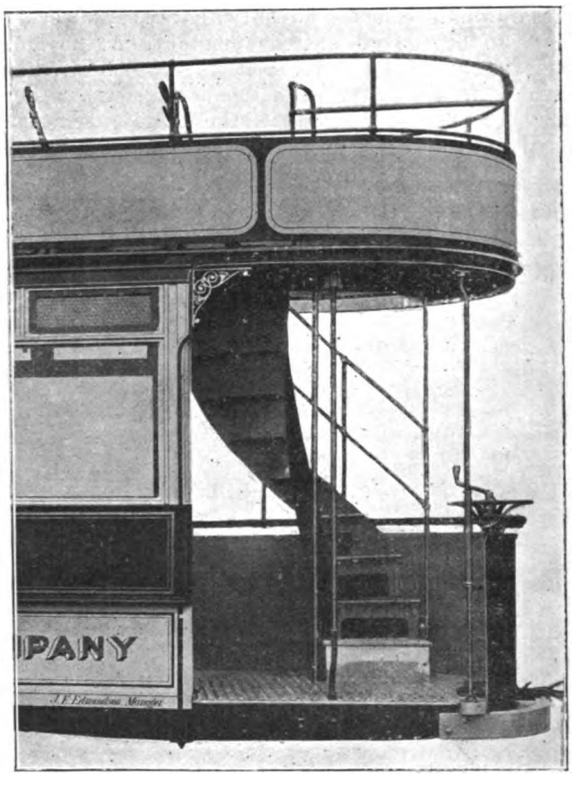
"Darstellung und Kritik der zur Reduction photographischer Himmelsaufnahmen aufgestellten Formeln und Methoden." By Dr. Phil. Walter Zurhellen.

"Die Beziehungen zwischen Aquivalentvolumen und Atomgewicht." By W. Borchers. (Halle-a-S.: Wilhem Knapp.) 0.80m.

"Die Elektrochemische Industrie Deutschlands." Vol. XII., "Monographien über angewandte Elektrochemie" series. By P. Ferchland. (Halle-a-S.: Wilhelm Knapp.) 2.50m.

THE "SEMI-REVERSED" STAIRWAY.

We give below an illustration of the semi-reversed stairway car, the new design recently brought out by the Brush Electrical Engineering Co. Cars of this pattern are now in use in Scarborough, Derby and elsewhere. It is seen that, while possessing



practically all the advantages of the reversed stairway pattern, it removes the disadvantage that the stairway partially obstructs the view of the driver.

THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

(*Concluded from p. 423.*)

Friday, July 1st.

The proceedings at Sheffield commenced somewhat late, owing to the unpunctuality of the train bringing the members from Derby, and by the time the Lord Mayor of Sheffield (Councillor J. R. Wheatley, J.P.) had concluded his welcoming speech little more than an hour remained for the discussion of each of the two Papers on the programme. A Paper by Mr. R. S. Downe (Southport) on "Boiler House Economies" was first taken. The author recommended that a rigid weekly analysis should be made of the units generated, together with the coal and water used. In taking the latter, he had found water meters unreliable after a few weeks' continuous running, and had recently employed two measuring tanks instead. To encourage careful stoking, Mr. Downe has introduced a bonus system for firemen at Southport. The bonus is divided between the four leading firemen, and has been fixed at 1s. per week for each tenth of a pound of coal saved below 6·5lb. per unit generated during the summer months and below 5·5lb. per unit during the winter months. Superheating is another means to economy, and the author has superheaters fixed in the down-takes of all his Lancashire boilers, and has been able in this way to raise the temperature of the steam leaving the superheaters by 80°F. to 150°F. Tests on one of his 250 I.H.P. Musgrave-Corliss condensing engines supplied with steam from a 7ft. by 28ft. Lancashire boiler with and without a Musgrave superheater showed a saving of 17 per cent. in water and 16 per cent. in coal with a superheat of 85°F. The author does not think that

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mechanical stoking conduces to much saving, but, on the other hand, is impressed with the advantages of forced draught. He apparently attaches more importance to avoiding a change in the class of fuel than to carrying out frequent analyses of it, but recommends the employment of a CO_2 recorder to keep a close watch on air leakages. Figures given in the Paper showed the value of investigations made in this direction in the author's own station. In concluding his Paper Mr. Downe expressed the opinion that it should be possible, by improvements in the design of boilers, to raise their thermal efficiencies considerably.

Mr. F. A. Newington (Edinburgh) stated that he had had satisfactory experience with Kennedy water meters for 14 years. He was of opinion that the bonus system should be extended to every department, if introduced at all, and several other speakers doubted its value also. Mr. Stromeyer (Manchester Steam Users' Association) recalled the fact that firemen were frequently paid a bonus of 1s. per ton by the colliery or coal merchants, which acted, of course, in the direction contrary to that desired by Mr. Downe. He mentioned another bonus scheme which had been tried in which the bonuses were not paid out until they exceeded £2, this sum always being kept in reserve to pay fines for black smoke prosecutions. Mr. Colley (Babcock & Wilcox Co.) also spoke on this question, suggesting that the bonus line should be varied according to the output of the station, but should not be a coal consumption too difficult of attainment, and Mr. Sugden contended that firemen were underpaid and that higher wages rather than a bonus system were necessary to attract better-skilled men. On the question of mechanical stokers, Mr. Newington admitted that the maintenance of his cost him 6·68d. per ton of coal used, but he hoped to reduce this figure by 50 per cent. by an alteration in design. The firing and trimming cost an additional 8·68d. per ton of coal. But with North Country and Scotch coal mechanical stokers were a necessity in order to prevent smoke. He suggested that a device should be got out for enabling the firemen to know the colour of the smoke emitted from the chimney at any time, and Mr. J. B. C. Kershaw mentioned how this was done in Belfast by means of simple mirrors, in a case that had come under his notice. Mr. Kershaw also disagreed with Mr. Downe as to there being no need for analyses of fuel. Mr. Fedden (Sheffield) gave figures *in support* of mechanical stokers and of induced draught. Originally, the wet type of marine boilers in use at the Sheffield electricity works were hand-fired, and each evaporated about 11,000lb. of water per hour, with an efficiency of less than 70 per cent. The addition of mechanical stokers increased these figures to 15,630lb. and 73·2 per cent., and, finally, by using induced draught and heating the air at the back of the boiler before it entered the furnace between the bars of the Bennis stokers, the evaporative capacity was increased to about 18,000lb. per hour and the efficiency to about 80 per cent. He found that the steam for driving the fans and providing the steam jets in the stokers represented 3·5 per cent. of the total generated. Mr. Stromeyer also spoke of the induced draught system which was extensively employed in Sheffield, but Mr. Newington was not much in favour of induced draught, the saving by which, he thought, was estimated at too high a figure. Mr. Druitt Halpin endorsed Mr. Downe's statements as to air leakage through the brickwork, and went even further by describing how it was possible to blow a candle out through a brick. He showed some interesting curves, giving the amount of air-leakage in boilers, and sketched a method of preventing the leakage of air through the dampers. He also spoke of the advantages of heating feed water with live steam. Mr. C. D. Taite (Salford) spoke of the waste of steam in the steam jets of the mechanical stokers. His repairs to the stokers during six months had amounted to 3½d. per ton of coal burnt, about half that mentioned by Mr. Newington. He had made considerable saving by using a CO_2 recorder, and he also mentioned that, by driving all his auxiliaries electrically, he used 5½ per cent. of the units generated in the summer and 7 per cent. in the winter.

Councillor H. J. Blakeway (Southampton) then read in abstract his Paper on "The Financial Position of Municipal Electrical Undertakings." He had compiled a table with regard to 155 electricity undertakings, and gave the deficits and surpluses at the end of the working year 1902-3, stating how many years the works had been in operation. Sixteen in their first year of working had a deficit of £18,398 in all, and seven yearlings made an aggregate surplus of £8,218. Of the two-year-olds, 18 showed a deficit and eight a surplus, and so on up to two hoary-headed undertakings in their 20th year, one of which made a deficit of £1,080, in 1902-3, and the other a profit of £2,814. Deducting the total deficits from the profits and taking the remainder as a percentage of the whole capital investment, only 0·9 per cent. is left for depreciation and renewals—a sum which Mr. Blakeway rightly regards as altogether insufficient. However, the author did not stop here, but went much further in his strictures on the policy of electricity committees, arousing the wrath of many old and experienced councillors. Taking no account of the fact that it costs less to generate that part of electrical energy which has a high load-factor than the part with a small one, he attacked all and sundry for charging for traction less than the cost of generating electrical energy for lighting, and expressed his inability to see why a lower price should be paid for a regular all-day power supply than for public lighting or tramways.

One councillor after another got up and endeavoured to show Mr. Blakeway wherein his fallacy lay, and although they each criticised his opinions differently, one and all agreed that he was utterly and hopelessly wrong. Dr. Panton (Bolton) opened the discussion and was followed by Bailie Willock (Glasgow) in his usual emphatic style. Councillor Bruce (Sunderland) spoke in a different strain; he was glad to have an opportunity of explaining to Mr. Blakeway the points which chairmen had constantly to explain to the younger and less well-informed members of the committee. Still, he thought it only wise to warn smaller undertakings not to copy too closely, in reducing prices, a large city like Glasgow, which could allow itself wider scope in this direction on account of its enormous output. Mr. Rider (L.C.C. tramways), the only engineer who spoke, objected to a municipal works being mentioned as in its 20th year of working. The station in question, Hastings, was originally a company one, and had become a municipal one only comparatively recently. Ald. Pearson (Bristol) spoke, among other matters, of depreciation and reserve funds, the main use for which, he contended, was to allow provision for years when proportionately large contributions had to be made to the sinking fund on account of large expenditures of new capital that had not yet become remunerative. Incidentally, he referred to the point raised by Mr. Rider, stating that in some cases local authorities "have to" buy company undertakings and pay £2 for every £1. Everyone was too busy expounding his own views to ask Mr. Pearson why the local authority *had* to buy. The debate was continued by Alderman Ivey (West Ham), Alderman Smith (Barrow) Alderman Duxbury (Bury), who mentioned amid cheers that electricity was in its infancy, and Councillor West (Coventry), and Mr. Blakeway replied briefly.

In the afternoon visits were paid to Messrs. Hadfield's steel works, to the Corporation tramway power house and to the Corporation new two-phase supply works at Neepsend, which is described in another column of this issue. At Messrs. Hadfield's some armour-testing experiments were made, and much interest was taken in the electrical method of ascertaining the speed of the projectiles. Some members also took advantage of the invitation to view the collection of old and new generating plant at the old Sheaf-street electricity works.

Saturday, July 2nd.

The annual general business meeting was held on Saturday at Derby. On the motion of Mr. J. F. C. Snell (Sunderland), seconded by Mr. W. A. Chamen (Glasgow), Mr. F. A. Newington (Edinburgh) was unanimously elected president for 1905, and, in accordance with the wishes of Mr. Newington, Edinburgh was provisionally selected as the place of meeting next year. Mr. Newington pointed out that, fortunately or unfortunately, as the members might think,

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he was without a chairman of committee, and until one was appointed he could not definitely say that it would be possible to hold the Convention at Edinburgh, although he did not have much doubt on the matter. As vice-presidents, Mr. R. A. Chattock (Birmingham) and Mr. S. E. Fedden (Sheffield) were elected. Before the voting for members of Council took place the president (Mr. T. P. Wilmshurst) pointed out that it was proposed to elect three engineer members this year, three next year, and three the year after, in order to keep the number retiring each year equal. As things stood at present, two would have to be elected this year, three next year, and four the year after. As a result of the voting, the constitution of the Council is now as follows :—

President, F. A. NEWINGTON, Edinburgh.

Vice-Presidents, R. A. Chattock* (Birmingham) and S. E. FEDDEN, Sheffield.

Past-Presidents, J. H. Rider (L.C.C. trams), J. F. C. Snell (Sunderland) and T. P. Wilmshurst (Derby).

Members.

J. K. Brydges (Eastbourne).	S. L. PEARCE (Manchester).
Ald. BRUCE (Sunderland).	H. Faraday Proctor (Bristol).
W. A. CHAMEN (Glasgow) (*Past-Pres.*)	Councillor SINCLAIR (Swansea).
J. Christie (Brighton).	Ald. J. P. Smith* (Barrow-in-Furness)
A. S. Giles (Blackburn).	H. Talbot (Nottingham).
Hamilton Kilgour (Cheltenham).	Bailie WILLOCK (Glasgow).
V. A. H. M'Cowen (Belfast).	G. WILKINSON (Harrogate).
Councillor Panton* (Bolton).	

Ald. G. Pearson,* Bristol, *Hon. Solicitor.*

J. H. Rider* (L.C.C.), *Hon. Treasurer.*

J. E. Edgcome, Kingston-on-Thames, *Hon. Secretary.*

New elections are in capitals, and re-elections are asterisked.

The annual report of the Council from July, 1903, to July, 1904, which was read by the hon. secretary (Mr. J. E. Edgcome) states that the membership continues to increase, and is now made up as follows :—Committees (members) 144, chief engineers (members) 156, chief assistants (associate members) 12, assistants (associates) 75, a total of 387, of which 46 have been elected since the last Convention.

The Parliamentary committee has dealt with a large number inquiries affecting municipal electrical undertakings, including the Supply of Electricity Bill, the "Bermondsey" clause, Repayment of Loans, Tramway Hours of Labour Bill, Free Wiring, &c. The Council itself has given most careful consideration to the Supply of Electricity Bill now before Parliament, and has taken steps to ensure that its objections on every point will receive attention in the proper quarter. After a reference to the regrettable death of Mr. R. C. Quin, already referred to in the presidential address, the question of subscriptions to the Association by local authorities was touched upon.

A petition has been made to the Local Government Board urging it to take steps to authorise metropolitan borough councils to subscribe to the funds of the Association, and in the meantime, arrangements have been made so that those local authorities who cannot see their way to subscribe as members might send representatives to the conferences.

The Council has, in response to an invitation by the Board of Trade, made certain observations upon the construction and equipment of electrical tramcars. The Associates' prize has been awarded to Mr. H. Howard, of Manchester, for his Paper on "Steam Turbines and their Efficiency compared with Reciprocating Engines." The Paper will be printed in the *Proceedings* of the Association. At the invitation of the Municipal Officers' Association, delegates from the Association attended a conference in London last December with regard to a bill for the superannuation of municipal officers, but after careful consideration it was decided not to take further part in the proceedings.

The Council has drawn the attention of the Institution of Electrical Engineers to an apparent discrepancy in clauses 12 and 29 of the Wiring Rules, the former of which had been read to mean that metallic tubing need only be electrically continuous throughout and connected to earth for pressures greater than 250 volts, and the latter referred to the tubes being electrically continuous throughout, and connected to earth, but this may only refer to damp places. Neither clause seems quite clear, the report adds, and both may require revision. The Council has also placed its views upon the standardisation of electrical accessories, and the drawing up of a model set of conditions of supply to private consumers before the National Electrical Contractors' Association, and a sub-committee has the matter under consideration and will report. In conclusion, the report states that the membership continues to increase steadily, and urges upon each member the necessity for seeing that every eligible member of his staff has an opportunity of qualifying for whichever class of membership he is eligible.

Mr. H. BOOT (Tunbridge Wells) moved the adoption of the report, and urged the Council to take into consideration the question of legalising the expenses of the delegates as well as subscriptions to the Association of those municipalities under Government audit. Last year he had the experience of having his expenses surcharged.

The PRESIDENT replied that the Local Government Board treated their views on this matter very sympathetically, but he was afraid there was nothing to do but to wait for the Board to move in the matter.

Mr J. H. CLOTHIER (St. Anne's-on-Sea) suggested that the engineer's salary should be increased to the amount of his expenses as a means of getting over the difficulty in question.

The report was then adopted.

Mr. J. H. RIDER then read his report as hon. treasurer. He said there was a deficit of £41. 15s. 4d., of which 15 guineas was irrecoverable, it being an accumulation of unpaid subscriptions. Another item in the balance-sheet was the last instalment of the preliminary expenses written off. The large amount of work done by the Parliamentary committee was increasing the printing bill, but he thought it was an expense which was well repaid. Altogether he considered the financial position fairly satisfactory as the Association did not exist to make a profit, but at the same time the expenditure should be balanced by the income. The report was then adopted.

The president (Mr. T. P. Wilmshurst) then opened a short discussion upon the Suppy of Electricity Bill* introduced by the Board of Trade.

Mr. WILMSHURST said that it had been under the serious consideration of the Parliamentary committee on several occasions, and while there were several clauses in the bill which they considered fair and a step in the right direction, there were one or two to which exception must be taken. The Association could not afford to oppose the measure, but it had been in communication with the Association of Municipal Corporations which was opposing the bill, and their views on the matter would be brought forward.

Mr. H. FARADAY PROCTOR (Bristol) who, as a member of the Parliamentary committee, has taken much interest in this subject, pointed out the items which it was thought the Association should oppose. The opinion of the committee was that it was undesirable that powers should be conferred upon the Board of Trade which were at present only held by committees of Parliament. The bill in question gave the Board of Trade power to make such other provision as appeared to them necessary, which would enable them to do anything they liked with the Electric Lighting Acts. At the present, perhaps, the officials of the Board of Trade were happily chosen; but this might not be the case always. A capital example of the advantage of dealing through Parliament in these matters was afforded by the Tyneside Tramways Bill (see our Parliamentary columns this week). The first clause in the Supply of Electricity Bill to which exception was taken was clause 4, which gave the Board of Trade power to vary the terms of purchase at present existing under the Electric Lighting Acts. Under the Electric Lighting Act of 1882 local authorities were given powers to purchase a company's undertaking at the end of a certain period of years. In 1888 the term was extended, but as a certain compensation to the municipalities, the second sub-section of the clause stated that any generating station, mains, or other works situated outside the district of the authority might be deemed to be situate in the district for the purpose of purchase. In connection with the present powers given to the Board of Trade under this bill exception was taken to the word "solely" in the second sub-section. This read that the generating station outside the borough was to supply electricity "solely" within the borough if the works were to be purchaseable. It was felt that this might give a loophole to a company to prevent the works being purchased, and they asked that the wording should be more liberal. The next objection was to the powers conferred upon the Board of Trade under sec. 3 with regard to supply in bulk, and further comment was unnecessary in view of his earlier remarks with regard to the transference of such powers to a public department. Sub-sec. 3 of clause 6, dealing with the consents of local authorities was also unsatisfactory, and a recent experience in Bristol led him to this conclusion. The Bristol Corporation had been twice refused permission by Parliament to carry mains through one district outside their area in order to supply another, but since then a company had been permitted to do so. Clause 10, relating to stand-by supply, he had at first regarded as satisfactory, but it had since come to light that the Liverpool Corporation had more favourable terms in one of their acts, and naturally, he thought the new Electricity Supply Bill should give equal favour. With regard to clause 11 he thought that anything given to the companies should be given to the local authorities.

* The full text of the Bill will be found in *The Electrician*, of May 6, p. 102.

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Mr. BOWERS (deputy town clerk, Glasgow) said he thought the provisions of the bill were rather in favour of the municipalities, but there were certain things in it not quite good enough. The Parliamentary Committee on the bill had sat on the previous Thursday, when the Hon. T. H. W. Pelham carefully explained the bill. The Committee was meeting again on Tuesday, when anyone could be heard against the bill. It was, therefore, quite competent for the Association to appoint any members to appear and speak with regard to any clauses. With regard to sec. 6, he did not think a local authority already supplying had much to fear if it were passed as it stood, although he thought some amendment was necessary. Clause 9, with regard to the dates for making up accounts, would be a serious inconvenience to Glasgow, where at present it was found most desirable that the accounts of every department should be made up to May 31st. The clause proposed to alter the general conditions of the Electric Lighting Acts. Personally, however, he did not think the conditions of the new act would override the authority of any special act which a local authority might have. With regard to stand-by supply (clause 10), the Glasgow Corporation had a special clause in a special act with regard to this also, but the one now proposed should be amended upon the lines of the Liverpool clause already referred to.

Ald. SMITH (Barrow-in-Furness) suggested that Ald. Pearson (Bristol) should give evidence on behalf of the Association before the Parliamentary Committee.

Ald. PEARSON said that, personally, he had never had any trouble with the Board of Trade, having found that when he got behind the sham of the "Board" there was reason and common sense. At the same time he objected to the legislation of the country being placed in the hands of permanent officials of any public department. The suggestion that the Liverpool stand-by clause should be embodied in the bill was a good one.

Councillor DAVIDSON (Harrogate) pointed out that the Association had already placed its views before the Association of Municipal Corporations and it might possibly be duplicating the evidence if they sent a witness as well.

Ald. BRUCE (Sunderland) said that his Corporation had petitioned against the bill and were going to call witnesses. Under all the circumstances, he thought the interests of the Association would be well looked after without going to the expense of sending their own witnesses.

The president said there was no intention to act independently, and, after further discussion, it was decided that steps should be taken to give evidence and do what was necessary in connection with the bill. On the motion of Ald. Smith (Barrow) a vote of thanks was passed to the various corporations and firms who had assisted in entertaining the Association during the Convention. A complaint was then made as to the lack of Papers by chairmen of committees and of the short amount of time allotted to the only one submitted this year. The president said that great difficulty was experienced in getting Papers of this class and if more were submitted they would be welcomed by the Council. On the motion of Mr. F. A. Newington (Edinburgh), seconded by Mr. J. H. Rider (London), a vote of thanks was passed to the retiring president, Mr. T. P. Wilmshurst. Votes of thanks having been passed to the honorary treasurer, solicitor and secretary, the proceedings terminated.

A special meeting was then held at which the following alteration in the Articles of Association was unanimously agreed to.

Members.

10. Every member shall come within one of the following descriptions:—

(*a*) The member shall at the time of his election be the chief electrical engineer engaged on the permanent staff of an electrical undertaking owned by a local authority, or the chief assistant or head of any engineering department in connection with such an undertaking of an actual or constructing capacity of not less than 5,000kw.

(*b*) The member shall be the committee appointed by a local authority to have control over a municipal electrical undertaking within the area of such local authority, and shall be represented as regards its qualification to vote by one member of such committee.

Associate Members.

11. Every associate member shall at the time of his election be an electrical engineer engaged on the permanent staff of a local authority in a position of responsibility in the capacity of assistant in connection with an undertaking having a plant capacity of at least 2,000kw.

Associates.

12. Every associate shall be an electrical engineer engaged on the permanent staff of a local authority in a position of responsibility in connection with an undertaking whose plant capacity does not exceed 2,000kw.

[Mr. E. T. Ruthven-Murray asks us to correct a statement he made in the discussion on Mr. Pearce's Paper on Thursday last week, reported on p. 423 of our last issue. He intended to say (2nd paragraph, line 20) that one of his 100kw. rotaries had dealt with 25 per cent. out-of-balance current, but by a slip of the tongue he said 75 per cent.]

ORGANISATION OF A METER AND TESTING DEPARTMENT.*

BY A. J. CRIDGE.
(Sheffield.)

In small stations it is usual for the mains engineer to take charge of the testing and installation of the meters required, but when the system has increased to a sufficient extent it will be found advisable to start a separate department to deal with this work.

For the purpose of controlling the supply of electricity for testing a switchboard will be required. The one here described controls a maximum supply of 10kw.—*i.e.*, 50 amperes at 200 volts single-phase alternating current. By means of a suitable transformer it is possible to get almost any voltage from 28 to 300 by altering the connections. This is done by causing the turns on the secondaries of the transformer to help or to oppose each other. Similarly, it is possible to get any current up to 300 or 400 amperes. The link connectors of the transformer, therefore, give a coarse adjustment, and the fine adjustment is made by means of suitable rheostats. The voltage is measured by Kelvin voltmeters, the current by Kelvin ammeters and the wattage by a Kelvin balance.

There are six main circuits which branch off from the switchboard. These are put in or taken out of circuit by plugs, and the ammeters are connected by plugs with flexible conductors attached. The use of the main circuit is :—

1. *Experimental.*—A pair of heavy cables run to a pair of big terminals on a bench. The current and the pressure can be adjusted to any figure desired, so that the circuit may be used for any purpose.

2. *Rheostat (Large).*—This is for the control of currents up to 125 amperes. It consists of carbon plates, and the resistance is increased or diminished by slackening or tightening a screw.

3. *Rheostat (Small).*—This is for the adjustment of small currents, from 0·1 to 5 amperes.

4 and 5. *Meter Benches.*—These are arranged to hold a total of 48 meters. The meters are placed in position on the bench and the series coils are disconnected from the shunt coils. The series coils are then connected to terminals on the bench by flexible connectors and the shunt coils joined across the proper pressure circuits by small flexibles to which are attached two-pin plugs. Attention has been given in the design of these benches to the need of fixing up a number of meters for testing in the most expeditious manner possible. All connections are made by plugs or clips. To join up any terminals not in use, copper bridge pieces are employed.

6. *Main Coil of Kelvin Balance.*—The balance shunt coil is disconnected from the current coil, and the latter, which constitutes circuit 6, is plugged in in series with the meter benches and rheostats. The shunt coil is connected across pressure circuit II., sub-circuit 3 (see below).

There are 12 pressure circuits provided, six on either end of the board. Only four of these are in use on one end and three on the other. They are as follows :—

I.	1. Meter bench (1)	Top shunt circuit.
	2. „ „	Bottom „
	3. Experimental.	
	4. Photometer.	
II.	1. Meter bench (2)	Top shunt circuit.
	2. „ „	Bottom „
	3. Shunt of Kelvin balance.	

Two-pin plugs are placed across each of the main circuits for the purpose of measuring the pressure between any pair of circuit leads or absorbed in any piece of apparatus. The use of the pressure circuits is almost obvious. On circuit I. the first two sub-circuits are for the shunts of meters connected to the top or bottom racks of meter bench I.

The third sub-circuit consists of a pair of leads which run to two terminals on the working bench, and to which may be connected any apparatus which does not take very much current. The most frequent use to which it is put is that of running incandescent lamps which are undergoing a life test. Sub-circuit 4 belongs to the photometer, to which reference will be made under the heading "Testing Lamps." Two sub-circuits are not yet in use. On circuit II., the first two sub-circuits supply the shunts of meters on meter bench II., and the third is the shunt of the Kelvin balance. There are, therefore, three spare ways on this circuit.

The testing of meters is carried out as follows :—A number of meters having been joined up in series on the benches with their series coils disconnected from their shunt coils, the current flowing through them is adjusted by means of the rheostats and measured by the balance. A few revolutions of the disc are observed, and the time taken is noted by means of a chronograph. The testing constant of the meter being known, the percentage accuracy can be calculated from these observations. The practice seems to be becoming general among meter makers of constructing all their meters in such a manner that the disc revolves a certain round number of times per minute at full load. Thus Ferranti meters

* Abstract of a Paper read before the Incorporated Municipal Electrical Association, June 29th.

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make 40 revs. per min. at full load, Westinghouse and Schuckert 50, Electrical Co. 60. Other makes of meters have a constant marked on the dial, giving the number of watts which cause the disc to make one revolution in an hour. Thomson-Houston meters form a well-known example of this kind.

A few words on the different kinds of meters will not be out of place here, but it is difficult to say anything new on this subject. The object of this Paper is not to say which type of meter is best nor to go into many constructional details. It will suffice to say that any induction meter which is suitable for inductive as well as non-inductive load is usually good. The day of meters with commutators is over; there are now so many good types of induction meters which are greatly superior, if only for this reason. The Aron meter is good, but the winding gear has been found to give a lot of trouble on alternating-current circuits; the contacts get dirty, because of the sparking which takes place so frequently. Some meters are now constructed with cyclometer dials, and most manufacturers are willing to supply their meters fitted in this way. These are infinitely to be preferred to the old type; the possibility of error on the part of the meter reader is entirely eliminated, and consumers like them because they are easier to read, and they are thus enabled to check their consumption.

It will be seen by making a small calculation that testing meters as described above are far more economical than the old-fashioned method of using a bank of lamps. A 10-ampere meter under the old method required 2kw. at full load, the pressure being assumed at 200 volts. By the use of the transformer we have 10 amperes at 28 volts = 280 watts, plus, say, 4 to 6 watts in the meter shunt, or a saving in power of nearly 87 per cent. This saving will amount to a considerable number of units during a year.

The meter, after being tested and adjusted, is sent out to an installation. The meter reader has to note the reading of the old meter, take out the fuses, take down the old meter and fix the new one, replace the fuses, note the reading of the new meter and try it for starting with an 8 c.p. lamp. If it is a new installation he has not to put in the fuses nor to try the meter, this being the duty of the testing inspector.

The maintenance of the station meters is an important matter, and they should receive frequent attention. It is useful for many reasons to know the total number of units generated; the works costs, percentage of waste, &c., are all determined from this total. A small error in large meters such as these makes a lot of difference, and great care should, therefore, be taken that these meters are kept in an accurate and satisfactory condition.

Demand indicators are not in use at Sheffield, but for the purpose of testing these, a circuit would be run to a suitable rack, and the indicators would be connected in series and set to zero. The required current would be passed through them for 30 or 40 minutes and readings would be taken. The necessary adjustments would be made from these observations.

Testing and Calibrating Voltmeters, Ammeters, &c.—Any instrument which needs testing is connected across the experimental circuit in series with a rheostat and a standard instrument, and comparisons are made at a number of points in the range. No detailed description of this work is necessary.

Testing Resistances.—A Wheatstone bridge is the best thing to use for this work. The Vulcan ohmmeter is a cheap and useful instrument, the range being from 0·1 ohm to 20 megohms, and the method of using the instrument is the same as the bridge.

Testing Lamps.—One of the pressure circuits is in use for this work. A voltmeter, ammeter and rheostat are connected on this circuit, together with the lamp to be tested. The standard light is a Simmance's 1 c.p. pentane lamp, and the comparisons are made on a direct-reading scale by means of a Bunsen disc. The photometer should be constructed for use in a light room, as space cannot often be spared to build a dark room. The results obtained by careful use of the photometer are very reliable. They agree closely with independent tests made elsewhere, although lamps often come out rather worse than the makers advertise. The lamps are put on for life test in a bank constructed to hold 25 at a time. Tests of the candle-power, &c., are made at intervals of 24, 100, 250, 500, 750 and 1,000 hours. The reason for the test at 24 hours is that some lamps increase in candle-power after they have been running a little while. It is frequently supposed by non-technical people that the energy taken by a lamp increases as time goes on. This, of course, is not the case; the total watts fall slightly, but as the candle-power falls more quickly, the watts per candle increase.

Testing Fuses, Switches, &c., submitted for Approval.—Not many appliances for use in consumers' installations are submitted, but when they are offered for examination, tests are made under both normal and abnormal conditions. For switches, fuse-boxes, &c., the abnormal conditions are to operate on double their stated capacity at double the proper pressure. The testing of time switches, prepayment devices, &c., may be placed in this division.

Two types of time switches which have been submitted for testing may be noticed with advantage. One, known as the "Tariff contactor," was designed for opening and closing the shunt of the second meter on two-rate systems. It is not intended for use on large circuits. It consists of a clock, driving two cams, which can be set to act at any desired times. When the proper time arrives the first cam causes the contacts to spring together, the shunt of the meter is closed, and it registers. At the end of the peak time the second cam comes into operation and the circuit is broken.

The second time switch, submitted by a Birmingham house, was operated by two clockwork movements, one of which indicated the time, while the other came into action when released at the time at which the switch was desired to operate. This second clock is driven by a powerful spring, and lifts the switch up or pushes it down by means of a connecting rod and suitable gearing.

The few prepayment meters in use in Sheffield are of the Vulcan type, penny-in-the-slot, which have proved quite satisfactory. The penny is inserted and the handle turned until the coin is heard to drop, when the switch is closed, and the spring wound up a certain amount. Eight pennies can be inserted at one time. 6d. per unit is charged for current supplied through prepayment meters; this includes meter rent. The revolution of the meter armature causes the spring to unwind gradually, and when all the energy prepaid has been consumed, the circuit is broken. Practically no trouble has been experienced with any of these meters since they were installed, with the exception of one or two cases where bent coins have been used.

Work in Connection with Consumers' Installations.—It is difficult to make a thorough inspection of a completed installation; consumers naturally object to having floor boards lifted, capping taken off, &c., when the job has been finished off. It will, therefore, be found advisable for the inspector to visit new installations while actually being wired, when joints can be examined, samples of cable can be taken, the methods adopted for laying concealed wires can be enquired into, and any other examination can be made.

After the inspection referred to in the preceding paragraph, very little remains to be done except to test the insulation resistance to earth and between leads. A convenient way is the use of Evershed's ohmmeter and generator, but it is more satisfactory to use the current from the town mains when possible. Recently a useful little testing set has been introduced for use on alternating-current mains. Its only fault is that the top reading is only 1 megohm. It can be made to transform up to double the pressure on the mains and thus comply with the I.E.E. rules. When short-circuited it may be used as a voltmeter. Testing on direct currents may be carried out on the town mains with a Silvertown set, using a 5 c.p. lamp in series, or with a Kelvin set. This is obviously open to the objection that the test is carried out at the declared pressure, instead of twice that amount. The use of batteries is objectionable; they are messy and unreliable, besides which they are awkward things to carry about when they are made for 400 or 500 volts.

In the case of a complaint of poor light, it will be advisable in most cases to send up and see if it is possible to advise the consumer to make any little alterations to the distribution of his lamps, or to put in new lamps. This, of course, is in addition to taking pressure tests. It is necessary to send a capable and tactful man on work of this kind.

Extinctions may be attended to by meter readers, as they are generally due to a fuse having blown for some reason. The instructions given in the Sheffield meter department are as follows:

1. A form must always be taken and the consumer's signature obtained before commencing work.
2. The Corporation's apparatus must first be inspected and afterwards the consumer's installation. Defects must be rectified as far as possible, and a full report made on the fuse form.
3. The new fuse inserted must always be of exactly the same size as the fuse blown, and if the new fuse blows it should not again be replaced.

On the form referred to, the consumer applies to the manager to remedy failure of electric light at premises situated ————, for which service the consumer agrees to payment of fee, which is 1s. or 2s. 6d. according to circumstances. The inspector makes his report on the same form, and it is handed to the meter superintendent, who decides whether a charge is to be made or not and sends it down to the general office.

The third instruction is given in order to ensure that no additional lights are connected without the knowledge of some of the staff.

During the evening, fault work is attended to by the mains department, but the procedure is similar in every way to that of the meter department, described above.

The Commercial and Clerical Side.—The procedure during meter reading will be readily understood from the following extracts from the meter inspectors' instructions. It should be understood that dial cards are used for taking the readings of the meters.

1. Meters must be read in the exact order in which the cards are placed, and each circuit must be completed before commencing another.
2. The exact position of the hands of the meter must be sketched on the reading card, commencing with the unit dial on the right hand; if a meter has more than four dials the reading of the others may be put down in figures at the left of the card.
3. The readings of meters must be entered on the consumer's meter cards with the date of reading, and initialled by the inspector. Readings

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should be compared month by month, and any abnormal increase or diminution in the consumption should be reported, in order that the same may be enquired into.

4. Each meter must be tried for starting with one 16 c.p. lamp, and any meter not doing so must be tried with more until it does start.

5. The number and size of any meter running on shunt, not starting with one 16 c.p. lamp, or being otherwise defective, must be taken and entered in the report book the same day as found.

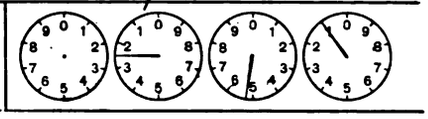
6. All Corporation seals on cut-outs, meters, &c., must be intact, and the Corporation's "Caution" label must be on every meter. Anything contrary to this rule must be entered in the report book the same day as found.

7. Inspectors must not make any remarks whatever on the state of the Corporation's apparatus or of the consumer's installation. All enquiring consumers must be referred to the office.

STREET East Street No. 99

NAME Smith, J.

METER No. 123456 K 1
10/200

DATE	
22-4-04.	

The monthly reading takes about 10 days. It is commenced every fourth Monday, so that there are 13 readings in the 12 months. Entering the readings up and settling the queries takes about 14 days. The readings are entered on account cards. The cards are arranged in the most convenient order for reading, and the town is divided into districts. Four men are engaged meter reading, and these follow each other on the different circuits every month—thus, in January A would take circuit 1, B circuit 2, &c.; in February A would take circuit 2, B circuit 3, and so on. In this way each inspector checks the man who preceded him, and the perpetuation of errors is avoided. If the clerk considers any reading doubtful he notes the name and address of the consumer with the suspected nature of the fault, and the foreman meter reader examines the meter, checks the reading and decides whether or not the meter should be changed and tested. When all accounts are entered up and queries settled the cards are sent down to the general office, where the invoices are made out and the ledgers entered up. Reading and account cards are ruled on both sides.

For keeping the records of consumers' installations cards are used giving full particulars.

It is almost impossible satisfactorily to keep meter stock records in books; it is better to use cards giving a description of the meter written along the top of the card; and, below, the movements of the meter are set forth, with dates against them, thus:—

No. 123456.	Type N.	Volts 200.	Amps. 10.	K 1.	Testing K 20.
In from makers					20.4.04
Out to J. Smith, 99, East-street.....					22.4.04

Received from makers.	Date.
Sent to.....	,,
In from	,,

The tests made should be immediately entered in a day book, and, with the aid of the date shown on the card, it will not be difficult to find any desired test. It is advisable to change consumers' meters at intervals not exceeding two years. A convenient method of keeping up the proper rotation is to use a meter changing card, ruled on one side and giving particulars of consumer's name, address, district, pressure of supply, type, constant, size and date fixed of the meter. This card should then be placed behind a guide card showing the same month two years ahead.

Name: J. Smith. *Address:* 99, East-street.
District: 3. *Pressure:* 200.

Capacity.	Type.	Constant.	Notice sent.	Fixed by	Date fixed.
10A	N	1	New consumer	Jones	22.4.04

The balancing of the three-wire low-tension network is in the charge of the meter superintendent, and to keep this correctly recorded cards are used, showing the consumer's name, address, demand, polarity and time of extinguishing. For a two-wire installation with two service lines, a white card is used; for a two-wire installation with three service lines, a salmon-coloured card, and for a three-wire installation two blue cards. A "totals" card is put at the beginning of each street or section of a street, and this indicates the state of the balance on any particular section at a glance.

The card which is left on the consumer's premises is ruled in three columns for date, reading of meter and inspector's initials. It is made to fold double, and on the outside are placed the consumer's name and address, the number and size of the meter and its constant for units. There are also a few printed notices and instructions for consumers.

The books used in the meter department need not be many. For the use and direction of the workmen three books are needed. They are:—(1) The work book, in which particulars of fuse replacing, special meter readings, disconnections, re-connections, &c., are entered. (2) The meter-changing book, in which particulars of all meter changes are recorded; and (3) the inspector's report book, in which workmen report any remarks made to them by consumers, any defects in meters or other apparatus, or any similar matter. The installations connected are entered in a day book known as the "Watts Wired Book." This book merely shows the name and address of the consumer, the distance in miles from the station, the wiring contractor, the consuming devices connected or disconnected, and the date. For noting particulars of installations, the testing inspector carries a pocket book with the necessary headings printed in it.

It is the duty of the meter department to attend to consumers' complaints of accounts. This is rather a delicate matter at times. If the meter is apparently correct, the consumer is asked if he will agree to pay the expense of testing if found so, while the Corporation make no charge if the meter is found to be inaccurate. This is, however, a rule which it is often advisable to break through to conciliate consumers.

It is also advisable to send up to see if the consumer cannot economise by re-arranging his installation, as in the case of the complaint of poor light already mentioned.

The staff of the Sheffield meter department consists of:—Meter superintendent; testing inspector and boy; chief clerk, two junior clerks and office boy; foreman meter inspector; meter tester; four meter inspectors; relief man—a total of 14 individuals.

The system of inter-departmental working will now be described. It is worked from the general office by means of the "Ticket Book." The operations in connection with this book are the following:—The intending consumer signs the application form and the clerk in the office writes the first ticket, giving particulars of the application. This is sent to the meter department, and the polarity, voltage and number of service lines to be installed are decided, and the counterfoil is sent back to the office. At the same time a ticket is issued from the general office to the mains department, directing it to prepare plans, &c. The third ticket to be written is sent from the general office to the mains department, and contains instructions to lay the service as decided above. When the service is laid, the counterfoil is sent to the office, which then sends out instructions to the meter department to fix meters. This is done and the counterfoil returned. When the contractor's test notice is in and the meters are fixed, instructions to test and connect are sent from the office to the meter department, and when the job is completed the final particulars of the service are sent to the drawing office. Additions are dealt with in a similar way, and thus the necessity of allowing the consumer's application to go out of the office is avoided. This system has been employed at Sheffield for nearly four years and has been found satisfactory.

DISCUSSION.

Mr. J. CHRISTIE (Brighton) opened the discussion. He said that, in his opinion, the organisation of a meter department had not received the attention from engineers that it deserved. Where the mains were judiciously laid, the losses in distribution could not account for anything like the serious discrepancy between the units generated at the station and the units sold. On the other hand, the inspection of consumers' wiring and fittings, whilst the work of fitting up was going on, was not, in his opinion, within the scope of the supply undertaking. The fire insurance companies should give more attention to this important matter. The card system described in the Paper had been in use in Brighton for many years very successfully.

Mr. J. R. DICK (Reason Mfg. Co.) said that, unfortunately, no treatise had ever been published in England dealing exhaustively with the subject of meters, although one or two books had been published in Germany and America. These, however, made no mention of some most important British meters. The first point in connection with the meter problem was that the percentage of revenue saved by metering 2 per cent. more of the units than was the case at present was equal to 15 per cent. of any saving which might be effected in the works costs, because what was saved in the units registered on the meters was at the full price of 4d., 5d. or 6d. per unit, whereas the percentage of the whole was of the order of 0·6d. or 0·8d. per unit. In testing meters a distinction ought to be made between the inherent accuracy and the apparent accuracy. Another point was the enormous importance of buying the best meter—*i.e.*, the one giving the highest permanent accuracy, and not the one that only went well for a short time. He quoted from a pamphlet by Mr. Haskins, of the General Electric Co. of America, endorsing this view.

Mr. VENNER pointed out that although Mr. Cridge had expressed a

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preference for meters without commutators he seemed to be using prepayment meters of that type.

Mr. W. A. CHAMEN (Glasgow) said that although he agreed that cyclometer dials were a great improvement, he had not found any very great willingness on the part of manufacturers to supply them. There was also a paragraph in the Paper with regard to the fixing of meters which he did not quite follow. It read as follows:—"The meter after being tested and adjusted is sent out to an installation. The meter reader has to note the reading of the old meter, take out the fuses, take down the old meter and fix the new one, replace the fuses, note the reading of the new meter and try it for starting with an 8 c.p. lamp. If it is a new installation he has not to put in the fuses nor to try the meter, this being the duty of the testing inspector." He would like to hear something more about the method adopted. It appeared that there were two distinct bodies of men who had to deal with meters at Sheffield. This was a departure from what most of them did, but if there were other engineers who adopted this plan and found it satisfactory he would be interested to hear about it. It seemed to him it was better not to let the meter reader have anything to do with the handling of the meters. This was the plan adopted in Glasgow, and by this means they had a check upon the mains department. It was all a question of administration and an important one when they remembered the truth of Mr. Dick's remarks about the 2 per cent. error in the meter. What was wanted was an automatic system of checking so that any fault on the part of the staff would be checked. He had had no experience with penny-in-the-slot meters, having refrained from introducing them because the gas department in Glasgow had been much defrauded by people breaking open the meters and taking the cash.

Mr. J. H. CAWTHRA (South Shields) expressed surprise at the necessity spoken of in the Paper for changing meters every two years. This perhaps explained the large staff employed at Sheffield. He asked how many consumers the staff of 14 had to look after.

Mr. J. BRYDGES (Eastbourne) had had, like the author of the Paper, a great deal of trouble with commutator meters. He was now altering these meters at considerable expense. With reference to testing, he had lately adopted a small portable accumulator battery, in which the cells themselves were very small, being of the size of test-tubes with plates resembling hair-pins. There were no outside connections at all, and it was found to be most convenient. The statement that "consumers who use a large amount of power frequently apply for a reduction in the price per unit, and this may often profitably be given," he thought amounted to preferential charging.

Mr. G. WILKINSON (Harrogate) thought that a staff of 14 men should be capable of looking after very much more work than was involved in the average meter department. In Harrogate there were 1,300 meters, and the staff was a meter inspector and two boys and the meter reader. The latter had nothing to do but to read the dials, and if there were anything abnormal in the reading, or the meter had stopped, he had to report it. In the latter event, a form was sent to the consumer telling him that the meter was not reading, and that, in the meantime, he would be charged on the average of the previous readings of the meter. If the consumer did not happen to be using the light he did not fail to advise the Corporation. As showing the degree of accuracy which he obtained in Harrogate, he mentioned the fact that 15 months ago there was a "rumpus" in the town, some people being under the impression that the Corporation was robbing them. There was a public indignation meeting at which some very unkind things were said about himself, and as a result a Board of Trade inspector was appointed who investigated about 120 meters, and in a turnover of £6,000 the discrepancy was not more than £30 or £40.

Mr. A. J. CRIDGE (Sheffield) in reply, said he agreed with Mr. Christie that the insurance companies should take more trouble in inspecting consumers' installations. The majority of the fire insurance companies in Sheffield looked upon the inefficiency of the apparatus as part of the risk. There were only a dozen prepayment meters with commutators at Sheffield. He had always found meter travellers willing to fit cyclometer dials, sometimes for a small extra charge and sometimes for nothing. With regard to the so-called two bodies of men, perhaps "meter reader" was not a very good term to use, as this official not only read the meter but did any outside work that was necessary, and probably was as good a workman as Mr. Chamen's mains man. At Sheffield there was only one testing inspector, who tested and joined up, and before he went away he only tried the meter by starting it, so that there was not really two bodies of men. With regard to the question of meters getting broken open, he had had a little trouble in this direction, but the adoption of a patent lock had got over it. Mr. Cawthra was very lucky if he did not have to renew his meters every two years. He had to do it sometimes a little earlier. The number of consumers on the Sheffield mains was 2,600, and the number of meters about 3,200. The question of preferential charging raised by Mr. Brydges was no more so than the demand indicator system, because this was what guided them in working out any rate at which a consumer was supplied. Mr. Wilkinson's circular before averaging out the accounts of consumers whose meters had not registered was asking for trouble. Mr. Wilkinson was also asking for trouble when he asked for a Board of Trade inspector. [Mr. Wilkinson here protested that *he* did not ask for the inspector.] With regard to the duties of a meter department, these consisted of much more than to attend to the meters. They had to fix them, read them, and make out the accounts ready to be sent to each customer. That was why they wanted so many clerks. The connecting up was also done by the department and that was why they wanted a testing inspector, so that there were a number of people who in other stations would not be counted as forming part of the meter department.

PROPOSED ALTERATION OF THE ELECTRIC LIGHTING ACTS.

A further meeting of the conference of municipalities and companies in connection with the question of actions in respect of vibrations caused by electricity works was held on Monday evening at the St. Pancras Town Hall. The preliminary meeting, held on Saturday June 4th, was reported in our issue of June 10th, and since then a meeting of the sub-committee appointed to deal with the question has been held. The meeting on Monday was to receive a statement by the chairman of the conference (Mr. T. H. W. Idris) as to his action in presenting a petition against the Supply of Electricity Bill now before a House of Lords Committee in consequence of communications received from the Board of Trade. The meeting was very thinly attended, only about 20 delegates being present, and these were mostly representatives of London Borough Councils.

The CHAIRMAN said that since the meeting on June 4th a communication had been received from the Board of Trade suggesting that, as the Supply of Electricity Bill had been referred to a Select Committee, the best course for those interested would be to present their views to that Committee. In consequence of this he had had a consultation with the Parliamentary agents of the St. Pancras Borough Council, and had taken it upon himself to present a petition on behalf of the conference against the Supply of Electricity Bill in respect of the question of vibration. The reason why he had taken this action was that, in order to secure a locus to appear before the Committee, petitions had to be sent in before the previous Thursday, and as there was no time to call a meeting of the conference to decide upon a course of action, he had decided to act in the manner stated. The meeting was called, therefore, to confirm or otherwise the course he had taken. Since he had presented the petition in question a number of letters had been received from some London companies objecting to this, and asking that their names be withdrawn from the petition. He wished to point out, however, that the petition went no further than the question of vibration, but some of the companies referred to seemed to be under the impression that the whole question of the Supply of Electricity Bill had been discussed in the petition. He therefore put it to the meeting "That the report by the chairman be received and the action taken approved."

This was immediately agreed to unanimously.

The CHAIRMAN then proposed that the following addition to clause 1 of the Supply of Electricity Bill be adopted:—

"4. Where any local authority, company or person having statutory powers of supplying electricity in any area are at the date of the passing of this act working and using, or have prior to the passing of this act worked, or used any generating, transforming or distributing station upon any lands not specifically authorised by Act of Parliament to be taken or used for that purpose, or have prior to the passing of this act acquired or contracted to acquire any such lands for the purpose of erecting thereon any such station, the Board of Trade may by provisional order authorise such local authority, company or person to use or continue to use such lands for working and using thereon a generating, transforming or distributing station."

This was passed unanimously.

On the motion of the chairman, it was also agreed that the delegates to the conference should recommend to their respective councils or companies that the expenses of supporting the petition against the bill be borne in proportion to the rateable value of local authorities or the nominal capital of companies.

The following committee was then appointed to see this matter through, and was empowered to engage counsel and call witnesses:—Ald. T. H. W. Idris (St. Pancras), Ald. John Buzzey (Poplar), Mr. R. M. Prescott (Fulham), Mr. A. Slatter (Barnes), and Councillor John Hickling (St. Pancras).

Mr. R. M. PRESCOTT (Fulham) said that the Fulham Borough Council was of the opinion that, having petitioned on one point against the Supply of Electricity Bill, the conference was put in a peculiar position, because it might be thought that they agreed to every other clause in that bill. The opinion of the Fulham Borough Council, therefore, was that the petition should be amended in order to oppose clause 6 of the bill. When the bill was before the Committee last Thursday, the Hon. T. H. W. Pelham had promised to amend the clause to meet the objections of the municipalities, but had since found that he had offered too much, and the proposal now was, he understood from private information, to dispense with the consent of the local authority only in respect of companies authorised to supply in bulk or for power purposes. Therefore, with this amendment the clause was just as dangerous as it was before, because if a company was allowed to come into their areas without their consent to supply electricity for power purposes it probably meant taking away half their supply. He therefore submitted the following resolution:—"That this meeting objects to clause 6 of the Supply of Electricity Bill proposing to amend the existing law, which in effect proposes that no provisional order authorising the supply of electricity by any other person than the local authority shall be granted by the Board of Trade except with the consent of such local authority, and in lieu thereof to empower the Board of Trade to grant a provisional order authorising the supply of electricity without such consent." This clause had practically been taken from the petition of the St. Pancras Borough Council against the bill.

Considerable discussion followed this proposal, many speakers pointing out that whereas on the question of vibration the companies and the local authorities attending this conference were in agreement, on the other question they were at variance, and therefore it would have the tendency to disunite them. It was also pointed out that a conference protesting

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against certain clauses in the Supply of Electricity Bill had been convened by the Shoreditch Borough Council, and the opinion was strongly held that the St. Pancras conference was going beyond its powers in dealing with anything but the vibration question. In the end a resolution was passed authorising the witnesses put forward by the sub-committee above referred to, to express an opinion supporting the resolutions passed at the Shoreditch conference on the other clauses in the bill.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

A New Emission.—While studying N-rays by means of a calcium sulphide screen, R. Blondlot has observed a hitherto unknown emission of apparently ponderable matter from a large number of bodies. In the first experiment described, a small patch or cross of the sulphide is made on a piece of card, and the latter is placed so that there is a free air-space both above and below. Then a metallic disc, say a two-shilling piece, is suspended above the patch, and the sulphide immediately becomes more distinct if observed nearly vertically, and this increase of distinctness persists on raising the coin to a considerable height above the patch, amounting to several metres. On taking the coin a little out of the vertical, the action ceases. In the second experiment, the patch is placed over the coin. There is then an increase of distinctness as long as the patch is not higher than about 6cm. above the coin. This seems to indicate that gravitation plays some part in forcing the emission downwards. On placing the coin on its edge and exploring the surrounding space by means of the patch, it is found that the emission takes the shape of two jets, proceeding from each surface, and having a curved path like a water jet, except that the path appears to be rather hyperbolical than parabolical, and to have a vertical asymptote. Pieces of copper, zinc, lead and moist cardboard have a similar action, while gold, platinum, glass and dried cardboard have not. The author describes several further experiments, showing that the emission behaves like a water jet. One of the most remarkable is the following:—A coin is placed in an inclined position, so that the jet proceeding from it goes slantingly upwards and down on the other side of a hori zontal patch. The patch then shows no effect, as the jet effectively clears it. Now another coin is substituted, but is placed symmetrically to the former on the other side of the patch. Again there is no effect. Lastly, the two coins are placed in position simultaneously. The two jets then collide, and proceed as one jet vertically downwards, and immediately the patch lights up. The emission traverses a sheet of paper or cardboard, and even a board 2 cm. thick, but is entirely arrested by glass. It can, therefore, be poured through a glass funnel. The author promises to communicate some further interesting properties of the new emission.

[R. BLONDLOT, *Comptes Rendus*, June 13, 1904.]

Measurement of Inductance.—M. Iliovichi describes a new method of measuring inductances in which any kind of galvanometer can be used, ballistic or otherwise, and it is possible to run Ayrton and Perry's secohmmeter at any velocity, thus enormously increasing the sensitiveness. These advantages are gained by making the current in the null method zero at every instant, while in the usual method, due to Pirani, it is only the quantity of electricity which traverses the ballistic galvanometer during a complete discharge that can be made zero. The coil whose inductance L is to be measured is in the arm *ab* of a Wheatstone bridge, whose resistance is r_1. The other three arms of the bridge are formed by resistances without capacity or induction, and their resistances are r_2 from *a* to *d*, r_3 from *b* to *c*, and r_4 from *d* to *c*. The source of electricity is placed in the diagonal *ac*, and the null apparatus in the diagonal *bd*. Between *c* and a variable point, *e*, on the resistance r_2 is shunted a condenser of capacity C. The method consists firstly in an adjustment for permanent equilibrium by operating upon the resistance r_4. Then comes an adjustment for variable equilibrium by displacing the point *e* along the resistance r_2. The latter may be formed by two twin resistance boxes. The point *e* then remains fixed, and the resistances $ae = x$ and $ed = y$ are so regulated that their sum always remains equal to r_2. The author then establishes the following formula for the inductance

$$L = Cr_3x\left(1+\frac{y}{r_4}\right).$$

It will be seen that this formula is very elastic. The current which traverses the inductance can be made as great as ever the wire will carry.

[ILIOVICHI, *Comptes Rendus*, June 6, 1904.]

Electric Convection in Liquids.—By means of their apparatus for ultra-microscipic observations, A Cotton and H. Mouton have studied the electric transportation of grains of colloidal substances through a solution traversed by an electric current. As electrodes, they employed plates of platinum a few microns in thickness, mounted on the microscope slide. As a typical solution, they employed Bredig's colloidal silver solution, which gives brilliant grains. They found that in the middle layer the particles travelled towards the anode, whereas in the layers immediately adjoining the top and bottom glasses the grains travelled towards the cathode. If, now, the layer of liquid is thinned down, all the grains travel towards the cathode. The double motion was already observed by Quincke in the case of starch grains, but owing to their size he was unable to produce a motion in only one direction by thinning down the layer. The thickness of the inverse layer is constant for any given substance composing the wall. For glass it is 0·025mm., for quartz it is less, and for gypsum it is zero. The movement starts as soon as the current does. So prompt is the start that the authors were able to employ a current of 42 periods per second. Every silver grain then appeared as a luminous line with brilliant ends. On giving a mechanical transverse motion to the solution, the lines were drawn out into curves. The curves were largest in the centre, diminished towards the walls, and were reversed quite close to the latter. The authors obtained a response even to an alternating current of 1,300 periods per second, obtained from a singing arc. With three electrodes disposed in a triangle and connected with a three-phase supply they succeeded in making the grains describe circular orbits.

[COTTON and MOUTON, *Comptes Rendus*, June 20, 1904.]

Photographic Records of N-rays.—After the failure of a number of capable experimenters to observe the variation in the brightness of a sulphide screen provoked by N-rays, E. Rothé recognises that a new objective means must be found of recording N-ray phenomena. The action upon the electric spark may be recorded with comparative ease, but since the sulphide screen is of much wider application it would be valuable to obtain a direct photographic record of the variations of its luminosity. This has hitherto not been accomplished owing to the fact that the greater part of the apparent brightening under the influence of N-rays is due to the action of the secondary N rays proceeding from the sulphide upon the eye of the observer. There is, however, a residual objective effect which the author has succeeded in photographing. The method employed was a differential one. A circular patch of the zinc sulphide was placed at a distance of 5mm. from a photographic plate, and it was found that an impression was produced in about five seconds. The impression was circular, with a penumbra whose external diameter could be measured to within ½mm. On taking a series of ten impressions at intervals of 20 seconds, it was found that the diameter of the patch diminished steadily. This steady diminution was, however, interrupted by any disturbing influence such as heat or cold, or N-rays or N′-rays. Every alternate exposure was then made under the influence of N-rays. The irregularity thus introduced was immediately perceptible to the eye, and on measuring the diameters it was proved that the N-rays had a distinct retarding influence on the diminution of the phosphorescence. In most cases, every two successive diameters became equal.

[E. ROTHÉ, *Comptes Rendus*, June 20, 1904.]

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THE I.M.E.A. MEETING.

After every annual Convention of the Incorporated Municipal Electrical Association, opinions are freely exchanged as to the "success" of the gathering, comparisons are made with previous meetings, the selection of the Papers and the tenour of the discussions are criticised, and the social events and visits to works are passed in review. The general opinion expressed with regard to the 1904 Convention has been one of satisfaction. The subject matter of the Papers, and, indeed, the Papers themselves, were of precisely the nature suitable to a meeting of municipal electrical engineers and members of electricity committees, and by the good judgment and tact of the President the discussions were certainly worthy of the Papers, and were kept strictly to the point. In one or two directions, it is true, there were complaints that the voice of the councillor was not heard with sufficient frequency during the debates, but it must not be forgotten that the majority of the non-technical delegates come chiefly with the object of hearing the proceedings at first hand, and of learning what they can of the latest tendencies of electrical engineering, and rather enjoy a rest from public speaking. They welcome the opportunity of exchanging views quietly with the representatives of other municipalities without the necessity of hazarding the expression of definite convictions in open meeting as a means of obtaining the opinions upon the various subjects from different standpoints. On the other hand, a free invitation is always given to the Chairmen of Committees to contribute Papers, and although on this occasion there was but one solitary response, it afforded an admirable opportunity for a debate demonstrating the business-like attitude which electricity committees are now adopting in tackling the by no means simple financial questions connected with electricity supply undertakings. A few years ago there would not have been so many town councillors able to detect the fallacy of the arguments advanced in Mr. BLAKEWAY'S Paper.

The engineering problems discussed during the three days of the meeting were all of considerable importance. On the first day the surface-contact system of traction was discussed for the first time on the basis of long experience and actual quantitative tests, and that a conclusion generally adverse to the system was arrived at points to the fair manner

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in which Mr. SHAWFIELD owned up to the defects of the system he was championing. The second day's discussions were of a more technical nature, dealing with methods rather than results, and an outsider coming into the meeting might well be excused for asking whether sub-stations were called polyphase on account of the many phases of opinion as to the correct method of equipping them. A valuable comparison of experiences with the different sub-station plant followed the reading of Mr. PEARCE'S Paper, and the Paper, similarly to Mr. SHAWFIELD'S of the previous day, was evidently carefully prepared with a view to promote discussion upon the more important points. Among a meeting of municipal electrical engineers such an occurrence as the Bristol switchboard fire could not go by without discussion. The Council wisely took the bull by the horns—an expression which we assure the Bristol electrical engineer is only used in a figurative sense—and invited Mr. H. FARADAY PROCTOR to open a debate upon the subject, thus preventing it from intruding itself at inopportune times throughout the whole proceedings. After such a highly technical morning at Nottingham, perhaps the councillors were not entirely to blame for complaining that the third day's proceedings did not start with the debate on financial questions instead of concluding with it; but Mr. BLAKEWAY had dropped such a firebrand in the form of his Paper on the financial position of electricity undertakings, that had that Paper preceded Mr. DOWNE'S we fear that the most strenuous exertions of the President would not have been able to stop the discussion before the hour for adjournment. This would have been regrettable, for Mr. DOWNE'S Paper dealt with a subject which deserves considerable prominence, and Sheffield was certainly the city in which to discuss it.

There was also plenty of interest in the works that were visited to suggest conversation on matters pertaining to "shop," and the fact that many members visited the Derby electricity works and the old generating station at Sheffield, for neither of which definite times were set aside on the programme, was another sign of the fact that the meeting this year was taken as a serious event. Edinburgh will probably be chosen for next year's convention, as Mr. NEWINGTON succeeds Mr. WILMSHURST as President, and we trust that the meeting there will prove as much an all-round success as this year's visit to Derby, Nottingham and Sheffield.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

Radio-activity: An Elementary Treatise from the Standpoint of the Disintegration Theory. By F. SODDY. (London: "The Electrician" Printing and Publishing Co.) 6s. 6d. nett.

The course of events in science during the past few years is calculated to make one sympathise with the Scotch professor who nearly a century ago, referring to the isolation of new elements by Davy, described that active discoverer as "a verra troublesome person." It is indeed no small charge on the time and energies of a fully-occupied teacher to keep up with the impetuous march of discovery in the domain of radio-activity. Fortunately, however, the pioneers in this new territory find time to summarise their discoveries and expound their views in language that can be easily understood. Mme. Curie's splendid Thesis forms an introduction to the subject that will ever remain worthy of that too liberally dispensed term—a classic of science. Prof. J. J. Thomson in his comprehensive treatise on "The Conduction of Electricity through Gases," has dealt pretty fully with radio-activity. Prof. Rutherford has recently given an admirable work, and now Mr. Soddy appears with one worthy to rank with the other three. I am only competent to speak of Mr. Soddy's book from the standpoint of a non-radio-active chemist, or perhaps I should say, after reading it, one with merely imparted radio-activity; but I think that there may be some advantage in this, as the book will be read mainly by people in the same position.

Mr. Soddy's book is written explicitly from the standpoint of the disintegration theory. It presents the subject, therefore, in the most revolutionary and disturbing form; it contains doctrines that will be met with flat scepticism by those whose scientific piety takes the form of a rigid conservatism; it embodies conclusions—those concerning the nature of polonium, for example—that will be disputed by eminent workers in the same field; but it gains immensely in interest by arraying the facts systematically in relation to a single simple and intelligible hypothesis. This hypothesis of atomic disintegration has provided the most sensational element in the new science of radio-activity. When it was developed by Prof. Rutherford and Mr. Soddy in a series of papers which constitute one of the most remarkable contributions ever made to physical science, the earliest comments upon it, even in scientific quarters, implied that it involved something like a *bouleversement* of accepted scientific ideas. I have never entertained any such opinion, and, on behalf of chemists at least, protest against the implication that we are dismayed by the idea of atomic disintegration. Quite the reverse. I believe the idea of the complexity of the chemical elements has been steadily growing, and I, for one, must claim to have deprecated for many years past the idea that the 69 elements were as rigid and unalterable as the Thirty-nine Articles. It is true, no doubt, that the long experimental struggle with Prout's hypothesis tended to a negative result, but that was only one line of attack on the problem of the complexity of the elements. Now, when an affirmative result appears from another line of attack, I find nothing whatever in it to dismay a chemist. The idea of a chemical atom being composite is entirely welcome and hopeful to us; it does nothing whatever to disturb what has been done either in practical or theoretical chemistry; it gives the prospect of explaining much, hitherto unexplainable by the doctrine of simple atoms. The physicists seem equally satisfied, unless it be that some of them find difficulty in ascribing so large an energy content to the atom as is required by the theory. Why they see such a difficulty I am unable to understand. But, anyhow, it cannot be justly said that there is any *prima facie* reason from the chemical side for any distrust of an explanation of radio-activity based on the spontaneous disintegration of a complex atom. The hypothesis in the hands of Mr. Soddy affords in the book before us an intelligible and fascinating explanation of the phenomena, and it is, moreover, the only hypothesis yet advanced to link the experimental facts together.

It must not be inferred, however, that the book is wholly involved with the hypothesis in question. The earlier part is a very clear exposition of the history and the experimental facts of the subject, and it is not until the eighth of the 12 chapters is reached that the doctrine of atomic disintegration appears. This earlier part of the book is easy reading on the whole, but the nature of the phenomena at times precludes perfectly simple language. When we are told that in the case of imparted activity "we measure the *ions* produced by the *rays* produced by the matter causing the imparted radio-activity which is produced by the emanation which is produced by radium," we fully agree with the author in saying that "the number of the steps involved in the production of the phenomena observed is one of the initial difficulties of the subject." It is, in fact, a sort of new house that Jack built, with the additional difficulty to the memory, that the successive differences are much less marked than those of the dog, the cat, the rat and the malt, and that each destructive incident may be accompanied by one or more capricious α, β or γ incidents of radiation. The table of metabolons of radium given on p. 146 shows seven stages of disintegration. It seems a good deal to ask that one shall accept four kinds of matter causing "imparted activity," one transition being unaccompanied by any radiation at all. Yet, one is bound to admit that, if the law of the rate of change of activity is universally applicable, the evidence for the existence of the non-radiating

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change is satisfactory so far as it goes. It is here that the greatest strain is put upon the disintegration hypothesis. As Mr. Soddy points out, if a non-radiating sub-atomic change can be established for radium, there is no reason to deny such changes for all known elements. Disintegration might thus be regarded as a normal state of atomic affairs, discernible only in the extreme cases where it is accompanied by radiations.

It is quite unnecessary for me to attempt to summarise the contents of Mr. Soddy's book. It will suffice to say that it is admirably planned and admirably written, and that he has succeeded fully in his endeavour to enable the reader to feel the clearness of aim which he attributes so appreciatively to Prof. Rutherford. The book conforms to the primary requirement of satisfactory work—that its author should be imbued with his subject and should write from the fulness of knowledge. Herein it differs most wholesomely from the mere compilations that form the bulk of scientific literature. It will be especially welcome to chemists, as it is written by a chemist, but it is suited to all readers who have a moderate knowledge of physics and chemistry and desire a connected account of radio-activity.

The book concludes with a chapter entitled "Anticipations." Reflections would, perhaps, have been a better word, for we find in this chapter an interesting discussion of the bearing of radio-activity on a number of known problems rather than a prediction of the particular solutions these problems will receive. Nothing more could be expected or would be wise. One thing Mr. Soddy does not tell us, and that is how far the disintegration theory is now favoured by Continental workers. Has the definite proof of the production of helium from radium brought them over to the theory?

In concluding this notice, I may allude with great satisfaction to the fact that the most active workers in the science of radio-activity are young, and I may express the fervent hope that their activity may not follow the radio-active law and show a rate of decay in a geometrical progression with the time.

ARTHUR SMITHELLS.

THE SPEN VALLEY LIGHT RAILWAY ACCIDENT AT DEWSBURY.

A report has just been issued by Major Druitt as the result of his inquiry into the collision between a tramcar and various vehicles which occurred on May 20th, in Halifax-road, Dewsbury, on the Spen Valley Railway. Major Druitt says:—

The car in question, No. 7, belonging to the Yorkshire (Woollen District) Electric Tramways, was a four-wheeled double-decked car with a top cover, fitted with the usual hand brakes, Spencer "Scotch" brake, and the Westinghouse magnetic slipper brake. The controller was of the H. D2 Brush pattern, and the car was also fitted with the Tidswell lifeguard. Up to two days previously to the accident it had been in the repairing shops having new wheels fitted, but was completed on May 18th, and taken out for a trial by the shed foreman, who found it in good order. Accordingly, it was put into service on the 19th, and was in use all that day, and both motormen in charge reported it in good order. On the day of the accident it was taken out at 12:10 p.m. by driver Stead, who took it a complete journey from Dewsbury to Cleckheaton and back, and started on the second trip at 1:30 p.m., and it was on the return journey from Cleckheaton to Dewsbury that Stead lost control of the car, which ran away down the steep hill into Dewsbury, first colliding with a waggon of mineral waters opposite the Bath Hotel, and subsequently some way further on with a cart, after which, leaving the rails, it ran on to the opposite pair of rails, colliding with another car from Birkenshaw in the Market Place, Dewsbury. Three passengers in the runaway car were injured and one in the Birkenshaw car.

Both driver and conductor of the runaway car and of the Birkenshaw car were injured. The driver of one of the waggons damaged by collision was also injured. The gradients of Halifax-road are in places very steep, but the rails were quite dry at the time of the accident. Stead came down the Shoulder of Mutton Hill (part of which is a gradient of 1 in 8) with the Westinghouse brake, and also the next steep gradient, and then made two stops without any trouble. He states that when he started from Oxford-road the Westinghouse brake acted very well at first while the controller handle was on the seventh, sixth and fifth brake notches, but when he moved it on to the fourth notch, so as to get less braking effect, the car suddenly shot away, and that afterwards he could not control the car, though he put the controller handle back to the seventh notch, when the maximum braking effect should have resulted. The car continued to gain speed, and seeing a waggon on the track a little way ahead, he applied the Spencer "Scotch" brake, which should have had the effect of a violent check on the speed of the car, but no effect resulted. As a last resort he states he tried feeding the motors in parallel, with the power handle in the reverse position, and the current cut off by throwing over the canopy switch, also without result, and that the controller handles were in this position when the first collision with the waggon at the Bath Hotel occurred. This is about 285yds. beyond Oxford-road. Stead states that by the first collision the front of his car was wrecked, and the controller and hand brake spindle bent back and rendered useless, so that he could do no more, and that when near the railway bridge, 300yds. further on than the hotel, he fell off the car while releasing his foot from the controller, which had jammed it. The speed of the car was estimated by witnesses at about 30 miles an hour at the time of the first collision.

By the final collision in Northgate the controller was thrown into the street, so it is impossible to draw any conclusions from the positions of the handles, which were bent and had evidently received blows. Their actual positions when found were such that no braking effect would have resulted, but it would be unfair to assume that they had been left by Stead in those positions. When the controller was put back into the body of the car and two broken connections made good, the car could be driven, and nothing was found to be wrong. I saw the car in this condition and nothing was then wrong with the Westinghouse brake. Taking all the evidence available into consideration, I think what probably happened was that Stead let the car go too fast after leaving Oxford-road—*i.e.*, when he put the controller handle to the fourth notch of the Westinghouse brake, and just then catching sight of the waggon foul of the line at the Bath Hotel (which is only 285yds. from Oxford-road on a very steep gradient, partly 1 in 9), put back the controller handle to the seventh notch, and not getting the immediate braking effect expected, at once applied what is known as the electric "Scotch" brake but this, when applied at the high speed which the car had then gained, has the effect of skidding the wheels for a short time, and the car does not check its speed at once, and feeding the motors in parallel with the power handle reversed and the canopy switch thrown off has a similar effect, though not so great. In each case Stead, in his anxiety to stop the car before colliding with the waggon, probably did not allow sufficient time for either brake to take effect, and after the first collision he did nothing. He says the reason for attempting nothing after that happened was that all his gear, including the spindle of the hand brake, was bent, but there is the evidence of witnesses throwing doubt on this. If the hand brake was still available Stead could have reduced the violence of the second collision very considerably, even if he could not have stopped the car, had he applied it, but it is impossible for anyone to say for certain in what condition it was with the exception of Stead himself. As far as can be judged, the car was in good order at the time of the runaway and had nothing wrong with the brakes. There is practically no doubt about this. I think the bad accident was caused by Stead's anxiety to prevent the first collision with the waggon at the Bath Hotel, and after that he lost his head and could do nothing. As before pointed out in accident reports, a much higher standard of training is required for men who are put in charge of electrically worked brakes than for those who have to use purely mechanical brakes, because in brakes of the first nature the men, as a rule, do not understand how and why the brakes act, and if, in an emergency, they do not at once get the braking effect desired or expected, they at once jump to the conclusion that the Westinghouse brake has failed and begin to try the effect of another brake without giving the necessary time for the first brake to act, with the result that the car runs away. The whole affair is a matter of seconds, and it requires the greatest knowledge of, and confidence in, the mechanism employed for a man to wait even a few seconds for the brake to take effect, while he is rapidly approaching an obstacle in his track, without thinking that something may have failed and acting on the impulse in a wrong manner.

HIGH-SPEED ELECTRIC RAILWAY EXPERIMENTS ON THE MARIENFELDE-ZOSSEN LINE.*

BY ALEXANDER SIEMENS.

(*Concluded from page 392.*)

The trial runs were started on June 23, 1902, with 7,250 volts., and this voltage was gradually raised until the locomotive successfully pulled a trailer on June 26th with just over 10,000 volts. Some of the details of the measurements taken during these runs are given in Table C. It is at once apparent that the efficiency of the locomotive is much greater than that of the cars at the trials in 1901, for the reason that its motors were working nearer to their rated output. Another reason is the absence of a transformer, so that a comparison at an output of 400 H.P. shows that the locomotive required for this, at 10,800 volts and $\cos\phi = 0{\cdot}85$, an average current of 19 amperes, while the cars at 6,300 volts and $\cos\phi = 0{\cdot}5$ consumed about 53 amperes. The losses in the conductors along the line are therefore 2kw. in the case of the locomotive and 17kw. in the case of the cars.

In conclusion, the report considers that the trials have proved the possibility of building motors for three-phase currents of 10,000 volts, used direct without transformers. It is mentioned that the motors and the gearing have worked without giving any trouble up to a

* Paper read before the Institution of Electrical Engineers on May 26th.

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Table C.—*Runs, at Constant Speed, of Three-phase Locomotive with one Trailer.*

Date, June, 1902.	Run No.	No. of periods per sec.	Weight of train in tons.	Time of measurements in secs.	Speed in km. per hour.	Average at feeding point. Amp.	Volts.	Kw.	Average value of cos φ calculated.	Average power at feeding point.	Weight of trailer in kg.
23	I.	30	52·25	810	70	10·0	7,250	76	0·60	At 70km./hr. 91kw. =124 H.P.	12,250
	II.	30	52·25	240	70	11·0	7,200	105	0·75		
24	I.	30	57·68	390	65–70	9·5	7,200	71	0·59		17,680
	II.	30	57·68	350	65–70	15·0	7,150	137	0·74		
25	I.	40	52·25	790	86	12·0	8,200	136	0·79	At 86km./hr. 184kw. =250 H.P.	12,250
	II.	40	52·25	800	86	18·0	8,100	222	0 86		
	III.	40	52 25	760	86–88	13·0	8,250	150	0·81		
	IV.	40	52·25	820	86	18·6	8,150	226	0·86		
26	I.	47	70 75	410	101–102	20·5	10.650	322	0·84	At 102km./hr. 293kw. =398 H.P.	30,750
	II.	47	70·75	390	102	18·5	10,850	286	0·285		
	III.	47	70·75	340	101·5–102	18·0	10,770	270	0·81		
	IV.	47	70·75	360	101·5–103	19·0	10,770	290	0·82		

speed of 100km. per hour, and that the working without transformers makes it possible to reduce the weight of the high-speed cars from 92 tons to 76–78 tons, an achievement which will materially diminish the cost of working and the wear and tear of the permanent way. In the interval between the experiments of 1902 and those of last year, the permanent way of the line was renewed throughout, and now it is equal to that of a German first-class main line. The rails are 12 metres long, Vignoles pattern, standard profile 8 ; they weigh 41kg. per metre, and are supported by 18 sleepers bedded in stone ballast. As a matter of precaution, guard-rails were added all along the line, but it was evident, when they were carefully examined after the trials, that even at the highest speeds their service had never been required. Owing to the losses in the feeder and to the reduced speed of the generating sets, the acceleration could not be raised beyond 0·15 to 0·18 metre per sec., although the motors on the cars would have been capable of developing more power than they actually did. The bogies of both cars were altered in accordance with the experience gained in previous trials, as requested by the syndicate. In the "A" car the switching arrangements were altered so that the motors can be started one after the other instead of simultaneously, and further ventilation for the motors has been provided. The electrical arrangements of the "S" car remain exactly as they were made in the first instance; the motor casing, however, is now supported by springs from the bogie-frame, so that only the rotating part of the motors remains rigidly fixed to the axle.

An arrangement for measuring the turning moment by means of registering the pressure exerted by the casing on a piston working an oil manometer has been added to one of the motors of the "S" car, and also devices for diminishing the pressure on the brakes with diminishing speeds. All the exhaust openings of the Westinghouse brakes have been united by a common pipe on which two exhaust valves are fitted. One of these can be manipulated by the driver and the other is under the control of an electrical contrivance, the circuit of which is closed automatically by a pendulum weight when the retardation exceeds a certain rate. These additions had been found necessary as the pressure on the brake blocks at the highest speeds had to be equal to 200 per cent. of the weight of the car, which at lower speeds would skid the wheels. For both cars the collectors were modified by dividing their horizontal arm into three parts, connected by springs, with a view of diminishing as much as possible the weight of the part receiving the blows caused by irregularities of the conductors and damping their effect further by sub-dividing the mass which has to be accelerated. In addition, the balancing wings which counteract the pressure of the wind on the collector arms were reconstructed with great care. A model of such a collector, kindly lent by Messrs. Siemens and Halske, is on the table.

With regard to the general arrangement of the electrical outfit, the running of the cars at high speeds showed that the weights have to be distributed symmetrically on both sides of the car, in order to prevent excessive swaying. For this purpose balancing weights had to be added in the "A" car because the transformers had not been placed exactly symmetrically in the first instance. The actual runs began on September 15th with the "S" car, on which day a speed of 150km. was reached, and the improvement in steadiness owing to the alteration of the bogies was most marked. During the following days the speed was gradually increased in the manner laid down in the original programme, until on October 6th a speed of 201km. per hour was attained with a current of 46 periods and 14,000 volts. It should be noted that in the curves with a radius of 2,000 metres the speed of the cars was restricted to 165km. to 170km. per hour, so as to avoid any danger. This point is in so far important as it shows that most of the existing main lines would be unsuitable for speeds greatly exceeding those of the present traffic.

One of the engineers, who was in the "S" car during the run, gives the following details :—

"After examining the car and all the apparatus, the current was turned on until each of the motors was supplied with 350 amperes, corresponding to 2,300kw. for the car. The feeding point, about 1km. distant, was passed at the speed of 80km. per hour; 2km. further. 120km. per hour was indicated; and at the first curve of 2,000 metres radius the speed was 170km.; Mahlow, 7km. from Marienfelde, was passed at 185km. per hour. Still the car is running quite smoothly, and all measurements can be noted down with greater comfort than in an ordinary express train. Keeping the power at 2,300kw. the last resistances are gradually cut out and the speed increases to 195km. per hour. Suddenly a sounding blow is heard against a window of the driver's cabin. It is no mishap to the car, but a bird is killed which has been overtaken by the car. At last, 1km. before Rangsdorf, the indicator passes the 200km. per hour mark, and for the space of another kilometre this speed is maintained, with an expenditure of 1,400kw. Then the brakes have to be applied, so that the car enters the second curve of 2,000 metres radius with a speed of 165km. and arrives at the terminal station of Zossen eight minutes after leaving Marienfelde. An examination of the car shows it to be in absolute order, its front covered with bees, gnats and other insects, which appear as if smashed by a heavy weight—naturally, as the air-pressure rose to 210kg. per square metre. The recording speed indicator showed that the maximum speed had been 200·8km. per hour."

After this memorable run further systematic measurements of air resistance, retardation, &c., were made, and the "A" car also began running. It made a record of 210·2km. per hour on October 28th, with a periodicity of 47·5 per second, all restrictions as to speed in curves being suspended on that occasion. During this run the car swayed so much that one of the conductors was broken and fell by accident on the foot of an official. The earthing device acted, however, so promptly that the man received no electric shock whatever. On the same occasion one of the transformers in the generating station was slightly damaged and in consequence the syndicate would not allow more than about 45 periods per sec. for the subsequent trials.

Table D gives a summary of the most notable runs, comparing the theoretical speed, which depends on the number of periods, the diameter of the wheels and the number of poles (three pairs), with the actual speed, from which the slip can be calculated. The slip of the motors in the "S" car was uniformly 2·8 per cent., so that it would have run up to 217·6km. per hour if it had been supplied with currents of 47·5 periods per sec. It is, however, of no great moment whether a few kilometres more or less were accomplished by one or the other car; the important fact has been successfully demonstrated that trains can be constructed and worked by electricity at about double the speed of the present express trains, on a permanent way not materially differing from that of a first-class main line, except that it would not be safe to allow curves having a smaller radius than 2,000 metres in parts of the line where the trains have to run at full speed. In most cases it will, therefore, be necessary to build special lines for high-speed working, and no general rule can be established whether it would pay to do so. Although the experimental cars carried transformers and were equipped with three-phase motors, there is no necessity that these features should be repeated in future. The trials of the

Table D.—*High-speed Runs.*

Date, 1903.	Car.	Periods per sec. p.	Corresponding speed $V = \frac{1{\cdot}25 \times \pi \times 3{,}600}{3} \times p$.	Max. speed during run V.	Slip $\sigma = (V - V_1)/V$.
			Km. per hour.	Km. per hr.	Per cent.
Oct. 28	A	47·5	223·84	210·2	6·0
Nov. 11	A	45·3	213·94	196·0	8·4
	S	45·3	213·94	208·0	2·8
Nov. 17	A	40·2	189·4	182·0	4·0
	S	40·2	189·4	184·0	2·8
Nov. 25	A	45·5	213·5	204 7	3·9*
	S	45·5	213·5	207·3	2·75*

* The strength of the soda solution in starter had been increased.

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Table E.—*Average Value of Measurements taken during Acceleration.*

	Date, 1093.	Level above ordnance datum.		Acceleration.			Final speed Km.-hrs.	Periods per sec.	At feeding point.			At collectors of car.						Wind.	
		Start.	Finish.	Time in sec.	Dist. in metres.	Av. rate.			Amps.	Volts.	Kw.	Amps.	Volts.	Kw.	Cos ϕ.	Kw.-hours.	H.P.	Direction.	Velocity.
Car A, 94,000kg.	*a* Oct. 28	48·14	42·8	360	13,450	0·162	210·0	48	132·0	10,401	..	132·0	10,110	2,040	0·88	205·0	2,770	E.	1·6
	a Nov. 12	40·05	42·3	393	12,580	0·123	174·0	40	112·0	9,840	1,570	112·0	9,000	1,440	0·825	162·0	1,960	W.	4·8
	a ,, 14	48·14	45·1	220	5,380	0·197	156·0	36	118·0	8,910	1,420	118·0	8,910	1,390	0·765	98·0	1,890	E.	3·5
	b ,, 17	48·14	42·1	360	10,100	0·134	174·0	40	146·0	8,750	1,840	146·0	8,670	1,760	0·80	186·0	2,320	S.S.W.	3·2
	c ,, 20	48·14	39·6	270	8,540	0·185	180·5	40	126·0	9,925	1,650	124·0	9,810	1,590	0·756	126·0	2,160	N.N.E.	2·6
	a ,, 20	48·14	47·35	280	8,520	0·178	180·0	40	118·0	9,850	1,600	117·0	9,705	1,570	0·80	131·0	2,140	N.N.E.	2·6
	c ,, 25	40·05	47·6	365	12,280	0·154	205·0	46	126·0	10,980	1,935	126·0	9,840	1,760	0·82	186·0	2,390	S.W.	3·2
Car S, 93,400kg.	Oct. 23	40·05	47·0	374	14,250	0·153	206·0	46	134·4	12,015	2,320	134·2	10,160	2,130	0·9	220·0	2,900	S.S.W.	4·9
	,, 26	40·05	42·2	410	12,450	0·123	180·0	40	113·5	9,380	1,520	112·8	8,050	1,415	0·9	161·2	1,925	S.E.	3·3
	b Nov. 13	48·14	42·14	350	10,050	0·114	162·0	36	125 2	9,120	1,650	124·8	8,900	1,572	0·815	152·6	2,135	E.S.E.	3·3
	,, 13	48·14	48·98	230	6,280	0·196	162·0	36	120·0	8,865	1,525	119·5	8,730	1,490	0·825	95·2	2,020	E.S.E.	3·3
	,, 25	48·14	42·2	400	15,100	0·145	209·0	46	134·3	10,630	2,090	134·0	10,240	2,010	0·845	223·0	2,730	S.W.	3·2
	,, 26	48·14	48·2	265	7,595	0·178	170·0	40	115·5	9,190	1,530	114·0	9,000	1,490	0·839	109·6	2,030	S.W.	5·9
	,, 26	48·14	48·0	280	7,650	0·181	170·0	40	118·0	9,040	1,550	117·7	8,785	1,520	0·853	109·8	2,070	S.W.	5·9

a Without bow fitting. *b* With sleeping car (44,300kg.). *c* With bow fitting.

Table F.—*Average Value of Measurements taken while Running at Constant Speed.*

	Date, 1903.	Average speed. Km.-hr.	No. of periods per sec.	At feeding point.			At collectors of car.					Power exerted on wheels calc. for level, calm and cos ϕ = 183.	
				Amps.	Volts.	Kw.	Amps.	Volts.	Kw.	Cos ϕ.	H.P.	Per run.	Average.
Car A (94,000kg.)	*a* Oct. 22..	172·5	40	100·0	9,855	1,335	100·0	9,360	1,295	0·795	1,745	1,389	..
	a ,, 24..	177·5	40	97·0	10,490	1,320	96·0	10,035	1,045	0·630	1,420	1,168	..
	a Nov. 14..	163·0	36	85·0	9,640	1,035	84·0	9,180	955	0·715	1,320	1,114	1,074
	a ,, 14..	163·5	36	81·0	9,460	980	80·0	9,110	935	0·740	1,270	1,034	
	b ,, 17..	175·0	40	109·0	9,870	1,575	108·0	9,360	1,460	0·835	1,985	1,496	1,544
	b ,, 17..	168·5	40	113·0	9,670	1,590	(113)	9,300	1,450	0·800	1,970	1,589	
	c ,, 19..	178·5	40	94·0	10,400	1,250	92·0	10,030	1,205	0·758	1,640	1,263	..
	d ,, 20..	182·0	40	93·0	10,930	1,170	89·0	10,560	1,080	0·655	1,470	1,363	1,314
	d ,, 20..	180·0	40	92·0	10,700	1,240	91·0	10,275	1,185	0·733	1,610	1,265	
	c ,, 20..	182·0	40	93·0	10,500	1,350	90·0	10,200	1,160	0·730	1,575	1,511	1,435
	c ,, 20..	181·0	40	94·0	10,300	1,300	93·0	9,900	1,230	0·780	1,610	1,360	
Car S (93,400kg.)	*e* Oct. 26..	180·0	40	103·1	9,630	1,425	102·1	9,000	1,380	0·860	1,875	1,535	..
	b Nov. 13..	163·0	36	102·8	9,600	1,382	101·8	9,000	1,269	0·800	1,720	1,322	1,325
	b ,, 13..	161·0	36	109·0	9,200	1,450	108·0	8,600	1,380	0·857	1,875	1,329	
	e ,, 13..	165·0	36	86·0	9,700	1,060	85·4	9,310	1,000	0·724	1,355	1,164	1,159
	e ,, 13..	165·0	36	83·2	9,600	1,065	83·0	9,100	1,010	0·770	1,372	1,155	
	e ,, 14..	165·0	36	88·0	9,400	1,100	87·4	8,900	1,040	0·770	1,412	1,203	1,146
	e ,, 14..	165·0	36	83·0	9,440	1,030	82·4	9,000	1,000	0·777	1,355	1,089	
	e ,, 23..	168·8	36	85·4	10,150	1,100	83·5	9,700	1,040	0·740	1,412	1,287	..
	e ,, 23..	168·0	36	84·5	10,100	1,080	83·7	9,600	1,020	0·730	1,385	1,250	..
	e ,, 26..	172·0	36	87·4	10,250	1,140	86·9	9,420	1,080	0·762	1,465	1,179	1,256
	e ,, 26..	171·5	36	90·0	10,000	1,185	89·5	9,500	1,145	0·776	1,555	1,334	
	e ,, 26..	171·5	36	87·0	10,050	1,125	86·5	9,540	1,070	0·750	1,453	1,166	1,254
	e ,, 26..	171·0	36	88·5	9,800	1,180	88·0	9,300	1,140	0·805	1,550	1,343	
	e ,, 26..	171·5	36	85·6	9,900	1,090	84·2	9,350	1,050	0·770	1,425	1,140	1,252
	e ,, 26..	170·5	36	92·0	9,640	1,210	91·5	9,060	1,170	0·810	1,590	1,365	

a Without wedge-shape bow fitting. *b* With sleeping car (44,300kg). *c* Without bow fitting. *d* With bow fitting. *e* Car by itself.

locomotive in 1902 have shown that motors can be built for working direct with current of 12,000 volts, and the 1886 patent foreshadows the possibility of using induction motors with single-phase currents, so that only one overhead line is required when the running rails are used for the return.

From the official report of last year's trial the Tables E and F have been compiled, giving data during acceleration and during running at constant speed. It was found that an ordinary express car could not be used as trailer at speeds exceeding 180km. per hour owing to excessive swaying, demonstrating the necessity of having a long wheelbase for the bogies and a symmetrical distribution of weights so that all wheels carry equal parts of the weight. Retardation experiments confirmed the formula previously found for the determination of air resistance, $P = 0{\cdot}005V^2$, but it was incidentally mentioned by Col. v. Scheve that for calculating the resistance of the air to projectiles the artillery officers used a formula of Newton's: $P = \frac{\triangle}{2g} V^2$, in which $\triangle$ is the weight of a cubic metre of air and V = velocity in metres per second. Taking the average value of $\triangle = 1{\cdot}293$ and expressing the velocity in kilometres per hour, Newton's formula becomes $P = 0{\cdot}0051V^2$, which agrees remarkably well with the formula deduced from the experiments. In concluding their report about last year's trials, the syndicate congratulate all those concerned on the successful achievement of the original problem, and they announce their intention of continuing the trials in order to test the endurance of the various apparatus and to investigate the question of employing single-phase motors. As the generating station at Oberspree is at present so overloaded that no current can be supplied to the Zossen line, the syndicate are investigating at present projects for establishing actual high-speed lines. They give, as an appendix to their report, such a project for a line between Hamburg and Berlin, but time will not permit to go into that subject to-night.

It would, however, be very ungrateful to conclude this Paper without expressing to the syndicate and to the firms who carried out the trials the warmest thanks for their kindness and liberality in placing the results of their work at the disposal of this Institution.

SOME PROPERTIES OF ALTERNATORS UNDER VARIOUS CONDITIONS OF LOAD.*

BY A. F. T. ATCHISON.

(*Concluded from page 389.*)

Some Wave-form Effects in Synchronous Motors.

The assumption that the E.M.F. wave-forms of alternators are sinusoidal, or even approximately so, is often too far from the truth to be made when considering many of the secondary and more abstruse phenomena which may occur in alternating-current circuits.

A case which is met with in practice is that of a synchronous motor or converter having a different open-circuit E.M.F. wave-form from that of the generator driving it.

The accompanying illustrations show the wave-forms of current taken by a synchronous motor whose open circuit E.M.F. wave-form differs considerably from that of the generator driving it,

* Abstract of a Paper read before the Birmingham Local Section of the Institution of Electrical Engineers on April 20th.

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Fig. 32 being that of the generator, and Fig. 2 that of the motor. The generator was the 12½kw. single-phaser by Fuller-Wenström with revolving armature (machine "D" previously referred to), having four slots per pole, and giving the somewhat remarkable triangular wave-form shown. The machine used as the synchronous motor was a smaller machine of the Fynn inductor type—in reality a 2-phaser with two slots per phase per "armature pole" (the number of inductors being naturally half that of armature coils of each phase), but with one phase entirely unused throughout the tests—of 5kw. output as a 2-phaser or 2½kw. as single-phaser (the machine "A" mentioned above). This arrangement gives us an example of a synchronous motor driven by a generator of considerably larger capacity, and neither of the machines giving sine waves of E.M.F.

The oscillograms, Figs. 35, *a* to *j*, show the form of P.D. and the controlling current when the motor was running light under different degrees of excitation, Fig. 35 *f* being the condition when the motor

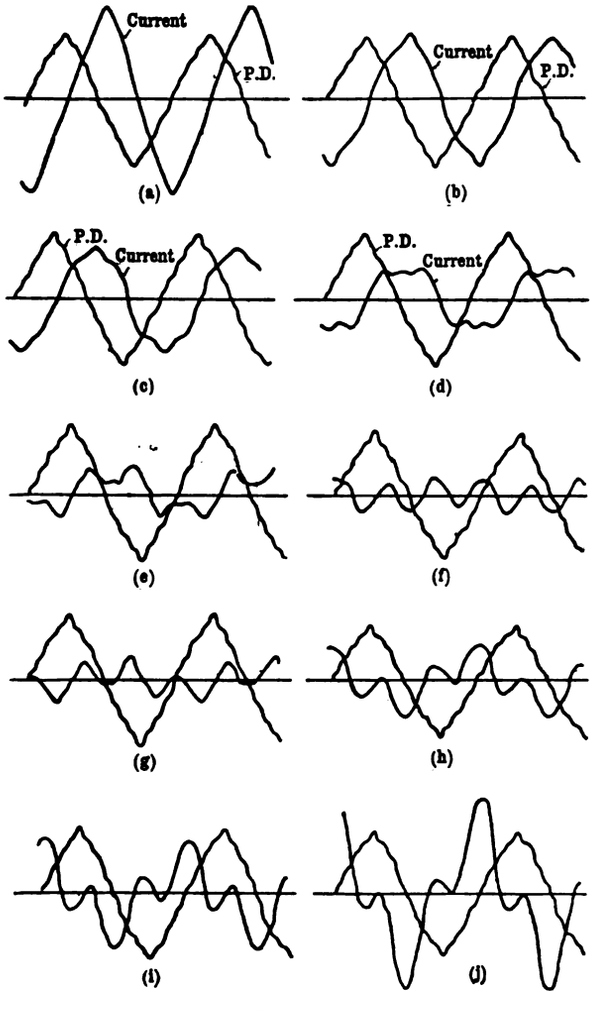

Fig. 35.

excitation was such as gave rise to the minimum value of controlling current—*i.e.*, the lowest point on the "V" curve. The current in this case was practically identical in form to that obtained after sychronising, but before cutting off the driving power from the motor —that is to say, the controlling current of the two machines running in parallel unloaded. It may be mentioned that the generator was driven throughout by a direct-current motor, so that no periodic fluctuations of driving torque occurred. On throwing off the belt from the synchronous motor (thus mechanically disconnecting it from a second D.C. motor which had been used to run it up to synchronism) and gradually weakening its field exitation, the current wave undergoes the remarkable alterations shown in Fig. 35, *f* to *a*, becoming more and more lagging in phase. On gradually strengthening the excitation (thus working along the other side of the V curve) the current wave again undergoes striking changes in form and develops an increasing lead in phase (Fig. 35, *f* to *j*).

It will be noticed that the open-circuit E.M.F. wave-form of the motor is completely obliterated throughout, the wave-form of P.D. across the terminals being that of the larger machine (in this case the generator) throughout.

On interchanging the two machines and running the larger one as a synchronous motor from the small one as generator, this was still found to be the case, the E.M.F. wave-form of the smaller machine never being at all discernible; this would result from the reactive effect of the same armature current on the field systems being relatively much more powerful in the case of the small machine than the large one; and, further, the ratio of armature turns to field coil turns being 1 to 120 in the large machine, as compared with 1 to 48 in the small machine (or 1 to 96 if we consider the field to be reacted upon by only half the armature coils in the inductor type of machine).

As an example of a synchronous motor of about the same output as the generator driving it, are shown Figs. 36, *a* to *f*. The inductor machine described above was run as a synchronous motor driven by a generator whose open-circuit wave-form has been shown in Fig. 17. This machine (the E.C.C. machine "C") is in reality a 3-phaser, but was only used as a single-phaser in these experiments. Since the armature was star-connected there is an absence of the harmonic of triple frequency in the E.M.F. wave, which is, in fact, nearly sinusoidal except for the high frequency "ripples" produced by the armature slots. Fig. 36, *a* shows the P.D. and current waves when the two machines are running in parallel and unloaded. The P.D. wave-form is then intermediate between those of the two machines individually, as would be expected from the fact of the machines being about of the same size and both normally excited. On gradually reducing the exeitation of the synchronous motor (the inductor machine), the wave-forms undergo the modifications shown in Fig. 36, *d*, *c*, *b*, successively, the current becoming

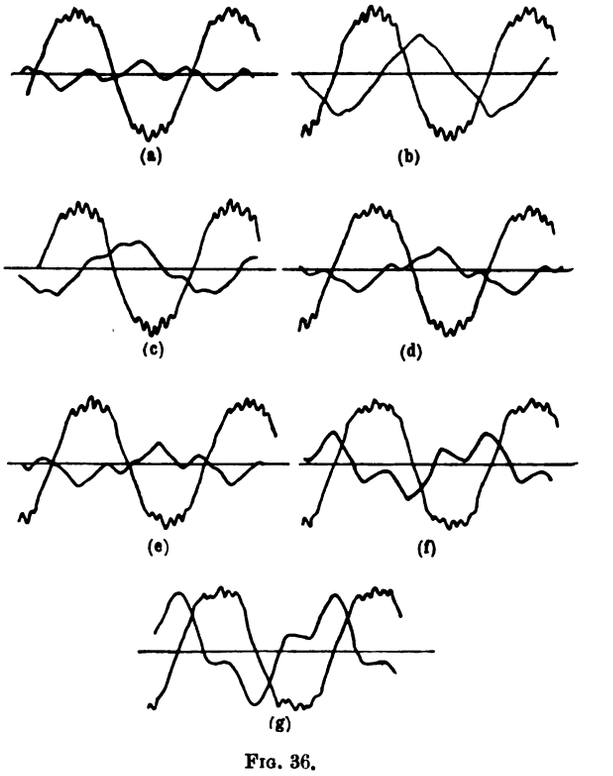

Fig. 36.

more and more lagging and completely changing its form, while the P.D. wave approaches more and more to the open circuit wave-form of the more strongly-excited machine (generator). If, instead of being reduced, the excitation of the synchronous motor be *increased* the waves in Figs. 36, *e* and *f* result; the current gaining in phase and the P.D. wave approaching more nearly the flat-topped wave of the motor E.M.F. (now the more strongly excited of the two machines).

On interchanging the machines and running the inductor machine as the generator and the other as the synchronous motor, the P.D. wave still approaches the form of the more strongly-excited machine (Fig. 37, *a*, with motor under-excited, and Fig. 37, *b*, with motor over-excited). If, instead of running light, the motor is mechanically loaded, the wave-forms are more distorted, Fig. 38, *a*, showing the inductor machine as motor under-excited and Fig. 38, *b*, the waves with the motor loaded to the same extent, but over-excited. The current is, of course, more nearly in phase with the P.D. owing to the power component which is required under load.

Similar examples of change of wave-form may be obtained in almost endless variety by altering the load and excitation.

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At any instant the current will be determined by the difference between the P.D. impressed across the motor terminals and the complete counter E.M.F. induced in the motor armature, or at any instant $i=\frac{v-e}{\gamma}$. Now, if the generator is considerably larger than the motor the value of v (if the line itself is non-conductive) will practically be that given by the open-circuit wave-form of the generator. The total E.M.F. induced in the motor armature, however, is due to a variety of causes. First, there is the E.M.F. due to the motion of the conductors across the existing field. This fixed distribution, however, is not that which exists when the machine is run on open circuit, but is modified as a whole by armature reaction, the extent of the modification and distortion depending upon the general angular relation of current wave and position of field poles in space—that is, on the general phase of the current and open circuit E.M.F. waves (these being, in general, of different forms, cannot be considered to have a *definite* angle of phase difference). There is, further, the E.M.F. induced in the conductors by the rise and fall of armature leakage flux or E.M.F. of true self-induction. This E.M.F. will be of a complex nature, but at any instant is $d(Li)/dt$, where L is the coefficient of leakage inductance of the armature at the instant considered. This inductance, however, is not constant, but is a function of the time (being dependent upon the relative position, in space, of armature coil and field pole) and, to a certain extent, of the current strength itself.

Since the current itself is in general a complicated periodic function of the time, it is clear that the leakage self-inductive E.M.F. may readily undergo great modifications by altering the working conditions of the motor. Further, any irregularities or harmonies in the current-wave are intensified in its time-rate of change, and hence, even if the inductance were constant and not a function of the time, the self-inductive E.M.F. would be of an extremely irregular form. In the case of a single-phase machine,

FIG. 37.

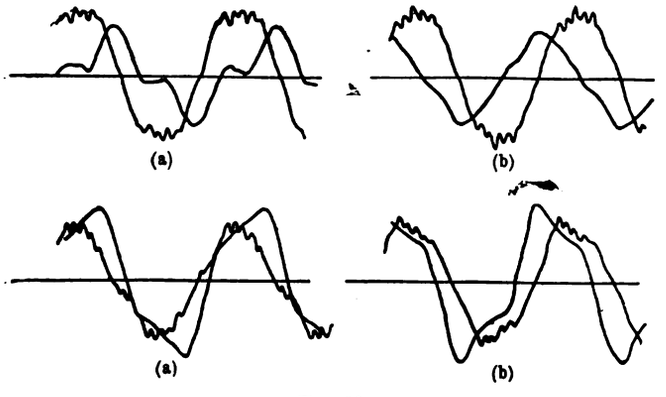

FIG. 38.

the effect of armature reaction is pulsating in character, being of double the fundamental frequency, but in a polyphase machine the resultant effect is nearly constant, and hence the resultant field remains modified as a whole by the reaction of the armature currents, the extent of the modification depending on the general phase of the current-wave.

As previously pointed out in connection with armature reaction in alternating-current generators, the leakage-flux combines with the mutual flux to produce a resultant flux which induces the complete E.M.F. in the armature conductors, although for the purpose of ahalysis it is more convenient to consider each flux as inducing its own E.M.F., and then to consider these E M.F.s to combine into a final resultant E.M.F. The effect of altering the excitation of the motor is to slightly retard or accelerate the rotor until the armature current-wave has assumed its phase-relation with the field poles correspondingly to the changed excitation. This not only alters the field distortion, and, therefore, the wave-form of the corresponding part of the counter E.M.F., but also directly alters the nature of the E.M.F. of leakage self-induction, since the variations of the coefficient of inductance will occur while the time-rate of change in the current is different owing to the general displacement of the current-wave.

A similar effect is produced by an alteration of the load on the motor; an increase of load momentarily retarding the armature until it assumes in space such a phase as gives rise to the necessary torque under the new load. If the maximum limit of this displacement is exceeded, the machine, of course, falls out of step from excessive overload.

The effects shown above in the oscillograms, Figs. 35 and 36, suggest that in the case of machines of different wave-form, conditions may exist which would give rise to unsteady parallel running without any irregularity on the part of the prime mover. I refer to the flow of *power* between the machines, which, in the case of such irregular current wave-forms, may undergo rapid alternations in direction. The wave of power, in fact, being the product of the waves of P.D. and current, reverse in direction whenever either of these factors pass through zero separately, and will therefore have a number of reversals per record equal to the sum of the reversals in the P.D. and current waves. Now, a reversal in the direction of the transmitted power—*i.e.*, a change from motor to generator action in either machine—will be accompanied by a reversal in mechanical stress in the machines, which, if of suitable frequency, might set up hunting. It will be seen from the above oscillograms that a change in the excitation in such dissimilar machines may so change the form of the current wave that the number of alternations in the power wave may be greatly altered. It is, in fact, in accordance with common experience that unsteady parallel running may often be improved by an alteration in the excitation of one machine, though the effect is usually attributed to the alteration produced in the time period of the natural oscillations of the rotor concerned.

The following is an abstract of the discussion which took place in connection with the Paper:—

Dr. SUMPNER said it was easy to give a definition of the power-factor of a three-phase system if all the voltages and also all the currents were assumed to be equal, a condition which was never exactly fulfilled; but where the voltages and currents differed, he did not think anyone had given a definition of the power-factor. Such a definition might be the following:—Suppose V to be the voltage between each main and the neutral point, or the mean of the three voltages if different, the volt-amperes of the circuit could then be defined as the product of V and the sum of the three currents in the mains; and the power-factor of the system would be the ratio of the watts to the volt-amperes so defined. Considerations of this kind, together with the oscillograms given by Mr. Atchison, made one very doubtful whether a good deal of the theory contained in this and other Papers could be looked upon as reliable, the more so as a large number of constants had to be determined from experience to make the theory work. Rothert's theory concerning ampere-turns was an instance. Similarly, though he (the speaker) was very much interested in Mr. Atchison's theory about two coefficients of self-induction of the armature, he thought same the criticism applied to that method also. Dealing with the asynchronous generator, he questioned the statement made by Mr. Atchison that "the asynchronous machine has a definite power-factor for every load, and, unless the power-factor of the external circuit was adjusted to this value the induction generator could not operate."

Dr. D. K. MORRIS said that Mr. Atchison had suggested that a difference of wave-form on two alternators running in parallel would give trouble. Was it not just such a difference of "effort form" on the part of the prime movers which usually caused defective parallel running; and was it not needed rather to require a certain similarity of effort, however irregular, than to specify the uniformity of the rotation of the alternators by the prime mover? Not only should the alternators be synchronised, but the engines should be in step also.

Mr. TAYLOR, referring to Dr. Sumpner's remarks on the mixing up of the armature reaction and the leakage flux in the armature, said he thought Mr. Atchison and those American writers whom he followed were warranted in combining the two effects if in practice it was found that the results agreed with the theory. Other writers kept the two quite distinct, and he (Mr. Taylor) preferred this from the point of view of simplicity.

Mr. MORCOM welcomed the confirmation which the Paper afforded to his own view that the engines were not always responsible for difficulties in parallel running.

Mr. ATCHISON, in reply, said that Dr. Sumpner's definition was, he thought, the only thing one could mean by the power-factor of an unbalanced polyphase circuit. He agreed with Dr. Sumpner that the general tendency nowadays of introducing an enormous number of arbitrary coefficients was a weak point, but he thought it was more or less a choice of evils. Either you must assume you were dealing with more or less ideal conditions, or else it appeared to be necessary to introduce certain arbitrary constants. It was perfectly true that an asynchronous machine, when started as a motor from a synchronous generator, could be loaded as a generator and worked on an external load of any power-factor, provided you kept the synchronous machine running with it. This synchronous motor would simply take the requisite amount of leading current, and the asynchronous generator would supply the requisite leading current; but if the external circuit be inductive the current which the asynchronous generator would supply to the synchronous motor would be very large in order that the *total* power-factor on the asynchronous generator might be the one value which corresponded to that particular load. If you cut off the supply from the synchronous machine, the induction generator would not operate unless the power-factor of the circuit that was left happened to be the particular power-factor corresponding to the load. With regard to the question of hunting of synchronous machines, the oscillograms were shown as being suggestive that hunting might occur when the machines were driven with a perfectly uniform prime mover. There was no question that it was possible for hunting to occur without any irregularities on the part of the prime mover, and he put forward the suggestion that it might be due to the difference of the wave-forms and, therefore, to the great variations which might take place in the flow of power between the machines.

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PHYSICAL SOCIETY.

At a meeting of the Physical Society held on June 24th, Dr. R. T. Glazebrook, F.R.S., president, in the chair, a Paper on

"Chemical Dissociation and Electrical Conductivity,"

by A. E. GARRETT and Dr. R. S. WILLOWS was read by Dr. Willows. It has been shown by Beattie (*Phil. Mag.*, 1899) that a mixture of salt and iodine, when placed on a zinc plate and heated, gives rise to electrical conductivity, although separately no such effect is produced. This is shown to be due to the formation of zinc iodide. Following on this, the electrical conductivity produced by heating various salts is investigated under different conditions of temperature and electric field. A large excess of positive electricity is found in nearly every case.

Mr. SKINNER expressed his interest in the Paper, and pointed out that the chief leak did not begin until the iodine was completely vaporised. He asked if the ions were produced in the mixture or in the gas. Had the authors tried the effect of screening the mixture from the electroscope?

Dr. C. CHREE remarked on the fact that the authors employed formulæ of the type $I = at^n$, t representing absolute temperature, under circumstances in which n was a large positive number, in one case as big as 100. To fit such a formula I must be practically either infinitely small or infinitely large, except over a very limited range of temperature. He should like some further details as to the method of arriving at formulæ of a type so remarkable physically, and as to the range of temperature wherein they were supposed to hold.

Dr. WILLOWS, replying to Mr. Skinner, said that the effect was still produced when the mixture was covered with a metal plate, but they had not tried screening with mica. In reply to Dr. Chree, he said that their formula held over a range of 100°C., and that Dr. H. A. Wilson had arrived at a similar formula which applied over a range from 200°C. to 1,000°C.

A Paper on

"The Magnetisation of Iron in Bulk,"

was read by Dr. W. M. THORNTON. The Paper is in three sections. The first describes a method of measuring large quantities of magnetism by the use of an exploring coil placed around the core and an exciting coil in series with a recording milli-voltmeter. This was applied to determine the complete loops of magnetisation for two rings of cast steel and cast iron weighing respectively 3 cwt. and 6 cwt. The results were checked by a quantometer. The second section deals with the curves of rise of magnetising currents, when the core is solid and when laminated, as affected by the reaction of the core currents, and also by the change of permeability during magnetisation. A second simple method is given of measuring large quantities of magnetism in circuits having a large time constant, suitable for testing dynamo-electric machines. From two curves of rise, with the current in one reversed, expressions are given for finding the total induction in the core and its ratio to the residual magnetism. In the last section an example is given of the sudden dip in the curve of rise observed only with large cores. The growth of current in a coil surrounding a solid circular core is calculated by Heaviside's formula, assuming constant permeability. No dip is found in the calculated curve, and it is therefore caused by a brief magnetic impulse which corresponds to the slip of the molecules at saturation seen in Ewing's model of the magnetisation of iron. Photographs are given showing the direction of flow of eddy currents in cores of rectangular section of proportions 1 : 1, 1·5 : 1, and 2 : 1.

Prof. S. P. THOMPSON expressed his interest in the Paper, and, referring to the curves showing the rise of the magnetising current, said he thought the explanation given by the author was not the only possible one. He was not inclined to think that the effect was due to internal eddy currents in the core. The fact that the growth of the magnetisation current was irregular was well exhibited in separately excited dynamos with large field magnets, where the effect could be easily seen in the movements of the amperemeter needle. In the author's curves showing the rise of the quantity of magnetism in a circuit with the current, first with the current direct and then with it reversed, he pointed out that a difference would be expected because the core would not be in the same magnetic condition at the beginning of the two experiments.

Mr. W. H. PRETTY said that the question of magnetisation tests of iron and steel in bulk was a very important one. The curves shown by the author suggest the possibility of detecting cavities in steel castings, as such castings would doubtless give curves differing from those representing a truly solid block of the same material cast at the same time and subjected to the same after-treatment. It would be interesting to have a series of tests on the same block of steel, say, in which each process in the manufacture is represented—*i.e.*, as cast after annealing, and after the surface-scale or skin has been removed to various depths; also after the block has been cut up into slabs or laminæ and put together again. Referring to the dip in the curves of rise of magnetisation observed with large cores, Mr. Pretty said it was not unlikely due to internal mechanical stress and the accompanying strain, and that as it became possible to obtain steel more and more homogeneous such internal molecular changes would become more apparent.

Dr. THORNTON, in reply to Mr. Pretty, said that he was now experimenting upon the effect of cutting up a large core into laminæ and then building up the core again.

THE ARON PORTABLE METER.

The Aron portable standard meter has been manufactured in order to provide a means of checking the accuracy of consumers' meters *in situ*. By the use of this instrument the necessity of removing meters for testing is obviated and the accuracy of contested meters may be proved or disproved in position.

In general principle the meter is the same as the ordinary Aron meter, though arranged in a slightly different manner to suit the particular class of work which it has to perform. Fig. 1 shows the general external appearance of the instrument and Fig. 2 shows it

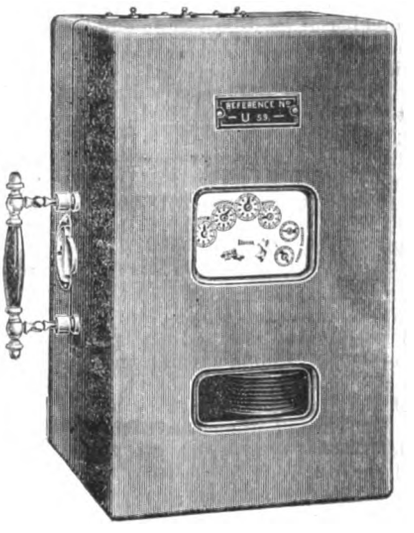

FIG. 1.

open. The main points of difference between the standard portable and the ordinary type of Aron meter may be noted in the second illustration, and are briefly as follows :—The pendulums are balanced and controlled by springs, which have the effect of making the meter more sensitive and independent as to whether it is set perpendicular or not, any ordinary table or floor being sufficiently level for testing purposes. All connections are on the top of the meter case and are of the plug type. The meter shown in the illustration is designed

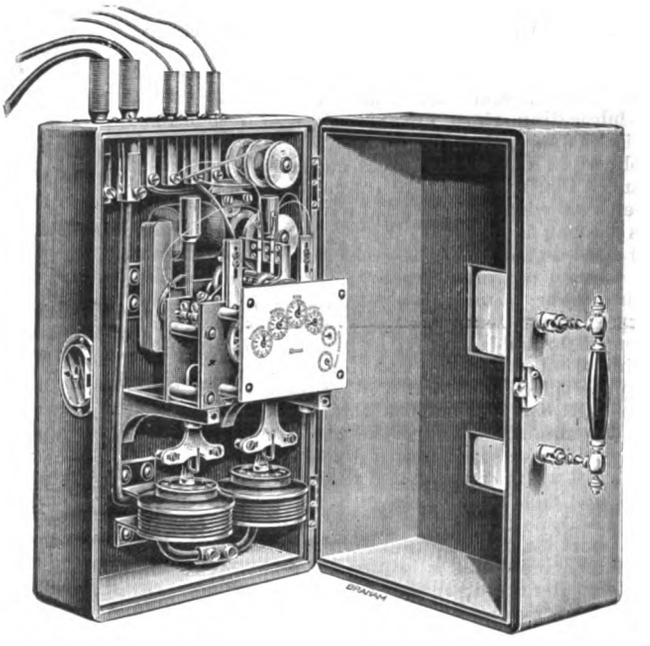

FIG. 2.

for 10 amperes at either 200 or 400 volts, but any capacity up to 500 amperes can be arranged for. Similarly, the instrument is also suitable for any voltage or combination of voltages, the same meter being equally suitable for 200 and 400 volts either alternating or continuous. Further particulars may be obtained from the General Electric Co.

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THE COLLIERY EXHIBITION.

Brief reference to this exhibition was made on pp. 417 and 452 of *The Electrician* of last week, and we now propose to give a more detailed description of some of the electrical exhibits.

Amongst the many kinds of cables designed for all purposes and exhibited by Messrs. W. T. Glover & Co. were some bitumen insulated cables, which are said to resist electrolysis completely, besides offering great resistance to the chemical action of bad pit water, &c. These cables are insulated with a patent bitumen compound, the outer layer of armour being tinned. Over the compound there is a mechanical protection in the form of tapes, braids, servings and metallic or non-metallic armour according to the use to which the cable is to be put. Fire-resisting cables were displayed, as were also a number of joint-boxes and similar contrivances.

The Diamond Coal-cutter Co. of Wakefield had several electric and compressed air coal-cutting machines on view. Their "Diamond" standard continuous-current disc machine, 19in. high, is designed for thin seams; the depth of under-cut is from 4ft. 6in. to 5ft. 6in. at the floor level. A coal-cutter driven by a polyphase motor was also shown by this firm.

Messrs. Ernest Scott & Mountain exhibited a 100kw. three-phase generator and several three-phase motors ranging from 25 H.P. to 100 H.P. A 30 H.P. 220-volt continuous-current motor, running at 400 revs. per min., was attached to a three-throw pump, the diameter of whose rams was 4in., the stroke being 6in. The pump is capable of delivering 50 gallons per minute against a head of 800ft. Liquid starting and reversing switches were also shown at this stand, as well as a coal-cutter of the disc type, driven by a 25 H.P. to 40 H.P. motor. The overall dimensions of the standard machine are: length 8ft. 6in., width 3ft. 3in., height from top of rail 1ft. 2in., total height from floor to top of machine, with rails, 1ft. 10in., ditto, with skids, 1ft. 8in. The frame is made in one piece, being a solid steel casting, and is specially designed to present as smooth a surface as possible, so that there shall be no obstruction in moving the machine about or difficulty in freeing it from fall in the roof, should this occur. All the working parts are totally enclosed, the motor and gear with cast steel covers, and the remainder with sheet steel plates readily removable. The whole of the gearing on the machine, with the exception of the projecting pinion and the rack on the cutter disc is machine cut, thus producing a maximum of efficiency. The bevel reduction gear runs in a bath of oil, the thrust being taken up by a ball bearing of ample size. The crown wheel is made separately from the smaller bevel wheel, so that in the event of renewal being necessary to either, this can be done with a minimum of expense. All the bearings throughout are of extra length, and are lined with white metal. Self-lubricating rings are provided, also sight-feed lubricators in various positions. A roller bearing is employed in the centre of the cutter disc, and is so arranged that the disc, which is made in halves, may be removed without interfering with the bearing itself. This bearing is lubricated by a grease cup and brass pipe fixed to the side of the machine. The cutter disc has a plain circular periphery, in which the slot is turned for securing the cutter boxes, these being independent of the wheel. The cutter boxes are arranged to hold straight cutters, which require a minimum of smithing, and are more easily and cheaply replaced than shaped cutters. The boxes themselves can be taken out if damaged, and replaced in a few moments.

The feed gear is operated by means of a worm wheel and worm carried on an extension to the motor shaft, the whole being enclosed in an oil-tight case and running in oil. The rope drum is fitted with an idle pulley, to carry the rope back under the machine when cutting backwards. Skids are fitted to the machine where it is not desired to lay rails and the floor is good enough for the machine to run level.

Two men are usually employed to work the coal-cutting machine, and the average rate of cutting is said to be 60yds. per shift of eight hours.

Messrs. Scott & Mountain also exhibited a small electric cableway in operation. This cableway possessed all the features of the full-sized structure. A steel rope, upon which the conveyor runs, is stretched between two towers, one of which is generally fixed, while the other is pivoted at its base. The latter takes up a slanting position and is suitably loaded with weights so as to keep the rope stretched. When the conveyor with its load is in the middle of the cableway, the sag of the cable is at its maximum, and the pivoted tower approaches the vertical. But when the conveyor nears the end of the ropeway, the sag of the cable gradually diminishes, and the tower drops more out of the vertical. This property is valuable, as it automatically diminishes the steepness of the rope at its extreme ends. Fig. 1 illustrates the conveyor itself as used at the Keyham and Devonport dockyard extension. Only one electric motor is provided, and it can be put into gear with the running wheels or with the haulage drums by means of levers actuated by the driver. The two haulage drums work independently, this allowing the motorman to either lower a load or to tip it. A trolley wire runs alongside the cable and conducts the current to the motor, the steel cable forming the return path. We understand that a cableway with a span of no less than 870ft. and designed to transport 800 tons daily from one side of the Zambesi river to the other (at the Victoria Falls) is in course of erection. This cable has a diameter of about 2½in. and carries a useful load of 10 tons at a time.

FIG. 1.—15 H.P. CONVEYOR ON THE KEYHAM-DEVONPORT DOCKYARD EXTENSION.

Messrs. Bruce Peebles & Co.'s exhibit included a 240 H.P. three-phase 3,000-volt induction motor and their patent single reduction gears, whose advantage lies in the fact that the pinion engages on the inside periphery of the large toothed wheel; the gearing is therefore well protected from falling material. There was also an electrically-operated winding gear built to the Ilgner patents by Messrs. Bruce Peebles & Co., who hold the licence for this system in England. Briefly, the system referred to consists of a motor-generator and the winding motor proper. The latter is started and regulated in speed by suitably adjusting the shunt resistance of the generator. It is thus seen that starting resistances are dispensed with, and that the speed regulation is very fine and gradual. A very fine exhibit was that of the Callender Cable & Construction

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Co. The display of cables was most representative, and included single conductor, concentric, triple concentric, twin and three-core cables insulated with bitumenised fibre, with impregnated paper and with Callender's vulcanised bitumen. Some samples of cable were protected by a solid leather sheathing. Callender's solid system of laying mains was illustrated by a short portion of cable laid in that way. A model of a pit shaft was on view, showing the various ways of carrying cables down the shaft so that they are relieved from strain and protected from dampness and from falling objects.

Fig. 2 is a sectional drawing of the three-pole switch fuse box which is designed for the control of trailing cables. The main body of the box consists of two compartments—one containing the switch fuses which are controlled by a removable handle in the possession of the responsible foreman. The fuses are arranged so that in the

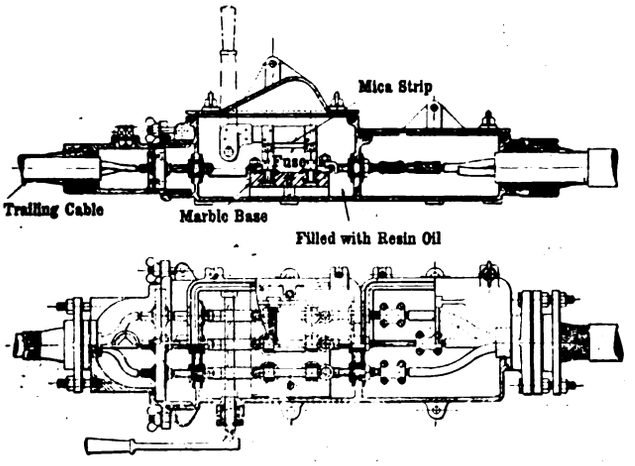

FIG. 2.—CALLENDER SWITCH FUSE BOX.

event of one blowing it is necessary to work the switch in the "off" position before it is possible to renew the fuse The compartment in which the fuse switch is worked is filled with resin oil. At the back of this is a second compartment, into which the main cable is brought and the cores connected to their respective terminals. This compartment has a separate lid to it, which hermetically seals it, so that no compound is necessary, and the connecting and disconnecting of the cable for lengthening or repairs may be done without difficulty. Two ends are supplied for the trailing cables, so that one can always be fixed on the spare trailing cable retained in cases of emergency. These ends are attached to the body of the box by means of wing bolts, which hold them securely in position, and it will be noticed that when the trailing end is removed from the box that a protecting screen is left, surrounding the sockets in the main box.

The main body of the box contains a hinged lid, which, when tightened into position, compresses a rubber grummet and renders

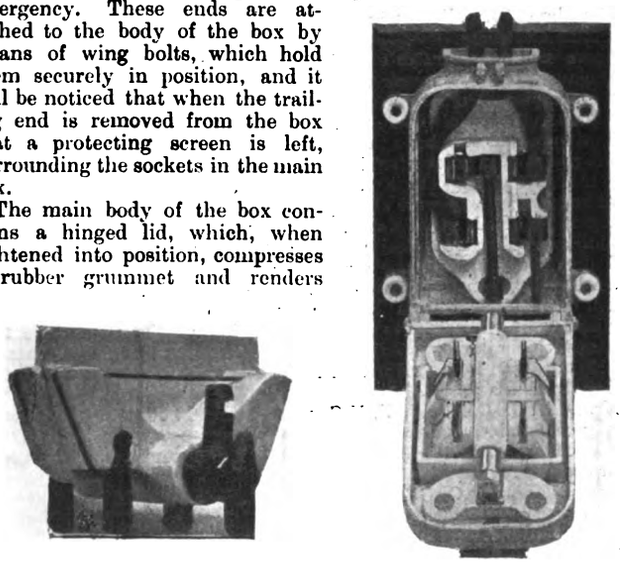

FIG. 3.—CALLENDER WARD FUSE BOX.

the interior hermetically sealed. When all fitting up is done the interior of the switch fuse chamber is filled with resin oil. Fig. 3 shows the design of the Callender-Ward fuse box. It contains a combined switching arrangement with fuse gear. By opening the lid the current is switched off from the installation, and by shutting the lid the switch contacts are closed. It will be seen that to replace a fuse there is no necessity to touch any "live" conductors.

Another exhibit was a four-way distribution box for underground work. Each fitting is arranged on a porcelain insulator of its own, and when all the fittings are in position the box is filled with a special compound up to ¼in. of the rim at the top of the porcelain. The plug fittings are suitable for either links or fuses. Where fuses are used for boxes put into the pit workings or roads, it is usual to fill the box over the compound with resin oil, so that all fittings are submerged and no sparking can occur in the air when a fuse blows. Gas-tight lids are provided for these boxes and no accessories, except a movable porcelain handle, are required in the manipulation of the fittings. They are suitable for dealing with two or three-wire mains, whether consisting of single or cored conductors. Another novelty was the cable clip, Fig. 4, which retains the cable in ordinary conditions, but lets it slip through its springy jaws whenever the cable is subjected to excessive transverse stresses, such as may, for instance, be occasioned by dropping coal.

Among the most interesting stands in the exhibition was that of the British Westinghouse Electric & Mfg. Co. Prominent in the centre of the stand was a large polyphase induction motor of 150 H.P rated output, at 480 revs. per minute, 400 volts and 25 cycles pe' second. In addition to this machine, three three-phase motors were exhibited, one being displayed in parts to show the construction, and another, of 15 H.P., coupled to a Worthington 4in. by 6in. triplex single-acting pump with a capacity of 90 gallons per minute against a head of 400ft. A fourth motor, of 20 H.P., was mounted on a Markham single-drum haulage gear capable of hauling a load exerting a pull of 7½ cwt. on the rope at a speed of 600ft. per minute. The drum runs loose on the shaft, but is connected to it by means of a double-cone friction clutch put in action by sliding the drum sideways by means of screw and lever, the thrust of the cone clutches being taken up by a thrust journal provided with gunmetal thrust collars. There were also two continuous-current Westinghouse type "TB" motors, of 5 H.P. and 19 H.P. respectively, these being totally enclosed. The detail apparatus included starters and controllers for both continuous and polyphase current motors. For starting polyphase motors, the switch is closed in a position which throws a transformer into circuit, and a reduced voltage is supplied to the motor till it has run up to speed. Afterwards the switch is thrown over, and the transformer is cut out of circuit, the motor now being directly-connected to the mains. The contacts of most of the starters and controllers were immersed in oil, as required for use in fiery pits. There were two separate switchboard panels, one for the control of a 14 H.P. continuous-current motor and the other a high-tension feeder panel. The motor panel had a single-throw double-pole quick-break knife switch and fuses, the poles being separated by a screen of refractory material with all live metal parts enclosed, and a starting rheostat. The feeder panel was fitted with a 2,000-volt alternating-current three-pole single-throw automatic oil-break switch, Westinghouse type B, and the following instruments:—Two static earth detectors, two alternating-current ammeters, power-factor meter, synchroscope, voltmeter, polyphase indicating wattmeter, integrating wattmeter and an overload and reverse-current relay. The panels were of white Sicilian marble, 2in. thick, with ½in. bevel edge. A number of other items, such as transformers, &c., which need not be enumerated in full, were exhibited.

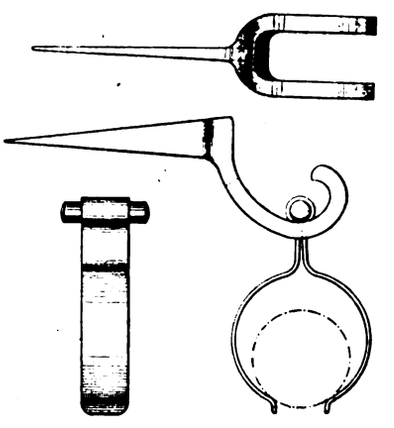

FIG. 4.—CABLE CLIP.

The St. Helens Cable Co.'s exhibit was very interesting. Their "Dialite" cables were much in evidence. This compound is said to be an excellent insulator, less inflammable than rubber and having a tendency to discontinue burning after once being ignited. It is claimed to behave very satisfactorily both mechanically and electrically, and to be extremely durable. The current required for the lighting of the stall was passed through a "Dialite" cable laid in boiling water. It is said to be specially adapted for colliery work, as it is quite unaffected by acids and other substances inimical to metallic armouring. It has no lead covering. The different methods of laying this cable were clearly shown in a section of road on the stand. The floor of this firm's stand was laid with rubber tiling, and samples were shown of mats, matting and other rubber goods used in collieries. The St. Helens Cable Co. are also makers of the switch shown in Fig. 5.

This switch is so designed that it is impossible to raise the cover unless the switch is off, and it is also impossible to close the switch after the cover has been raised. A disc is attached to the spindle of the switch arm, and has a small notch cut out of it. When the cover is down it depresses a vertical lever by resting upon its upper end. This keeps the end of another lever out of the notch, and the disc is therefore free to revolve. Thus it will be seen that the

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switch can be opened or closed while the cover is down. The cover can, however, only be raised when a pin, which is attached to it by a lug, is free to leave a slot in the disc; and the latter is never permitted to do this except when the circuit is broken by the switch. Immediately the cover is raised, the lever rises under the action of a spring and enters the notch, preventing the switch being closed until the cover is lowered. The box itself is made gas-tight and it will be seen that no spark can possibly occur except when it is closed. For bringing the cables into the box there is a

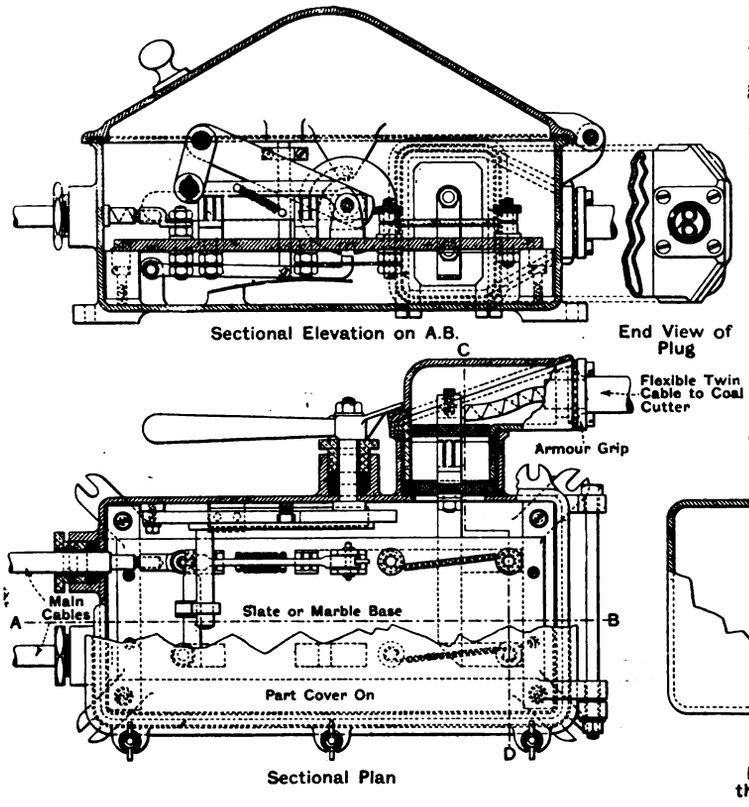

FIG. 5.—SAFETY GATE END SWITCH BOX.

plug which is not gastight, because, as is obvious from the illustration, it cannot be removed until the circuit has been broken by the switch.

Another ingenious device, shown in Fig. 6, was exhibited by the St. Helens Cable Co. This is for suspending cables when passing down the shaft of a pit or similar places. The outer casing is of steel with a pear-shaped piece of wood, bored to fit the cable, within

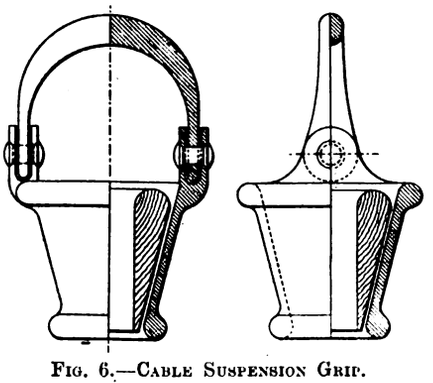

FIG. 6.—CABLE SUSPENSION GRIP.

it. The armouring of the cable is stripped and bound around the outside of the wood which is then dropped into the steel sleeve. Thus, the cable is supported almost entirely by its armouring and it is clear that the greater the weight the tighter is the armouring gripped.

A Proposed Memorial to Gramme.—Subscriptions are being collected for the purpose of erecting a memorial to the late Zenobe Gramme, whose name is so closely associated with the dynamo he designed M. Ernest Gerard, 25, Avenue des Arts, Brussels, has consented to receive donations.

PARLIAMENTARY INTELLIGENCE.

SUPPLY OF ELECTRICITY BILL.

The Select Committee of the House of Lords appointed to consider the Supply of Electricity Bill promoted by the Board of Trade sat for the first time on Thursday last week. The Committee is as follows: Lord Wolverton (chairman), Lord Stanley of Alderley, Marquis of Bath, Lord Ellesmere and Lord Colchester. The complete text of the bill was given in our issue for May 6. Amendments to the bill have been lodged by a considerable number of municipalities, electric light companies and gas companies, but all those whose amendments are on the same clauses and to the same effect will only be heard by one counsel.

The Hon. T. H. W. PELHAM, one of the assistant secretaries to the Board of Trade, in explaining the objects of the bill, said that the Board of Trade had power, under the Electric Lighting Acts of 1882 and 1888, to grant provisional orders authorising both companies and local authorities to supply electrical energy for all purposes, and the chief object of the present bill was to extend these powers so as to remove the expense which, in certain cases, promoters were put to in having to secure their powers by private bill. For instance, at present it was beyond the powers of the Board of Trade to authorise the compulsory acquisition of land or the supply of electricity in bulk. Neither could the Board of Trade give the necessary powers to a number of local authorities to carry out a joint scheme. The principal object of the bill, therefore, was to enable promoters to proceed by provisional order rather than by the more expensive method involved in a private bill. Incidentally, also, it sought to remove certain practical difficulties which everyone had experienced in the working of the Electric Lighting Acts of 1882 and 1888. A number of the provisions in the bill were the recommendations of the Joint Committee which sat in 1898. After detailing the various clauses of the bill, he specially referred to clause 6, which reads as follows:—

1. The Board of Trade shall, on considering whether any provisional order should or should not be granted, take into consideration the views of the local authorities affected on the subject; but whether the consent of any local authority is or is not given may grant the order or not at their discretion.

2. Sec. 1 of the Electric Lighting Act, 1888, is repealed from the beginning of the section down to "with such consent."

3. The notice required by sec. 4 of the Electric Lighting Act, 1882, to be given to a local authority on or before July 1 need not be given to the local authority of a district in which it is not intended to take power to distribute electricity.

There was considerable opposition on the part of municipalities to this clause, but his opinion was that the present position of local authorities would not be weakened, as if they were unsuccessful in convincing the Board of Trade that their consent should not be dispensed with, they would still have the opportunity of opposing the confirmation of the provisional order when it came before Parliament. It was thought that this gave an opportunity to companies to come in and compete with local authorities who were already giving a supply, but this was not the intention of the Board of Trade, as he was prepared to add a proviso to the bill exempting from the operation of this clause those authorities who had already obtained and were exercising their powers to supply electricity.

On Tuesday, an application was made by Mr. E. MOON, K.C., on behalf of the Metropolitan Electric Supply Co. He said he made the application in view of the previous decision of the Committee that parties with similar opposition should be heard en bloc, but the case of the Metropolitan Co. was different to the other electric supply companies, and that was his reason.

Mr. BALFOUR BROWNE, K.C., representing 13 other London electric supply companies, said there was no objection.

The CHAIRMAN (Lord Ellesmere) said the Committee would reserve their decision.

Lord ROBERT CECIL, K.C., then made an application that the London borough councils should be heard distinctly from other bodies.

The Chairman agreed.

The Hon. J. D. FITZGERALD, K.C., addressing the Committee on behalf of the Municipal Corporation Association said there were several points in the bill to which exception was taken. The first point was with regard to the compulsory acquisition of the land which was provided for in the first clause of the bill. The general rule hitherto had not been to give powers to acquire land compulsorily. Naturally, there were exceptions, but he contended that the existing electric lighting acts provided all that was necessary. Under this bill it was proposed to alter existing arrangements, and after having considered it very carefully the Municipal Corporations Association took considerable objection to the proposal under clause 1 to allow land to be acquired compulsorily outside the area of the company or authority who were giving the supply, without the consent of the local authority in whose area the proposed land was. The ground for the objection was that any such powers necessarily involved the right to break up streets and roads

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intervening between the district taking the supply and that within which the generating station was situated. The matter was, therefore, a very serious one and a highly contentious one. In the case of power bills it would confer very wide authority upon the power companies. In fact, it would enable such schemes to be promoted by provisional order. The practice in these matters hitherto had been quite satisfactory. Another point was the power which was contained in clause 4, sub.-sec. 1, enabling the Board of Trade to dispense with or override the right of the local authority to purchase an undertaking at the end of the 42 years, which was now given under the Electric Lighting Act of 1882. There had been a few exceptions to this—notably, in the case of the power companies—but these had always been at the instance of Parliament, and he ventured to suggest that this should be continued, and that the power to vary the terms of purchase should not be vested in a public department. Another matter of considerable importance was with regard to the consent of the local authority, which was to be dispensed with under clause 6. He thought the existing law was quite sufficient for all purposes. The first section of the Electric Lighting Act of 1888 must be looked upon as a sort of compromise between the local authorities on the one side and the Government department on the other. At present the Board of Trade could dispense with the consent of the local authority, but they were under an obligation to state their reasons for so doing in a special report to Parliament. Why should not the Board of Trade continue to do this? The consent of local authorities had been dispensed with on several occasions under these circumstances, but the object of the bill was apparently to relieve the Board of Trade from the necessity of stating their reasons for dispensing with any such consent. It was a convenient thing to be able to give a decision without giving a reason for it, but it was not a very desirable thing. The local authorities attached considerable importance to this provision and saw no reason why the Act of 1888 should not be continued. Mr. Pelham had stated that it was not the intention of the Board of Trade to alter in any way the lines upon which they had hitherto proceeded, and therefore it really came back to the point that the only reason was to relieve them of the necessity of reporting to Parliament. These were the main matters of objection, although there were some smaller matters dealt with in the amendments which had been deposited.

In answer to Lord STANLEY, Mr. FITZGERALD said the objection to compulsory acquisition of land without the consent of the local authority was not any question of compensation but a matter of public convenience. By acquiring the land compulsorily, a power company, for instance, would necessarily have powers to break up streets even if it were giving no supply in that district. It meant that this could be done on a very large scale.

The Hon. T. H. W. PELHAM said he wished to redeem his promise given at the previous sitting to propose an amendment to clause 6, in order to meet the objections of certain local authorities. He proposed to take out sub-sect. 2 of clause 6, and to add the following proviso to sub-sect. 1 of that clause:—"Provided that this sub-section shall not apply to any provisional order authorising a company to supply electricity, otherwise than in bulk or for power purposes, only so far as the order relates to any district in which a provisional order is in force authorising the local authority to supply electricity." The present policy of the Board of Trade, he continued, was not to give competing powers where already there was a local authority or company in possession. This policy had always been adopted with the exception of one or two cases in London. But there was no doubt that the Electric Lighting Act of 1888 strictly provided that no monopoly should be given to anybody, and it was open to the Board of Trade to grant a competing order. The effect of this proviso would be that if a company were to come forward to compete with a local authority for ordinary supply they would have to obtain the consent of the local authority.

After some discussion as to future procedure,

The CHAIRMAN said that the Committee would hear the Metropolitan Electric Supply Co. separately, but that their amendments must be sent in at once.

It was then decided to hear any general statements by counsel for petitioners on Thursday and to then proceed with the consideration of the various amendments seriatim.

The Hon. T. H. W. PELHAM suggested two amendments to meet objections raised by Mr. Fitzgerald in his speech above. One was that if a power scheme were to be brought before the Board of Trade it would recommend that procedure be by bill following the lines of the Scotch Local Government Procedure Act. The other one was that in the case of mains laid in roads outside the district of the area of supply, the consent of the local authority should be necessary, unless the Board of Trade saw fit to dispense with the consent.

Yesterday Lord Wolverton was in the chair.

Mr. C. C. HUTCHINSON, on behalf of the Gas Companies' Protection Association, asked for leave to be heard with respect to amendments.

The Chairman assented.

Mr. LEWIS COWARD, K.C., then addressed the Committee on behalf of the London County Council. He said that under the Electric Lighting Act of 1882 it was contemplated that each local authority should have the right to purchase the undertaking of a company supplying within its area at the end of 21 years. In 1888 another Act of Parliament extended the period of purchase to 42 years. In London the practice of the Board of Trade had been hitherto in all orders granted to companies to fix as the date of purchase 42 years from August 26, 1889, the object being to synchronise the various dates of purchase. Consequently, in every case, with one exception, all the London company undertakings become purchaseable in 1931. At present, in London there were 30 purchasing authorities, including the City Corporation and the London County Council. The rights of the London County Council extended to all embankments and bridges and tunnels. After handing in a table of all the electric supply undertakings in London, both municipal and company, he said with regard to the companies that, seven of them supplied electrical energy in the areas of more than one local authority, and two of them had their generating stations outside their area of supply—viz., the Metropolitan Electric Supply Co. and the Charing Cross & Strand Electricity Supply Corp. Consequently, these generating stations were not purchaseable by the local authorities in whose areas a supply was given. There was another complication by reason of this fact. In London there were one or two companies popularly known as "bulk" companies. One of them was the Charing Cross Co., which had power to supply in "bulk" in Poplar, Bethnal Green and Stepney, and, outside London, in West Ham. The other company was the Kensington & Knightsbridge Electric Supply Co., whose station was in Hammersmith, where they had no power to supply. There was a further company—viz., the Central Electric Supply Co.—which was somewhat different, inasmuch as it was only empowered to supply in bulk to two other companies. The London County Council agreed with a large number of the recommendations of Lord Cross' Committee in 1898, but he did not think that there was any justification—in which he was supported by all the London borough councils—for exempting what were called "bulk" companies from the purchase terms of the Electric Lighting Acts. Both in 1898 and in 1901 conferences of the London local authorities had been held with regard to this matter, and the London County Council was asked to promote a bill putting this question on a better basis, by providing that the County Council should purchase these undertakings, and also providing that the London County Council should supply electricity in "bulk" should the local authorities desire it. In 1902 and 1903, therefore, the London County Council promoted bills with this object. In 1902 the bill was refused by Parliament, but in 1903, after conferences with the Board of Trade, which thought that it was matter for general legislation, the bill was withdrawn and the Board of Trade promised to bring in a bill for this purpose, and the present bill the Council looked upon as a fulfilment of this promise. They welcomed it as a move in the right direction, to some extent. But in some respects it did not touch the very special difficulties which applied to London. The principle underlying the two bills promoted by the London County Council was that it was quite clear that, under the Electric Lighting Acts, the local authorities should purchase the undertakings of companies and also that they had the right to supply electrical energy. The Council also felt that these "bulk" supply companies had sought to alter to some extent the character of the act, and the Council objected to anything being done to the advantage of the company and to the disadvantage of the local authority. The tendency was to upset the bargain which Parliament had enunciated both in 1882 and 1888. Companies had established their undertakings originally with the clear and unmistakable language of the Electric Lighting Acts before them, and the County Council felt that they should not be heard now, and to say that their shareholders would be injured by this new act, which merely carried out the provisions of the original acts. The companies had no complaint, so far as he could see, so long as they received, at the time specified in their Acts of Parliament, the amount which it was ordained that they should receive, and it did not seem to matter whether the amount was given piecemeal by a number of authorities or not, provided they got it at the specified time.

The Hon. T. H. W. PELHAM, for the Board of Trade, pointed out that the bill did not propose to exempt from purchase any company now purchasable.

Mr. COWARD, continuing, said it might be impossible in a great many instances in London that the local authorities should be able to purchase a self-contained electrical undertaking; but he ventured to think that the local authorities should not be placed in any worse position by being prevented from buying at all, and especially in the case of the bulk companies. With regard to the Metropolitan Electric Supply Co., the Paddington Borough Council was in the happy position of having a special clause in the company's orders of 1890 and 1898 providing that the company should erect a generating station or stations sufficient for the needs of the district. With regard to the Central Electric Supply Co., this company supplied solely in "bulk." The generating station was situated in Marylebone, but the areas of the Westminster Electric Supply Co. and the St. James' & Pall Mall Co. which it supplied were almost entirely in Westminster. The directors of the Central Electric Co. were the same as those of the other two companies, and there was no doubt that the object of the Central Co. was to evade the provisions of the general law. The decision of the Committee which passed the bill incorporated the purchase provisions of the Electric Lighting Acts, but the result was that, although the company was purchaseable, there was no one to purchase it because the company had no area. The London County Council had endeavoured to get over the difficulty by inserting in their bill of 1903 a clause providing that the Central Electric Supply Co. should not be purchased unless the local authority purchased the other two companies. This state of affairs was one that should not be allowed to continue. If the bill purported to cure what was obviously a blot, then it ought to cure it, and not perpetuate a state of affairs to which objection had always been taken.

Mr. BALFOUR BROWNE, on behalf of 18 London electric supply companies, argued that the duty of the Committee was to follow the report of Lord Cross' Joint Committee of 1898. In many respects the bill carried these recommendations out, but he objected to the power of proceeding by bill being taken away. Dealing with some of the clauses, he said that the question of the local veto was an important one. The Joint Committee above referred to was of the opinion that the existing state of affairs needed revision, but that the local authorities should be heard before any consent was dispensed with. This veto had stood in the way of the development of both electric lighting and traction, and in connection with the latter the veto had been used as a means for screwing concessions out of tramway companies. He therefore supported clause 6

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as in the original bill in preference to the amendment proposed by the Board of Trade. With regard to the question of purchase of "bulk" companies, he contended that the London County Council was seeking to tie the hands of the Board of Trade by insisting upon such a purchase clause. On four separate occasions, and before four separate Committees, the London County Council had endeavoured to secure the insertion of a special purchase clause of this character, but it had been refused on each occasion. He therefore asked that no purchase clause should be inserted in this bill to apply to "bulk" supply companies. With regard to the question of audit, he said the companies were quite content with the present Board of Trade audit. On the question of allowing local authorities to supply electrical energy in bulk outside their area he most strongly dissented. If this were allowed it might happen that a small local authority could erect a large generating station outside its area for the purpose of supplying a large railway company, for instance. This was not a manner in which the ratepayers' money should be speculated with, and objection was taken to it. There were other matters which he would deal with when the amendments were gone into.

Mr. E. MOON, K.C., for the Metropolitan Electric Supply Co., said that he objected to a purchase clause, but as he agreed with all that Mr. Balfour Browne had said, he would adopt all his arguments, and make no speech.

Mr. CLAUDE BAGGALLAY, K.C., on behalf of the metropolitan gas companies, said that his objection was on a matter of principle as competitors with the electrical industry. He objected to the extension of the provisional order system as was proposed by the bill. At present gas companies could not, under the Gas and Waterworks Facilities Act, obtain compulsory powers for the acquisition of land. If this bill were passed it would give privileges to electrical competitors which the gas companies did not have. The bill would also give electrical undertakers a preferential position so far as breaking up of streets in districts where no supply of electricity was given. This affected the gas and water companies' mains in a way which was not now the case. He was aware that the bill sought to carry out the recommendations of Lord Cross' Committee, but before that Committee the gas companies had not been heard. They objected to the Board of Trade being allowed to decide these matters, because when the provisional orders came up for confirmation before Parliament, the gas companies, if they opposed, were always met with the prejudice that the orders had been granted by a public department, and the stronger and more efficient were the permanent officials of the Board of Trade, the stronger was the prejudice against the gas companies. The general tendency of legislation nowadays was to favour electric lighting undertakings at the expense of the gas companies, and the promotion of this bill was in itself an indication of the same thing. The bill gave privileges to electrical undertakings which had never been given to the gas companies and which it was not now proposed to give to them. It was a matter which should be threshed out at greater length than would be the case in connection with this bill. There was no immediate urgency, because already the recommendations of Lord Cross' Committee had lain dormant since 1898.

The CHAIRMAN said he hardly thought this could be said.

Mr. LEWIS COWARD pointed out that the London County Council had already promoted two bills based upon the recommendations of Lord Cross's Committee.

Mr. BAGGALLAY: Did they embody the extension of the provisional order system?

Mr. COWARD: No.

Mr. BAGGALLAY: That is my point.

Lord ROBERT CECIL, in addressing the Committee for the London Borough Councils of Fulham, Hackney, Hampstead, Hammersmith, Islington, Poplar, St. Marylebone, Shoreditch and Woolwich, pointed out that the bill would give the Board of Trade authority to sanction provisional orders for large power schemes to supply areas without the consent of the local authorities. Undoubtedly this was one of the main objects of the bill. There were two kinds of power schemes—viz., those supplying authorised distributors in bulk and those supplying direct to consumer. Both were very objectionable to his clients, but his chief opposition was to the latter class of scheme. These schemes would enter into direct competition with the local authorities. Lord Cross' Committee reported that where there was a large undertaking proposing to compete with a local authority no variation of the existing law should be made. The amendment proposed by the Board of Trade that the clause should only apply to persons supplying in "bulk" or for power purposes only did not remove his objection, because the supply of electricity for power purposes was one of the mainstays of most of the London undertakings, and if competition were allowed it would ruin the undertakings. This power to grant provisional orders by the Board of Trade without the consent of the local authority was not justified by any facts which had come to light since 1888. Local authorities in London were supplying electricity for power purposes more cheaply than any London companies. Therefore, he submitted that the proposed provisional order procedure was singularly ill adapted to such a state of things as existed in London at present. He maintained that the existing power of veto, which was modified by the power held by the Board of Trade, was sufficient.

Mr. PELHAM, for the Board of Trade, said that he thought the Board would be able to meet Lord Robert Cecil by the deletion of the words "or for power purposes only" from the amendment which he proposed on the second day to clause 6.

Mr. CLEASE, on behalf of the Kensington & Knightsbridge Electric Supply Co., and the Notting Hill Electric Lighting Co., said they were satisfied with the principle of the bill, but he reserved their right to appear on clauses.

Mr. FREEMAN, K.C., on behalf of some other London local authorities owning electrical works, said he wished to move an amendment to clause 1, but would prefer to do so on the consideration of clauses.

Mr. PELHAM said he should like to state the exact position of the Board of Trade in view of the many criticisms to the bill. Provisional order procedure had been laid down by Parliament originally as being the most convenient in respect of electrical undertakings. In certain cases a bill had to be promoted because it would be ultra vires for the Board to grant a provisional order. The Joint Committee of 1898 suggested an alteration in the general law, and it was with the intention of carrying out this recommendation rather than increase its duties that the Board of Trade had promoted this bill. The Board had already as much to do as it wanted. But under the new conditions the control by Parliament would not be diminished. Procedure by provisional order was advantageous in contentious cases because the parties could meet together at the offices of the Board of Trade, and a little patience often brought about an agreement and a consequent reduction in expense. He disagreed with the view that the gas companies were unfairly treated in comparison with electrical undertakings. With regard to power schemes, the Board of Trade had no desire to undertake to authorise large schemes because they had no power to investigate the finances of the companies. Under provisional orders the companies were limited companies, whereas the power supply companies were all Parliamentary companies which the Board had no power to authorise. This was a safeguard on this point, therefore. With regard to the removal of the power of purchase, the only new power in the bill was that enabling local authorities to purchase generating stations if they were outside the area, but the generating stations so purchased could only be used for the purpose of supplying that particular district.

Mr. COWARD pointed out that this would prevent such an undertaking as the Central Electric Supply Co. from being purchased at all.

Mr. PELHAM said the opinion of the Board of Trade was that such cases should be dealt with by special act. Continuing on the question of the veto, he said a suggestion had been made that the Board did not wish to report its reasons for dispensing with the local consent. He could only say, in reply to this, that they were quite willing to continue in this respect as hitherto. The main object of the Board of Trade in introducing the bill was to assist the local authorities as well as companies. All the clauses were founded upon the recommendations of the Joint Committee of 1898. He would, therefore, take it that some points could be considered as approved, and if these could be passed as constituting the principle of the bill, clauses could be considered, and he had no doubt that the Board of Trade would be able to meet many of the amendments before the next meeting of the Committee.

The CHAIRMAN, after consultation with the Committee, announced that the preamble of the bill was proved.

Clauses were then considered.

On behalf of the London gas companies, it was asked that clause 1, giving power for compulsory acquisition of land be deleted, for the reason that it was giving electrical undertakings greater privileges than the gas companies had. The application was refused, and

The Committee adjourned.

TYNESIDE TRAMWAYS AND TRAMROADS BILL.

REJECTION OF THE COMPULSORY RUNNING POWERS CLAUSES.

On consideration, prior to third reading, of the above bill in the House of Commons on Thursday last week,

Sir J. WOODHOUSE moved that the bill be re-commited to the former Committee in respect of clauses 15 and 16, which granted compulsory running powers over certain of the tramways belonging to the Newcastle Corporation. After giving figures comparing the sizes of the two undertakings, he contended that no case of public necessity had been made out. But the bill involved a much larger principle than this. There was at present no precedent for such compulsory running powers, although several cases existed in which running powers had been mutually arranged. The evidence of the company as to the population outside Newcastle which required these running powers was particularly weak, and it was on these grounds that he asked for the re-commital of the bill.

Sir W. PLUMMER, who seconded the motion, said the important principle of compulsory running powers as compared with voluntary agreement was at stake. If this principle of compulsory running powers by a company over municipal tramways were once accepted, the value of municipalisation would be reduced to a farce. It would strike a serious blow at local self-government and injuriously affect the prosperity and progress of great municipalities. Although he was one of those who originally opposed the municipalisation of tramways in Newcastle, he felt it to be his duty, now that the system was working, to endeavour to make it a success.

Sir EDWARD STRACHEY, Chairman of the House of Commons Committee which passed the bill, thought it was rather late in the day to raise the question of principle only when the bill had been through committee, and was up for third reading. The point of view from which the Committee had considered the matter was the interest of the travelling public. They had had strong evidence from the working men of the district as to the necessity for through running. The Committees of both Houses had been unanimous that the running powers were necessary, although it would have been better if they could have been secured by agreement instead of compulsion. He was not an opponent of municipal trading, but wished to see it carried out on sane and Imperial lines, and not from the narrow point of view of the Newcastle Corporation.

Mr. H. C. SMITH, in supporting the decision of the Committee, thought that if the principle involved was such an important one it should have been raised when the bill was read a second time.

Mr. J. W. BENN supported the motion. The London County Council had made, and were making, amicable arrangements with their neighbours in respect to running powers, but they would strongly resent

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compulsion. Outside tramways touched the County Council's lines at 15 points, and the effect of the passing of this bill would be that the Council would be bombarded with applications for running powers. Such an incursion would seriously diminish the earning powers of the municipal lines. The question of electric power was also important, because in London they could only provide energy for the outside cars by displacing an equal number of their own.

Mr. BONAR LAW said that, in his view, there had never been a case before the House in which the advantages of a through service had been more clearly indicated. There was no new principle at stake, as the Newcastle Corporation seemed to imagine. If the decision of the Committee were to be upset, it would establish the principle that there was one scale of justice for municipalities and another for companies. Such a thing would be deplorable, and would throw obstacles in the way of private enterprise.

Mr. RUNCIMAN spoke against the decision of the Committee, and thought a serious blunder had been made.

Mr. W. RUTHERFORD and Mr. J. A. PEASE supported the decision of the Committee. The Newcastle Corporation had obstinately refused to allow a single car of the company to run over their lines, and therefore the company had no other course but to come to Parliament.

Mr. GRANT supported the motion, which, on a division, was passed by a majority of 36.

The bill was accordingly recommited in respect of clauses 15 and 16.

[The Committee stage of the bill in the House of Lords will be found reported on p. 916 of our issue for March 25, and the Committee stage in the House of Commons will be found on pp. 320 and 359 of our issues for June 10 and 17 respectively.]

On Wednesday the bill came before Sir Edward Strachey's Committee again.

The CHAIRMAN stated that the bill had been referred back to the Committee by an order of the House to consider the running powers clauses. There was no instruction given to the Committee, and they had absolutely as free a hand as they had before. The trend of the debate in the House was that the Corporation and the company ought to have come to an agreement before the Committee, and that, in case of sale, no additional value should accrue from the running powers given. The Committee would take it that, as regards the Tyneside Co. they would not want to call fresh evidence, but only to rebut, if necessary, any further evidence given by the Newcastle Corporation for the purpose of trying to show that the previous unanimous decision of the Committee was wrong and required revision. If that was assented to by the company, the Committee would like to know if the Corporation desired to call fresh evidence against the running powers, or if they desired to make any further proposal with reference to running powers by agreement over the two tramway systems. Further, did the Corporation desire to ask for protection in case of sale by the company to the Corporation or any other party in regard to any increased value of the company's tramways owing to running powers having been given to the company.

Mr. SOUTTAR (Parliamentary agent for the tramway company) said they concurred in the course of procedure suggested by the chairman. They did not wish to call any fresh evidence. There was an idea in the air that a proposal should be made for mutual running powers, but if any such idea was entertained, a proposal on the matter should come from the Corporation. Owing to the late period of the session the company desired that the matter should be investigated at once, and he would ask the Committee to appoint as early a day as possible to proceed with the further hearing.

Mr. H. R. CRIPPS, for the Corporation, said that this was not a matter that could be carried on as if only an individual were concerned. The Newcastle Corporation was in a difficulty because most of their responsible officers were engaged in another bill, and they had had very little time to devote to the matter up to the present. Probaby, within the course of the next week they would be able to take the matter up. It would necessitate the meeting of two committees, and probably their amalgamation. There would have to be a report to the Corporation, and then the Corporation would have to consider it.

The CHAIRMAN said the Committee wished to know at once, and the Corporation ought to be able to deal with the matter without delay. There should be no difficulty in bringing up an agreed clause. Were the Corporation ready to say that they were prepared to enter into a treaty with the tramway company.

Mr. CRIPPS said they were perfectly prepared to negotiate with the company, and probably the best way to commence the negotiations would be to have a meeting rather than a proposal to be made by one side or the other. Arrangements were being made for meetings of the committees and Corporation, and if the proceedings were adjourned over next week it would be convenient.

Mr. SOUTTAR, for the company, objected to such a course. He said there might be opposition again at a later stage, and at the late period of the session it was a serious matter for his clients.

The CHAIRMAN said the matter was not a new one sprung upon the Corporation, and they ought to have given great consideration to it already.

The room was then cleared, and when the parties were re-admitted,

The CHAIRMAN said "In view of the agreement arrived at on August 25, 1903, between the Tyneside Co. and the representatives of the Newcastle Corporation, the Committee desire the parties to draw up and submit to them a clause upon some such basis, and providing that in the case of a sale no increased value should accrue in consequence of such agreement as to running powers. The Committee will adjourn until Tuesday, July 19, at 11:30, and the Committee wish to state that if no agreement is arrived at, the Corporation must be prepared to go on with the case on that day and bring further evidence against clauses 15 and 16."

OTHER ELECTRICAL BILLS.

When the *Electric Lighting Provisional Order Confirmation Bill No. 4* came before a Committee of the House of Lords, presided over by the Earl of Lauderdale, on Monday, it was announced that the Kingswood Order was now unopposed.

On the consideration of *Tramways Provisional Order Confirmation Bill No. 1* by the Earl of Lauderdale's Committee, in the House of Lords on Monday, it was announced that the only opposition to the Calverley Order was settled with, and consequently it is proceeding unopposed.

The *Loch Leven Power Biil* came before a Committee of the House of Commons on Tuesday, presided over by Capt. Jessel. Sir Ralph Littler, K.C., who appeared for the promoters, said that the object of the bill was to secure an extension of time of one year for the completion of the works authorised under the company's act of 1901. The only opposition was on behalf of a landowner with whom the company was under an agreement to purchase certain of his property costing £6,500 before March 31 next. This gentleman, however, now opposed the extension of time, and stated in his petition that he objected to the existence of the company altogether. After hearing Mr. Balfour Browne, K.C., on behalf of the landowner in question (Sir John Stirling Maxwell), the Committee decided to pass the preamble of the bill subject to the condition that the company should purchase the land of Sir John Stirling Maxwell as provided for in the original act for the sum of £6,500 before March 31 next.

In the House of Lords on Thursday last week the *Bridlington Corporation* and the *Wolverhampton Corporation Bills* were read a third time and passed. On Friday the *Plymouth Corporation Bill* was read a third time and passed. On Monday the *Ilford Urban District Council Bill* was read a third time and passed, as also was the *London County Council (Money) Bill*.

In the House of Commons on Monday the *Rotherham Corporation Bill* was read a third time.

The *London United Tramways Bill* is now proceeding unopposed. The measure has passed all stages of the Houses of Commons, and the proceedings before Committee were reported in our issue for May 6. Yesterday the House of Lords Unopposed Committee found the preamble proved.

The *North-Western Electricity and Power Gas Bill* was passed by the Unopposed Committee of the House of Lords on Thursday last week. The bill, which has already passed the House of Commons, proposes to acquire additional lands for generating stations, to remove restrictions as to the erection of stations, to acquire electricity undertakings by agreement, &c,

The *Bristol Corporation Bill* was before the Unopposed Committee of the House of Commons yesterday. The proposal of the bill is to incorporate a certain portion of the urban district of Barton Regis into the city of Bristol, and to apply the electric lighting powers which the Corporation already have to the added area. The Barton Regis Urban District Council, which already has a provisional electric lighting order, will retain this so far as the portion of the district not included in Bristol is concerned. The preamble of the bill was found proved.

The *West Riding Tramways Bill* was also considered by the Unopposed Committee of the House of Commons yesterday. It has already passed the House of Lords, and was reported in our issue of May 6. A point raised before the present Committee was the question of the variation of the terms of purchase under the Tramways Act of 1870. The period proposed in the bill is 42 years, and with this the Committee agreed. Another point to which some objection was taken was the power to enter into working agreements with local authorities and others along the line of route. The parliamentary agents pointed out the great convenience which this power placed in the hands of the company, especially with regard to small portions of line, and also with regard to the supply of power in case of breakdown. The Committee concurred in this view, and found the preamble of the bill proved.

The *Bournemouth Corporation Bill* which has already passed the House of Lords was also considered by the Unopposed Committee of the House of Commons yesterday. For the promoters it was stated that the object of the bill is to vary the route of a certain tramway which the Corporation is acquiring from the Poole and District Electric Traction Co., as part of their undertaking under an act of 1902. The route, it was explained, was not satisfactory to the Corporation, hence the present application. Another proposal was to buy out a toll bridge which is in the hands of a company, and over which the proposed tramway would run. The Committee ordered the bill to be reported for third reading.

The *Portmadoc, Beddgelert and South Snowdon Railway Bill* was before the Unopposed Committee of the House of Commons yesterday. The objects of the measure were fully reported in our issue for March 18 last, when it was considered by a House of Lords Committee. A provision is now contained in the bill for the capital proposed to be raised to be reduced to £54,000. The undertaking is to be acquired by the North Wales Electric Power Co. The bill was ordered to be reported for third reading.

The *North Wales Electric Power Bill* was next considered. A lengthy report of the proceedings before the Committee in the House of Lords will be found in our issues for May 6 and 13, and no new provisions have been inserted. Some discussion took place as to the powers to use overhead wires and also as to the acquisition of the provisional orders of local authorities, but in the latter case it was pointed out that there was a precedent for this in the case of the Leicestershire and Warwickshire Power Bill of this year (see *The Electrician* for June 24). With regard to the question of overhead wires, it was argued that, if these powers were curtailed, it would defeat the object of the bill, as the area to be served was of such a rural and sparsely-populated character. The preamble of the bill was found proved.

The *Holywood Tramways Bill* was yesterday passed by the Unopposed Committee of the House of Commons. It has already been passed by the House of Lords (see *The Electrician*, May 6).

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DANGER FROM ELECTRIC RAILWAYS.

In the House of Commons on Monday,

Mr. RENWICK asked the President of the Board of Trade whether his attention had been called to another death caused by the unprotected third rail on the North-Eastern Railway at St. Peter's, Newcastle-on-Tyne, and whether he would inform the House as to what was being done by the Board of Trade to compel the railway company to take the necessary steps to avoid further loss of life.

Mr. GERALD BALFOUR said the accident referred to, which caused the death of a boy who was trespassing on the line, had been reported to the Board of Trade. This case, together with two similar previous accidents, was being investigated, and when they had been reported upon, the question of precautionary measures would be taken up.

TELEPHONE COMMUNICATION.

In the House of Commons on Tuesday,

Capt. BAGOT asked the Postmaster-General whether it was a fact that, if Post Office telephone call offices were established in country village post offices, callers would not be able to communicate with subscribers to the National Telephone Co. in the nearest or any adjacent town in which the exchange was in the hands of the company. If this was so, was it owing to statute law or some agreement between the Postmaster-General and the Telephone Co., and, if so, would steps be taken to remedy this state of affairs?

Lord STANLEY said the absence of right of intercommunication between call offices and exchanges of the Post Office in any provincial exchange areas and the system of the National Telephone Co. in the same areas was not due to any statutory provision or to any agreement between the Postmaster-General and the company. It arose from the fact that he had no power to require the company to give such intercommunication, although he would be glad if such an arrangement could be brought about.

INDIAN CABLE RATES.

In the House of Commons on Friday last week Sir EDWARD SASSOON asked the Secretary of State for India whether, in view of the results achieved and the responsiveness of the traffic consequent on the last reduction on the Indian cable rate, he would assist the efforts of Lord Curzon for obtaining a further reduction to 2s. per word.

Mr. BRODRICK, in a printed reply, said he should welcome the reduction of the rate to 2s. per word, but until he was in possession of the figures of working of the traffic for the financial year 1903-4, which completed the period of three years under the new system, he would not be in a position to state whether he was entitled to take any action under the agreement with the telegraph companies concerned.

ELECTRICITY IN MINES.

In the House of Commons last evening (Thursday),

Mr. MARKHAM asked the Home Secretary whether, seeing that the recommendations of the Electricity in Mines Departmental Committee are in some respects opposed to the latest practice adopted by electrical engineers, and are therefore opposed by engineers, he would, to expedite the passing of a uniform set of rules, ask the coal owners' and miners' associations to form a joint committee to agree to the main recommendations of this Committee which are not the subject of any serious controversy.

Mr. AKERS DOUGLAS: I am not aware that the Committee's recommendations are opposed to the latest practice of the engineering profession. One of the members of the Committee was a distinguished engineer, and the Committee received very great assistance from the profession in their inquiry. I do not propose to delay the establishment of the rules by referring them to a further committee as suggested. The rules have been for some time under the consideration of the Owners' Association, assisted by a number of electrical engineers, and the communications received lead me to hope that, subject to modifications on some minor points, the recommendations generally of the Committee (on which I may add the miners were ably represented) will be accepted.

Mr. MARKHAM: Seeing that the Electricity in Mines Committee recommended that the application of special electrical rules should be left in the hands of His Majesty's Inspectors of Mines, could the right hon. gentleman, in view of the fact that most of the inspectors have had no practical experience whatever of electrical work, ask the House to vote the necessary money to enable him to appoint a sufficient number of electrical inspectors, so that an inspection could be made by these inspectors at least once a year at all collieries where electrical plant is installed? He also asked the right hon. gentleman to say how many deaths due to electricity occurred last year in mines and shafts.

Mr. AKERS DOUGLAS: The view of the Committee was that the enforcement of these, as of all other, special rules should be left in the hands of the Inspectors of Mines, and I agree with that view. The appointment of special inspectors for the purpose would be undesirable. If, however, as the matter proceeds, it should appear that there is any necessity for it, I should be prepared to consider the possibility of giving the inspectors the assistance of expert advice in the matter.

The number of deaths last year in mines from electric shock was four.

Waipori Falls (N.Z.) Power Scheme.—A bill is being promoted in the New Zealand Parliament to enable the Waipori Falls Electric Co. to supply and use electrical energy in Dunedin, in the counties of Taieri, Bruce, Tuapeka and Waikouaiti, in the boroughs of Milton, Mosgiel, Green Island, Caversham, South Dunedin, St. Kilda, Mornington, Roslyn, Maori Hill, North-East Valley, West Harbour and Port Chalmers, and in the road districts of Peninsula, Tomahawk and Portobello.

CORRESPONDENCE.

TROLLEY-WIRE INSULATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From the report in your issue of this date of the discussion on Mr. Shawfield's Paper, I gather that that gentleman asserted that single insulation is the general rule on the B.E.T. lines in his district. As the engineer responsible for the large amount of that work done between 1898 and 1901, I must ask you to contradict Mr. Shawfield's statement. All the work done under my supervision had double insulation, whether span-wire or bracket-arm, and I have every reason to believe that the work done since has been similarly insulated. I cannot understand how Mr. Shawfield was led to the belief he entertains.—Yours, &c.,

July 1. HENRY M. SAYERS.

LEGAL INTELLIGENCE.

Re South Lancashire Electric Traction & Power Co. (Ltd.)

In the Chancery Court of Lancaster, at Manchester, on Monday, the Vice-Chancellor (Sir C. Hall, K.C.) appointed Mr. John Salter, manager of the company, and Mr. Henderson, C.A., of London, receivers in a debenture-holders' action against this company.

Hunter v. Hardie.

At Denbigh County Court recently, Judge Sir Horatio Lloyd heard this remitted action from the High Court for the recovery of £82. 13s. 6d. for work done, materials provided, &c. Defendant had paid £72 into court with a denial of liability, and counterclaimed for £24 as the amount required to carry out the work according to specification. The evidence showed that defendant had let the contract for an electric lighting installation at his country house at Trefnant, St. Asaph, to plaintiff. The work was carried out in accordance with specifications, and no complaint was made until payment was demanded. Then defendant repudiated the amount claimed on the ground that the work was badly done, and that the pendants and other fittings were not according to contract. Mr. A. Kelly, electrical engineer and insurance expert to the Liverpool and Royal Lancashire Insurance Co., said the work done by plaintiff was a good average job, and he would advise his company to accept the risk without additional premium.

For the defence it was said that Mr. Hunter agreed to carry out the work in all respects equal to another installation, but that when completed it was nothing like it, nor was it carried out according to specification.

Mr. Whitfield, electrical engineer, and Mr. Walter Edwards, architect, said the fittings were of the most ordinary character.

His Honour delivered his reserved judgment last week and gave judgment for plaintiff with costs.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Library and Technical Instruction committee of Belfast invite applications for the following positions in the Municipal Technical Institute:—(*a*) Head. Mechanical Engineering department, salary £500 per annum; (*b*) head. Textile department, £350 per annum; (*c*) assistant lecturer, Physics and Electrical Engineering, £160 per annum; (*d*) assistant lecturer, Practical Mathematics, £160 per annum. All particulars from Mr. Fras. C. Forth, Director of Technical Instruction, the Institute, Belfast, to whom applications by noon July 26. See also advertisement.

Marylebone (London) Borough Council invite applications for the following positions in connection with their electricity undertaking:—(1) Resident engineer; (2) mains superintendent; (3) meter department superintendent; (4) installation inspector; (5) accountant in electricity department. An advertisement elsewhere in this issue gives particulars of some of the qualifications required, and applications, with full particulars, should be sent to Mr. James Wilson, town clerk, Town Hall, Marylebone-lane, London, W., by 3 p.m. July 20.

A senior lecturer in electrical engineering is required for the Municipal School of Technology, Manchester. Salary £350 per annum. Further particulars are given in an advertisement. Applications (on forms to be obtained) to the Principal, Mr. J. H. Reynolds, by July 16.

An assistant electrician is required for experimental work in Messrs. Crompton & Co.'s instrument department at Arc Works, Chelmsford. See advertisement.

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A mains assistant is required for the electricity department of the County Borough of West Ham. Salary £2. 5s. per week. Applications to the borough electrical engineer (Mr. W. J. W. Bullock), Tucker-street, Canning Town, E. See advertisement.

The Council of the University of Birmingham, invite applications for a chair of electrical engineering. Stipend £1,000 per annum. Applications to the secretary (Mr. Geo. H. Morley) by Aug. 1.

London County Council require chief lecturers in the physical department (with knowledge of electrical engineering) and the engineering department of Poplar Technical Institute. Salary £250 each. Also lecturers in chemistry and mathematics. Salaries £100 each. Applications by 10 a.m. 13th inst.

A lecturer is required to assist in the engineering department of the East London Technical College, Mile End-road, London, E. Salary £200.

Shift engineers and sub-station attendants are required by Wakefield & District Light Railways Co. Applications to resident engineer, Belle Isle, Wakefield.

An assistant lecturer is wanted in the department of prime movers at Glasgow and West of Scotland Technical College. Applications by 25th inst.

An assistant master in elementary science (and to assist in chemistry and physics evening classes) is required at Dewsbury Technical School. Salary £100. Applications by 14th inst.

Bury (Lancs.) Education committee require teachers of physics and chemistry. Commencing salaries £100 each. Applications by 11th inst.

A lecturer in civil engineering (£300 a year) and an assistant lecturer and demonstrator in mechanical engineering (£200) are required in the University of Leeds from Oct. 1. Applications by 23rd inst.

Mr. J. A. Donachie has been appointed resident engineer at the Scottish House-to-House Electricity Co.'s station at Coatbridge.

York Electric Light committee recommend the appointment of Mr. F. E. Wilkinson (charge engineer at Reigate) as charge engineer at £100 a year.

Mr. J. P. Gabbutt, B.A. (Peterhouse College, Cambridge), has been appointed junior lecturer in mathematics at University College, Nottingham.

Mr. J. Galloway, of Blackburn, has been appointed superintendent of the Rochdale car depot at £150 per annum.

Mr. R. R. Knight, of Wood Green, has been appointed second assistant engineer at Bromley (Kent) electricity works.

Aberdeen.—The revenue of the Corporation tramways department for the year ended May was £64,071, and the working expenses were £38,997, leaving a balance of £25,074, an increase of £1,659 over previous year.

Interest, preliminary and parliamentary expenses and sinking fund charges for the year were £12,765, leaving £12,288, compared with £13,129. £8,000 has been voted for the renewal of lines, and £4,288 written off as extra depreciation on the value of buildings. During the year £61,656 had been expended on new works, making the total capital expenditure £314,407, after deduction of £16,377 for depreciation written off since the Corporation acquired the tramways. During the year the cars carried 15,500,000 passengers, an increase of 3,385,393 over the previous year.

Adelaide (South Australia).—According to Reuter, a proposal is before the South Australian Government "to purchase all the suburban tramways," the lines "to be converted to electric traction, and then leased to operating companies." But there is already the Adelaide Electric Tramways Co. at work in the city.

Argentina.—The proposals of the Mayor of Buenos Ayres for the establishment of municipal electricity works, to compete with the existing supply undertakings, are not to be proceeded with owing to an unfavourable report thereon by committees.

Lacroze Bros. are seeking a concession from Congress for electric tramways between Buenos Ayres (where the system would be connected with La Capital Co.'s lines), San Martin and Campo Mayo.

The Director of the Buenos Ayres municipal electrical department recommends that telephone companies be exempt from taxation if they place all their wires underground.

Australasian Electric Lighting and Traction.—The Fremantle and East Fremantle (W. Australia) joint committee have followed the example of Dunedin (N.Z.) Corporation by placing the work of equipping their electricity supply works and electric tramways in the hands of Noyes Bros. on a commission basis, in preference to letting contracts for the work at lump sums.

Bangor.—The Electric Lighting committee recently recommended that the salary of the borough electrical engineer (Mr. Price F. White) be increased by £40 per annum. It has now been decided to allow Mr. White to act as consulting engineer to Carnarvon Corporation conditionally upon the increase of his salary being postponed until April, 1905.

Blackpool.—The financial statement of the Electricity Department for the year ended March 31 shows a total income of £31,631. 17s. 1d., including £17,619. 9s. 3d. from sale of current for private lighting, £7,617. 6s. 4d. for current supplied to the Tramways committee, £777. 10s. 6d. for current supplied to the Blackpool, St. Anne's and Lytham Tramways Co. and £5,400. 12s. 9d. from public lighting.

Expenditure was £17,830. 6s. 3d., including generation expenses £13,035. 6s. 11d., cost of distribution £1,124. 8s. 10d., and management £1,311. 13s. 8d. Gross profit was £13,821. 10s. 10d. Interest and sinking fund absorbed £11,468. 6s. 11d., and after paying the first annual instalment of one-third cost of coal elevator (£383. 8s. 2d.), and voting £82. 16s. 9d. to meet expenditure in excess of sanctioned loan, the balance (£1,886. 19s.) was transferred to the general district fund. The total capital expenditure to March was £182,969. 10s. 10d., an increase of £5,204. 0s. 3d. for the year, of which £6,463. 1s. 6d. has been repaid. 2,570,890 units were generated, compared with 2,388,482 in the previous year. 1,052,440 units were sold by meter, 231,296 supplied to public lamps, 1,009,015 to the Corporation tramways department and 93,063 to the Blackpool, St. Anne's and Lytham Tramways Co. There are 263 public arc and 463 incandescent lamps.

Birmingham.—At the Council meeting on Tuesday the extension scheme of the Tramways committee, referred to in our issue of June 17, was adopted, with slight modifications as to routes, &c.

Bo'ness.—In forwarding sanction to the borrowing of £25,000 for electricity supply, the Secretary for Scotland stated that the whole of the procedure in reference to cases where working agreements had been entered into by local authorities, under sec. 11 of the Electricity Act, 1882, for the erection and maintenance of electricity supply works, is under review.

Brighton.—The accounts of the municipal tramways department for the year ended March show a deficiency of £4,778. It is proposed to increase the fares over the longer distances from 1d. to 1½d., as the present charges are considered insufficient to cover working expenses and to provide for depreciation. The heavy gradients render the working costs heavier than on the tramway systems of other towns. An extension of the tramways from the Aquarium to the railway station is approaching completion.

Cheltenham.—The chairman of the Lighting committee (Ald. Norman) stated at the Council meeting on Tuesday that the increase in the revenue of the electricity undertaking, compared with the previous year, was £1,651, and that the credit balance was £8,429, allowing nearly £1,000 to be put to depreciation. Besides paying interest and sinking fund, there was at present invested or awaiting investment in the sinking fund account £20,390, against the accumulated deficiency of £18,918. In March next there would be no necessity for a demand on the rates, because the rearrangement of prices would bring in a surplus of £1,500.

Chorley.—The Council have accepted the offer of Mr. Oswin Hansom for a transfer of the Chorley Electric Lighting Order, 1898, for £384.

Coventry.—An inquiry was held on Tuesday into the application of the City Council to borrow £31,575 for electric lighting extensions. The town clerk (Mr. G. Sutton) said that after Mr. Jeckell's appointment as manager, he advised that department should be put on a sound financial basis and that it would be necessary to double the capital expenditure. There was at that period an application for a loan of £23,000, and subsequently sums of £19,411, £2,000 and £5,000 were borrowed. The present application was practically a completion of the Council's decision in 1901 to double the capital. £7,500 out of the amount applied for had been spent. The department had recently commenced making a profit, and no more loans would be required to complete the scheme. Mr. J. A. Jeckell also gave evidence.

Crewe.—The Council are borrowing £4,500 for extensions of plant at the electricity stations, laying additional cables, &c.

Croydon.—Last week the Council referred back the recommendation of the Tramways committee to obtain Parliamentary powers to construct four additional tramway routes at an estimated cost of about £70,000. Considerable difference of opinion was disclosed as to the merits of rival routes.

The balance of the net revenue of the electricity undertaking has been appropriated as follows:—£5,000 to reserve and £3,407. 8s. 10d. carried forward.

Sanction to a further loan of £20,000 for extension of mains, &c., has been applied for. A scheme for hiring and hire-purchase of electric motors has been drawn up, and the Council have conditionally accepted the offer of the Lancashire Dynamo and Motor Co. for the supply of direct-current motors.

Customs Decisions.—The general rate of duty on conduit piping used in connection with electric lighting and power installations has been fixed by the Cape Town Customs authorities at 10 per cent.

Dartford.—The arrangements for the construction and working of electric tramways in the district by J. G. White & Co. under lease from the Council are practically completed. The lessees will

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pay the Council 1½d. per unit for current, of which it is estimated nearly 400,000 units per annum will be taken.

Derby.—For the year ended March 31 there was a net profit of £1,719. 10s. on the Corporation's electricity undertaking.

The electric tramways are to be extended at an estimated cost of £2,000.

Disclaimer.—The Exchange Telegraph Co. desires to state that a paragraph which appeared in a London newspaper alleging that the late Mr. F. E. Macmahon was the inventor of the tape machine which he sold to the Exchange Telegraph Co. is incorrect. The machines used by Mr. Macmahon were hired from the company at an annual rental.

Dudley.—In future consumers of electrical energy for power will be supplied at 1d. per unit for 22 hours and 6d. per unit for the remaining two hours of heavy load.

Electric Light and Gas Competition.—In a memorandum prepared for the information of the Edinburgh and Leith Gas Commissioners, their chief engineer (Mr. W. R. Herring) says:—

There is no denying the fact that we are losing ground so far as lighting is concerned—most of the new houses now being built, even three and four-roomed tenements, are being fitted exclusively for lighting by electricity.

And, further—

With the present competition of electricity and the losing of most of our large consumers, the cost of administering the undertaking is increasing as a consequence of our output being now spread over a large number of smaller consumers, and the disparity between the consumption at mid-winter and the summer season is becoming even more marked than hitherto. During the summer months 60 to 70 per cent. of the gas works plant and the distributory system is lying idle, whilst the capital and interest charges continue. As a matter of fact, the entire output only represents 190 days of full work out of the 365 in the year.

Electrical Exhibition.—From July 12 to 16 inclusive there will be held in the Town Hall, Burton-on-Trent, an electrical exhibition, the object being to bring the Corporation's electrical department more prominently before the general public of the city. Up to the 6th inst. 26 firms had decided to be represented at this, the first exhibition of the kind held at Burton-on-Trent. It is intended to make a special feature of motor driving for domestic and general industrial purposes, as this branch of electrical work has made rapid strides during the past few months—from 60 H.P. to 234 H.P. There is at the present time quite 100 H P. for which enquiries are being made, and a large extension is likely to result from the holding of the exhibition.

Electricity in Mining.—New electrical plant is being installed at Broken Hill (N.S.W.) Block 10 mines.

Glasgow.—The tenth annual report of the Corporation tramways department shows that for the year ended May 15 the revenue was £724,851. 5s. 8d. (against £656,572. 7s. 11d. in the previous year) and the working expenses (including depreciation) £496,266. 14s. 11d. (against £431,870. 2s. 10d.), leaving £228,584. 10s. 9d. (against £224,702. 5s.)

This gross balance has been applied in meeting interest and sinking fund, &c., on the cost of Govan and Ibrox tramways, interest on capital, sinking fund, parliamentary expenses and annual payment to common good, in all £147,794. Out of the net balance (£80,790. 10s. 3d.), £62,000 has been applied in writing down cost of buildings, ducts, cables, overhead equipment and power station plant, the balance of £18,790. 10s. 3d. being added to general reserve, The gross revenue for the past year showed an increase of £68,278. 17s. 9d. over the previous year, but the average traffic revenue per car-mile decreased from 11·19d. to 10·58d. The average working expenditure per car-mile showed an increase from 5·21d. to 5·26d., due to the increase in the amount of taxes and accident insurance. The expenditure under all other headings showed a reduction per car-mile. The total capital expenditure on June 1, 1903, as reduced by depreciation, was £2,129,512. 1s., and £431,851. 13s. 3d. was expended during last year. From capital expenditure £78,619. 8s. 7d. (amount of annual depreciation, £12,864. 14s. 2d.) Parliamentary expenses, and £62,000 (for special depreciation) had to be written off, making the net capital expended £2,107,879. 11s. 6d. The amount of the credit of the permanent way renewal fund at 31st May, 1903, was £136,789. 9s. 7d., but £60,827. 5s. 5d. was added out of revenue during the year, and £4,610. 16s. 3d. had to be deducted, being amount expended on renewals throughout the year. The balance standing at the credit of the fund was £193,005. 18s. 9d. The general reserve is now £33,008.

The total number of electric cars in stock is 682, and the Corporation have decided to build 100 additional cars. The number of cars has been increased by 71 during the year. Experiments are being carried out with different types of top covers. The total cost of inspection and repair of cars at the car sheds and workshops throughout the year was £29,954. 17s. 11d. and £28,211. 16s. 10d. further was charged against revenue to meet depreciation.

Gorton.—Sanction has been obtained by the Council to the borrowing of £18,926 for the purchase and reconstruction of the tramways in the Gorton District belonging to the Manchester Carriage & Tramways Co.

Halifax.—On Wednesday the Council adopted the recommendation of the Tramways committee to proceed with the extension of the Corporation tramways from Brighouse to Bailiff Bridge at an estimated cost of £12,746.

Inverness.—Edmundson's Electricity Corp. have acquired a site here for the erection of electricity works.

Islington (London).—The accounts of the electricity department for the year ended March show a net surplus of £1,054.

In discussing the accounts, the former chairman of the Electricity committee (Mr. Samuel Lambert) considered the balance-sheet very satisfactory. The income for the year was £48,436, against £44,427 in 1903, while the expenditure was £28,513, a decrease of £304 against 1903. Nearly 200 consumers had been added during the year. The total number of units sold was 2,867,647, against 2,364,358. The borough treasurer stated in his report that the success was, to a large extent, due to the demand for motive power. The number of units sold for day lighting and motor power was 289,894, an increase of 213,221 in about six months, while they had paid off their loan, £26,818. 10s., entirely out of revenue.

King's Norton.—On Wednesday it was decided to rescind a resolution passed in February, 1902, not to proceed with an electric lighting scheme. It is probable that a municipal scheme will be ultimately decided upon.

Kingston-on-Thames.—Sanction to a loan of £15,850 for electric lighting extensions has been received by the Council.

Launceston (Cornwall).—The terms upon which Messrs. Crompton & Co. are to establish electricity works have been agreed between the Council and the company. The Lighting committee have declined to renew the gas company's contract for public lighting for more than one year.

Light Railways.—The Brackenhill Light Railway (Extension of Time) Order, 1904, and the Portsmouth and Hayling Light Railway Order have been submitted to the Board of Trade for confirmation. Objections by 30th inst. and 25th inst. respectively.

The Board of Trade have confirmed the Ripon and District, the Leek, Caldon Low and Hartington (extension of time, &c.), and the Witney, Burford and Andoversford Light Railway orders.

Lincoln.—Sanction to a loan of £10,839, repayable in 30 years, has been received by the City Council.

Liverpool.—The Finance committee of the Corporation have decided to loan £100,000 to the Sunderland Corporation and £100,000 to Tynemouth Corporation at 4 per cent. per annum in each case. It was explained that the money proposed to be lent was part of the sinking fund (£278,608, or 2·6 per cent. of total debt) set aside against the corporate debt. The Corporation loan out this sinking fund because there are no willing sellers of their 3½ per cent. and 2½ per cent. stock.

The Corporation have decided to apply for sanction to borrow £400,000 for extensions of the electricity supply undertaking.

London County Council.—At Tuesday's meeting the Finance committee reported that the amount required to be paid for tramway purposes for the quarter to Sept. 30, 1904, is estimated at £150,000. Loans for electric lighting purposes were made to Bermondsey (£28,850) and Shoreditch (£7,000).

Tramway Accounts.—The Highways committee submitted the accounts of the tramways for the year ended March 31. The capital expenditure amounted to £2,124,228. 15s. 9d., of which £140,714. 13s. 8d. has been repaid out of revenue. During 1903-4 the expenditure on capital account was £619,765. 8s. 2d., chiefly in connection with reconstruction for electric traction. The total receipts and working expenses were:—

	Electric and Cable traction.	Horse and Cable traction.	Total.
Total receipts	£226,535 15 7 ..	£309,703 11 11 ..	£536,239 7 6
Working expenses	147,658 4 10 ..	294,128 2 1 ..	441,786 6 11
Gross revenue..	78,877 10 9 ..	15,575 9 10 ..	94,453 0 7

Debt charges (£100,536. 14s. 9d.) for interest and sinking fund and £2,200 for income tax had to be set against the total of £94,453. 0s. 7d. above shown, leaving a deficiency of £8,283. 14s. 2d. to be carried to appropiation account. When the estimates for the current year were passed it was anticipated that the deficiency on the working of the southern lines would be upwards of £15,000. The expenses of working have been, since the introduction of electric traction, considerably higher than they are expected to be when the permanent arrangements with regard to the supply of power can be brought into use. The total amount of the renewals reserve fund established in connection with the undertaking at the beginning of 1903-4 was £35,072. 0s. 3d., to which should be added £957. 0s. 8d., interest received on part of the fund invested and on the bank balance. The fund has been utilised to the extent of £5,256. 16s. 2d. in repaying the outstanding debt on the omnibus services formerly run by the Council, and the uninvested moneys of the balance of the fund are being temporarily used to defray the expenditure incurred in the provision of the temporary generating stations at Loughborough Junction and Deptford. The expenditure already incurred under this head is £21,206. 3s. 2d., and of this £2,895. 12s. 5d. is charged against the revenue of the year, while the remainder will be charged over the period during which the temporary stations are used. The Councils tramway system extends over a total length of 39⅞ street miles, of which 19¼ miles

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of double track have been reconstructed on the conduit system. On March 31, 1904, in addition to these tramways, further lengths of line amounting to about 7 miles of double track, had been or were about to be reconstructed. The total number of passengers carried during the year was 133,139,085, compared with 109,615,496 in the previous year. The average fare per passenger was 0·93d. the same as in 1902-3, and the number of car-miles run was 11,536,534, 1,425,594 more than in the previous year. The permanent way has been well maintained, and the machinery, plant and rolling stock have been kept in thorough repair.

With regard to the Northern system—*i.e.*, the tramways owned by the Council, and leased to the North Metropolitan Tramways Co.—the total expenditure to March 31 last was £854,033. 19s. 8d. The amount expended on capital account during the year was £4,503. 18s. 3d., and this amount, together with £207. 18s. 10d. already spent, represents the expenditure on preparation of plans, &c., and the acquisition of land in connection with the proposed reconstruction of these tramways for electric traction. The outstanding debt in respect of the undertaking at March 31 was £751,749. 7s. 4d., repayments of capital amounting to £102,284. 12s. 4d. having been made out of revenue since the acquisition of the undertaking. The total receipts from all sources were £65,061. 4s. 10d., and the expenditure £794. 4s. 7d., leaving net receipts £64,267. 0s. 3d. Out of this sum interest and sinking fund charges (£36,609. 16s. 7d.) have been paid, the surplus carried to appropriation account being £27,657. 3s. 8d.

Capital expenditure amounting on March 31 to £216,693. 10s. 5d. has been incurred in respect of generating stations and other matters of a general character not properly chargeable to either the northern or southern systems of tramways. The total amount expended for these purposes during the year was £104,893. 12s. 8d. Expenses amounting during the year to £1,871. 5s. 7d. in connection with the promotion of tramway legislation by the Council have been charged against revenue, and against this account have also been charged payments for interest and sinking fund £8,492. 13s. 4d., expenses of training motormen £825. 7s. 10d., cost of ceremony of inauguration of electric working on Tooting tramways £639. 0s. 11d., and other expenses of a miscellaneous character amounting to £1,311. 7s. 8d., total £13,139. 15s. 4d. There have been miscellaneous receipts amounting to £2,462, leaving a deficiency of £10,677. 15s. 4d., to be carried to appropriation account as a charge against the surplus revenue of the Council's tramways generally. The surplus revenue available on April 1, 1903, was £29,869. 6s. 5d., of which £20,000 has been applied in relief of rate, leaving £9,869. 6s. 5d.; the surplus revenue on the northern system in respect of the year 1903-4 is £27,657. 3s. 8d., and the deficiency on the southern system is £8,283. 14s. 2d., and on the general account £10,677. 15s. 4d., making a total deficiency of £18,965. 9s. 6d. The available surplus revenue amounts, therefore, to £18,565. 0s. 7d.; and this sum is carried forward in the accounts for the current year.

It was decided the report should stand over.

London County Council Tramways.—The Highways committee of the County Council has convened a conference of representatives of metropolitan councils north of the Thames for the 14th inst. to consider the system of traction to be adopted on those tramway routes where difficulties have arisen as to the use of the conduit system.

Madras.—The Madras Government are said to be about to apply to the Mysore Durbar for the loan of the services of Major Joly de Lotbinière, R.E., for a few months in connection with the scheme for the utilisation of the water power of Periyar dam for generating electric current, it being proposed to ascertain whether it is possible to conduct electric power from the dam to Madras city for electric lighting and power transmission purposes. The distance from the dam to Madras city is 300 miles.

Manchester.—During the year ended March last the length of single track comprising the Manchester municipal electric tramway system was increased from 78 miles to 137 miles 1,602yds.

Capital expenditure to date is £1,485,162. During the year the traffic receipts were £603,182. 6s. 10d. (against £306,249. 15s. 8d. in the previous year), and total receipts £611,881. 3s. 8d. (against £317,690. 9s. 2d.). Working expenses were £392,504. 7s. 8d. (against £193,989. 11s. 9d.), leaving gross profit £219,376. 16s. (against £123,970. 17s. 5d.), or, including interest, £222,456. 6s. 6d. (against £126,566. 16s. 5d.). Interest absorbed £52,000, capital redemption £27,000, rent charges £20,000, and street improvements £2,012. £70,000 was placed to reserve, renewals and depreciation, leaving £50,000 for relief of rates. 120,772,368 passengers were carried at an average fare of 1·2d., and 13,617,448 car-miles were run. Electrical energy per car-mile cost 1·84d. (against 1·94d. in the previous year) and 16,815,764 units were consumed. Total working expenses were 6·78d. (against 6·95d.), and the total revenue per car-mile 10·67d.

At the meeting of the Corporation on Wednesday the accounts were approved.

Marylebone (London).—At the meeting of the Council last evening Mr. G. Cornwallis-West was elected a member of the Electric Supply committee in the place of Mr. J. Sparks, resigned.

The Electric Supply committee reported the completion of the purchase of the Metropolitan Electric Supply Co.'s Marylebone undertaking in accordance with the Council's resolution. The only question that had presented any difficulty was the form of receipt to be given by the company for the various sums of money handed over to them on the Council's behalf. This difficulty (the committee reported) had been met by the acceptance by both parties of a detailed receipt in the form of an agreement, showing by whom the money had been accepted on behalf of the company and the obligations which the company entered into with regard to the handing over of the Marylebone undertaking. This receipt-agreement is dated July 5, and the seal of the Council was duly ordered to be affixed thereto at last night's meeting.

The Electric Supply committee announced the resignation of Mr. Councillor Bailey as a member of the committee.

Municipal Telephony.—The third annual report of the Glasgow Corporation Telephone department has just been issued.

The proportion of rentals brought from last year was £20,714. 15s. 9d., and gross revenue from rentals for the year from June 1, 1903, to May 31, 1904, was £50,968. 18s. 10d., less the proportion of rentals applicable to year 1904-5 carried to suspense account (£24,170. 19s. 9d.), leaving £26,797. 29s. 1d. Sundry receipts (including terminal fees £659. 6s. 9d.) were £2,126. 6s. 4d.; total revenue, £49,639. 1s. 2d. Working expenditure (including Post Office royalty, £5,007. 1s. 1d. and terminal fees £958. 2s. 4d.) was £29,119. 2s. 11½d.; net revenue, £20,519. 18s. 2½d., out of which have to be met interest (£8,525. 13s. 8d.) and sinking fund (£8,343. 6s. 8d.), leaving a surplus of £3,650. 17s. 10½d., which has been carried to general depreciation. This sum, with £2,092. 9s. 7d. standing to credit of that account at May 31, 1903, makes a total of £5,743. 7s. 5½d. for depreciation. The whole plant is stated to have been efficiently maintained out of revenue. The borrowing powers at May 31 were £333,890. The amount borrowed at that date was £285,490, leaving £48,400 unexhausted. Sinking fund at May 31, 1904 (at rate of 3½ per cent. per annum), amounted to £16,110. Capital expenditure for the past year was £50,050. 8s. 4d., making a total of £320,787. 12s. The capital expenditure for the year was incurred in joining up additional subscribers' lines to existing exchanges, extending existing switchboards to accommodate additional lines and opening new exchanges at Balmore and Duntocher and Nelson-street (the latter being in course of construction), and new underground work for the general extension of the system, including junctions between exchanges. The estimated value of the underground, overhead and switchboard plant not yielding revenue is £79,000. The Telephone committee are considering the desirability of changing the present method of operating. Last year the department suffered a loss of £1,131 in terminal fees. This year the loss amounts to £299. The number of telephone offices now open is 235.

It was reported to the Swansea Telephone committee on Monday that there were 825 subscribers connected to the Corporation's telephone system and 121 awaiting connection. The manager is preparing a report on proposed extensions estimated to cost £1,800. A communication from the Postmaster-General to Glasgow Corporation was read stating that the question of telephonic intercommunication was not likely to come before Parliament this session.

Neath.—Col. A. G. Durnford, R.E., held an inquiry last week into the application of the Corporation to borrow £5,000 for electricity supply, chiefly for laying mains, &c., as current in bulk will be taken from the South Wales Electrical Power Distribution Co.

Newport (Mon.).—The Council are recommended by the Electricity and Tramways committee to extend the electric lighting area and to light the whole of the tramway routes by arc lamps suspended from the tramway poles.

Nottingham.—The Corporation will promote a bill for powers to extend their electric tramways in the eastern portion of the city at an estimated cost of £110,000.

Ormskirk.—A report is being prepared on the question of the adoption of electric lighting.

Perth.—For the year ended May 15 the revenue of the electricity department was £5,764 and the expenditure £3,880.

The balance to credit of sinking fund account is £1,425. The charge for current has been reduced from 4½d. to 4d. per unit to private consumers.

Presentation.—The Brighton local staff of the National Telephone Co. on Tuesday presented the district manager (Mr. F. J. Madgen) with a gold albert and a pair of silver entrée dishes on his resignation.

Provisional Order Revocation.—The Board of Trade have revoked the Rickmansworth Electric Lighting Order, 1901.

Queensland (Australia).—To keep in touch with the latest developments in electrical science, Mr. John L. Hesketh is proceeding (as representative of the Government) to the St. Louis Purchase Exposition.

Redditch.—In presenting the minutes of the Electric Supply committee on Tuesday, the chairman (Mr. F. Dolphin) said they had come unanimously to the opinion that the new gas engine could not be accepted, and it was decided to arrange for substituting steam generating plant of 340kw. capacity. Application has been made for sanction to a further loan of £8,500 for extensions of the electricity undertaking.

St. Anne's-on-the-Sea.—Capital expenditure on the electricity undertaking during the year ended March was £8,272. 2s. 3d., making the total £32,572. 9s. 1d., and the year's revenue £6,504. 17s. 9d., including £2,241. 3s. 5d. from private consumers, £2,485. 5s. 2d. from the tramway company for traction and arc lighting, and £1,402. 17s. 8d. from public lighting.

Working expenses were £3,204. 2s. 5d., generation expenses £1,889. 8s. 10d., distribution £139. 18s. 11d., and management £491. 8s. 5d. Gross profit was £3,300. 15s. 3d. £890. 14s. 3d. was required for interest and £854. 14s. 10d. for sinking fund, and the

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balance, (£1,689. 7s. 11d.) was applied to depreciation. 543,396 units were generated, 68,727 used by public lamps, 293,481 supplied to the tramway company, and 121,784 to private consumers. There are 249 private consumers and the equivalent of 14,033 8 c.p. lamps are connected. 78 Nernst lamps are included in the public lighting. The total maximum supply demanded was 401kw.

St. Pancras (London).—The accounts of the electricity undertaking for the year ended March show total capital expenditure £460,368. 8s. 10d., an increase of £38,677. 6s. 4d. during the year.

The revenue of £75,774. 0s. 3d. (compared with £68,372. 2s. 7d.) included £63,143. 13s. 9d. from private consumers, £11,367. 7s. 6d. from public lighting, £194 meter rentals and £624. 17s. 2d. sundry chargeable works. Working expenses were £35,686. 11s. 4d. (against £36,096. 5s. 8d.), total generating expenses £20,728. 11s. 11d., distribution costs £4,556. 17s. 6d. Management expenses were £2,711. 11s. 2d., law and parliamentary charges £1,533. 12s. and rents, rates and taxes £2,335. 1s. 10d. Out of the gross profit of £40,087. 8s. 11d. (against £32,275. 16s. 11d.) interest required £13,093. 3s. 5d. and sinking fund instalments £6,122. 5s. 10d. The net profit was £20,583. 13s. 2d. (compared with £16,818. 0s. 6d. in previous year). Adding to this the amount from 1902-3 unappropriated (£530. 0s. 11d.), the total disposable amount was £21,113. 14s. 1d., of which £16,000 has been added to reserve and £2,319. 9s. 6d. carried forward. 5,613,170 units were generated, 3,694,046 were supplied to private consumers, 909,390 to public lamps and 126,905 to public buildings. There are 461 public lamps, and the total maximum supply demanded was 3,193kw. The numbers of lamps connected and applied for are equivalent to 84,788 16 c.p. incandescents (compared with 75,156 last year) and 759 arcs (against 646). Motors number 312 (against 259).

Salford.—The Tramways committee recommend the Corporation to apply for sanction to borrow £16,318 for electric tramcars and rail cleaning and watering cars.

Shoreditch (London).—The accounts of the electricity undertaking for the year ended March 25 were presented on Tuesday.

A surplus of £1,043. 17s. 1d. was shown after debiting the electricity account with the whole of the cost of the destructor, less charge to general rate of 2s. per ton for refuse destroyed, and also paying loan charges (£13,460. 19s. 2d.). The sales increased during the year by nearly 9 per cent., and the total costs increased by less than 4 per cent. The accounts were approved and £1,000 of the surplus carried to reserve.

Shoreham.—Hove Electric Lighting Co. will apply for a provisional electric lighting order for Shoreham.

South Africa.—The "British and South African Export Gazette" states that Pietermaritzburg Tramways sub-committee, acting on suggestions from their new tramways manager (Mr. P. Finlayson) intend to order a tower waggon and additional tramway current meters and to extend the tramways.

Johannesburg Town Council have decided upon an expenditure of £31,458 for extensions of the electricity mains to suburban districts, £7,485 for substituting underground for overhead cables, and £12,640 for rearrangements, &c., of generating plant.

Amongst electricity schemes in course of realisation or projected are those of Boksburg, for which tenders have been invited; Mafeking, for which Mr. Mordey Lambe (borough electrical engineer of Kimberley) has been appointed consulting engineer; Pietersburg (Transvaal) and Vryheid (Natal), which are so far only in the projected stage; and Kalk Bay, whose municipality has received Parliamentary authority to raise a loan for electrical purposes.

Natal public estimates for 1904-5 include £14,000 for further development of the Government telephone system, including £6,000 for remodelling the Durban-Maritzburg section, £1,200 for an extension to Dundee, £2,000 for an exchange at Newcastle, and various sums for linking other places with the system. The line from Pietersmaritzburg to Ladysmith is almost completed.

South Shields.—Out of the net profit of £1,303. 16s. 8d. on the past year's working of the electricity undertaking the Electrical committee have voted £300 to general district rate account, the balance being carried to reserve.

Southwick.—Hove Electric Lighting Co. will apply for a provisional electric lighting order for Southwick.

Spanish Telegraph and Telephone Tenders.—We understand that the tenders invited by the Spanish Government Telegraph Department for the trunk telephone lines projected between Madrid and the French frontier towns of Hendaye and Port-Bou (with the ultimate looping through to Paris) have failed to attract offers, owing presumably to the unsatisfactory conditions made by the Spanish Government. We understand, however, that the scheme will again come forward, as there is a strong feeling both in Madrid and Paris that direct telephonic communication between the two capitals should be established without delay.

With regard to the tenders invited for the supply of submarine telegraph cables to the Spanish Government, recently noted in these columns, we learn that it has not yet been decided whether fresh tenders will be invited by the Spanish Government. The matter rather depends upon whether any private firm or company is prepared to come forward and undertake the work by arrangement.

Stockport.—The Corporation have withdrawn their offer of £23,000 for the Hazel-grove tramway route.

Stockton Heath.—Warrington's proposals to supply electricity in Stockton Heath have been approved by the Parish Council, the condition being that the charges for current do not exceed those of Warrington.

Telegraphic Vocabularies.—The important decision of the International Telegraph Conference held in London in 1903 (whose "Rules and Regulations" have now been confirmed by all the contracting States) that the difficulties attendant upon the compilation of suitable vocabularies for code messages were best met by allowing the completest latitude to compilers of these commercially indispensable publications, has quite naturally put vocabulary compilers on their mettle, and we are threatened with a number of vocabularies of only more or less value in this respect. It is essential, however, that in the preparation of such lists of words the compilers should be thoroughly acquainted with telegraphic work, in order that the many causes of error may be eliminated and the telegraphing public provided with words which can be depended upon from every point of view. Mr. James Nicolson, A.M.I.E.E., has had a large experience in this branch of work, and has set himself the task of preparing a consono-vowel vocabulary, which, while conforming strictly to the conditions laid down by the London Conference, meets the requirements of the telegraph and cable companies and gives to commercial houses an infinite number of good words to draw upon for the compilation of private and public telegraphic codes. The first part of Mr. Nicolson's code, the compilation and revision of which has been undertaken by his son, Mr. Alex. McL. Nicolson, of London, has now been issued by Messrs. Whitaker & Co., and contains 125,000 consono-vowel combinations. We have examined Mr. Nicolson's book with some care, and, since such combinations have been sanctioned by the States contracting to the St. Petersburg Convention, we consider Mr. Nicolson's system the best that has yet come before us for examination. The fact that under such a system the number of words available is practically limitless is an additional advantage, as it enables phrase-code experts to provide for every conceivable requirement of the merchant, and so is available for codes covering the largest number of possible "subjects." It is also to the credit of this vocabulary that it affords the merchant an effective double check upon all messages received. How far it will involve repetitions by the telegraph companies only time and experience can prove.

Torquay.—At the Council meeting on Tuesday the mayor moved the adoption of the Electric Lighting committee's recommendation:

"That in view of the fact that the Dolter Tramway Co's bill had passed the House of Lord's Committee, and that the company would probably require a supply of electricity, the plans and specifications for the Council's new electricity works be proceeded with, so that sanction for borrowing the necessary capital might be obtained by the time the company's bill was finally passed." He said the estimated expenditure for the works was £42,000, of which £2,000 for building and £8,000 for generators was reasonably chargeable to the traction department, and by running lighting sets from the same shafts as the traction generators the Council would practically get the day load lighting supply for nothing.

The committee's recommendation was adopted.

Wandsworth (London).—The County of London Electric Supply Co. have introduced an alternative flat rate of 6d. per unit for current supplied to private consumers, and meter rental has been reduced by about 25 per cent.

West Bromwich.—Sanction has been received by the Council to the following loans:—

£1,751 for feeder cable, £548 excess expenditure on extensions and £1,000 for street lighting. It has also been decided to apply for a further loan of £1,300 for laying mains.

For electrical energy supplied in future to electric motors up to 3 H.P. consumers are to have the option of an increase of ½d. per unit in the charges or pay for a minimum consumption of 200 units per H.P. per quarter; also, in cases where light and power are used on the same premises, the current for power is to be registered by the lighting meter, so that all current used for power will be charged for at the 1½d. rate.

Westinghouse Automatic Signalling.—Following upon the inauguration of the Westinghouse automatic signal system on the Ealing and Harrow branch of the Metropolitan District Railway about a year ago, the whole of the railway is now being thus equipped. About a week since, four track circuits worked on the same principle were brought into use at the newly-opened Highbury station of the Great Northern and City Railway. These track circuits govern two "home" signals and a "starting" signal in either direction—*i.e.*, six signals in all—the two home signals working simultaneously. This installation is said to be the first application of the Westinghouse automatic signals on a London tube railway. The Westinghouse Brake Co. were responsible for the work, and we understand the installation is giving complete satisfaction.

Wills.—The estate of the late Mr. James Staats Forbes, who was for many years director and chairman of the Edison & Swan United Electric Light Co., president of the National Telephone Co., and intimately associated with the principal railway interests of the country, and who died in April last, aged 81, has been valued at £135,367 gross, of which £118,867 is net personalty. The Railway Servants' Orphanage benefits to the extent of £5,000 under the will

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The gross value of the estate of the late Col. B. H. Martindale, a director of the City of London Electric Lighting Co., has been sworn at £12,614. 18s. 8d.

Wireless Telegraphy.—We announced in October last that the London, Brighton and South Coast and the Western of France Railway Companies had decided to place Newhaven and Dieppe in wireless telegraph connection on a system invented by M. O. Rochefort, a French engineer. The work of erecting towers, &c., has now been commenced.

The Northern Lights Commissioners' steamer "May," at present in Granton Harbour, is being equipped with the Marconi system of wireless telegraph apparatus. Apparatus is also being fitted up at the lighthouse on Inchkeith, as an experiment, with a view (it is stated) to its introduction to other steamers and lighthouses under the control of the Commissioners.

Wiring Consumers' Premises in the Metropolitan Area.—The London County Council has circulated amongst the Metropolitan Borough Councils an intimation that their application to Parliament next session for power to enable the borough councils to wire consumers' premises, &c., can only be proceeded with if the councils concerned give to it the fullest possible support.

York.—The extension of the Foss Islands electricity works will be formally opened on 18th inst. The Electric Light committee recommend extensions of mains at a cost of £275, and propose to lay a new main cable.

Robertson Electric Lamp Works Annual Excursion.—An enjoyable trip to Folkestone was made by nearly 400 employés of Robertson's Electric Lamp Works last Saturday. Travelling by special train the party arrived at their destination at about 10:30, and at once "took possession" of the town. Fortunately the weather was fine and a most agreeable time was spent. Mr. C. L. Robertson and Mr. C. Wilson, respectively director and joint manager, were present, as were also a number of guests. Mr. Wilson, in responding to the toast of his health, which was proposed after the luncheon, said he thought the Robertson lamp was in the front rank, and it was the duty of all present to do their utmost to keep it there.

Outings.—On Saturday the annual outing of the officers and workpeople of the Electric Construction Co., Bushbury Works, Wolverhampton, took place, when a large party spent a pleasant day at Blackpool.

The employés of Bournemouth & Poole Electricity Supply Co. had their annual outing at the New Forest on June 25.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Walthamstow Urban District Council invite tenders for the supply, delivery and laying of cables, troughing, boxes, &c., for two years. Specifications, &c., from the consulting engineer (Mr. J. Enright), 68, Lincoln's-inn-fields, London, W.C., and tenders to Mr. C. Sydney Watson, clerk to the Council, by 5 p.m. 22nd inst. See also advertisement.

West Ham Council invite tenders for the removal and re-erection of four Babcock-Wilcox water-tube boilers. Specifications from the borough electrical engineer (Mr. W. J. W. Bullock), Tucker-street, Canning Town, E., after 11th inst. Tenders to the town clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, E., by 4 p.m. July 15. Further particulars are given in an advertisement.

Dublin Corporation invite tenders for 12 months' supply of machinery oils for their electricity works. Specifications from the town clerk (Mr. Henry Campbell), City Hall, Dublin. Tenders by noon July 22. See also advertisement.

Dublin Corporation require tenders for 100,000 pairs of arc lamp carbons. Tenders to secretary (Mr. Fred. J. Allan), 3, Cork-hill, Dublin (addressed chairman of Lighting committee), by 9th inst.

Wigan Corporation invite tenders for hand reversible three-wire battery booster and switchboard, compound-wound double-field balancer and cables. Specifications, &c., from the borough electrical and tramways engineer (Mr. James Slevin), Bradford-place, and tenders to the town clerk (Mr. Harold Jevons) by noon 19th inst. See also advertisement.

Tenders are invited by the Scottish office of the *May-Oatway Fire Appliances (Ltd.)* for wiring the fire alarm installations set out in an advertisement. Tenders close at noon July 15. Particulars from managing director, 49, Queen-street, Glasgow.

The managing director of the company also invites tenders, accompanied by samples, for a year's supply of overhead line, deliverable in 10-mile lots, for cash. See advertisement.

Bristol Corporation Electrical committee invite tenders for (*a*) H.T. switch gear, (*b*) water-tube boilers, (*c*) two 1,000kw. three-phase E.H.T. turbo-alternators, (*d*) two 500kw. induction type motor-generators, E.H.T. to D.C., (*e*) E.H.T. cables, (*f*) E.H.T. transformers, (*g*) E.H.T. switch gear. Tenders to Mr. H. Faraday Proctor, city electrical engineer's office, Temple Back, Bristol, by 10 a.m. July 15.

Handsworth District Council invite tenders for water-tube boilers, engines and dynamos, hand-travelling crane, storage battery, arc lamps and posts, switchboards and boosters. Tenders to the clerk (Mr. H. Ward), Council House, Handsworth, near Birmingham, before noon July 11.

Rochdale Corporation invite tenders for supply and erection of two steam turbines direct-connected to two three-phase alternators, or for alternators connected to high-speed triple expansion engines; also for one motor-driven three-phase alternator. Tenders by 18th inst. to the town clerk (Mr. James Leach), Town Hall, Rochdale.

Metropolitan Asylums Board invite tenders for the installation of fire alarms at Darenth Asylum, *Dartford*, and for telephones at the Eastern Hospital, *Homerton*, and the Western Hospital, *Fulham*. Tenders by 10 a.m. 20th inst.

St. Pancras (London) Council invite tenders for main switchboard at King's-road power house. Tenders to the deputy town clerk (Mr. H. T. Richards), Town Hall, Pancras-road, N.W., by noon July 19.

Devonport (Tasmania) Town Board invite alternative tenders for 50 or 100 smallest-size meters to read direct in B.O.T. units on 220-volt direct-current circuits. Mr. Geo. H. Lofts is town electrical engineer.

Dartford District Council require tenders by noon 19th inst. for extension of underground and pilot cables in existing spareways and for laying lighting cables with road work, junction boxes, &c.

Rhyl District Council invite tenders by 18th inst. for 1,400yds. 0·2 concentric feeder cable.

Messrs. Wm. Lee, Son & Co. (Ltd.) invite tenders for an electrical installation at their cement works, *Halling*, near Rochester. Further particulars can be obtained of the manager of the works.

Radcliffe District Council require tenders by 16th inst. for tramway permanent way construction (6½ miles single track), including copper bonding.

Mardel Plata (Argentina) Municipal Council are inviting tenders for public electric lighting, the contract with the local company having expired.

TENDERS RECEIVED AND ACCEPTED.

London County Council have received the following tenders:—

For Coal and Ash Conveyors at Greenwich Generating Station.

New Conveyor Co. (*accep'd.*)	£4,763	Blake, Barclay & Co. ..	£6,551
C. A. Cass	7,394	Babcock & Wilcox ..	4,971
R. Dempster & Sons ..	7,271	Edgar Allen & Co. ..	4,582
Spencer & Co.	6,881		

50kw. Electric Generating Plant for Poplar Technical Institute.

W. Sissons & Co. (*accepted*)	£475	P. Brotherhood	£541
Belliss & Morcom.. ..	546	W. H. Allen, Son & Co. ..	520

For wiring Tooley-street fire station, 11 tenders, varying from £133. 10s. to £166. 5s. 6d., were received, and the lowest (that of Rashleigh Phipps & Co.) was accepted.

For wiring Bayswater sub-station, 11 tenders (£121. 2s. 6d. to £195) were received, the lowest, that of Rashleigh Phipps & Co., being accepted.

Eleven tenders were also received for wiring Kilburn sub-station (varying from £143 to £192. 9s.) the lowest in this instance, that of Rashleigh Phipps & Co., was likewise accepted.

Royton District Council have received tenders from the following firms in connection with their electric tramways:—

Permanent Way.—Wm. Underwood & Bro. (*accepted*), Hughes & Stirling, James Brunton, R. W. Blackwell & Co., Wm. Griffiths & Co., Edmondson & Wyatt, G. Freeman & Sons, J. G. White & Co., Bennie & Thompson, Dick, Kerr & Co., Wm. Hy. Worthington, A. Graham & Sons, J. E. Mayall, J. & W. S. Briscoe, G. Law, and Pegg & Bailey.

Overhead Construction and Equipment.—Brush Electrical Engineering Co. (*accepted*), F. M. Smith & Co., George Hill & Co., British Insulated & Helsby Cables, Wm. Underwood & Bro., Dick, Kerr & Co., British Thomson-Houston Co., R. W. Blackwell & Co., and J. G. White & Co.

Cables.—W. T. Glover & Co. (*accepted*), Callender's Co., W. T. Henley's Co., Siemens Brothers & Co., British Insulated & Helsby Cables, St. Helens Cable Co., W. F. Dennis & Co., Johnson & Philips, Western Electric Co., and Simplified Underground Conductor Co.

The Scottish office of the May-Oatway Fire Appliances have accepted the tenders of Carrick & Topping for wiring installations of the May-Oatway fire alarms (for direct connection with the fire brigades) on the works of the St. Mungo Mfg. Co., Govan, and Messrs. Hay Bros., Glasgow, and at the King's Theatre, Glasgow; also those of W. Douglas (Ltd.), J. Maxwell & Son and D. T. Niell & Co. for similar installations on the premises of the Leith Provident Co-operative Society, Adam Smail (Dundee) and E. Chalmers & Co. (Leith) respectively.

Mather & Platt have secured a contract for the supply of electrical plant to Simonstown (Natal) dockyard, including two Babcock boilers, two Browett & Lindley-Mather & Platt generating sets, surface condenser with pumps, &c., overhead travelling crane, storage battery and booster, two portable motor-generators, switchboard,

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with dynamo, battery motor and feeder panels with instruments, switches, &c., also motors for the workshops with accessories.

Meldrum Bros. have received an order to instal and fix mechanical stokers to four boilers at the Grove Hospital, to four boilers at the Park Hospital, and to two boilers at the Northern Hospital of the Metropolitan Asylums Board. This firm have already in hand three sets of stokers for another of the Metropolitan Asylums Board's institutions.

The tender of the Dunedin (N.Z.) Engineering Co. has been accepted for the pipe line for conducting water from Waipori Falls to the power house in which it is proposed to generate energy for Dunedin and the surrounding districts (see also under "Waipori Falls").

Shoreditch (London) Council has accepted the following tenders for 12 months' supply of coal:—Gothard & Co., Manners' nuts, 12s. 6d. per ton, delivered in barges; ditto, best Welsh smokeless, No. 1 Bwllfa, 21s. 4d., delivered in vans; Rickett, Cockerell & Co., North's nuts, 20s. 5d., delivered in vans.

Ilford District Council have accepted the following tenders:—
British Westinghouse Co., 1,000kw. Westinghouse-Belliss set; Kelvin & James White, extension to main switchboard and extension to distributing switchboard; Lassen & Hjort, water purifying plant; W. T. Henley's Co., feeder pillar, &c.

Tucuman Municipal Council have accepted a tender from Señor Belisario S. Garcia for public electric lighting. The River Plate Electricity Co. have hitherto held this contract, the charges for current being $28.50 per month for arcs and $6 for incandescents. There are 180 of the former and 92 of the latter in use.

The contract for the construction of the light railway extensions from Cheltenham to Charlton Kings and Leckhampton (over 6 miles) has been let to R. W. Blackwell & Co. at about £40,000. The work will be commenced within three months and is to be finished by the end of the year.

Stepney (London) Council have accepted the tender of the Electric Motor Supply Co. for wiring the Whitechapel public baths at £237. 8s. There were 30 tenders, ranging from that of the accepted tender to £669.

Salford Tramways committee have accepted the following tenders:—Dick, Kerr & Co., 10 single-truck, double-decked cars at £580 each, 10 double-truck combination cars at £697 each, and two rail-cleaning and watering cars at £1,082. 10s. each.

Lincoln City Council have accepted the following tenders:—Brush Co. (eight trucks and eight car bodies); British Westinghouse Co. (eight electrical equipments, two magnetic track brakes and spares); Milnes, Voss & Co. (two top-seat covers).

Warrington Tramways committee have accepted the following tenders:—
Babcock & Wilcox, four mechanical stokers, £957.
Bell Bros., water-softening plant, £450.

Holyhead Council have accepted the tender of the National Electric Construction Co. for laying additional electric lighting mains, &c, at £1,750.

East Ham District Council have accepted the tender of W. J. Fryer & Co. for wiring and fitting up the technical college for electric lighting at £679.

Richard Hornsby & Sons have secured a water-tube boiler contract for Finchley electricity works to work alongside the existing plant.

Birmingham Electricity committee have accepted the tender of Wm. Sapcote & Sons for excavation, concrete and brickwork for the foundation of their new Summer-lane generating station at £15,777.

Wednesbury Corporation are recommended to accept the tender of F. J. Smith for the erection of an office, test room and stores adjoining the electricity sub-station.

Stoke-upon-Trent Town Council have accepted the tender of the Reason Mfg. Co. for electricity meters, demand indicators and house service cutouts.

Derby Council have accepted the tender of Rawlinson & Sons for a telescopic trimming ladder at £19. 15s.

Derby Town Council have also accepted the tender of J. G. White & Co. for constructing the permanent way of the tramways from East-street to Victoria-street at £2,000.

Exeter City Council have accepted the tender of the British Westinghouse Co. for the erection of a steam generating set (with Belliss engine) at £2,260.

Johannesburg Corporation have ordered three 30kw. and six 15kw. transformers from the British Westinghouse Co.

Leeds City Council have accepted the tender of Isaac Gould (Ltd.) for extensions at Kirkstall tramway depot at £4,032. 1s. 3d.

Dudley Council have accepted the tender of Ferranti Limited for a 400kw. steam dynamo at £2,200.

Dover Corporation have accepted the tender of G. Lewis & Sons for extensions of the electricity station buildings at £1,222. 10s, and that of Matthews and Yates for an electric ventilating fan at £20.

Buckingham Council have accepted the tender of the local electric light company for public lighting.

Croydon Corporation have accepted the tender of Babcock & Wilcox for steam pipe work at £997.

BUSINESS NOTICES.

We are asked to state that Mr. G. Almenräder has been appointed assistant manager to the manager (Mr. F. Winter) of the London agency of Dr. Heinr. Traun & Sons. Mr. Almenräder has been in the service of the agency for the past 18 years.

J. H. Edwards, F. Armstrong, A. L. Stephens and W. D. Armstrong, electrical and mechanical engineers, Bristol, Cardiff, &c., have dissolved partnership. Debts by J. H. Edwards and A. L. Stephens, who continue as Edwards & Armstrong.

G. E. Mansfield and W. G. Dexter (trading as Mansfield & Dexter), electrical engineers, Vulcan-road, Leicester, have dissolved partnership. Debts by Mr. Mansfield, who continues.

T. Usher and Wm. Schmahl (trading as the Armorduct Improved Electric Conduit Co.), 6, Farringdon-avenue, London, E.C., have dissolved partnership. Debts by Mr. Schmahl.

We are informed that Messrs. Featherstone Smith & Sons, 67, Leadenhall-street, London, E.C., have been appointed wholesale selling agents, exporters and shippers to Cryselco Limited, makers of the Cryselco incandescent lamps.

BANKRUPTCIES, LIQUIDATIONS, &c.

In the failure of Carl Vigant de Falbe (lately carrying on business as the Electric & General Contracting Co. at 17, Shaftesbury-avenue, London, W.C., and now of 1, Penywern-road, Earl's Court, London), the public examination has been fixed for 11:30 July 20 at Bankruptcy-buildings, Carey street, London, W.C.

F. W. Parkes & E. Sadleir, electrical engineers, The Dingle, Colwyn Bay, have been ajudicated bankrupt.

Claims against the Automobile Mfg. Co. (Ltd.), 48 and 49, Long-acre, London, W.C., must be in by 18th inst. to Mr. H. de V. Brougham, Carey-street, London, E.C.

A meeting of Dover Electricity Supply Co. (Ltd) (whose undertaking has been acquired by Dover Corporation) will be held on Aug. 3 at the Burlington Hotel, Dover, to receive an account of the winding-up.

Messrs. A. J. Crane, G. A. Paul, J. White, C. G. Penney, and J. D. Gibbes have been appointed a committee of inspection to act with the official receiver and liquidator (Mr. G. S. Barnes) in the winding up of the Automatic Telephone Co. (1903) (Ltd.)

An order has been made for the winding-up of the Electro-Voelker Syndicate (Ltd.), 65, George-street, Croydon.

Sale by Tender.—Owing to change of system and closing of their old electricity station, Exeter Corporation have a quantity of plant for disposal, particulars of which are set out in an advertisement. Schedule and form of tender from the city electrical engineer, Mr. H. D. Munro, to whom tenders by 12 noon July 15.

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 80, Birley-street, Blackpool.

In the important business district of Tabernacle-street, Finsbury, London, E.C., Messrs. B. Brampton & Co., Finsbury House, Finsbury-square, E.C., have to let two floors in eligible warehouse premises.

Land to be Let or Sold.—Messrs. Walfords, 27, Bolton-street, Piccadilly, London, have some exceptionally eligible land at Stamford, Lincs., for sale or to be let. Stamford is connected with three railway systems, and is within moderate distance of the Midland coalfields.

Patents, Designs and Trade Marks.—Notice is given that Mr. Henry Harris Lake seeks leave to amend specification of letters patent No. 1,093 of 1903 for "Improvements relating to devices for synchronously operating phonographs and cinematographs," as set out in the "Illustrated Official Journal (Patents)" of June 29. Opposition must be lodged at the Patent Office, 25, Southampton-buildings, London, W.C., within one calendar month from date of said journal. See also advertisement.

New Watertight Tumbler Switch.—To get over the difficulty which is presented when using tumbler switches for outdoor work or in exposed positions where moisture is present, the General Contracts Co., of 102A, Charing Cross road, London, W.C., have put on the market a novel form of their patent "Strut" switch enclosed in a watertight box. To facilitate manufacture the standard type of switch is used complete, secured in the metal box, either with or without the ordinary cover as may be desired, and, in order to retain the full advantage of the tumbler action and at the same time produce a switch that is absolutely watertight, a second dolly is introduced working in a ball-and-socket joint in the cover of the watertight box. This second dolly carries a cupped end which fits over the ball of the permanent switch dolly, thus forming a smooth working joint between the outer dolly and the switch lever. For

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convenience in coupling, the wires are carried through glands in the side of the box, so arranged as to give sufficient length of wire to allow the switch being removed for making the connections, space being allowed in the bottom of the box for the slack wire to stow when the switch is fixed in position. The additional dolly and outer cover, being concentric with one another, admit of the cover being unscrewed with the switch in any position, and, as there are no small screws or loose parts in connection with this portion of the case to be removed when making the wire connections, and so interfere with the adjustment of the watertight joint, the switch becomes one of the simplest and most effectual watertight switches on the market. It is made up to take any form of gland or tube connection.

The Sub-target Gun Machine.—The Sub-Target Gun Co. is exhibiting a device for enabling shooting practice to be closely followed and recorded on a miniature target, called the "sub-target," placed at the side of the gun independent of the target proper. The machine itself consists of a cast-iron stand, which serves as a support for a horizontal metal construction carrying the indicating and recording mechanism. At one end of this horizontal construction is a small upright metal holder for the miniature cardboard targets. In front of this target a needle point plays, which is connected by levers and joints to the gun in such a way that its movements with regard to the sub-target correspond to the movements of the rifle with regard to the target proper. Any rifle may be used and is attached to the mechanism at two points. On pulling the trigger, a short electrical contact is made in a small contact box screwed to the rifle, and a current impulse from a dry battery is sent through a solenoid, which in its turn causes the sub-target to advance towards the needle. In this way a needle prick is made on the sub-target, indicating the point where the real target would have been hit.

Superheated Steam Applied to the Willans Engine.—A neat pamphlet, descriptive of and illustrating the use of superheated steam as applied to the Willans engine, is issued by Messrs. Willans & Robinson, Victoria Works, Rugby, and copies can be obtained on application. The text is accompanied by several graphic diagrams showing the saving in steam consumption on Willans triple expansion, compound expansion and simple engines.

Post Office Telephone Directory.—A directory of the Post Office telephone exchange system in England and Wales, Scotland and Ireland, corrected up to the end of June, has just been issued, and contains, in addition to the names, addresses and numbers of subscribers, a complete list of Post Office call offices in the United Kingdom, and particulars as to rates of subscription and of the various facilities offered to subscribers to this service. The time during week days and Sundays the service is open at the various call offices is furnished. A list of subscribers who rent circuits in connection with the International and Inland Trunk Telephone Exchanges is also given. The list of subscribers to the London Telephone Exchange system of the Post Office is published separately.

Catalogues.—Messrs. Nalder Bros. & Thompson, 34, Queen-street, London, E.C., send us an advance copy of a new edition of section 1 of their main list. This section deals chiefly with soft iron solenoid instruments (switchboard and portable patterns), accumulator cut-outs, &c. Of these instruments, &c., numerous illustrations are given and the accompanying particulars cover a wide range of information.

The New Brotherton Tube Co, have ready a new descriptive catalogue of their "Excelsior" system of electric conduit.

Messrs. E. P. Allam & Co. have ready new circular lists of "Premier" house service fuse boxes and ironclad switches, cutouts and motor-starters.

Messrs. Archibald J. Wright (Ltd.), 318, Upper-street, London, N., have issued a new price list of automobile electrical accessories, copies of which can be obtained on request.

Mr. W. Clark Fisher, Gordon-road, West Ealing, London, W., who is the patentee and manufacturer of galvanometers, potentiometers and other instruments of precision for all classes of work, has ready a new list dealing with these instruments. Lengthened reference has been made in *The Electrician* to some of Mr. Fisher's specialities, and the list now ready will supplement these descriptions, and should prove useful to all users of this class of apparatus.

The National Electric Co. of Milwaukee, U.S.A., forward a well-illustrated list of stationary and portable motor-driven air compressors. Amongst the illustrations is that of a neat example of the portable type of these machines enclosed in dust-proof cover, constructed so as to give easy access to all parts of the apparatus.

Imports.—The following are official values of imports of electrical machinery, material and apparatus into this country during June:—

Electrical machinery, £54,633 (an increase of £2,136 over June, 1903); telegraph cables and apparatus, £1,672 (decrease £1,850); other electrical goods £56,170 (decrease £4,264). The total exports of the three classes during the six months ended 30th ult. were respectively £269,444 (decrease £43,558), £16,485 (decrease £13,655) and £384,098 (increase £23,184.)

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from June 29 to July 5, with the ports of destination:—

Aden, £42. *Africa*—Alexandria, £54; Cape Town, £677; Durban £2,556 (including £120 telegraph material); East London, £1,299 (including £92 telegraph material); Simonstown, £222. *Argentina*.—Buenos Ayres, £349. *Australasia*—Adelaide, £65; Brisbane, £379; Fremantle, £557; Lyttleton, £350; Melbourne, £1,030 (including £640 telegraph material); Sydney, £4,169 (including £23 telegraph material); Wellington, £1,991 (including £617 telegraph material). *Azores*, £100. *Belgium*—Brussels, £90. *Borneo*—Sarawak, £4. *Brazil*—Rio Janeiro, £19. *Burma*—Rangoon, £54. *Canada*—Halifax, £172; St. John's, £91; Toronto, £562. *Ceylon*—Colombo, £156. *Chili*—Iquique, £300 (telegraph material). *China*—Shanghai, £42. *Cochin China*—Saigon, £90 (telegraph gear). *France*—Bordeaux, £17. *Germany*—Bremen, £30; Hamburg, £250 (telegraph material). *Holland*—Amsterdam, £155; Rotterdam, £442 (including £400 telegraph cable). *Hong Kong*, £735. *India*—Bombay, £152; Calcutta, £677 (including £90 telegraph material). *Japan*—Yokohama, £535. *Norway*—Christiana, £18. *Peru*—Callao, £150 (telegraph material). *Russia*—St. Petersburg, £1,055. *Straits Settlements*—Singapore, £75. *Turkey*—Constantinople, £15. *Zanzibar*, £15. Total £19,743, against £23,027 in the corresponding week last year (July 1 to 7).

COMPANIES' MEETINGS AND REPORTS.

Electric & General Investment Co. (Ltd.)

The fifteenth ordinary general meeting was held on Wednesday, Mr. GEORGE HERRING presiding.

The SECRETARY (Mr. J. Cecil Bull) read the notice calling the meeting and the auditors' report.

The CHAIRMAN said: Gentlemen, we are very sorry to submit this report after the prosperous reports we have hitherto been able to lay before you. As we have always told you this Company is dependent more or less on the state of the electrical industry, and that industry, for some reason or other which I cannot understand, is at present under a cloud so far as the price of securities goes. Why I cannot understand it is that the lighting companies are doing very well, and as regards the traction companies they are paying good dividends. In spite of that being the case, the market for electrical securities is not good, and that is why our report is not up to the standard of past reports. All the same, we have not done badly. We have made a gross profit of £15,804, and after paying all charges we are left with nearly £8,000 to pay dividends. But the unfortunate part about it is that the dulness of the market for industrial electrical securities had caused the Board to consider it only prudent to add a sum of money to the contingencies fund. I hope you will agree with us in that respect. This provision for contingencies was £35,761 at the date of the balance-sheet, but we are proposing to increase it to £41,575. The loan account, standing at £122,963, may appear to you to be large, but it is smaller than it was last year. With regard to the sundry creditors (£45,730) that money is now nearly all repaid. On the other side of the balance-sheet we have investments at cost, £297,326. There is the unfortunate feature of the whole thing, and I want to tell you plainly the exact position. The market price of these investments at the moment does not represent that amount. With one or two exceptions they are dividend-paying securities, and, of course, we are receiving the dividends. We do not feel inclined to sell them. We are not pressed to do so, and we have no intention of parting with them at the present depressed price. If we had to do so we should feel that we were sacrificing our property, because we believe their real value to be above the market prices now ruling. The sundry debtors, £31,385, is more a book entry than anything else, and I may tell you that there is not a single doubtful debt among them. Coming to the profit and loss account, you will see that the profit on issues made by the Company, interest and dividends, &c, come to £15,804. On the other side you will see we have paid the preference dividend, the general charges, and 1s. per share, or 5 per cent., on the ordinary shares. That leaves us with £6,813, and we propose to pay another 1s. per ordinary share, amounting to £1,000, and to carry the balance of £5,813 to contingencies fund, thereby raising it to £41,575. If we had to sell our securities at the present low market price, this provision for contingencies would, we consider, amply cover all loss on realisation. I tell you that so that you may be in no fear as to our not having provided amply for depreciation on our investments. While regretting that the report is not so good as usual, although 10 per cent. is not bad, I would call your attention to the fact that since 1891 we have given the shareholders back in dividends £3. 18s. 1½d. in respect of each £1 share. I hope, therefore, that you will submit with a good grace to the reduction of the dividend on this occasion. We must all trust that the industrial electrical companies will before long find more favour with the public as investments, and that the value of the securities will rise to the proper and fair level. I now move the adoption of the report and accounts.

The motion was carried unanimously, as was a resolution approving the dividends.

Mr. J. B. Braithwaite, jun., the retiring director, was re-elected, as was the auditor, Mr. G. T. Rait, and the proceedings terminated.

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BELFAST STREET TRAMWAYS CO.—A special meeting was held on Monday to consider the Belfast Corporation bill to purchase the company's undertaking, &c. The chairman (Mr. Geo. Richardson) said the Corporation had introduced a bill to acquire the undertaking of the company, and a meeting had taken place between the agents of the Corporation and the company to arrange terms. Under that tentative agreement the company was to be paid the price of the lines, &c., to be ascertained by arbitration. They were further to receive what the Sydenham and Ligoniel undertakings had cost them, plus 10 per cent. premium, and also £3,000 payable under sec. 39 of the 1888 Act. In consideration of giving up possession on Dec. 31 next, they were to receive a sum equal to three years' net profits, calculated on the basis of the annual net profits for the five years ended Dec. 31, 1903, minus debenture interest and rent paid to the Corporation. The Corporation was to compensate the directors, manager and secretary by paving them three years' fees and salaries. The company would retain its sinking fund investments, and any cash that might be in hand on Dec. 31 next, the Corporation taking over all pending contracts and indemnifying the company therefor. This agreement was approved by the shareholders.

BRITISH ALUMINIUM CO. (LTD.)—At the meeting on Tuesday the chairman (Mr. H. Wolfenden) said the company had made great progress during the past year. There was an improvement in the financial position, mainly due to the net profit of £16,877 made during the past year, compared with £3,392 loss in 1902. In the current year there would be an increased production. The company were selling all the aluminium they were producing, and effecting a reduction in their stock besides. Last year they sold about 30 per cent. more than in 1902 and during the past six months the sales were 30 per cent. greater than in the corresponding period of 1903. The board had decided to suspend the manufacture of carbide of calcium, and to apply the whole of their power at Foyers to the production of aluminium. The directors proposed proceeding with the development of the Loch Leven water power. A large outlay of capital was involved.

CHILI TELEPHONE CO. (LTD.)—The report of the directors for the year to March 31 shows that the aggregrate number of subscribers at all centres was 5,814 compared with 5,371 at the beginning. The gross revenue in Chili from all sources was $916,542, an increase of $75,349. Expenditure in Chili was $422,409, increase $20,890, making the net income in Chili $494,133, an increase of $54,459 over the previous year. The average rate of exchange was 16·36d., compared with 15·68d. Converted into sterling the net income in Chili is £33,687, increase £4,964. The balance to credit of revenue, including £2,637 brought forward, is £31,207, of which £14,010 has been carried to reserve for renewal of plant, &c. The directors recommend a final dividend of 4s. per share (less tax) making 7 per cent. for the year, and leaving £2,502 to be carried forward. £21,000 debentures, which matured on March 31 this year, have been paid off, and arrangements have been made to extend the remainder (£35,000) until such time as the finances of the company will permit of their being also paid off. The total mileage of the company's lines at March 31 last was 9 884 miles 468yds., an increase over the previous year of 678 miles, 1,366yds.

ELECTRIC CONSTRUCTION CO. (LTD.)—The directors' report for the year to May 31 shows a net profit of £14,773. 1s. 2d., or, with £4,394. 13s. 10d. from last year, £19,167. 15s. Dividend on the 7 per cent. preference shares requires £4,394. 12s., and a dividend of 4 per cent. on the ordinary shares £8,968. £2,000 is put to general reserve (making this £32,000), leaving the balance forward £3,805. 3s. The year has been marked by excessive competition among manufacturers of electrical machinery, and the company's manufacturing profit has inevitably suffered. This competition still continues and the margin of profit at present prices is small. The orders in hand include important contracts with the London County Council and the Great Western Railway Co. Revenue has been charged as formerly with £5,000 for depreciation, also with maintenance and all renewals of plant. The depreciation account now amounts to £53,000. The relations with the employés continue satisfactory, and the usual bonus, but reduced proportionately with the dividend, has been awarded to all who have for 12 months given good and zealous service. The balance-sheet shows an important improvement in the financial position. The company's interest in the Crystal Palace District Electric Supply Co., which was taken over from the old corporation, has been sold, and the Madras electric tramways undertaking has been transferred to the Madras Electric Tramways (1904), Ltd., in consideration of £50,000 in cash and £70,000 in fully-paid shares of that company, which, on the basis of last year's profits, should yield a dividend of 5 per cent. The cash thus realised has provided for repayment of the advance from the company's bankers. As the general reserve was partly made up of profit on other assets of the old corporation previously realised, that account has been debited with £4,000 to meet the loss in realising these properties. The company's future income will benefit by these realisations.

ELECTRICAL POWER STORAGE CO. (LTD.)—The report of the directors for the year to May 31 shows that the profit for the year (including £594. 4s. 3d. brought forward) is £10,360. 10s. 7d. Out of this £3,500 has been carried to reserve and £1,000 to contingent fund. A dividend of 6 per cent. on the ordinary shares is recommended, absorbing £5,389. 13s. 7d., leaving £470. 17s. to be carried forward. The buildings, plant, tools, &c., have been maintained in thorough repair and condition at a cost of £4,297. 16s. 7d., provided out of revenue. The directors take pleasure in recording a successful year in spite of prevailing dullness of trade and consequent keenness of competition. The company's products continue to give satisfaction to its customers, the volume of orders increasing steadily year by year.

GREENWOOD & BATLEY (LTD.)—The directors' report for the 12 months ending March 31 last shows that, after providing for interest and expenses of management, and allowing for doubtful accounts, there is a profit of £25,978. 4s. 2d., or, with £3,306. 1s. 7d. from last year, £29,284. 5s. 9d. £5,000 has been written off for depreciation of plant, and £5,000 off book value of investments, and the directors recommend that the full dividend on the 7 per cent. preference and of 5 per cent. on the paid-up ordinary shares be declared, absorbing £15,615. 13s. 3d., and that £3,668. 12s. 6d. be carried forward. £4,735. 0s. 9d. has been expended during the year on maintenance account and charged to revenue. The works are well employed at the present time.

NEW GENERAL TRACTION CO. (LTD.)—At the meeting on Wednesday, the chairman (Baron E. B. d'Erlanger) said that for some time the shareholders could not expect the revenues of the Traction Co. to cover the latter's full fixed charges. The prior lien bonds of the company would have to be all issued. The £60,000 subscribed on the public issue were entirely taken by the directors and their friends, being guaranteed at 97½, as the issue met with no response either from the public or the shareholders. The directors would probably invite tenders from the shareholders for the remaining prior lien debentures. Receipts for the year from the Norwich tramways showed a slight improvement, but he regretted that a law suit was pending with the municipality relating to the repairs of the roadway. At Coventry the receipts were substantially the same as last year. In Douglas the season had only just begun. The financial position of the company, and their past experience, had precluded them from dealing with Mexborough as yet. Their Philadelphia property was now fully running, and they might expect some returns from this in the near future.

ROYCE LIMITED.—The report for the year ended March 31 shows that, after providing for trade expenses, depreciation, repairs and replacements, paying debenture interest upon £23,100 stock issued since last report, the year's working has resulted in a loss of £1,397. The directors fear the depression in the electrical trade is likely to continue.

THOMAS PARKER (LTD.)—At the meeting on Monday Mr. C. T. Mander said the diminished profits were the result of the general depression in trade, and the recent fierce competition in the electrical industry. Large economies had been effected during the year in methods of construction and works management, and the works were now full of orders. The economies and modifications in their methods had enabled them to reduce their prices very considerably, and that was probably why the orders in the latter period of the year were more satisfactory.

NEW COMPANIES.

BISHOP'S STORTFORD & STANDSTEAD ELECTRIC LIGHTING CO. (LTD.) (81,397.)—Reg. June 29, capital £1,000 in £1 shares, to carry on at Bishop's Stortford, Herts, and Stanstead, Essex, and elsewhere the business of suppliers of electricity, electricians, engineers, &c.

BRENTFORD ELECTRIC SUPPLY CO. (LTD.) (81,399.)—Reg. June 29, capital £1,000 in £1 shares, to carry on the business of electrical and mechanical engineers, contractors, electricians, suppliers of electricity, manufacturers of electrical apparatus, owners of railways and tramways, generators, accumulators, transformers, users and suppliers of electricity, &c. The subscribers are F. W. Reynolds, F. E. Savory, H. B. Renwick, F. C. McQuown, electrician, A. S. Cobden, A. D. Dallas, engineer, J. J. Lightfoot. Reg. office, Moorgate-court, Moorgate-place, London, E.C.

CAMBERLEY ELECTRIC SUPPLY CO. (LTD.) (81,400.)—Reg. June 29, capital £1,000 in £1 shares. The objects and other particulars same as Brentford Electric Supply Co., Ltd. (*q.v.*)

FARNHAM AND DISTRICT ELECTRIC SUPPLY CO. (LTD.) (81,401.)—Reg. June 29, capital £1,000 in £1 shares, to carry on the business of an electric light and power company, to construct or acquire any tramways in or near Farnham, &c. Reg. office, York Mansion, Westminster, London, S.W.

HAYWARDS HEATH ELECTRIC SUPPLY CO. (LTD.) (81,403.)—Reg. June 29, capital £1,000 in £1 shares, to carry on the business of suppliers of electricity, electricians, mechanical engineers, manufacturers of and dealers in apparatus and articles used in connection with the generation, distribution, supply and employment of electricity, &c. The subscribers are F. W. Reynolds, F. C. McQuown, electrician, H. B. Renwick, J. G. Shortis, J. J. Lightfoot, J. Hazard and T. F. Bickford. Reg. office, Moorgate-court, Moorgate-street, London, E.C.

HUNTER ELECTRIC CANDLE LAMP CO. (LTD.) (81,387).—Reg. June 28, capital £800 in £1 shares, to acquire certain inventions relating to electric incandescent lamps and fittings and letters patent relating thereto, to adopt agreements with N. Burt & Co. and C. C. Regnart, and to carry on the business of manufacturers of and dealers in electric candle lamps and fittings, &c. First directors: C. C. Regnart, C. H. Burt, W. Last and E. Dunand. Reg. office, 17, Newman-street, Oxford-street, London, W.

KINGSBRIDGE & SOUTH DEVON ELECTRIC LIGHTING & TRACTION CO. (LTD.) (81,440).—Reg. July 1, capital £2,000 in 1,990 ordinary shares of £1 each and 200 deferred shares of 1s. each, to carry on at Kingsbridge, Salcombe and elsewhere in Devonshire the business of an electric lighting and power company, and to construct, fix and maintain generating stations, cables, wires, lines, accumulators, lamps, works, &c. First directors J. R. Parkin, D. T. Gregson, F. W. Sturton, C. H. Brown, A. Wright, A. G. Field and O. B. Thomas. Reg. office, 25, Victoria-street, London, S.W.

PADDINGTON ELECTRIC SUPPLY CO. (LTD.) (81,426.)—Reg. June 29, capital £1,000 in £1 shares, to carry on the business of electrical,

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mechanical and chemical engineers, electricians, contractors, suppliers of light, heat, sound and power by electricity, manufacturers of electrical apparatus, &c. The subscribers are E. Boulnois, M.P., W. Hayes Fisher, M.P., E. J. A. Balfour, Dr. W. Leaf, Capt. E. J. Bax, M. R. Pryor and F. J. Walker. Reg. office, 19, Carnaby-street, Golden-square, London, W.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26⅛d. per oz. (July 7). Consols 89⅞—89⅞ for money, 89⅞—90 for account; 2½ per cent. annuities 89½—89⅝ (July 7). Consols Pay Day, Aug. 4; Stocks and Shares Continuation Days, July 12 and 26; Ticket Days, July 13 and 27; Pay Days, July 14 and 28; Mining Share Carry-over Days, July 11 and 25.

BLACKHEATH & GREENWICH DISTRICT ELECTRIC LIGHT CO. (LTD.)—The directors are offering to the share and debenture holders a further £30,000 4½ per cent. first mortgage debenture stock at par and a further 30,000 7 per cent. cumulative preference shares of £1 at 23s. to meet the instalments payable under agreements for the purchase by the company of the undertaking of the Crystal Palace District Electric Supply Co. (Ltd.)

COMPAGNIE GENERALE DE TRACTION (PARIS).—The loss on the past year's working is stated to be £157,760, the total deficit to date being £295,200.

DUBLIN UNITED TRAMWAYS CO. (LTD.)—Subject to audit, the directors recommend payment of the dividend for the half-year ended June 30 on the 6 per cent. preference and at the rate of 6 per cent. on the ordinary shares, after setting aside £2,000 to reserve and appropriating £3,000 towards cost of electric welding the Dalkey line, carrying forward £4,015. 19s. 2d.

ELECTRIC SUPPLY CORP. (LTD.)—On another page will be found particulars of the offer for subscription of £46,600 shares of £5 each at par in the Electric Supply Corp. (Ltd.) which has been formed with a capital of £250,000 (in 50,000 shares of £5 each). The present issue represents £233,000 of the above capital. Payments have to be made 10s. per share on application, 10s. on allotment and future calls of not more than £1 per share at not less intervals than two months. The company acquires provisional orders for the supply of electric current for lighting and power in 18 towns in England and Scotland, and the entire capital of £250,000 in ordinary shares is to be applied, it is stated, to meet the actual cost of plant and machinery and preliminary expenses, no promotion moneys being paid. An advantageous agreement has been entered into with Messrs. Crompton & Co., who have contracted to carry out the required works at a profit of 15 per cent. on prime cost, and it is estimated that the company will therefore start business in each town where powers have been obtained with the minimum expenditure on capital account. The centralisation of the administrative and engineering departments is held to be a further guarantee that working costs will be kept at a minimum. There are no preference shares to come before the ordinary shares now issued. The Chelmsford Electric Lighting Co. (Ltd.) has been acquired by the new company as a going concern. It will be seen from the particulars published elsewhere that a number of towns have been selected where the operations of the company will be first put into execution. The list of subscriptions opens on Tuesday next, 12th inst., and will close on Friday, 15th inst. Copies of the full prospectus can be obtained of the secretary, Mr. Francis R. Reeves, at the offices of the company, Salisbury House, London Wall, London, E.C., and from the bankers, Messrs. Barclay & Co., 54, Lombard-street, London, E.C.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The directors recommend payment of a bonus of £6 per share on 19th inst. to holders of ordinary shares out of profits on capital account made by the sale of the company's Marylebone undertaking to the Marylebone Borough Council. At an extraordinary general meeting of the company on the same date the chairman will explain the views of the board as to dealing with the balance of the purchase-money.

NATIONAL TELEPHONE CO. (LTD.)—The directors resolved yesterday (Thursday), subject to audit, to recommend the following dividends for the half-year ended June 30, after payment of the preference dividends, at rate of 6 per cent. per annum on the preferred stock, at rate of 5 per cent. per annum on the deferred stock (less tax in all cases), £100,000 being carried to reserve and about £9,000 forward.

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—An interim dividend at the rate of 3 per cent. per annum has been declared.

POTCHEFSTROOM (TRANSVAAL) ELECTRIC LIGHT & POWER CO.—The capital of this company is to be increased from £6,000 to £12,000.

RAND CENTRAL ELECTRIC WORKS (LTD.)—The result of working for the month of June shows 949,835 kw.-hours generated, yielding a gross revenue of £8,800. For the corresponding month last year the result was 675,241 kw.-hours and £6,136 gross revenue.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The directors have declared an interim dividend on the 7 per cent. preference shares and on the ordinary shares at the rate of 10 per cent. per annum for the half-year ended June 30. The share transfer books will be closed from 16th to 30th inst. inclusive.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed July 20 a special setting day in 6,135 £1 fully-paid ordinary and 33,000 £1 fully-paid vendors' ordinary shares of the *Rhodes Electrical Mfg. Co. (Ltd.)* The committee have been asked to appoint special settling days in a further issue of 25,000 £1 fully paid shares of *Marconi's Wireless Telegraph Co. (Ltd.)*, and a further issue of £25,000 £10 fully paid 5 per cent. cumulative preference shares of the *London United Tramways (1901) (Ltd.)*, and to allow the latter to be quoted.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The transfer books will be closed from 4th to 12th inst. inclusive, preparatory to the payment of the interim dividend of 12s. per share.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	July 2	1,447	+ 60	5	7,463	+ 1,217
Airdrie	June 24	506	...	20	3,862	...
Ayr Corporation	July 2	867	+ 19	7	2,945	- 7
Barnsley	June 24	285	+ 39	25	4,164	- 246
Barrow	,, 24	156	...	20	3,154	...
Bath Electric Trams, Ltd.	,, 29	678	...	26	15,060	...
Bexley District Council	,, 20	165	...	38	6,821	...
Birkenhead	...	...	...	...	...	...
Birmingham Corporation	...	...	...	...	...	...
Birmingham Tramways Co.	July 2	5,855	+ 471	26	139,022	+ 8,555
Blackburn Corporation	,, 1	990	+ 90	14	13,870	+ 989
Blackpool Corporation	June 30	966	+ 19	13	11,400	+ 548
Blackpool and Fleetwood	July 4	792	- 106	26	9,992	- 688
Blackp'l, St. Anne's & Lytham	June 30	558	+ 95	25	8,763	+ 5,740
Bolton Corporation	July 3	1,928	+ 2	14	25,722	- 185
Bournemouth Corporation	June 29	1,014	+ 44	‡13	14,2.6	+ 8 0
Bradford Corporation	July 2	4,694	+ 493	13	60,995	+ 10,216
Brighton Corporation	,, 3	1,187	+ 208	13	12,666	+ 260
Brisbane Tramways	May 11	2,422	+ 190	20	45,879	+ 184
	,, 18	2,507	- 76			
Bristol Trams & Carriage	July 1	5,885	+ 9	6	32,224	- 1,882
Buenos Ayres & Belgrano	June 5	3,447	+ 211	7	23,649	+ 465
Burnley Corporation	July 2	1,113	+ 318	14	14,668	+ 3,681
Burton Corporation	,, 3	375	...	¶13	4,614	...
Calcutta Tramways Co.	,, 2	₹33,891	+₹3,048	1	₹33,891	+ ₹3,008
Camborne-Redruth	,, 4	144	+ 30	9	1,054	- 71
Cardiff Corporation	,, 2	2,179	+ 53	13	27,433	+ 1,038
Carlisle Tramways Co.	,, 2	317	+ 48	26	5,019	+ 316
Central London Railway	,, 2	6,476	- 312	26	178,218	- 2,506
Chatham & Dist. Lt. Rys.	June 30	(33	- 76	16	14,682	+ 1,989
City & South London Rly.	July 3	2,511	+ 56	1	2,511	+ 56
Cork Electric Trams Co.	June 30	551	- 76	26	11,382	- 910
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 24	682	+ 178	25	12,650	+ 2,030
Dover Corporation	July 2	284	+ 20	14	2,948	- 139
Dublin & Lucan Railway	June 30	250	...	26	2,973	+ 293
Dublin Southern District	July 1	1,193	+ 133	26	123,010	+ 8,156
Dublin United	,, 1	4,429	+ 593			
Dudley—Stourbridge	June 24	888	- 8	25	10,417	+ 719
Dundee Corporation	,, 29	834	- 27	...	...	...
East Ham Council	July 2	757	- 16	13	10,259	+ 972
Gateshead & Dist. Trams	June 21	1,154	+ 31	25	21,289	+ 1,059
Glasgow Corporation	July 2	15,852	+ 1,215	†5	69,659	- 261
Glossop	,, 2	101	...	27	2,477	...
Gravesend—Northfleet	June 24	293	+ 19	25	6,014	+ 724
Gt. Northern & City Rly.	...	...	...	...	...	...
Greenock & Port Glasgow	,, 21	664	- 10	25	18, 70	+ 631
Halifax Corporation	,, 22	1,469	+ 42	13	19,612	+ 1,147
	,, 29	1,745	+ 82			
Hartlepool Tramways	,, 24	841	+ 82	25	6,811	+ 675
Huddersfield	...	...	...	...	...	...
Hull Corporation	July 2	2,240	+ 316	13	23,418	+ 3,276
Ilford District Council	,, 2	511	- 61	14	6,609	+ 522
Ilkeston Corporation	June 29	153	- 67	...	...	...
Ipswich Corporation	July 2	588	...	13	6,567	...
Isle of Thanet Co.	,, 2	990	- 108	...	...	...
Kidderminster & District	June 24	152	+ 8	25	2,863	- 120
Kirkcaldy Corporation	,, 29	223	- 48	23	5,614	...
Lanarkshire Trams Co.	,, 30	657	...	26	15 030	...
Leeds Corporation	July 2	6,278	+ 237	15	81,677	+ 4,597
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	June 25	10,674	- 100	24	258,912	+ 5,585
Liverpool Overhead Rly.	July 3	1,639	+ 17	27	44,100	+ 60
*London County Council	...	...	...	...	...	...
Lowestoft	,, 2	214	...	¶49	9,611	...
Manchester Corporation	,, 2	12,918	+ 242	13	153,819	+ 3,702
Mersey Railway	,, 2	2,033	+ 720	26	89,536	+ 8,831
Merthyr	June 24	218	+ 5	25	5,004	+ 180
Middleton	,, 24	370	- 38	25	7,691	+ 121
Nelson Corporation	July 2	125	+ 50	14	1,612	+ 703
Newcastle-on-Tyne Corp.	,, 2	3,421	+ 178	26	93,761	+ 11,470
Newport (Mon.)	,, 2	524	+ 52	13	6,790	+ 1,628
Oldham, Ashton & Hyde	June 24	556	- 56	†5	13,330	- 749
Oldham Corporation	,, 19	1 090	...	16	18,213	...
	,, 26	1,137				
Perth (W. A.) Elec. Trams.	July 1	1,355	+ 201	26	31,891	+ 4,644
Peterborough	June 24	161	+ 2	25	3, 89	- 157
Poole and District	,, 24	321	- 3	25	6,244	- 2
Portsmouth Corporation	July 2	2,220	+ 87	¶13	23,978	+ 2,257
Potteries	June 24	1,669	+ 134	25	41,996	+ 3,436
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 24	187	- 2	25	2,180	- 2
Salford Corporation	July 4	4,197	+ 197	14	55 824	+ 4,695
Sheerness	June 22	82	...	25	1,820	- 870
Sheffield Corporation	July 3	4,788	- 9	§14	66,561	+ 1,908
Southampton Corporation	...	...	...	...	...	...
Southend Corporation	June 29	427	+ 21	13	4,713	+ 320
Southport Tramways	,, 24	835	+ 12	25	7,407	+ 388
S. Staffordshire Trams.	,, 24	723	- 2.7	25	19,427	- 1,169
Stockport Corporation	July 1	810	+ 215	13	7,779	+ 5,299
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	June 24	588	- 15	25	12,713	+ 801
Taunton Trams	,, 24	51	- 5	25	1,295	- 93
Tynemouth and District	,, 24	531	- 25	25	6,495	- 817
Tyneside Trams Co.	,, 22	1,180	+ 616	26	9,502	+ 717
	,, 29	627	+ 171			
Wallasey District Council	July 2	843	+ 31	§13	9,820	+ 446
Walsall	...	...	...	...	...	...
Warrington Corporation	June 30	885	- 5	13	4,188	+ 78
West Ham Corporation	,, 30	1,107	...	18	18,228	...
Weston-super-Mare	,, 22	167	+ 30	25	1,611	- 7
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 24	418	+ 19	25	9,352	- 203
Worcester	,, 24	842	+ 147	20	5 825	+ 2,450
Wrexham	,, 24	108	- 32	25	2,788	- 812
Yorkshire Woollen District	,, 24	642	+ 271	25	14,342	+ 6,223

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 8 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 9 days.

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE	LAST DIVIDEND	NAME.	Price Wed., July 6	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE.	BUSINESS, WEEK TO JULY 6. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	5 —5¼	4 15 3	April, Oct	5 7/32	5 1/8
St.	6%	† Do. Permanent 6% Deb. Stock	135 —140	4 5 8	..	137 5/8	135
St.	5%	†Auckland Elec. Trams 5% Deb. (red.)	98 —100	5 0 0	..	99 1/2	98 1/2
10	6%	Barcelona Tramways Ord.	7½—8½	3 10 8	..	8 3/16	..
10	5/0	† Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	93 —98	4 13 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 —100	5 2 0	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	1/16—1/8	..	..	..	..
1	..	Do. 5% Cum. Pref.	1/16—1	..	..	1/16	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4½	5 17 8	..	4	..
St.	4½%	† Do. 4½ per Cent. Deb. Prov. Certs.	96 —101	4 9 3	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	18½—19½	4 2 1	Feb, Aug	..	..
10	4%	† Do. Cum. Pref. (fully paid)	10 —10½	3 16 2	..	..	..
St.	4%	† Do. 4 per Cent. Debs.	106 —108	3 15 3½	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100 —103	5 16 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	99 —102	4 18 6	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10¾	4 12 10	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103¾—105¾	4 6 2	..	104½	104
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	9¼—9¾	8 4 2	..	9 5/16	9¼
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—11	5 9 1	Feb, Aug	10 15/16	10 25/32
St.	5/0	Do. 5 per Cent. Perpetual Debs	115 —118	4 5 9	..	117½	116 3/4
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	95 —98	..	..	96 3/4	..
5	3/0	Buenos Ayres and Belgrano Ord.	2¾—3¼	4 16 0	..	3 5/16	3
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼—5¾	5 4 4	..	5 1/16	..
5	3/0	Do. "B"	5 —5¼	5 9 1	..	..	..
St.	5%	† Do. 5 per Cent. Debs.	105 —108	4 12 8	..	..	..
St.	5%	† Do. 5% 2nd Deb. Stock Prov. Certs.	101 —104	4 16 6	..	101½	..
St.	5%	†Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	94 —99	5 1 0	..	..	..
5	3/6	Calcutta Tramways	7 —7¼	4 0 0	..	7 1/16	..
100	4½%	† Do. 4½% 1st Deb. Stock (red.)	105 —108	4 3 3	..	107	105
1	1/0	Cape Electric Tramways Shares	1⅞—2⅛	8 0 0	..	2 1/16	..
St.	4%	Central London Ordinary Stock	90 —93	4 6 0	June, Dec	92½	92
St.	4%	Do. 4 per Cent. Pref. Stock	102 —105	3 17 3	..	104	..
St.	4%	Do. Deferred Stock	79 —82	4 17 7	..	..	..
100	4%	Do. 4 per Cent. Debs.	113 —116	3 10 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2%	City and South London Rly. Con. Ord.	47 —49	4 16 11	Feb, Aug	48¼	47¼
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —126	4 0 0	Feb, Aug	..	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 —109	3 13 5	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 10	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8¾	Gt. Northern & City Rly. Prf. Ord. (4%)	4 —5	..	..	4¼	4
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	18 —19	5 5 3	Mar, Sept	..	..
10	6%	‡†Do. 6 per Cent. Pref.	13¾—14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡†Do. 4½ per Cent. Debs.	107 —109	4 2 8	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	88 —91	4 7 11	..	..	..
10	1½%	Liverpool Overhead Railway Ord	3¾ —4	3 8 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	98½—100½	3 19 6	Jan, July	..	..
10	5/0	†London United Trams. 5% Cum. Pref.	10¾—11½	4 8 10	..	10 3/4	..
St.	4%	† Do. 4% 1st Mort. Deb. Stock	102 —104	3 16 11	..	1 3	102 3/8
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	3/4—1	..	..	1/8	..
1	0/6	Do. 5% Cum. Pref.	3/4—1	5 0 0	..	7/8	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 5 0	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 —2	..	May	..	..
St.	5%	†Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 —102	4 18 1	..	102	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	9½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	103½	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	89 —92	3 7 11	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*†African Direct Tel. 4% Mrt. Deb. (red.)	57 —101	3 19 2	Jan, July	..	..
10	..	Amazon Telegraph	2¼—3½	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	12/6	Anglo-American	46 —49	5 18 0	F,My,Ag,N	..	..
St.	25/0	Do. Preferred	91 —93	6 3 6	F,My,Ag,N	92 3/8	91 1/2
St.	2/0	Do. Deferred	6½—7	1 8 7	F,My Ag,N	6¾	6⅝
100	$2	†Commercial Cable Capital Stock	170 —190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	93 —95	4 2 6	Jn Ap,Jy,O	..	..
10	5/0	Cuba Submarine Ord.	6½—7½	8 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	† Do. 4½ per Cent. Deb.	98¾—101¾	4 9 2	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10½	6 4 0	Ja,Ap,Jy,O	..	..
100	4½%	†Direct West India Cable 4½% Rg. Db. (rd.)	99 —101	4 9 2	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	126 —131	5 7 0	Ja,Ap,Jy,O	130	128½
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —90	3 17 9	Ja Ap,Jy,O	89½	87½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 6	May, Nov	106½	105
10	6/6	Eastern Extension	11¾—12½	5 14 0	Ja,Ap,Jy,O	12 7/16	12 1/16
St.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 15 0	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	99 —102	3 19 0	Feb, Aug	..	..
20	4%	Do. 4% Mauritius Sub. Debs. (red.)	99¾—102¾	3 18 9	May, Nov	100	..
10	5.0	Gt. Nrthn. (of Copenhagen) exc coupon 61	2 1/2—2 5/8	5 13 2	Jan, July	..	..
100	4½%	†Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 —101	4 9 2	June, Dec	..	..
25	37/6	Indo-European	42 —45	5 11 2	May, Nov	..	..
100	4%	†Pacific&Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..
10	6/0	†West African Telegraph Shares	6 —7	5 14 3	..	..	..
2½	..	West Coast of America	1/16—3/16	..	..	..	..
100	4%	† Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	3/8—½	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½—6¾	8 17 9	May, Nov	6¾	6¾
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	..	..
100	5%	*†Do. 5 per Cent. Debs.	99 —102	4 18 1	Jan, July	..	..
10	3/C	†Western Telegraph	12½—13	5 7 8	Mr,Jn,O,D	12¾	12 5/8
100	5%	*†Do. 5% Debs. (2nd Series, 1906)	101 —104	4 16 3	June, Dec	..	..
St.	4%	† Do. 4% Deb. Stock (red.)	99 —102	3 18 5	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	†Elec. & Gen. Investment 6% Cum. Pref.	4¾—5½	5 14 4	..	5	..
10	5/0	Globe Telegraph and Trust	8¾—9¼	5 19 0	Ja Ap Jy O	9	8 3/4
10	3/0	Do. 6 per Cent. Pref.	13 —13½	4 8 11	Ja Ap,Jy,O	13⅜	13⅛
8	4/0	Reuter's	6¼—7¼	5 6 8	April, Oct	..	..

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THE ELECTRICIAN:

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NOTES.

THERE are a few points of more than ordinary interest in the speech delivered by the chairman of the Electric Construction Co. at the annual meeting yesterday. Along with others, the Company has felt the effects of the wave of depression which has been sweeping over the country during the past two years, and only just now show signs of receding. Unfortunately, Mr. BARCLAY is not by any means optimistic, and calls attention to the fact that the limit has been reached so far as economies at the works are concerned; but he hopes to improve matters by increasing the output of the works. His statement regarding the fall in prices of electrical machinery is startling. It seems that, in certain classes of electrical machinery, prices are 40 to 50 per cent. lower than they were in 1900, and it is not likely that the cost of production has been reduced in the same ratio. This information is certainly interesting, and it seems a pity that the chairman did not give a few details as to what the classes are and to what he attributes this extraordinary fall. Probably it is due to the same cause which has reduced the Company's dividend—viz., cut-throat competition.

THE Chairman of the Electrical Power Storage Co., on the other hand, had a more cheerful message for his shareholders. Substantial sums have been put to reserve, contingency and depreciation funds, and a dividend of 6 per cent. is to be paid once more. Competition is admittedly keen, but no anxiety is expressed regarding the possibility of meeting it, in spite of the marked cutting of prices, of which all manufacturers are complaining. Mr. COURTENAY is evidently sceptical regarding the possibilities of the Edison battery, and calls attention to the fact that no inventor has a monopoly of alkaline batteries. Indeed, the E.P.S. Co. is itself carrying out experiments in this direction. It is true that very little has been heard of the Edison battery lately, but it is, none the less, to be hoped that such a beautiful example of engineering skill and ingenuity will not be relegated to the already long list of commercial failures. The E.P.S. Co. is to be congratulated on having emerged from a year of such difficulties with so good a report and balance-sheet.

THE recently-published specification of a new apparatus used by Mr. MARCONI in syntonic wireless telegraphy is reprinted on another page. The purposes of the new arrangement of wires and condensers are stated to be to assist in syntonic working and to eliminate the effects of such disturbances as arise from natural atmospheric discharges. It will be remembered that the hopes which accompanied the youth of Mr. MARCONI'S jigger were similar in character, though the real strength of that elegant instrument developed in quite another direction. The idea underlying the design of the jigger and of the new unnamed apparatus is that the sensitive recording part of the receiver shall be coupled to the air-wire only by electromagnetic means, or, as we may say, etherially. The hope of the inventor is, of course, that any unwelcome vibrations, accidentally, or otherwise, present on the air-wire, may not cross easily over the dielectric bridge provided for the rightful guest. This trust is not wholly misplaced if the secondary circuit possesses a natural period identical with that of the signal-bearing radiation; for then the authorised oscillations can get on the further side a better footing, so to speak, than can the intruders. But by far the greatest merit of the jigger, regarded as a first improvement on the plain air-wire, lay in its provision of a considerable P.D. at the exact place it was wanted—namely, the coherer electrodes. The same object was accomplished just as neatly by SLABY and ARCO with their "extension-wire," which is connected with the air-wire, not etherially, but by common solder.

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MR. MARCONI'S new arrangement supplants the jigger where the "detector magneticum" replaces the coherer; for the "detector magneticum" must be applied at a potential node, the coherer at a potential loop. But while the jigger exalts the voltage of the air-wire oscillations, and thus enhances the sensitiveness of the whole receiver, the new arrangement, if we can judge fairly from the drawings, produces no such augmentation of acuteness. Its virtues will, therefore, lie in its powers of sorting the useful oscillations from among the undesirables. This sifting process, it will be seen from one of the figures on p. 511, has been carried to great lengths by Mr. MARCONI. Even in the simplest form a double sifting occurs. First, the oscillations on the air-wire have to excite others on a connected "extension wire" of the same equivalent length as the air-wire; and, second, these latter oscillations produce in an isolated open circuit of twice the equivalent length of the air-wire other oscillations which operate directly on the iron of the detector. Doubtless at each step the vibrations of the selected frequency will be freed to some extent from their undesired associates, but it seems more certain that at each step, in the present arrangement, those vibrations will themselves suffer attenuation.

THE success of the steam turbine has had the beneficent effect of stimulating manufacturers of reciprocating engines to apply every known artifice indicated by modern science and up-to-date engineering to the design of their engines. That they have succeeded in reducing the steam consumption to a very low figure is shown by the curves printed elsewhere in this issue, relating to steam consumption tests on a 210 H.P. Willans engine working with highly superheated steam. It has been long known, of course, that the use of superheat reduces the steam consumption considerably, but we are not far wrong in saying that the results obtained by Messrs. Willans and Robinson have hardly, if ever, been excelled, even by steam turbines of very much larger size than the machine referred to. Ten pounds of steam per brake horse-power hour with a 210 H.P. engine is, indeed, a splendid achievement of which the engine makers may well feel proud. The test curves of the 210 H.P. engine referred to are also remarkable in showing how small is the increase in steam consumption with decreasing loads when highest superheat is employed.

WE would call the attention of tramway managers to the judgment in the Norwich tramway case, recorded elsewhere in this issue. The exact liability of a tramway company with regard to the maintenance of the roadway adjoining the track has never been clearly defined, and Mr. Justice PHILLIMORE'S decision upon this point will be read with interest. As a stay of execution has been granted, we may look forward to a still more authoritative pronouncement in the Appeal Court with regard to the question at issue.

MR. F. O. HUNT deals with the calculation and design of motor-starting switches and resistances in a somewhat theoretical article in another part of this issue, and his conclusions have been put to a practical test in a neat manner by Mr. J. K. CATTERSON-SMITH. The oscillograph curves obtained by the latter gentleman are of considerable value, inasmuch as they point out that Mr. HUNT has greatly over-estimated the effect of self-induction of the armature with regard to the throttling of the starting current. It is pointed out by Mr. CATTERSON-SMITH himself, that the motor used in the tests had a "stiff" field, but since this is generally the case with present-day commercial motors, it appears most likely that in calculating the dimensions of starting resistances, no heed need be taken of the armature self-induction. Mr. HUNT'S suggestion to assist the ohmic resistance of certain starters by building the resistance coils with self-induction, met with little approval. In order to obtain an appreciable amount of self-induction the coils would have to be heavily iron-armoured, thus increasing the cost and weight of the apparatus. It can also be foreseen that both the ventilation and the insulation of the coils would be rendered more difficult than is the case in the present design.

IN an editorial note of October 2nd of last year we regretted the fact that, although much had been said and written on the theoretical side of self-exciting and compounded alternators on HEYLAND'S ingenious system, yet practically no actual curves and figures relating to their performance in practice were available. We are, therefore, glad to be able to publish to-day a series of working curves, obtained from tests on a 360kw. Heyland alternator as well as on an 8kw. experimental machine. The article, which is clearly written, points to an extension of the system, tending to increase still further its sphere of applicability. We refer to the proposal to compound the continuous-current exciter, so that the exciting current furnished by this dynamo to the field system of the alternator increases and decreases with the load on the system. Such exciters would need to be merely standard machines, but amply dimensioned in order to provide room on the poles for the auxiliary winding and also in order that the fields may be worked on the lower part of the characteristic. It would not be absolutely necessary, of course, to fix the auxiliary commutator on to the shaft, but it could be driven separately by a small synchronous motor, using very little power.

AS to the cost of these self-exciting and compounded alternators, including all their auxiliary apparatus, from information received in connection with alternators up to 750kw. in size, it would appear to be about equal to that of an ordinary type of alternator of equal capacity for direct coupling to a high-speed engine. This would, we are informed, apply to machines compounded for constant pressure from no load to full-load on a power-factor of, say, 0·8. Over-compounded alternators would be somewhat more expensive. Slow-speed compounded alternators, too, are not quite so advantageous with regard to cost when compared with the corresponding sizes of the ordinary alternator.

AS will be seen in our Parliamentary columns this week, the Light Railways Bill has now passed through all the stages of the House of Lords, and, as the measure is of a non-contentious character, very little doubt need exist that it will pass quickly through the Lower House and receive Royal Assent this session. The object of the Bill is to remedy the somewhat unsatisfactory state of things that has existed since the Light Railways Act of 1896 expired on December 31, 1901, although

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this Act has subsequently been continued as a temporary measure year by year. Under the new Bill the provisions of the Light Railway Act of 1896 are made permanent, and, in addition, it allows further elasticity in respect to light railway orders. For instance, if the Board of Trade finds itself unable for any reason to confirm an order, it may, if it thinks fit, submit the order to Parliament in the shape of a Confirmation Bill. This will have the effect of obviating the expense of proceeding by special Bill, which is now necessary if the Board of Trade refuses to confirm any order granted by the Light Railway Commissioners. This power is contained in sub-section 1 of clause 2. Under sub-section 2 of the same clause it is laid down that opponents may be heard before the Select Committee or Joint Committee to which the Bill may be referred, as is at present the case with private Bills. Sub-section 3 of clause 2 puts it upon the Board of Trade to submit a report to Parliament in such cases with respect to the order. The Bill is short but useful, and we can only hope that no difficulties will be placed in its way this year, as was the case last session.

Goldsmiths' Institute at New Cross.—It is announced that the offer of the Worshipful Company of Goldsmiths to provide, in connection with the recent gift of their New Cross Institute to the University of London, an additional sum of £5,000 for the purpose of carrying on classes of a polytechnic character during the coming session, has been gratefully accepted by the Senate of the University of London.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 18, 1902
Beissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Dakar—Konakry	May 13, 1904
Chio—Tenedos	June 21, 1904

Institution Visit to America.—A circular has been issued by the American Institute of Electrical Engineers relating to the arrangements which have been made for the reception and entertainment of electrical engineers attending the International Electrical Congress at St. Louis. Many of these particulars have already appeared in *The Electrician*. A special circular tour has been organised by the A.I.E.E., in the course of which a number of places of interest will be visited. The cost of a ticket for this tour will be £30. Tickets may be secured in advance from the secretary of the Institution, and early application should be made. All foreign electrical engineers who may visit the United States in connection with the International Electrical Congress are invited to take part in the circular tour, but it is expected that they will be properly accredited by the society of which they are members.

Stokes Memorial in Westminster Abbey.—On Thursday last week the Duke of Devonshire, Chancellor of the University of Cambridge, unveiled a memorial to the late Sir George Gabriel Stokes, which has been erected in the north aisle of the choir of Westminster Abbey. Preceding this ceremony was a meeting in the Jerusalem Chamber, which was attended by, amongst others, the Dean of Westminster (who presided), the Duke of Devonshire, Sir William Huggins, Lord Kelvin, Lord Rayleigh, Sir Arthur and Lady Stokes, Sir Arthur Rücker, Sir B. Samuelson, Sir J. Gorst, Sir Norman Lockyer, Sir William Crookes, Sir James Dewar and Professors J. A. Ewing, H. Lamb, J. Larmor and J. Perry. After an opening speech by the Dean of Westminster and eloquent speeches to the memory of the great dead by Sir William Huggins, Lord Kelvin, Lord Rayleigh and others, the Duke of Devonshire unveiled the memorial in the Abbey. The memorial is a bronze medallion, showing, in deep relief, an excellent portrait of the late Sir G. Stokes. It carries the following inscription:—"George Gabriel Stokes, 1819—1903."

Single-phase Traction in Austria.—According to the *Zeitschrift für Elektrotechnik*, the Stubaitalbahn, the first single-phase electric railway in Austria, is to be opened during the present month. The line in question is about 12½ miles long, and has several long gradients of 4·5 per cent. A narrow gauge—*i.e.*, 1 metre (3ft. 3⅜in.)—has been adopted. Each train is made up of one motor car, equipped with four 40 H.P. to 50 H.P. single-phase motors. and two trailers. The motor equipment is said to be powerful enough to run a train weighing 44 tons up the gradients mentioned at a speed of 15½ miles per hour. Electric energy at 10,000 volts is supplied from the "Sillwerke" power station, but the voltage is subsequently transformed down to 2,500 volts, at which pressure current is fed into the trolley wire. The whole installation, including the Sillwerke, which has at present a plant capacity of 5,000 H.P., has been carried out by the Austrian Union-Elektricitäts-Gesellschaft.

Tramway Running Powers at Newcastle.—The Newcastle Corporation has had under consideration the proposal made by Sir Edward Strachey's Committee in the House of Commons last week that an amicable arrangement should be come to with the Tyneside Tramways and Tramroads Co. in respect to reciprocal running powers. It is stated that certain proposals have been forwarded to the company to the effect that an interchange of traffic shall take place between the centre of Newcastle and the company's terminus at Wallsend on similar terms to those now operating at Liverpool. It is proposed that a number of the company's cars should run to the centre of Newcastle, the Corporation having these cars under their control and paying to the company a certain sum for the use thereof. On the other hand, it is also proposed by the Corporation that they should be allowed to run a certain number of cars to Wallsend, but that, as the distance between the Corporation's and the company's termini is so short, it is not thought that a change of conductors should take place. A meeting of the directors of the Tyneside Company and members of the Newcastle Tramways committee was to be held yesterday to discuss the proposal, which will afterwards be placed before a special meeting of the Corporation, in order that representatives of the Corporation may receive instructions as to what course to pursue before the Committee when it meets next Tuesday.

Engineering Societies' Visit to Germany.—On Wednesday a party of members of the Glasgow University Engineering Society and ladies, numbering over 50, and including the president of the Society, Mr. J. B. Henderson, left Glasgow for a 10 days' tour through a number of engineering works in Hamburg, Kiel, Berlin and Stettin. In Hamburg they are to be joined by 12 members of the University College (London) Engineering Society, accompanied by Prof. Cormack. This is the third joint visit of the two societies and the eighth of the Glasgow Society. Among the places and works to be visited are the following:—On Friday, July 15th, Messrs. Blohm and Voss and the docks and harbour of Hamburg; on Saturday, the Imperial shipbuilding yards and the Germania shipbuilding yards, both in Kiel; on Monday, the Technical High School of Charlottenburg and its laboratories in the morning, the afternoon being devoted to an inspection of the works of Messrs. Ludwig Loewe & Co., including their power station. On the following day visits are to be paid to the Allgemeine Elektricitäts-Gesellschaft and the Berliner Maschinenbau-Actien-Gesellschaft. As an alternative, the members may visit on this day the Stettiner Maschinenbau-Actien-Gesellschaft "Vulcan" in Stettin. On Wednesday, the programme includes visits to Messrs. Siemens & Halske, the Museum of Arms, the Royal Palace and the Royal Stables. Thursday is dedicated to general sight-seeing in the neighbourhood of Berlin. The morning of Friday is to be spent at Messrs. C. P. Goerz, Friedenau, and in the afternoon the company will leave for Hamburg, and from thence the same evening to Leith, arriving at the latter place on Sunday morning, July 24th.

Wireless Telegraphy and U.S. Navy.—We are informed that on June 28th important contracts were signed by Rear-Admiral Manney, of the United States Naval Bureau of Equipment, and Mr. Abraham White, president of the American De Forest

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Wireless Telegraph Co., for five of the largest wireless telegraph stations ever contracted for by any Goverment. The stations are to be situated at Guantanamo, Cuba, Porto Rica, Panama Canal coaling station, Key West, Dry Tortugas, Pensacola, and the distances involved vary from 350 to 800 miles. These contracts on the part of the United States navy are highly significant, as marking a new departure in the purpose of that department to establish and maintain long-distance telegraphic communication for commercial as well as military purposes. Not only will the stations afford a supplementary means of communication for the navy, but will enable war vessels to be in touch with the shore throughout the Gulf and Carribean waters. The most important line is that from Panama to Guantanamo, which is necessary on account of the Panama Canal operations, although the most difficult is from Cuba to Porto Rica, inasmuch as the mountainous island of Hayti lies directly between. This latter distance is 450 miles. The contract calls for the erection of masts and towers by the navy as well as the installation of the engines. The electrical equipment will be installed by the De Forest Company, who will work the stations for 30 days to the satisfaction of the navy department. It is estimated that nine months will be sufficient to put all stations into operation. The award of these contracts to the De Forest Company is the result of official tests of the system conducted during the early part of June by the wireless telegraph board of the navy.

The Junior Institution of Engineers.—A visit of this Institution was recently paid to the Chelsea generating station of the Underground Electric Railways Co. The general manager (Mr. J. R. Chapman) and the resident engineer (Mr. J. W. Towle) were present, and the visitors were enabled to make a complete examination of the work so far as it had advanced. The station will supply current for working the trains of the District Railway from Whitechapel to the various western and southern termini—Richmond, Wimbledon, Hounslow, Ealing, &c.; also the tube trains of the Baker Street and Waterloo Railway, the Great Northern, Piccadilly and Brompton Railway and the Charing Cross, Euston and Hampstead Railway. About 150 trains will constitute the initial equipment of these lines. The station is designed for 10 units of 5,500kw. each, and one unit of 2,500kw. Three-phase current at 33⅓ $\sim$ per second and 11,000 volts will be distributed to 23 sub-stations. The site comprises 3·67 acres, and has a water frontage of 1,100ft. The building is 453ft. 6in. long by 175ft. wide, with an office annexe 25ft. by 81ft. On this basis the square feet occupied per kilowatt, including the office building, is 1·36, and the cubic feet per kilowatt, measured from the ground level to the peak of the roofs, is 139. The steel frame of this building is entirely self-supporting, and contains 6,000 tons, while the foundations extend from 30ft. to 36ft. below the ground level, and the loading of the clay does not exceed 4 tons per square foot. Attention may be called to the group system which has been followed throughout in both the mechanical and electrical installation—*i.e.*, eight boilers are grouped to one turbo-generator; these boilers have their own feed pump, and the generator supplies its own section of 'bus bar. No attempt is made to cross-connect the steam piping of the different groups except at the east end of the building, where three groups are brought together in one small auxiliary header for supplying exciters, air compressors, house pump, &c.

Power Required for Electrically Lighting Railway Carriages.—An interesting note of some experiments conducted by Mr. Staby, member of the Direction of the Bavarian Royal Palatine railways, with a view to ascertaining the amount of power required to generate the electric current to light railway carriages by Stone & Co.'s well-known system, was recently published in the *Railway Engineer*. In order to measure the energy consumed trials were made with a third-class carriage fitted on this system, and hauled by an accumulator car of standard guage, the amount of current being measured by specially calibrated instruments, interposed between the accumulator and the motors. The section of Lndwigshafen–Schifferstadt was selected for the trial runs; it is 7·5 miles long, quite straight and practically level. In order to eliminate any influence of the weather, the trial runs were made on days when there was no wind, at intervals of one hour, and the instruments were read when passing the railway kilometre posts. The lighting dynamo of the hauled carriage was adjusted by tightening the belt, so that its output at 24·9 miles per hour amounted to 35 amperes. The seven compartments and the two lavatories of the carriage contained 14 incandescent lamps of 12 normal c.p. and two of 8 normal c.p.; so that the total lighting was of 184 normal c.p., which, assuming the average normal candle-power to require 3·5 watts, required altogether 644 watts. The lamps, therefore, require 27 amperes at 24 volts, so that 8 amperes of the output of the dynamo were available for charging the batteries. The averages of the amounts of energy consumed on 18 trips under the two sets of conditions, running at a speed of 28 miles per hour, were:—When the dynamo and the incandescent lamps of the hauled carriage are in use, 40·866kw.; when the driving belt was taken off the dynamo of the hauled carriage, 39·300kw. The difference, therefore, was 1·566kw. Tests at higher speeds were conducted on a stationary testing set, and it was observed that at a train speed of about 56 miles per hour the energy required to operate the generator for the same number of lamps amounted to 2·46kw.

Opening of the Frome Electric Lighting System.—The electric generating station at Frome (Somerset) was put into operation on Friday, July 1st, and it is expected that that part of the scheme which is still unfinished will be rapidly completed, so that public lighting may be supplied on August 1st. A provisional order was obtained by the Urban District Council in 1901, and in January, 1903, the Local Government Board sanctioned a loan of £20,000. This was borrowed from the Prudential Assurance Co., the sum to be repayable by equal half-yearly instalments of principal and interest over a period of 25 years. On the recommendation of Mr. Medhurst, consulting engineer to the Council, it was decided to place the carrying out of the scheme in the hands of a private company, the Corporation advancing the necessary capital. The company was also to work the system at its own risk during 25 years, and in this time to refund the initial outlay of the Corporation. At the end of this period the entire installation was to pass into the Corporation's possession free of charge. Clauses were also drawn up which enabled the Corporation to take over the undertaking at earlier dates on agreed terms. Tenders were invited on this basis, and that of Messrs. Edmundson & Co., who agreed to carry out the scheme for £20,156, was accepted. Last November it was decided to extend the system of mains as originally intended, and also to buy a fresh site for the cooling tower. In order to carry out these plans, a new loan of £8,500 was sanctioned and borrowed. The buildings comprise a boiler house, engine room, accumulator house, offices, workshop, testing room and showroom for fittings. In the boiler house, which is 48ft. by 42ft., there are two B. & W. boilers, capable of evaporating together 8,400lb. of water per hour, and fitted with Meldrum's "Koker" stokers, the latter being operated by a 2 H.P. electric motor. There is room for another boiler, and one side of the boiler house is only of a temporary character. Forced draught is employed. The make-up feed water is drawn from tanks situated above the economiser chamber, and is passed through a Boby heater detartariser heated by the exhaust from the feed pumps. In this way the hardness of the Frome water is expected to be reduced from about 25deg. to about 2deg. The two feed pumps, by Messrs. J. P. Hall & Sons, have a capacity of 2,000 gallons per hour against a pressure of 160lb. Either can be connected to the cooling tanks, the feed tanks or the hot well. Adjoining the boiler house is the coal bunker, holding from 80 to 100 tons of coal. The engine room is 48ft. by 30ft., and is built on concrete piers, which had to be sunk some 20ft. Two Parsons steam turbines are installed, one for driving a 75kw. continuous-current dynamo at 4,000 revs. per min., while the other is directly coupled to a 150kw. dynamo running at 3,500 revs. per min. Current is generated at 480 volts and distributed on the three-wire system. All turbine bearings have forced lubrication. In the engine room is also a balancer-booster set. Two accumulator rooms, situated one above the other, contain a storage battery of 400 ampere-hours capacity, consisting of 260 cells of the D.P. Company's make.

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SELF-EXCITING AND COMPOUNDED ALTERNATORS.

[COMMUNICATED.]

Readers of *The Electrician* will remember the articles which appeared last year,* dealing with alternators excited and compounded on the Heyland principle, and the correspondence to which they gave rise in our columns. To those following the matter, the particulars given below, relative to recent machines of this class, will no doubt prove of interest.

The Heyland method of self-exciting and compounding three-phase alternators of the revolving field type does not necessitate any alteration to the standard design beyond replacing the exciter by a commutator of special construction (with three sets of brushes), and winding the magnet wheel with a number of interconnected parallel circuits, which are connected up to this commutator instead of to the usual slip rings. If the three sets of brushes are connected to the alternator terminals by means of a small pressure transformer, the machine becomes self-exciting, and if, in addition, they are connected into the armature winding (for instance, at the neutral point) with the help of a current transformer, the machine can be arranged to compound itself for constant terminal pressure at any load and power-factor, or to over-compound, if desired. Such machines are synchronous, and their performance differs in no respect from that of standard alternators, excepting that they have no pressure drop. Their method of operation is also precisely the same, except that no hand-regulation of the field circuit is required to keep the pressure constant, and that the alternators must be connected by an equalising conductor when in parallel, just as in the case of compounded continuous-current machines. The connections of two high-pressure three-phase generators operating in parallel are indicated in Fig. 1; each generator requires a three-pole equalising switch in addition to the usual main switch, while the equalising conductor is a three-core cable. If the neutral points of the generators are earthed, the equalising switches and cable are but a few volts above earth potential.

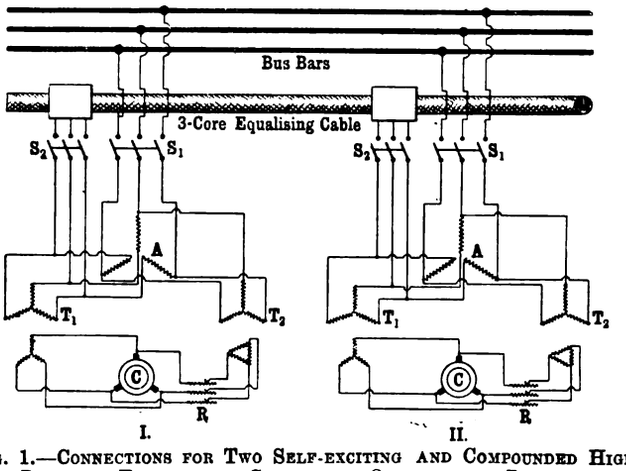

FIG. 1.—CONNECTIONS FOR TWO SELF-EXCITING AND COMPOUNDED HIGH-PRESSURE THREE-PHASE GENERATORS OPERATING IN PARALLEL.

A. Armature Winding of Generator.
C. Commutator for the Field Winding.
R. Field Regulating Resistance.
S_1. Main Switch (3-pole).
S_2. Equalising Switch (3-pole).
T_1. Current Transformer for the Compounding.
T_2. Pressure Transformer for the Excitation

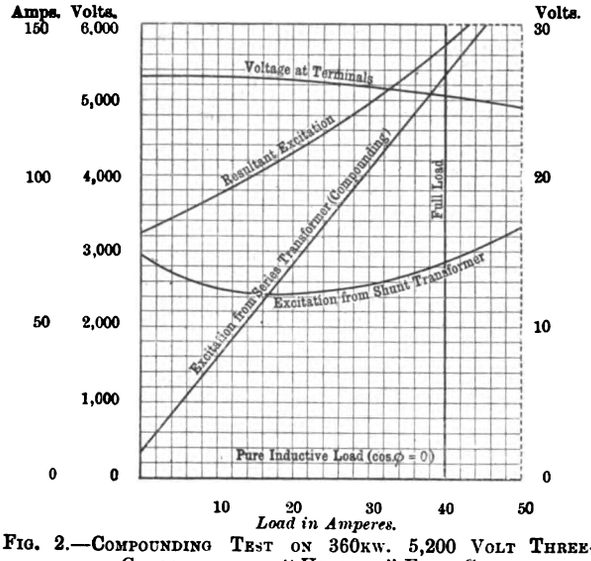

FIG. 2.—COMPOUNDING TEST ON 360KW. 5,200 VOLT THREE-PHASE GENERATOR WITH "HEYLAND" FIELD SYSTEM.

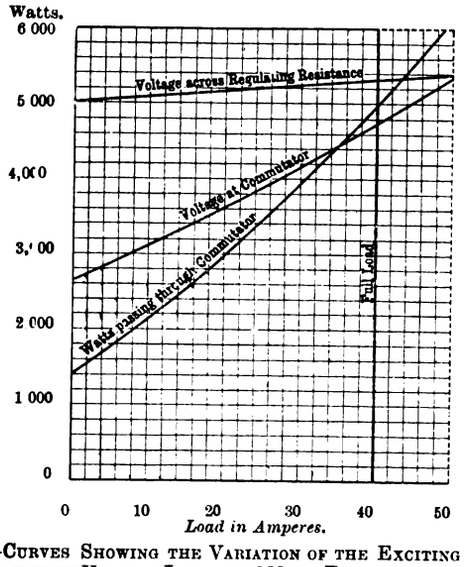

FIG. 3.—CURVES SHOWING THE VARIATION OF THE EXCITING PRESSURE AND ENERGY WITH VARYING LOAD FOR 360KW. THREE-PHASE GENERATOR.

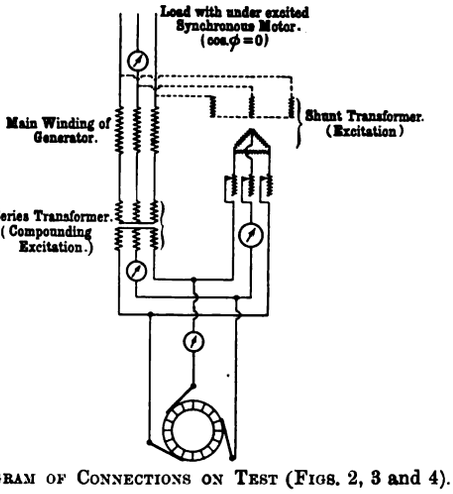
Load with under excited Synchronous Motor. (cos φ = 0)
Main Winding of Generator.
Shunt Transformer. (Excitation)
Series Transformer. (Compounding Excitation.)

DIAGRAM OF CONNECTIONS ON TEST (FIGS. 2, 3 and 4).

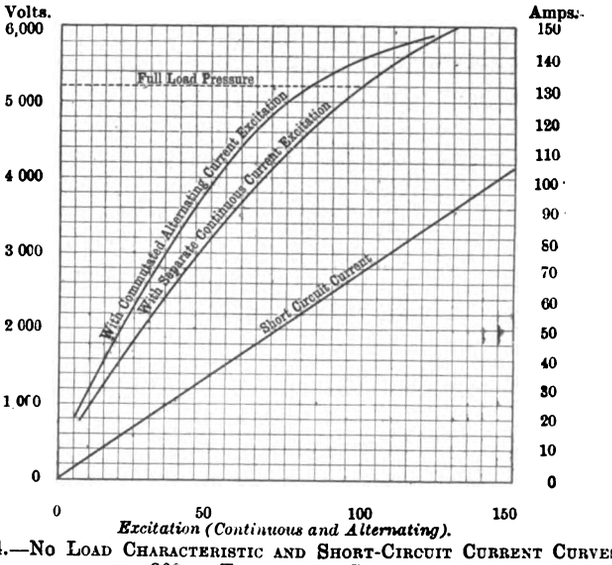

FIG. 4.—NO LOAD CHARACTERISTIC AND SHORT-CIRCUIT CURRENT CURVES FOR 360KW. THREE-PHASE GENERATOR.

* Eborall, Vol. LI., pp. 442 and 486; Heyland, Vol. LI., p. 969; Meyer, Vol. LI., pp. 803 and 1038. See also Correspondence in Vol. LI., pp. 902, 940, and Vol. LII., pp. 23 and 60.

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Some curves illustrating the performance of a recent 350kw. three-phase compounded generator, built by Kolben & Co., and designed to give a constant pressure of 5,200 volts at its terminals at all loads, and a power-factor of 0·8, are given in Figs. 2, 3 and 4. The compounding tests were carried out on loads of practically zero power-factor, and even under these conditions the full-load pressure drop is only 4·8 per cent. (Fig. 2), while the full load excitation watts (Fig. 3) are 5,000, or 1·92 per cent.

The curves of Figs. 2 and 3 are very instructive, as showing the manner in which the shunt and series excitations vary with the load and with a fixed adjustment of the shunt regulator, while the curves of Fig. 4 illustrate the better utilisation of the active material which is rendered possible in these compounded alternators. This latter figure gives (1) the short-circuit current curve of the generator, (2) the no-load characteristic with direct-current excitation, and (3) the no-load characteristic with the three-phase excitation, a special test having been made for the purpose of obtaining the direct-current characteristic. It will be seen that at a (direct-current) excitation corresponding to 5,200 volts at full load, the short-circuit

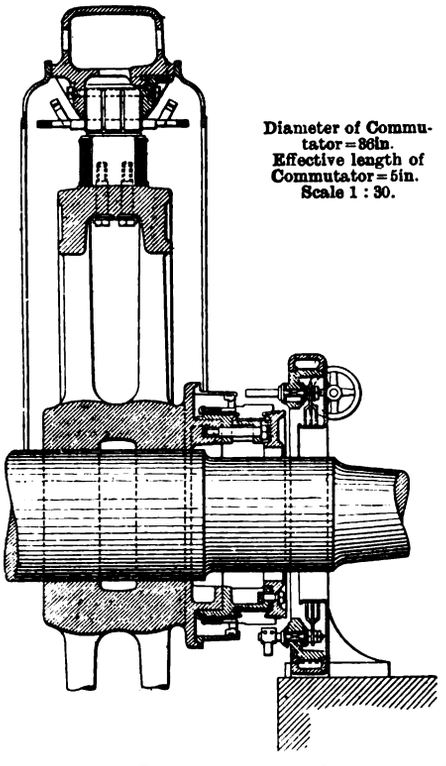

FIG. 5.—CROSS-SECTION OF SELF-EXCITING AND COMPOUNDED THREE-PHASE GENERATOR, 350KW. 3,000 VOLTS AT 125 REVS. PER MIN., AND 50 CYCLES.

current is only 69 amperes, or 1·7 times the full-load current. Notwithstanding this heavy armature reaction, the generator compounds exactly for constant terminal pressure at full load and 0·8 power-factor with considerably less than the moderate excitation loss given above.

This generator is provided partly with metallic and partly with carbon brushes. Under these conditions the commutation is excellent, the brushes remaining always in a fixed position; while, on the other hand, the machine excites itself as quickly and easily as an ordinary shunt dynamo. It was found, however, that the commutation is somewhat sensitive (to varying brush pressure, for instance), but this result is wholly due to the fact that the commutator dimensions were somewhat too small. This feature will be accordingly eliminated in future designs.

As illustrating the commutator dimensions necessary in the most unfavourable cases (slow-speed plant), reference to Fig. 5 may be made, showing a 350kw. three-phase generator at 125 revs. per min., now being built by the Electricité et Hydraulique Co., for operating an electrically-operated winding engine in the St. Elisabeth mine (Belgium). This generator will be set to work shortly, after which we hope to give particulars of its performance.

The curves given in Fig. 6 (*a* and *b*), relative to a small three-phase E. and H. machine installed in Messrs. Witting, Eborall & Co.'s London repairing shops, are of some interest, firstly, as showing the capabilities of the type with regard to over-compounding, and, secondly, as illustrating the performance when operating single-phase. This generator, being designed for operation at low pressure (140 volts), is provided with an auxiliary winding for the excitation, while the commutator is connected into the main armature winding at the neutral point—it constitutes the latter, in fact—for the compounding; thus no transformers are required, the sole accessory to the machine being a three-legged resistance in the exciting circuit, which, under ordinary circumstances, remains untouched. It is worthy of note, moreover, that, although the field system of this generator is laminated throughout (the field system being non-standard in this respect), it excites itself immediately the exciting circuit is closed.

From Fig. 6A it will be seen that when operating as a three-phase generator it compounds level on a full inductive load (41 amperes), and over-compounds 9 per cent. on full non-inductive load, both with a fixed adjustment of the regulator; these results could be reversed, if desired, by other winding proportions.* From Fig. 6B it will be seen that when operating as an 8kw. single-phase generator (one phase being disconnected, thus leaving three-phase excitation and single-phase compounding) the drop is but 2·75 per cent. on full inductive load (33 amperes), while with the same value of load current on a non-inductive load, the machine compounds practically level.

The only disadvantage that has been met with up to the present with these compounded generators is in connection with the low-pressure excitation. Considerations of commutation require that this pressure should not be more than about 30 volts, and this means that the leads between the

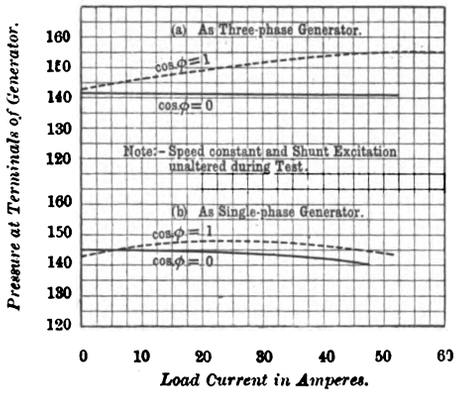

FIG. 6.—(A AND B) COMPOUNDING TESTS MADE ON E. AND H. GENERATOR RATED AT 10KW. THREE-PHASE OR 8KW. SINGLE-PHASE.

machines and the regulator on the switchboard become somewhat heavy and expensive, as well as the regulator itself. This does not apply to the compounding circuits, as the series transformer is mounted directly on the generator, in the position that would be otherwise taken up by the exciter, and consequently the length of these leads is reduced to a minimum. In any case, the disadvantage in question only makes itself felt to an appreciable extent with really large generators, and with these the increased cost of the switchboard connections is not a serious matter. But in order to get over it, Mr. Heyland has recently proposed an ingenious modification of his method of compounding, which may be briefly referred to here. Instead of making the generator self-exciting and compounding, as in the case of the machines referred to above, Mr. Heyland proposes to retain the direct-coupled exciter, and to compound the latter. That is to say, the exciter is provided with a supplementary inter-connected multiple-circuit winding on its field system, in addition to its ordinary shunt winding, the supplementary winding being supplied through a current

* See, for instance, the tests made on a 20kw. three-phase generator (*The Electrician*, Vol. LI., p. 490).

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transformer and commutator as before. The latter must rotate synchronously, and can either be placed on the shaft of the alternator (or direct-coupled exciter), or it can be independently driven by a small synchronous motor. The commutator is, of course, quite small, as it only has to carry the compounding currents, which form but a part of the total excitation of the alternator, and the same remark applies to the brush gear and auxiliary winding on the field system of the exciter. The exciter with its main (shunt) winding furnishes then the excitation necessary for the alternator at no load; as the load comes on, the field of the exciter is correspondingly increased, owing to the converted current, proportional to the load current, which circulates in its auxiliary field winding. If the dimensions of the exciter and alternator field systems are properly chosen, the compounding of the main unit, for any load, or power-factor, can be made exact.

With this arrangement, the commutator and brushes exchange their functions; the brushes are connected to the various circuits of the auxiliary winding on the exciter field magnets, while the compounding currents are led into the commutator with the help of slip-rings. Fig. 7 shows the actual connections for the compounding commutator of a six-pole exciter for a three-phase alternator; had the latter been a single-phase machine, but two slip-rings would be required.

Probably the most important application of this method of indirect compounding will consist in its application to existing installations. At comparatively small expense, the exciters

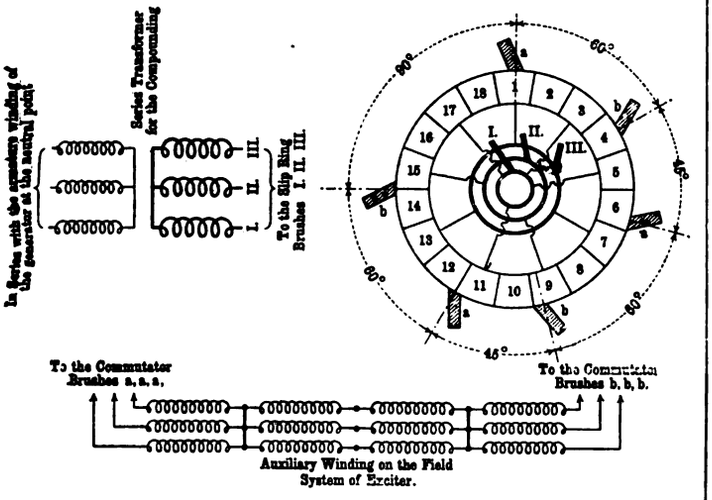

Series Transformer for the Compounding
To the Slip Ring Brushes I. II. III.
To the Commutator Brushes a, a, a.
To the Commutator Brushes b, b, b.
Auxiliary Winding on the Field System of Exciter.

FIG. 7.—ILLUSTRATING CONNECTIONS OF COMMUTATOR, &C., FOR EXCITERS COMPOUNDED (OR OVER-COMPOUNDED) BY THE HEYLAND METHOD.

at present used can be exchanged for compounded exciters, and the generators thus made to compound for constant pressure, irrespective of the value of the load, or of its power-factor. Particularly for the case of some single-phase stations, the adoption of compounded exciters will do away with the great difficulties at present experienced in dealing with motor loads.

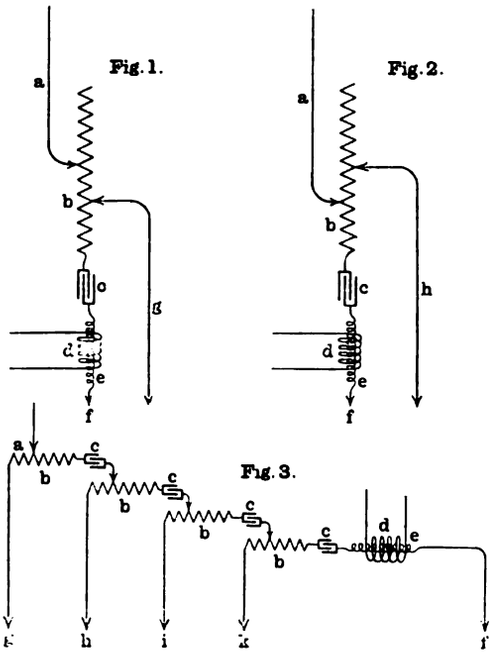
SYNTONIC WIRELESS TELEGRAPHY.

The following is the complete specification of patent No. 4,869 of 1904, granted to Mr. G. Marconi, and entitled "Improvements in Wireless Telegraphy."

This invention relates to improvements in telegraphy through the natural media, by means of electric waves, and especially to circuits forming part of a receiver, by which tuned or syntonic effects can be obtained, and the effects of natural disturbances, such as thunderstorms, upon the receiver are minimised. According to this present invention, an exposed aerial or elevated conductor is grounded by means of several connections of different inductance and capacity, instead of by one, as has heretofore been the usual practice. Referring to the accompanying diagrammatic drawings, Fig. 1 shows one form of apparatus useful in carrying out this invention; Fig. 2 shows a second form of apparatus, and Fig. 3 shows a third form. The most suitable form of this invention is shown in Fig. 1, in which *a* represents the receiving aerial adjustably connected to the inductance coil *b*, *c* a condenser connected to the inductance coil, *d* a suitable receiver or detector, such as my magnetic detector described in my specification No. 10,245 of 1902. One terminal, *e*, of the detector is grounded at *f*, and another ground connection, *g*, which is preferably flexible or adjustable, is joined to the inductance *b* at a certain point, the position of which is dependent upon the period of the electric wave radiated from the distant transmitting station.

This receiving system is syntonised or attuned to one particular frequency of electrical waves radiated from any one of a number of differently attuned distant electric radiators in the following manner:—The size of the condenser *c* is fixed, and the inductance *b* is varied by adjusting its connection with the aerial until signals are received on the responder or detector *d*. Then, by sliding the flexible or adjustable ground connection *g* along the inductance *b* or otherwise, a point is found at which, if a new ground connection is established, waves of the particular frequency radiated from a given distant transmitting station from which it is desired to receive signals will be received and detected to the exclusion of signals transmitted from other stations radiating waves of different frequencies. It has been discovered that this ground connection *g* may be made without weakening, but rather strengthening the signals in the detector *d*. The position of the ground connection *g* in the inductance *b* is dependent upon the length of the wave to be detected. It should be connected at or near the node or point of no potential of the electric wave which it is desired to read or detect, and the detector *d* will then be unresponsive to electrical waves of frequencies other than that for which the system has been adjusted as described. By means of this present invention, a very sharp selectivity of signals is obtained, and the troublesome effects of atmospheric electricity are largely or wholly eliminated.

In Fig. 2 is shown a modification of Fig. 1, the ground connection *g* of Fig. 1 being replaced by another at *h* of Fig. 2, the position of which on



the inductance *b* may be found similarly to the adjustment of *g* as hereinbefore described. Many extensions of the arrangements shown in Figs. 1 and 2 will readily suggest themselves. In Fig. 3 is shown one such extension comprising a series of similar syntonic circuits, each in tune with the wave transmitted, the system being grounded at the nodal points *g*, *h*, *i*, *k* and *f*, which are determined by the periodicity of the wave transmitted. This arrangement gives a particularly sharp attunement, and is especially adapted to eliminate the stray or extra signals caused by atmospheric disturbances. While three embodiments of this invention are shown and described, they are not desired to be understood as limiting the claims thereto. Obviously other modifications within the scope of this invention will readily suggest themselves to persons skilled in wireless telegraphy.

The following are the claims:—

1. At a receiving station employed in wireless telegraphy the combination with the usual connection of the aerial to a capacity such as the earth through an inductance, a capacity and the receiver, of one or more other connections substantially as and for the purposes described.

2. At a receiving station employed in wireless telegraphy, the combination with a receiver connected at one end to capacity, and at the other end to an aerial, inductance and condenser, and a second earth or capacity connection adjusted to make contact with the inductance at a point to be found by ascertaining the position of the node or point of no potential of the electrical waves which it is desired to detect in the aerial, substantially as and for the purposes described.

3. The method of selectively detecting electrical waves by means of a grounded aerial, receiver and inductance, which consists in adjusting a second earthed conductor to make contact with the inductance at a point found by ascertaining the position of the node or point of no potential of the electrical waves which it is desired to detect, substantially as and for the purposes described.

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HIGH-SPEED ELECTRIC RAILWAY EXPERIMENTS ON THE MARIENFELDE-ZOSSEN LINE.

BY ALEXANDER SIEMENS.

The following is an abstract of the discussion on the above Paper which took place before the Institution of Electrical Engineers on Thursday, May 26th. The Paper appeared in full in *The Electrician* for June 10th, 17th, 24th and July 8th :—

DISCUSSION.

Thursday, May 26th.

Prof. SILVANUS P. THOMPSON said that an auxiliary indicator had been mentioned, and he was curious to know what kind of an instrument it was. The preliminary formula for the wind pressure did not agree with the formula given further on. It looked as if it should read 0·007 instead of 0·07. It was stated that connecting certain instruments directly to the high-pressure line made them independent of frequency, but he would like to know exactly how that cryptic sentence was to be taken. Mention was made of cars with four motors—two on each axle—and of locomotives with only two motors. In the latter case it was said that the switch gear was so arranged that each motor could be switched in separately. He would like to know whether any experiments were included with the use of motors in cascade for getting acceleration at different rates. Lastly, he drew attention to the discrepancy between the experience on this line and upon the Central London Railway as to the trouble caused by the weight of the locomotive. Apparently the trouble arose in this case when the motors were not separated from the cars, whereas on the Central London Railway the trouble had been when locomotives were used.

Mr. S. Z. DE FERRANTI said the thing which the Paper brought out most strongly was the difference between the opportunities in Germany and those in England for developing new things of this kind. The information given in the Paper was of the highest possible interest, but the one great thing that it brought home was that the conversion of our existing railways in the manner adopted at Zossen was a matter of impossibility. Curves were most serious upon the best lines. Taking, for example, the L. & N.W. Railway between London and Manchester, upon which there was a constant service of about a mile a minute all the way, he said that he generally made two journeys a week between the two places, and spent most of his spare time checking the regularity of the speed. That line, which he considered to be the finest in the country, was quite out of the question for this extra high speed, although it was a thing to be ardently wished for, as even 3¼ hours in the train became very tedious when occurring often. It was only necessary to watch the shadows across the table caused by the side of the window to see the effect of the curves. There was not a straight run for any appreciable period of time. The shadows were continually shifting backwards and forwards, and at times it almost looked as if the train were going back to its starting point.

Mr. PATCHELL : Was it a luncheon car ?

Mr. FERRANTI, continuing, said the result was that our best lines could not benefit to the full extent in the matter of high speed. On the other hand, these experiments were of the greatest possible value because they would enable us to maintain a very high average speed. The principal economy in fast travelling was to go up hills as fast as down—in fact, to maintain a high uniform speed. He hoped the German experiments would be repeated in other countries which had not been so fortunate as to be able to originate them.

The Hon. C. A. PARSONS asked if any attempts had been made to reduce the wind resistance. The Paper mentioned that the air resistance was much the largest portion of the whole resistance. He thought that by suitably modifying the form of the car it could be reduced a great deal further than it had been. Perhaps, also, some method of boxing in the motors would also have a beneficial effect in this direction.

Mr. W. H. PATCHELL agreed with Mr. Ferranti that it was a sad thing to know that these results had been made in Germany, but, at the same time, we must be glad that, like many other good things, we have been able to import the results without a prohibitive tariff. He was over the Zossen line himself three months ago in an ordinary train—at least, he was told that it was the line upon which the experiments were made—and he remembered the jolting he got. If the engineers got these results on such a line it was very much to their credit, and if the line was made heavier and laid in accordance with the best English practice, the readings on the instruments would be more accurate, because the psychological effects were not solely due to the speed, but to the permanent way. The liquid resistances were very nice, but their huge size for a comparatively small motor made him wonder at their use on the cars. It struck him that if the cars were to be loaded up with these resistances they would be something like the Heilmann locomotive, and their commercial efficiency would not be very great. The diagram of air pressures was not quite clear; it did not show what the pressure was behind the car, and this was a matter which might furnish some valuable comparisons between the wind pressure at the front and rear. Steam locomotive engineers were not going to sit down under these experiments. They were now getting out a locomotive the cylinders and cranks of which were so arranged that there was no vertical couple unbalanced and no horizontal couple unbalanced, so that it would neither pound nor rock, and then they would see how far they could keep up with the electrical car.

Mr. W. M. MORDEY agreed that the experiments had been of very great use in showing how to run electric cars at very high speeds, but he also thought they showed how not to do it. However interesting the actual results might be as a solution of the problem of getting a lot of power into a car, it must have been evident to everyone—in fact, it seemed to have been evident to the minds of the syndicate—that the three-phase system was not the one that could be used practically, or was likely to be used for either high-speed or low-speed electric railway working. A look at the very ingenious and beautifully designed collector —of which there had to be three on each car—was alone sufficient to show that there was room for improvement. Personally, he had no interest in any system at all, but he had recently had an opportunity of visiting the experimental line at Oerlikon where the single-phase system was in use. [Mr. Mordey then explained the arrangement described and illustrated on p. 232 of our issue of May 27th.] He hoped the syndicate would follow up the excellent results obtained by attempting to simplify the electrical arrangements. When we had obtained the first essential to successful electric railway working—*i.e.*, simplicity - we should then be in a position to persuade railway directors to electrify their main line railways.

Mr. E. W. SMITH asked if the question of a slanting axis to the front of the car was ever discussed. The author had referred to a signal repeater which repeated the signals on the cars. He would like to know whether they were successful, as so many had been tried in England up to the present, but had failed to stand the abuse they got in ordinary use. The fact noticed that the iron sleepers did not wear so well as wooden ones was quite in accordance with the usual results.

Mr. ALEXANDER SIEMENS, in reply to the discussion, pointed out that he had stuck closely to the official reports of the syndicate, the last of which, as a matter of fact, he had only received two days previously. They had not tried using the motors in cascade. The indicator mentioned by Prof. Thompson was simply a pendulum which for acceleration flew out behind and for retardation flew out in front. He had not gone into the details of the instrument, because it had been fully described in the articles referred to. He did not think that the experiments generally proved that locomotives were better or worse than motor cars, as some speakers seemed to imagine. They had not been experimented with with that idea, but because locomotives happened to be a handy way of carrying the motors. As to the shape of the car, this had been carefully studied, and the syndicate came to the decision that a paraboloid would be best, but this was precluded owing to the inconvenience which it would have caused to the driver. Therefore the centre part of the paraboloid had been developed into a cylinder. He did not believe Mr. Patchell had travelled upon the high-speed line. Probably when he asked the question of the people there he spoke his best German and was misunderstood. The ordinary line from Dresden ran alongside the high-speed line, and that was most probably what Mr. Patchell travelled on. The high-speed line had been laid with a great deal of care, and last year had been put into the same state as the German first-class lines. But he did not say that it was equal to an English first-class main line. Mr. Mordey thought that the experiments had been carried out as they ought not to have been, and he then showed at once how not to discuss a Paper - *i.e.*, by bringing in something totally different. The Oerlikon system was very nice, and the Oerlikon collector was also very fine; but Mr. Mordey had absolutely overlooked one statement in the Paper—viz., "At first the conductors were carried by insulators, each fastened to a movable wooden arm, and the current was collected by a horizontal bar, turning round a horizontal pivot and pressed by a spring above against the conductor. When the speed of running was increased, these horizontal bars jumped at the insulators and caused so much sparking that this arrangement had to be abandoned." If the Oerlikon people ran a little bit faster they would find the same thing. It was not that such a simple idea had not occurred to other people, It had been tried and found impossible to run at high speeds with it. Then Mr. Mordey was very indignant that the three-phase system had been tried in Germany. But the object of the experiments was twofold. It was, first, to see how, at very high speeds, energy could be transmitted through a conductor along the line to the car, and after three years' experiments the collector shown had been developed out of that simple horizontal bar which Mr. Mordey had described very graphically. The second thing was to find out what sort of a permanent way was needed. The syndicate wished to settle the question whether an ordinary permanent way was good enough for high speeds. Now that they had settled these important points, they would devote their attention to the best way of utilising the electricity on the car. They could not do everything at once. The great loss in starting and stopping had been commented upon by the syndicate themselves, but as the system was to be used for long distances, where there would only be one acceleration, it was not of any very great consequence. He could not discuss Mr. Mordey's system in the short time at his disposal, and concluded by thanking his audience for the kind manner in which the Paper had been discussed.

Darwen Tramway Accident.—A curious occurrence took place on an electric tramcar belonging to the Darwen Corporation on Saturday evening. It appears that the cable running from the trolley wheel to the automatic switch became connected to the metal work of the car, and as the fault was on the trolley side of the safety switch, and the circuit breaker at the station did not come out, the arc thus caused was sustained for some time, and set fire to the insulation and woodwork in the vicinity. Owing to the number of people who were on the top of the car crowding down the staircases, neither the conductor nor driver was able to get at the trolley arm in order to take it off the overhead wire. We are informed that the only results were a few slight shocks and a small amount of damage to the car.

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THE NORTH-EASTERN RAILWAY AND CARVILLE POWER HOUSE.

(Continued from page 472.)

Perhaps the most striking feature of Carville power station, at any rate so far as actual appearance is concerned, is the 'bus bar arrangement. Stretching from one end to the other of the turbine room and occupying two complete galleries, there are six long concrete cells each containing a 'bus bar built up of strip copper and having a sectional area of 2½ sq. in. There is absolutely nothing inflammable, and it is impossible to touch or even see any live metal without removing one of the iron doors which are admirably shown in Fig. 7. This picture is the first that has ever been published which shows a switchboard of this type, and it illustrates very clearly the extent of the space occupied by the board. Opposite each of the square black patches, which represent iron doors, there is an insulator which performs the double duty of supporting the 'bus bar and forming a channel through which passes the copper connection from the isolating switch to the 'bus bar. In order to make a breakdown on the 'bus bars a practical impossibility, there is no auxiliary gear whatever on the 'bus bar gallery. No small wiring or potential transformers for synchronising or for 'bus bar voltmeters are allowed (these all being put on the machine or feeder side of the switch, as the case may be); in fact, the only connections are the main cables.

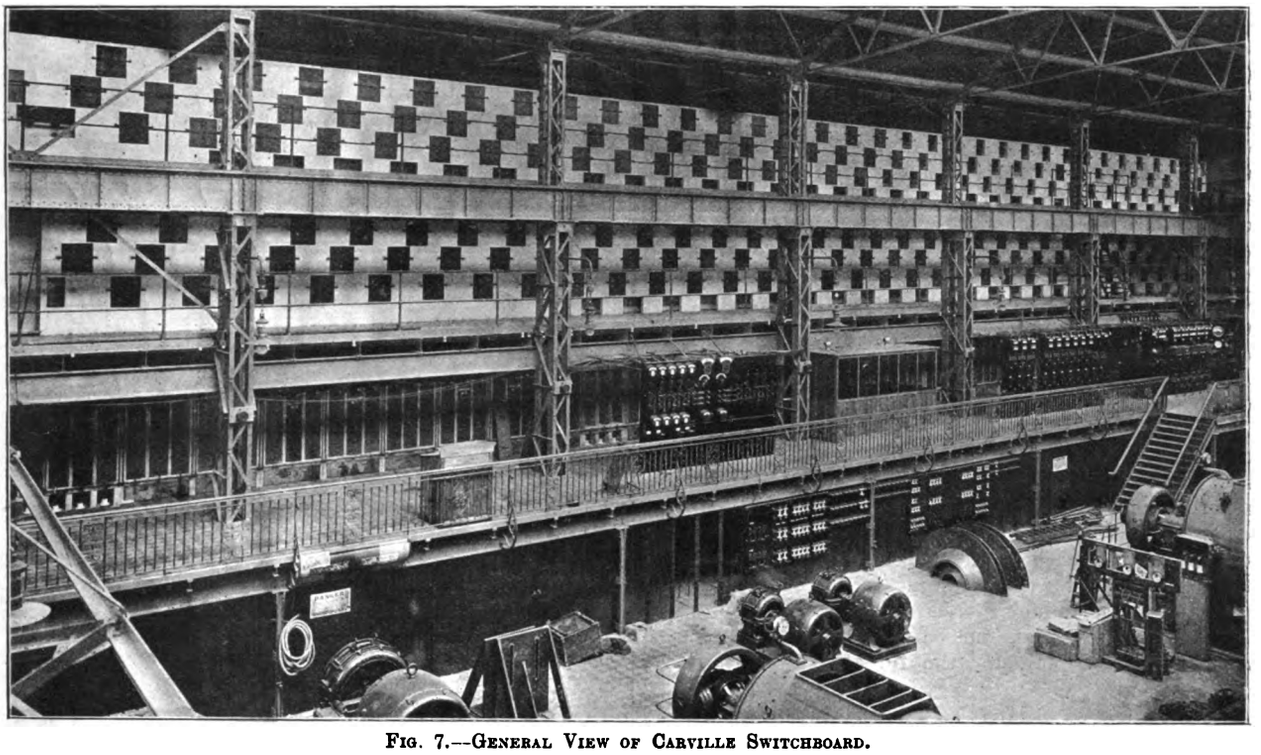

FIG. 7.—GENERAL VIEW OF CARVILLE SWITCHBOARD.

So far, we have described the feeder panels only, and with regard to the generator panels it merely remains to say that they are arranged in an exactly similar fashion, with the exception of a few details. The concrete partitions for the generator panels are carried quite down to the floor level, instead of being cut off to make room for the three-way dividing boxes, this being done owing to the fact that three separate cables are used for generators, whereas the feeders are single three-core cables. There is also the absence of the feeder-isolating switches and spark-gaps alluded to earlier. With a remote control arrangement it is obviously not essential that the high-tension gear itself should be placed in the same relative order as the operating panels, and, to make the cable runs as short and safe as possible, each set of generator switch gear has been placed opposite the machine to which it belongs, although on the operating board all the generator panels are placed together. There are four complete spare panels on the board, and as the engine room is extended

FIG. 8.—OPERATING BOARD.

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from time to time the concrete work can be added to as required. In addition to the feeder and generator panels there are also two interconnector panels, which are similar to the feeder panels. The "interconnectors" consist of six single cables, which are used for interconnecting the Neptune Bank station with Carville, so that the two stations may run in parallel.

The control or operating board, Fig. 8, is situated on a special platform in the engine room proper and on the same gallery level as the oil switches. It consists of three main panels of black enamelled slate, comprising a generator panel in the centre, a feeder panel on the left for the traction supply to the North-Eastern Railway, and a feeder panel on the right for the Supply Company's general power and lighting supply. Perhaps the first point of interest calling for attention in connection with the control board is the arrangement which has been adopted for synchronising, Swinging panels have been provided at each end of the board for carrying the 'bus bar voltmeters, the rotary synchroniser and the synchronising lamps and voltmeters. It has already been mentioned that there are no instruments of any kind on the main 'bus bars, that all instrument transformers, &c., are on the generator or feeder side, as the case may be, of the oil switches. Hence it becomes necessary, when observing the 'bus bar volts, to observe simply the voltage of a machine which is running on the 'bus bars. This, of course, gives the 'bus bar volts equally accurately, and a similar method is adopted in synchronising. Referring to the general diagram of connections, Figs. 10 and 10A, it will be seen that two sets of receptacles are provided on each panel for synchronising, and for each of these two sets there are two different hand plugs, one for the "running" machine and another for the "incoming" machine ; there are also two receptacles and plugs, one for each set of 'bus bars. Under running conditions the voltmeter plug for the top set of 'bus bars is

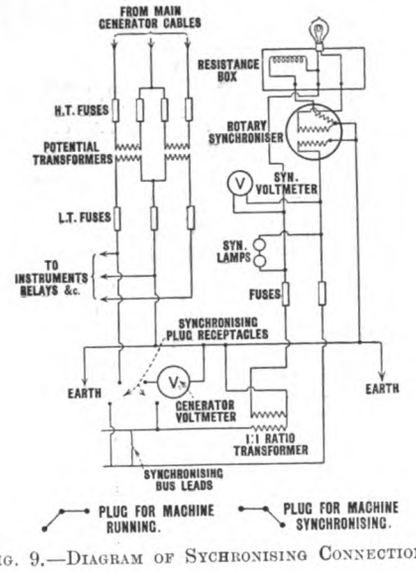

FIG. 9.—DIAGRAM OF SYCHRONISING CONNECTIONS.

inserted on the panel of a generator which is connected to the top set of 'bus bars, thereby connecting up the top voltmeter on the synchronising panel to indicate the pressure on this set of 'bus bars. Similarly, the voltmeter plug for the bottom set of 'bus bars is inserted in the panel of a generator working on these 'bus bars, thus making the bottom voltmeter indicate the pressure on that set of 'bus bars. When synchronising an "incoming" generator, the "running" plug is inserted in the panel of a generator which is already on the 'bus bars with which it is intended to synchronise, and by inserting the "incoming" plug on the panel of the "incoming" generator, the synchroniser is put into operation. As the "bright lamp" method of synchronising is in use elsewhere on the company's system, it has been adopted at Carville for emergency use in case the rotary synchroniser is out of commission. A diagram of the synchronising connections is shown in Fig. 9. With regard to the necessity for using "bright lamp" synchronising, a difficulty arose, as, owing to one pole of every potential transformer being earthed, it was found that, in order to avoid having both poles earthed at the same time at the lamps and synchroniser, it became necessary to use connections which gave dark lamps at synchronism, and in order to avoid this a 1 : 1 ratio transformer was put in on one pole. The reason for this will be apparent from the diagram. As there are no 'bus bar potential transformers, and as synchronising is done between two generator potential transformers, the same pole is earthed on each of them, and if they are connected in the usual way to give bright lamps, both poles will be earthed. They have, therefore, been connected to give dark lamps, and the 1 : 1 ratio transformer in one of the leads then alters its phase by 180deg. so as to obtain bright lamps.

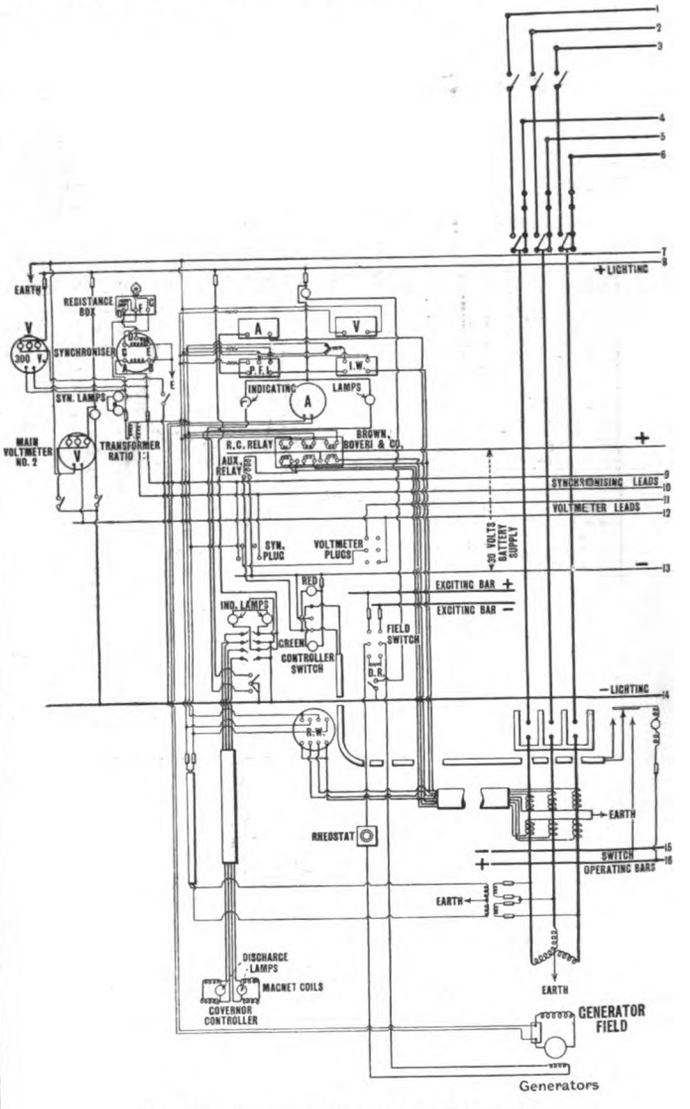

FIG. 10.—GENERAL DIAGRAM OF CONNECTIONS.

All the indicating instruments except the excitation ammeters are of the horizontal edgewise type. The switch-indicating lamps are arranged so that a red lamp lights when the switch is closed and a green one when it is opened. Should a fault occur on the control wiring it is indicated by both lamps going out. The 'bus bar indicating lamps are controlled from a throw-over tumbler switch, and are intended merely as a record of which selector switch has been closed. The control switches for operating the motors of the main oil switches are of the two-way type—one way for closing the switch and the other for opening. Normally, the control switches are held open by a spring, and the cycle of operations is as follows :—To close a main oil switch its corresponding control switch is pushed over to the upper contact, in which position it need remain only sufficiently long for the motor to carry the oil switch over its dead centre, as previously explained. From this point the oil switch closes automatically, and, on the attendant taking his hand off the control switch, it is opened by a spring, and a small coloured

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pin, which passes loosely through the blade of the switch from back to front, indicates whether the oil switch is open or closed. To open the oil switch, the control switch is thrown over to the lower contact, and the motor, carrying the oil switch over its bottom dead centre, thus opens the switch automatically.

The exciting 'bus bars and fuses are fixed to iron work at the back of and above the generator board. All regulation is done on the exciter fields, and, consequently, comparatively small currents have to be dealt with by the Ferranti rheostats and field switches on the panels. The greatest care has been taken to make all the small wiring at the back of the panels a safe and at the same time a neat and workmanlike job, the wires being symmetrically spaced and held to the slate by insulating clamps. All the secondaries of the instrument transformers are earthed on one pole, so that it is impossible for anything on the operating panels to become alive at high tension. A feature calling for special attention is the way in which low-tension operating wires are run from the control board to the high-tension panels. Screwed iron barrel is used for this purpose, accessible throughout its length and in no case buried under concrete floors. Two draw-in boxes are provided in each run of piping and all the wires are labelled. There are three pipes for each operating panel, one being used for the oil-switch leads, another for the potential transformer secondary leads and the third for the current transformer secondary leads. Multi-core cables are used except on the panels themselves, as they are not so liable as single wires to become damaged whilst being drawn into the pipes.

For driving the station auxiliaries there are two 750kw. three-phase transformers. These are mesh-connected on the high-tension side and star-connected on the low-tension; they reduce the voltage from 6,000 to 480. The diagram of connections, Fig. 10A, shows the connections from these transformers to the 'bus bars. Running the entire length of the station, under the operating platform are the low-tension 'bus bars for station work; they are of strip copper, taped, and carried on brackets. Distribution boards, facing the engine room, have been put in wherever required and the panels of these boards have a standard width of 2ft. For cleaning the high-tension gear, a service of compressed air piping has been laid on all the floors, with cocks at convenient places to which an armoured rubber hose with a long insulating nozzle can be attached; the supply is obtained from a motor-driven air compressor in the basement. The British Thomson-Houston Co. have supplied all the high-tension gear described above, and Messrs. Reyrolle & Co. were the contractors for certain of the low-tension gear.

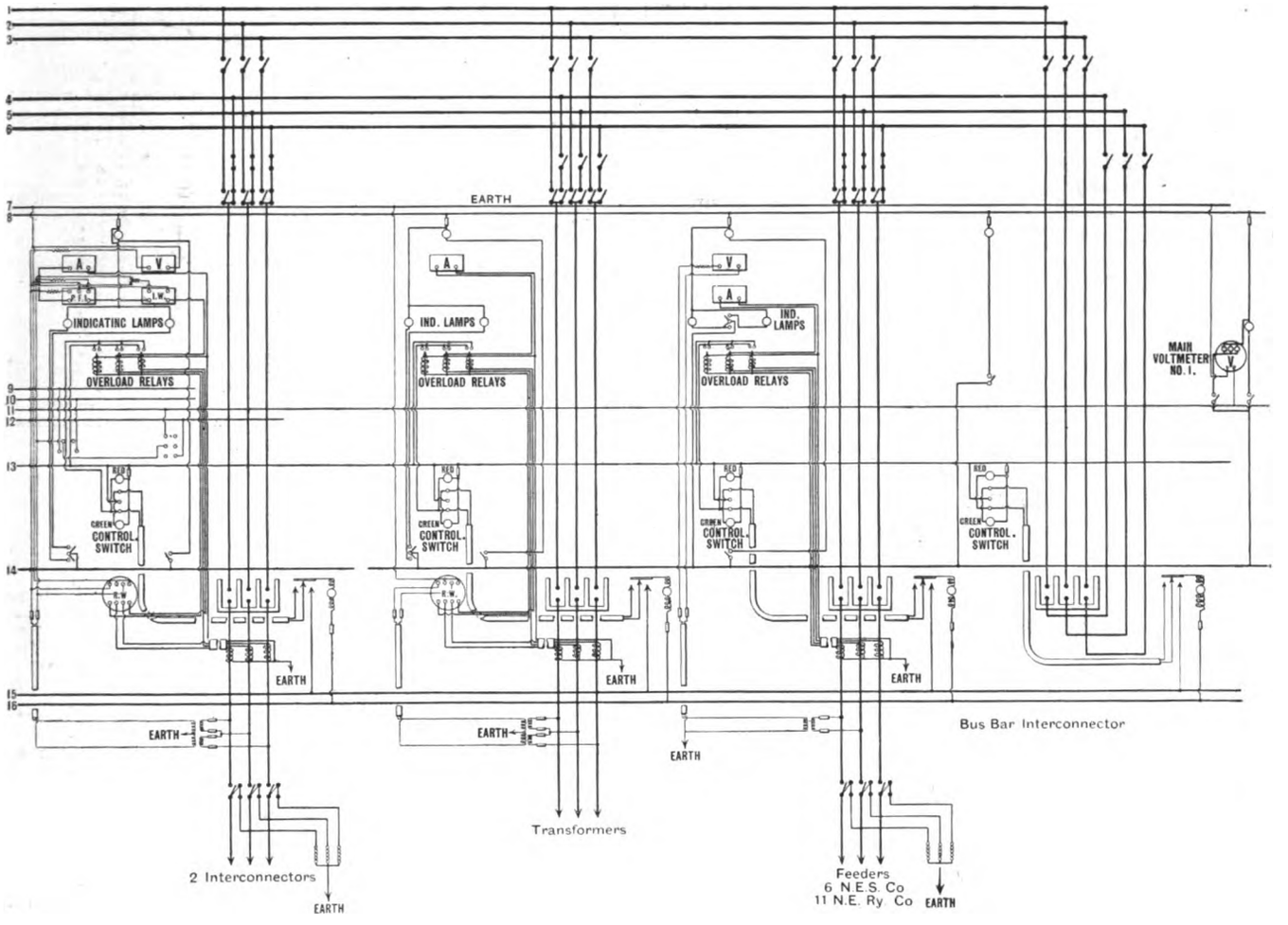

FIG. 10A.—CONTINUATION OF GENERAL DIAGRAM OF CONNECTIONS.

The small numbers 1—16 refer to similar conductors.

(To be continued.)

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Transactions of the Junior Institution of Engineers." Vol. XIII. Edited by W. T. Dunn. (London: Percival Marshall & Co.) 10s. 6d.

"Proceedings of the Royal Society." No. 496. Vol. LXXIII. (London: Harrison & Sons.) 1s. 6d.

"Obituary Notices of Fellows of the Royal Society." Part 3. (London: Harrison & Sons.) 5s.

"Proceedings of the Royal Society of Edinburgh." No. 3. Vol. XXV. Session 1903-4. (Edinburgh: Robert Grant & Son.) 3s.

"The Theory of the Lead Accumulator" By Dr. F. Dolezalek. Translated by C. L. von Ende. (London: Chapman & Hall). 10s. 6d.

"Propriétés et Essais des Matériaux de l'Électrotechnique." By F. de Poncharra. (Paris: Gauthier-Villars.) fr.2·50.

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THE WESTINGHOUSE UNIT-SWITCH SYSTEM OF MULTIPLE-UNIT TRAIN CONTROL.

The Westinghouse system of multiple-unit train control has been variously alluded to and described in our columns, especially in connection with our description of the electrically-equipped trains for the District Railway (see *The Electrician*, Vol. LI., p. 5). The latest development of this system, involving several modifications, is being fitted on some of the cars of the Metropolitan Railway of London, and, we are informed, has also been applied on the

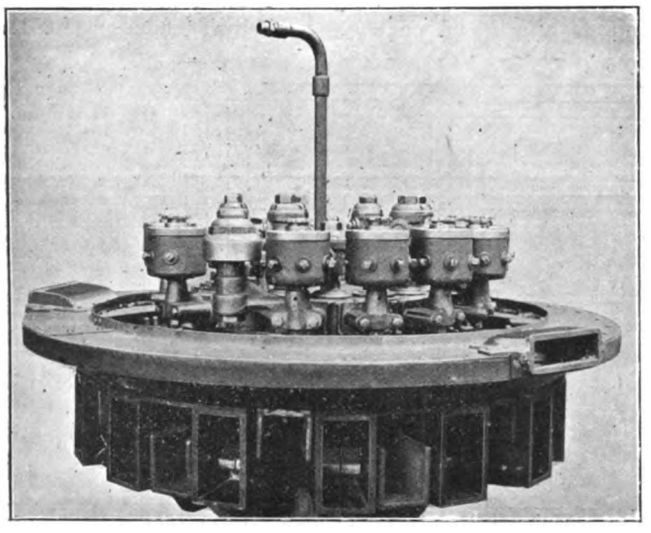

FIG. 1.—WESTINGHOUSE TURRET CONTROLLER.

Brooklyn Heights Railway (314 sets of motors and controlling gear), the West Side Elevated Railway of Chicago (156 sets) and the Metropolitain Railway, Paris (102 sets).

For large and heavy cars requiring very powerful motors the latest form of controller is the Westinghouse turret controller. It consists of a number of radially-grouped circuit-breakers or unit-switches, which are closed by air pistons working against powerful springs, these springs opening the switch contacts when the air pressure is removed. Fig. 1 shows a turret controller with its cover removed, and Fig. 2 illustrates its position on the underside of a motor coach. The 15 separate circuit-breakers or "unit-switches" which are employed are secured to a circular base, and are provided with a common magnetic blow-out coil at the centre. This single blow-out coil is a special feature, as it secures the ideal condition of maximum blow-out effect with minimum weight and space; and the number of parts and the amount of wiring necessary is very much reduced. Further, the use of a single coil enables it to be made of greater magnetic strength than could be the case if a number of smaller coils were used—one to each switch. The air pistons actuating the radial switches work in vertical cylinders, and the air admission is controlled by needle valves operated by iron clad electromagnets, which, together with the cylinders, project above the main base casting of the turret, as seen in Fig. 1. A single pipe connection supplies compressed air to a central reservoir chamber, and ports around the latter admit air to the various magnetic valves and thence to the cylinders; this construction reduces the amount of air piping and joints to a minimum.

A view of the turret controller, partly in section, is given in Fig. 3. Here P is the compressed-air supply pipe, C the air reservoir, p the port leading to the magnetically-operated valve V and p' the port leading from the valve to the cylinder operating the switch S, which is shown in the open position. Another of the switches, S', is shown closed, and a section of the cylinder and piston operating it is given. B is the large blow-out coil, and two of the iron pole-pieces emanating therefrom may be seen to the right and left of the figure. These pole-pieces, which are more clearly shown in Fig. 1, are U-shaped, and point alternately up and down, the top ones being bolted to the main iron casting and the bottom ones to the extremities of a cast-iron spider. The core of the magnet is fixed to and hangs down from the main casting, and supports the spider and

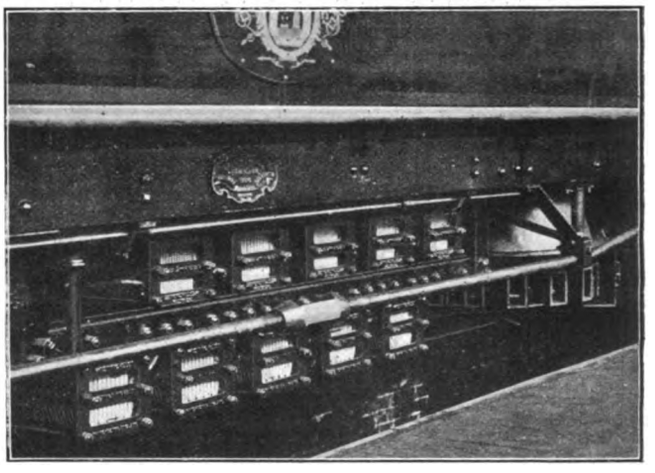

FIG. 2.—WESTINGHOUSE TURRET CONTROLLER AND RESISTANCES FIXED TO A METROPOLITAN RAILWAY CAR.

also the attachment for the bottom cover. It may be mentioned that the general arrangement of parts has been somewhat modified since Fig. 3 was drawn, but the latter represents the general principles very closely. The contacts of each switch are enclosed in a vulcabeston box or arc shield (Fig. 1), and the magnetic lines from one top and one bottom pole pass through each such box, in a direction normal to that of the line of break of the switch—that is to say, horizontally. The strength of the blow-out field is such that test currents up to 18,000 amperes have been repeatedly and successfully broken, the burning at the switch contacts being negligible. When the switch contacts are brought together and also when they are separated, a spring in the moving arms comes into play and brings about a rolling and sliding motion of the contacts, and so keeps their surfaces in good condition and prevents all tendency to burn or weld. This spring is shown at *sp*, in Fig. 3. Copper shunts are provided for all working pins and bushings in the switches, and the contact plates are easily renewable.

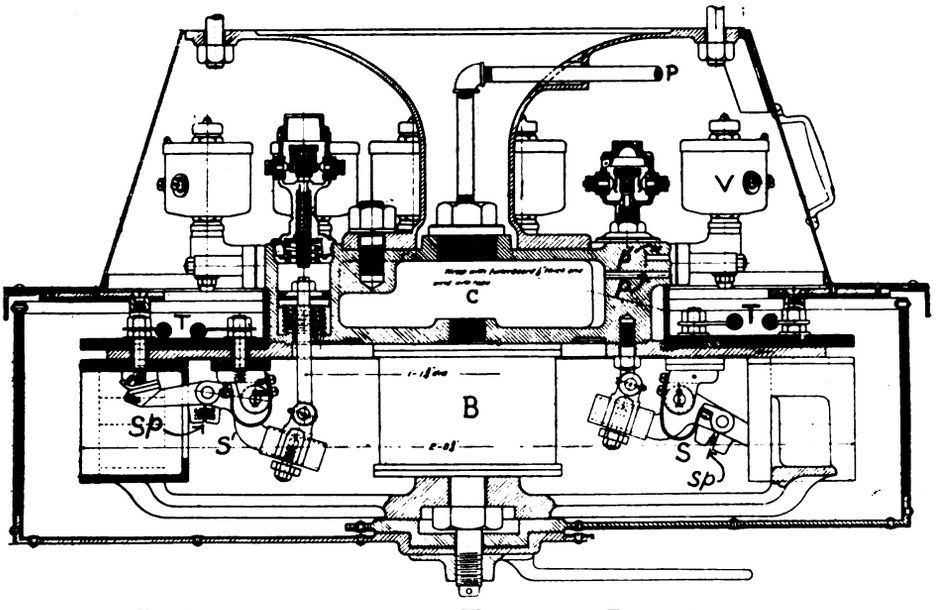

FIG. 3.—SECTIONAL ELEVATION OF WESTINGHOUSE TURRET CONTROLLER.

When the exhaust port of the cylinder is opened, the spring under the piston drives the latter up and opens the switch. The switch terminals are shown at T, T in Fig. 3, both these and the switch parts being insulated from the circular base-plate of the controller by sheets and bushings of vulcabeston. It is a good point that the terminals are on the opposite sides of the base to the switches, the cables being thereby divided off from the latter. Another advantage is that the low-tension circuit terminals on the magnet valves are well separated from the comparatively high-tension switch terminals. The magnets and valves are enclosed by a

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hinged truncated cone-shaped cover which can easily be removed, and the switches are enclosed by a revolving cover, the halves of which telescope within each other.

In addition to the turret controller a complete motor coach equipment includes a reverser, an automatic excess-current and no-voltage return relay, one or more small master controllers, and a switchboard for the controlling of the car lighting, compressor and battery circuits. The reverser, which governs the direction of current through the motors, and consequently the direction of motion of the car, is operated by an air-motor, the admission of air being controlled by electromagnetically operated valves similar to those on the turret controller. Fig 4 shows its construction. The over-

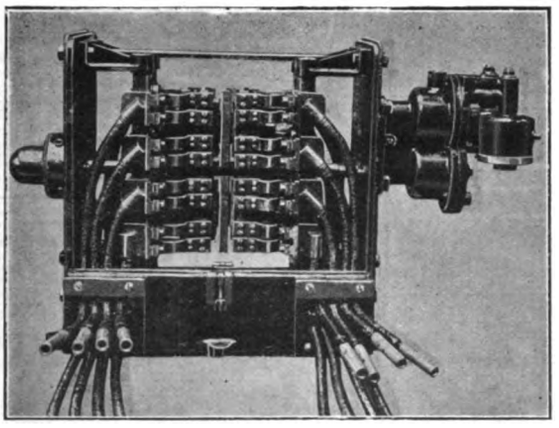

FIG. 4.—THE PNEUMATICALLY-OPERATED REVERSING SWITCH.

load and no-voltage return relay is connected with the operating magnet of one of the cylinders in the turret, this cylinder actuating the switch which acts as main circuit-breaker. The no-voltage part of this relay, which is mounted on the end of the case, is of considerable importance, its function being to prevent the sudden restoration of full voltage to the motors and consequent flashing thereat after any unforeseen interruption in the supply of power. When this no-voltage device acts it causes the controller to go back to a point with high resistance in circuit, the latter then gradually and automatically "notching out" the resistances as soon as the supply is resumed. It should be noted that the no-voltage action of the relay is not so instantaneous as to take notice of instan-

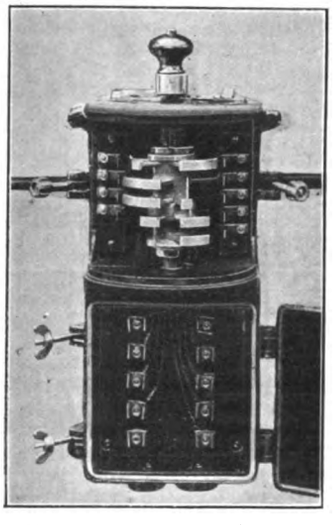

FIG. 5.—MASTER CONTROLLER.

taneous interruptions due to the car contact-shoe passing over points or crossings; and also that it does not act when the supply is suddenly cut off and then suddenly comes on again.

The connecting link between the electric and pneumatic gear and the driver is the master controller, which is very compact, as seen by Figs. 5 and 6. The currents operating the valve magnets of the turret controller are very small, and, as they are derived from a low voltage (seven-cell) storage battery there is no necessity for arc shields or blow-out coils in the master controller. The latter has five notches for forward running and five for backward running, in addition to the neutral point. At the first "forward" notch the emergency brake valve is set. At the second, the main supply circuit is closed and the reverse set. At the third, the motors are connected in series with all resistances in. At the fourth, an automatic acceleration device comes into action, and the controller goes on notching up, provided it is not checked by the limit switch, till the eighth and last series notch is reached, the limit switch coming into play in order to maintain a uniform accelerating current. As the master controller drum is rotated, the pistons in the turret are actuated in due order, and the corresponding switches are closed. When the master controller handle reaches its last notch, the turret switches which have already been put on are simultaneously opened, and a number of others simultaneously closed, this making the parallel connections for the motors. Then, subject to the action of the limit switch, the controller automatically notches up to full parallel, and the highest speed point is reached. It is of special importance to note that should the driver throw his handle over to full parallel at the start, the controller will still work automatically and gradually through all the series and parallel positions, so that no harm can be done to the motors. A further advantage of this automatic acceleration is that it ensures the utmost economy in power consumption. An ingenious safeguard is provided in case the motorman should lose his hold of the controller handle through inadvertence, accident or sudden illness. The handle, when released, flies back to its neutral position by spring action, and in so doing interrupts a circuit through the magnets. The effect of this is to open a valve and allow the air in the main pipe of the air-brake system to escape, with the result that the brakes are applied immediately throughout the train. When the brakes are not required to act, however, as in reversing, their above-mentioned automatic application may be prevented by passing the controller-handle

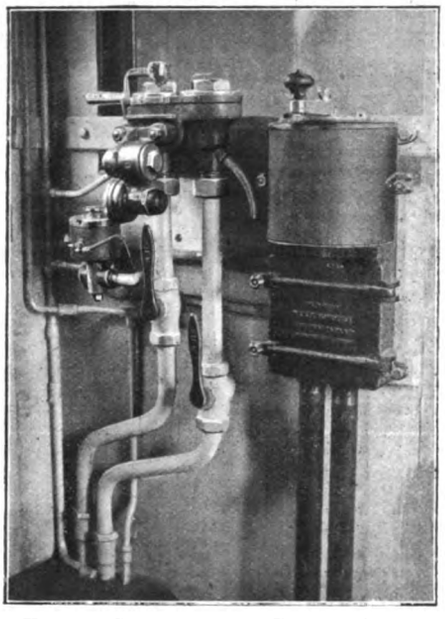

FIG. 6.—VIEW OF CONTROLLER AND BRAKING ARRANGEMENTS.

rapidly over the neutral notch. In running backwards the operation of the controller is similar to its operation with forward running.

The motor coaches that are being equipped for the Metropolitan Railway will be fitted with four 150 H.P. motors—*i.e.*, 600 H.P. in all—and each coach will weigh approximately 39 tons. The complete train will consist of two motor and four trailer coaches, and it will be possible to split it up into five, four, three, two or single-coach trains as the density of the traffic decreases. The unusual power of these equipments is the reason for the large number of resistance steps in the controller, there being eight series and eight parallel positions. Nevertheless, the weight of the turret resistances, reverser and pneumatic controlling gear is less than that of an ordinary electromagnetic control equipment. The cables are encased in asbestos slate mouldings. The nine-way low-tension controlling circuit sockets and plugs constitute the only electrical connection between neighbouring cars.

Three beams for carrying the collecting shoes are fitted underneath the car. The two outer ones are fixed on each end of the car, and are provided with a positive collecting shoe at each extremity and a negative shoe in the middle. The shorter middle beam is placed at the centre of the car length and carries a negative or return-current shoe only. The necessity for having collector shoes at each side of the car is explained by the fact that the conductor rail is sometimes on one side of the track and sometimes on the other. The shoe is similar in construction to that used on the Mersey Railway (*The Electrician*, Vol. LI., p. 202), but in this case the action of gravity in securing electrical contact between the shoe and the rails is aided by a helical spring.

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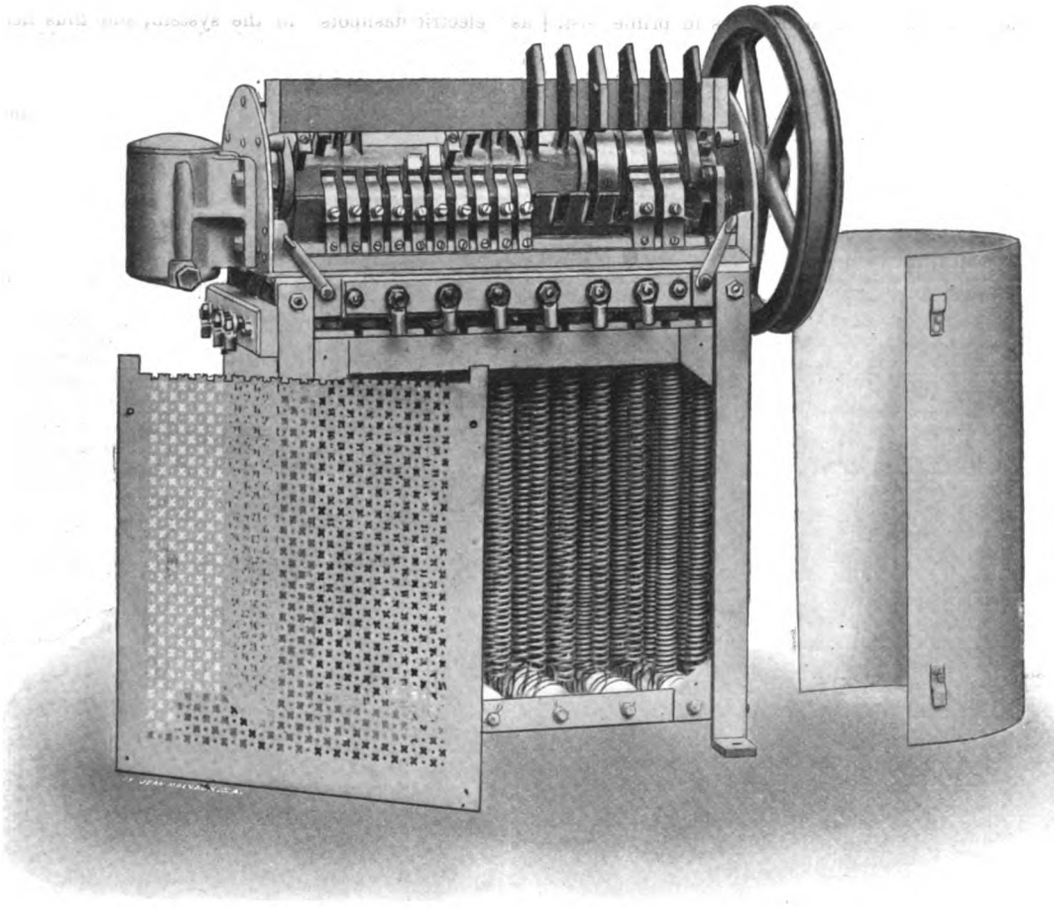
SINGLE-PHASE ELECTRIC HOISTS.

The following description of two single-phase electric hoists in use at Messrs. Davis & Sons' hosiery mills at Derby (briefly referred to in our issue of June 17th) will doubtless interest many of our readers. The lifts are operated by Heyland motors, each of 6 H.P., supplied by Messrs. Witting, Eborall & Co. They are of their standard type, arranged with carbon brushes on the slip rings, so as to be suitable for running in either direction. The controllers (see illustration) are operated by cords from the lifts themselves. The motors are reversed by changing the connections of the starting coils, the connections for the running coils being always the same. These connections are made in the controller itself, which also cuts out the starting coils after the motor has run up to a certain speed. The controller also contains all the necessary contacts for the resistances, which are placed in series with the ordinary three-phase rotor of the motor. The controller itself is mounted on the top of the framework which contains the resistances, and the whole is exceedingly neat and compact. The cutting out of the starting coils has to be done by the operator in two steps, firstly, starting up the motor, and then when the lift has obtained a certain speed moving the controller right over so as to cut out the starting coils and gradually short-circuit the rotor resistances. Messrs. Furse & Co. of Nottingham, who installed the lifts, have connected the motor to worm gearings by a chain drive making the first reduction, and the worm gearing making the second reduction. The lift cages run in wood guides, the ropes passing over grooved wheels to the balance weights. The controller is coupled with a balanced brake and over-travel cut-out. All the gearing, motor, brake, worm gearing, controller and over-travel gear are mounted on a cast-iron bed-plate. Although the lifts were only intended to lift 5 cwt. at 100ft. per minute, they will start very well with a 50 per cent. overload without requiring too high a starting current.



POLYPHASE SUB-STATIONS.*

BY S. L. PEARCE.
(Chief Electrical Engineer, Manchester.)

INTRODUCTION.

The author does not intend to put forward anything particularly original on this subject, but proposes to deal with the various types of sub-station equipments that have come chiefly within his own experience, and to consider some practical points that have arisen in connection with their working.

Considerations determining Equipment.—There are several considerations which will determine the particular type of equipment to be employed, and it is desirable briefly to state these :—(*a*) Traction or lighting requirements. (*b*) Frequency of the system. (*c*) Two *v.* three-phase.

The first of these considerations is of great importance, as it will be seen hereafter that some equipments are more suitable for the ever-varying loads and overloads met with in traction work than for the steady lighting loads where a constant pressure is of prime importance.

The second consideration will depend almost entirely on the first. As the frequency of a system has such an important bearing on the capital cost, it is desirable wherever possible that this should be kept high, say from 40 to 50 cycles, otherwise the main generators, transformers and motors will become much heavier, and, therefore, more expensive, and at this frequency "mixed" systems can be conveniently operated. The lowest frequency at which arc lighting can be done satisfactorily is about 42, and incandescent lighting between 30 and 40. On the other hand, a low frequency of 25 is desirable for the operation of rotaries, as the difficulties of commutation and parallel running increase with the frequency.

The third consideration—viz., the question of two-phase *v.* three-phase—will be decided on for reasons apart from those connected with the sub-station. The relative cost and efficiency of generating plant and transmission lines for two or three-phase will have to be taken into account. It may fairly be stated that three-phase generators are cheaper to build and lighter than two-phase, whilst their

* Paper read before the Incorporated Municipal Electrical Association, June 30th. Slightly abridged.

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efficiency is equally good, if not better. The transmission cables are simpler, as also are the switching devices. Theoretically also, at any rate, a greater power can be transmitted in a three-phase system with a given weight of copper than on a two-phase system. As far as the machinery at the sub-station is concerned, there is little to choose between two and three-phase where efficiencies and cost are concerned, as will be seen from Table I., which is taken from Mr. Field's Paper on "Systems for Feeding Low-tension Networks," read before the International Engineering Congress, Glasgow, 1901. Taking these various points into consideration, there is little doubt that three-phase is to be preferred, as it is no more complicated than two-phase, has advantages in prime cost, gives a better over-all efficiency, and has been adopted in the majority of installations in this country. The author is aware, however, that there are one or two successful two-phase plants at work. In these cases two-phase has probably been adopted owing to a system of single-phase mains having previously existed. The change from single-phase to two-phase can be readily made, as has been done in the case of the Metropolitan Company, where two-phase motor-generators are used for that part of their system requiring direct current. The equipment to be considered in this Paper will be of the three-phase type, with terminal voltages of from 5,000 to 10,000.

Converting Equipments.

(*a*) *Rotary Converters.*—The voltage on the A.C. side between slip-rings is a definite percentage of the D.C. voltage, being approximately 61 per cent. for three-phase working with three slip-rings, 70 per cent. for two-phase with four slip-rings, 35 per cent. for six-phase working with six slip-rings, and 50 per cent. for four-phase with four slip-rings. These values are dependent on the pole-width.

Table I.

Type of sub-station.	Cost.	Efficiency of equipment. Full load.	¾-load.	½-load.	Total weight. Tons.
Three-phase rotary with transformers.	A £2,160	91·0	89·75	86·75	33
	B 2,560	92·0	90·5	888·	31
Two-phase ditto	A 2,240	91·0	89·75	86 75	34
	B 2,580	92·0	90·5	88·0	32
Three-phase synchronous motor-generator.	A 2,400	89·5	88·25	85·25	42
	B 2,280	86·5	85·0	81·5	44
Two-phase ditto	A 2,400	89·5	88·25	85·25	42
	B 2,280	86·5	85·0	81·5	44
Three-phase induction motor-generator.	A 2,680	89·0	87·75	84·75	50
	B 2,260	85·5	84·5	81 5	44
Two-phase ditto	A 2,680	89 0	87·75	84·75	50
	B 2,300	85·0	84·0	81·0	45

N.B.—A and B refer to different makers.

All the above refer to 500kw. converter equipment, operating at 25 cycles and 6,500 volts.

The outstanding advantages to be obtained from the use of this class of converter are low prime cost, high efficiency, ability to stand overload limited only by the temperature rise, small floor space for a given output, and the high-power factor which can be maintained over the system. On the other hand, there is a certain want of stability which manifests itself in sensitiveness to variations in the line voltage, causing difficulty in parallel running, and a tendency to hunt and get out of step. This want of stability is more noticeable in rotaries built with laminated steel poles than in those with solid pole-pieces. The regulation also is not as flexible as in other systems, and switch gear and switching operations become somewhat complicated, but for purely traction schemes, their high efficiency and ability to stand very considerable overloads, are factors of great importance which more than outweigh the disadvantages named. Although the six-phase connection for rotaries is complicated, there is a considerable economy to be gained in the use of it—a fact which is being recognised in the latest installations in this country. Owing to the distributed nature of the tappings on the A.C. side, the heating of the armature is more uniform, and there is, consequently, a considerable gain in the output, since this depends on the temperature rise.

The step-down transformers may be connected up either "star" or "mesh." The advantage of the latter method lies in the fact that should one transformer be put out of circuit through any cause, the supply will not be interrupted; the remaining transformers will still maintain a three-phase supply to the converter, which can be run at its full load as long as the heating in the two remaining transformers does not become excessive. "Star" connected transformers are cheaper in first cost, since the pressure between the centre point of the star and the ends of either transformer is proportionally less than the line voltage. For lighting schemes with distribution on the three-wire or three-phase system, there is a distinct advantage to be gained by the "star" connection, since the centre point can be connected to the middle or neutral conductor for balancing purposes.

It has been pointed out previously that rotaries should be operated at low frequencies of 25 to 30 cycles per second to attain the best results. This guarantees the more stable operation of the machines, and permits a wider range of compounding than is obtainable with higher frequencies. The author believes that the tendency in the future will be towards standardising periodicities of 25 and 50, as the latter, being an exact multiple of the former, enables the prime movers to be built on exactly similar lines, the only difference being in the number of poles. Where rotaries are being operated at 40 to 50 cycles, it would appear desirable to have connected on the same system a proportion of induction motors, which would tend to act as "electric dashpots" in the system, and thus help to make the rotary converters more stable than they would be in a system having nothing but rotaries.

(*b*) *Synchronous Motor-generators.*—This type of equipment consists of a synchronous motor driving one or more generators, the whole constituting one complete and self-contained set. No intermediate transformers are necessary, as the line pressure is brought straight on to the terminals of the stator of the motor. It is usual to build the motors of the revolving-field type, with the exciting current led up through slip rings to the field coils, either from an independent exciter mounted on to the end of the shaft from the generator terminals, from the low-tension lighting 'bus bars or other means to be described later. The merits of this system, in which higher frequencies can be employed, are simplicity of operation, flexibility, high power-factor in working and the fact that the regulation of one direct-current side pressure is independent of the alternating-current voltage. As compared with rotaries, they are some 3 to 4 per cent. less efficient, and their ability to stand overloads is determined by the overload capacity of the generator. For lighting and "mixed" systems, the synchronous motor generator has much to commend it on the ground of stability, satisfactory parallel running and ease of regulation.

(*c*) *Non-synchronous Motor-generators.*—The high-pressure currents in this case also are led either through choking coils or direct to the motor, and the starting up is accomplished from the high-tension side. Consequently, no complicated switch gear is required, and synchronising is obviated. As with synchronous equipments, the regulation on the D.C. side is independent of the A.C. The great drawback to non-synchronous motors is the comparatively low power-factor at which they work. For mechanical reasons, the width of the air-gap in induction motors is considerable, more particularly with small units, and it is advisable to watch this closely with a view to keeping it equal at top and bottom of the rotors. In order to avoid heavy lagging currents on the system, the motors should be run well up to their full load. Lagging currents not only waste energy, but pressure regulation becomes exceedingly difficult owing to their demagnetising effects. It is for these reasons that the use of small non-synchronous motor-generators alone is not to be recommended, but a combination of the types (*b*) and (*c*) can be used with good results. In every sub-station means must be provided for starting up from the A.C. side in the event of low tension D.C. not being available. For this purpose the motor-generator with an induction motor is specially useful owing to the rapidity with which it can be started to enable a supply of direct current to be obtained for starting up the synchronous sets. If the latter be run with their fields "stiffened" or slightly over-excited, the heavy lagging currents of the induction motor may in some measure be compensated for, and the power-factor of the system thereby improved.

A modification of the ordinary induction motor-generator has recently been brought forward by one firm in this country under the name of "motor-converter." This combination consists of a D.C. generator coupled to an induction motor—the two machines being electrically as well as mechanically interconnected. H.T. currents at 50 periods circulate in the stator windings of the induction motor. Owing to the back E.M.F. of the D.C. machine the speed of the rotor, however, corresponds to half synchronism only. Currents are therefore generated in the rotor windings at a periodicity of 25, and these currents pass into the D.C. armature by suitable cross connections, and are there commutated. Theoretically, half the power of the combination is transmitted through the shaft, and the remaining half through the electrical cross connections. In the first case the D.C. machine acts as a generator; in the latter

Table II.

Voltage 6,500. Frequency 50.

—	Asynchronous motor-generators.	Synchronous motor-generators.	Rotaries (not including transformers).
Output	220kw.	220kw.	220kw.
Costs	£6·1 per kw.	£5·5 per kw.	£3·8 per kw.
Efficiency (full load) ..	86%	89%	92%
Floor space	12′ 3″ approx.	12′ 3″ approx.	7′ approx.
	8′ 5″ ,,	8′ 5″ ,,	7′ ,,
Power-factor (full load)	92%	Unity.	Unity.

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case the motor acts as a transformer, and the D.C. machine as a generator. To a certain extent, therefore, this machine appears to combine the advantages possessed by both motor-generators and rotary converters, and the practical results obtained therefrom will be of considerable interest.

Table II. shows the relative cost, efficiency, floor space, and power-factor of various sizes of the three classes of equipment.

Fig. 1 comprises three curves showing the approximate relative cost of three types of sub-station equipment.

(d) Static Transformers.—The distribution of polyphase currents at low pressure is undoubtedly coming to the front. There are already in this country instances of new and successful public lighting schemes on this system, and a considerable demand is springing up in various towns for a supply of three-phase current to large works, more particularly in engineering and shipbuilding districts. A sub-station of this type has recently been put down in Manchester for the supply of three-phase current at 200 volts to some extensive locomotive works, where it is expected that the ultimate demand will be approximately 700kw. It seems reasonable to suppose that the present recognised systems of converting A.C. to D.C. will in time be superseded by one embodying direct transformation from high to low pressure. When one considers the increased capital involved in respect of plant and buildings for sub-stations equipped with rotaries or motor-generators, the increased labour costs for running and maintenance and the moderate all-day efficiencies obtained, it would appear that the polyphase system of

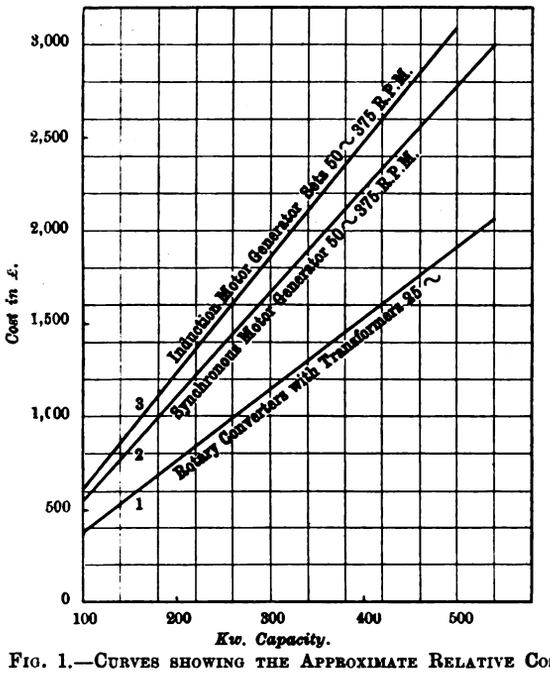

FIG. 1.—CURVES SHOWING THE APPROXIMATE RELATIVE COSTS OF :—
1. Rotary Converters with Transformers and Reactance.
2. Synchronous Motor Generator Sets. Motors wound for 6,000 volts.
3. Asynchronous Motor Generator Sets. Motors wound for 6,000 volts. Sizes 20 kw. to 500kw.

distribution for mixed "lighting and power schemes" has much to recommend it. The three-phase motor is proving eminently satisfactory where speed regulation is not a prime essential, and the difficulties even in this respect are not insuperable.

The transformation of polyphase currents can be, and more frequently is, carried out by the use of three single-phase transformers, which may be connected up either "mesh" or "star" fashion. The advantage of using three-phase transformers is a saving in copper and iron, resulting in a lower first cost; further, their common magnetic circuit tends to reduce any variation in the pressure between the phases, and for this reason they are preferable for use on lighting circuits. The great advantage in using the single transformer type is that breakdown risks are minimised and a smaller amount of spare plant is required. These points largely counterbalance the advantages attendant on the use of three-phase transformers. Transformer units should be few in number and of as large an output as possible, since, although any gain in efficiency by the employment of large units may be inappreciable, simplicity in the arrangement of the sub-station and the reduction of the switch gear required to a minimum are important factors.

Either oil-cooled or forced-draught ventilation transformers will give good results, particularly if in the former proper means are taken with the larger units for securing the cooling of the oil by circulating cold water through it or vice versa. The second method has been more generally used in the author's experience. This type of transformer, constructed with sub-divided coils, not only keeps the transformer cool by allowing the forced air to circulate, but renders it more easy to insulate for voltages up to 10,000 with perfect safety. Forced draught cooling involves the use of a blower, which is usually driven by a small inductiou motor operating at low pressure. Such types of transformers are capable of giving very large outputs for their weights and high efficiencies. There is always the risk of breakdown of the induction motor to be reckoned with, a state of affairs which usually ends in the particular bank of transformers being put speedily out of commission.

The transformer with natural draught ventilation has much to commend it, as without a doubt air blasts, oil or any other cooling devices are somewhat open to objection. Given large radiating surfaces inside and out, combined with ample ventilating spaces through which currents of fresh air can continually pass, this type should give as good results as either of the former.

The following table gives the comparative cost for the various types of a 250kw. equipment working at 5,500 volts and 50 periods :

——	Three-phase transformers.	Three single-phase transformers.
	£ per kw.	£ per kw.
1. Oil cooled	0·8	1·4
2. Cooled by air blast	0·78	1·17
3. Natural cooled	0 9	1·5

SWITCH GEAR.

Position of Boards.—It will be found convenient to place the high and low-tension boards on different galleries, either opposite to or at right angles to one another, but on the same level, with easy means of communication between the two. This arrangement, besides having the advantage of separating the high-tension and low-tension gear, will facilitate the wiring up of the station and avoid any dangerous crossings of the cables.

Type of High-tension Board.—Much has been written on this somewhat thorny subject, and the matter is still to a great extent *sub judice*. Three distinct types, however, have come within the author's experience—viz., the flat board, the multi-frame, and the cellular or compartment board. The former with its exposed switches, fuses, and wiring, &c., mounted sometimes dangerously low down, and small space provided at the back, is quite unsuitable for high pressures, and is rarely seen now in later high-tension sub-stations. Several modifications of this type, however, are in use, such modifications consisting in the raising of the height of the high-tension 'bus bars and partially covering them in, live fittings of any description being exposed only at the back and top, the front being absolutely free from any high-tension work, and instruments mounted at the front being worked off transformers. Examples of high-tension switchboards on these lines have been installed at the Central London sub-stations, and are doing good service.

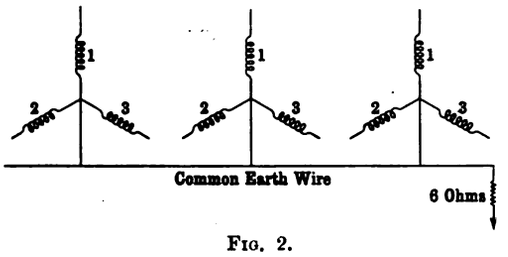

FIG. 2.

The "Multi-frame" type of board may be said to represent very largely the Continental practice, and consists of practically two or more distinct frameworks, the first carrying the marble front on which are mounted the switch handles and instruments worked off transformers. The second framework may be behind or above the former, thus forming a second gallery. This latter carries all the high-tension work. Ample passage-ways are provided all round, and, in addition, all high-tension parts are enclosed in caging of iron meshing with suitable doors which can be locked as required. This type has the disadvantage of taking up considerable floor space, but the possibility of attendants getting round to the high-tension portions at the back is not great, and the boards are readily accessible for cleaning and repairs when required Next to safety should come efficiency and reliability, and on these points the multi-frame board gives excellent results.

The "cellular and backless" type of board in one of its particular forms is well known in this country, and has been most extensively used in single-phase systems. Its adaptation for two and three-phase working will be watched with considerable interest, especially as in some schemes it has come into direct comparison with the multi-frame type. The whole arrangement of this type of board is too severely compact for the higher pressures and powers, and repairs are not easily effected when required, but the saving in floor space is considerable, which is a consideration when sub-station sites are restricted in this respect.

Other types are generally modifications, combinations or extensions in some form or other of those named. In somes cases the switch-

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gear is sub-divided into sections, occupying different galleries, or forming groups on the same gallery. In other cases all the high-tension gear is remote controlled, operated by hand direct or auxiliary relay apparatus, either electrical or pneumatic.

Arrangement of 'Bus Bars.—The arrangement of the 'bus bars is the first question to decide when the type of board has been settled. Simplicity as far as it is compatible with reliability of supply is essential. With a mixed system the author considers that this is fairly obtained by using one set of 'bus bars for lighting and another set for traction, every feeder and every machine being provided with "change-over" or "selector" switches, so that they can be connected up to either set of 'bus bars. In effect a set of duplicate 'bus bars is thereby provided. Means can also be provided, if desired, for coupling together the two set of bars in the sub-station, but where it is the rigid practice to keep the traction and lighting 'bus bars separate, it may be desirable that coupling switches should be provided at the generating station only. In the case of a lighting system only, it is still advisable as a stand-by and as a means of isolating any generator on to any feeder, that a duplicate set of 'bus bars should be provided. The use of a second 'bus bar has always been found invaluable in the testing of any faulty feeder or machine, as it permits of this being done during the hours of ordinary supply. Such an arrangement of duplicate bars is, in the author's opinion, preferable to the so-called ring systems with disconnecting links. For these reasons the extra capital cost involved will be well repaid by the increased reliability and efficiency of working.

The question of "fusing" or not fusing is one that is still much debated. If fuses be decided on, then two conditions may be laid down as essential: (1) They must open circuit cleanly and without enabling a rise in potential to take place. (2) They should be situated on a gallery or in a basement alone; in short, they should be severely isolated from the rest of the high-tension gear, where, in the event of failure of action, the damage is confined to a comparatively small area. They should also be in duplicate.

It may safely be stated that excessive rises in pressure on interrupting the circuit are not experienced with oil-break fuses, but whether this or the ordinary type be adopted, the employment of spark-gaps in addition on the system is to be recommended, as the additional expense is trifling. Some one has truly said that fuses are very good things to do without, and from the author's recent experience he is inclined to the conclusion that fuses are not to be relied on in extra high-pressure work, and that the substitution of an "overload" oil-break automatic switch with time limit and mechanical or electrical control attachment will give the best results. Such an arrangement should be fitted to each high-tension machine in the sub-station, the high-tension feeder ends being connected straight on to the 'bus bars, and controlled by automatic oil-circuit breakers of the overload type at the power-house end only. In some cases reverse-current circuit breakers have been fitted on the feeders at the sub-station ends to ensure continuity of supply in the event of a short-circuit occurring on any one feeder.

For the protection of high-tension overload circuit breakers, in the event of a feeder breaking down and to ensure their reliable working, the arrangement shown in Fig. 2 has been adopted in one or two systems in America, and is to be used on the Metropolitan District Railway, London. Between the centre point of the star-winding of the main generator or the sub-station converters and the earth-bar a resistance is inserted which will only carry four times the full-load current of the machine. As three-core feeder cables rarely break down between cores, but generally to earth, the amount of current passing can only with this arrangement equal four times the full-load current of the generator.

Synchronising.—The tendency appears nowadays to be in the direction of synchronising at the line voltage. There appears to be little to recommend this, and it certainly is desirable on the grounds of safety to work off low-tension synchronising 'bus bars.

Cable-charging Gear.—The question of the advisability of providing cable-charging apparatus is another moot point. The author believes that in the majority of cases there is probably no need for this provision, and he would instance the Central London and Glasgow equipments with high-tension feeders some 4 to 5 miles in length. The American practice is decidedly opposed to the instalment of this apparatus, and there is hardly a power station in the States to be found so equipped. It would be out of place somewhat to consider the pros and cons of the question in this Paper, or of the various types used—viz., (1) separate motor-generator forming the cable charger; (2) water resistance; (3) the "Partridge" arrangement, involving the employment of a three-phase transformer, the primaries being connected in series with the three-core cables, and the secondaries connected up to a non-inductive resistance.

High-tension switch gear appears to be passing through a transition stage, designs seem to be changing almost every year, and nothing can be called standardised in this direction. Probably the design of the future will be one that combines the cellular or compartmental arrangement with remote control.

(To be continued.)

CONFERENCE ON THE TELEPHONE QUESTION.

A second meeting of the Conference, called together by the City Corporation to consider the statements that had been made by the Postmaster-General with regard to a possible purchase of the National Telephone Co.'s undertaking by the Government, was held on Tuesday in the Council Chamber of the Guildhall. The previous meeting was held on May 18th (see *The Electrician*, May 20th, p. 191).

Mr. A. C. MORTON, chairman of the Conference, said that a letter had been received from the Postmaster-General in reply to a communication enclosing copies of the resolutions passed at the last meeting, and it read as follows:—

June 6, 1904.

SIR: In reply to your letter of the 25th ult., I am directed by the Postmaster-General to say that he has carefully considered the resolutions, of which copies were enclosed in your letter, passed at the Conference of representatives of the local authorities of the London telephone area at the Guildhall on the 18th ult.

The first resolution is to the following effect:—"That this Conference is of opinion that it would be inexpedient for the Government to acquire the undertaking of the National Telephone Co. on any other terms than those set out in the agreement between the Postmaster-General and the company dated November 18, 1901."

As you are no doubt aware, the agreement with the National Telephone, Co., dated November 18, 1901, had reference solely to the London telephone exchange area; and its provision, so far as the purchase of the National Telephone Co.'s system is concerned, were limited to their plant in the London area, and could not take effect until 1911, when the company's licence expires. On the other hand, the proposals which have been recently under discussion have reference to the acquisition of the company's exchange system in the whole of the United Kingdom at some date in the near future. In these circumstances Lord Stanley is in some doubt as to the intention of this resolution.

If the intention was to suggest that the company's system, not only in London, but in the whole of the United Kingdom, should now be acquired on the terms agreed upon for the London system in 1911, he thinks that the company could hardly be expected to accept at the present time, when they are at liberty to carry on their business for seven years more, the terms which they accepted as applicable on the termination of their licence, when their plant can no longer be used by them for its present purpose.

The intention may have been, on the other hand, to recommend an arrangement for the purchase of the company's plant throughout the country in 1911 on the terms agreed for the purchase of their plant in London at that date. Such a solution, although there is something to be said in its favour, would present many difficulties, and Lord Stanley is convinced that the acquisition by the Government of the whole telephone system of the country in the near future, provided that the price to be paid is reasonable, would be more for the public advantage. It is because he holds this opinion that he consented to enter upon the negotiations now in progress, and he observes, from the report of the meeting of the 18th inst., that some, at any rate, of the representatives then present shared his opinion.

The second resolution of the Conference is as follows:—"That this Conference is of opinion that before any agreement is entered into with the National Telephone Co. for the purchase of their system within the London telephone area the terms of the proposed arrangement should be submitted for the consideration of the local authorities within that area, and in the event of Parliament appointing a Committee to consider purchase negotiations between the Postmaster-General and the National Telephone Co., that the local authorities within the area in question should be enabled to submit their views before such Committee, and steps be taken to secure accordingly."

Lord Stanley has already stated in Parliament that full opportunity will be given for the consideration by Parliament of any agreement between the Government and the National Telephone Co. which may be proposed, and the views of the local authorities of the London area will no doubt be expressed by their representatives in the House of Commons. He does not see his way to promise that an agreement, which would be applicable to the whole of the United Kingdom, should be directly submitted to local authorities representing only a limited part of the country.

If that were done, there would be no justification for not submitting the agreement to all local authorities throughout the country—a course which Lord Stanley can hardly suppose would be seriously suggested.

As regards the third resolution, which was to the effect that the Conference were of opinion that the charge for the use of a telephone in the London area should be materially reduced, Lord Stanley observes that the calculations on which this resolution rests have not been stated, but he desires me to point out that there are two systems of charge in London, the unlimited service system and the message rate system. The resolution would appear to have reference to the unlimited service system only. This system, in Lord Stanley's opinion, is unsuitable for a modern telephone exchange service, and owes its continuance to the force of custom and the demands of a limited number of large users.

As regards the charge—namely, £17 a year—I am to point out that the Select Committee of 1898 reported that a charge of this kind could not be considered unduly high for the class of large users. The London exchange system is constantly increasing, both in the number of subscribers and the number of exchanges. A few years ago the number of subscribers was less than 20,000. At the present time it is over 50,000, with about 70,000 exchange telephones. The growth of the system has greatly increased its value to subscribers, but the cost of construction and maintenance has increased in even greater proportion, and this must

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necessarily be the case in every growing exchange system. It is clear, therefore, that no fixed rate for unlimited user can adequately correspond with such conditions. If fixed with regard to the cost of the service for a large exchange system, it must necessarily be prohibitive for small users, and, if fixed on the basis of the cost of a small exchange system, it must soon become unremunerative.

In Lord Stanley's view the proper method of charge for an exchange service is that which was recommended by the Select Committee of 1898, under which the payments of the subscribers are fixed in proportion to their user. The message rate system offered by the Post Office fulfils this requirement, and its advantages have been proved by its acceptance by more than 90 per cent. of the subscribers to the Post Office London system. In the United States where, during the last few years, the telephone exchange system has been largely improved and developed, methods of charge of this kind have been widely adopted, and have proved an effective means of increasing the number of subscribers.

The fourth resolution of the Conference had reference to the trunk line service. Lord Stanley desires me to say that the recent Telegraph (Money) Act has enabled him to begin the construction of a large number of additional trunk lines, involving an expenditure of about £300,000 before March 31 next. The work is now in progress and will be pushed on as rapidly as possible in order to meet the growing demands of this branch of the Post Office telephone service.—I am, Sir, your obedient servant,

(Signed) J. C. LAMB.

Another letter, the Chairman said, had been received from the Huddersfield Chamber of Trade which referred to the purchase of the telephone system of the United Kingdom, but this was nothing to do with this particular Conference. Their business only concerned the London telephone service. With regard to the letter from the Postmaster-General, since it was written a question was put to Lord Stanley in the House of Commons by Mr. Lough, one of the members for Islington, and the reply was that, "After careful consideration, I have arrived at the conclusion that it would not be in the public interest to exercise the compulsory powers of purchase reserved to the Postmaster-General by clause 17 of the National Telephone Co.'s licence. I shall, therefore, not give notice to the company under that clause, and I am unable to say at present whether the negotiations now in progress with a view to a voluntary sale will lead to a satisfactory result." In answer to a further question by Mr. Gibson Bowles, the Postmaster-General said: "There is plenty of work to be done by the telephone department without actually entering into direct competition with the National Telephone Co. If the negotiations fall through—I cannot yet say whether they will or not—the circumstances will be entirely changed, and then I shall have to consider what action we shall take as regards competition." Therefore the idea of purchasing the interests of the Telephone Company by arbitration—*i.e.* Stock Exchange prices—had been given up, and there had been a further promise that any agreement come to with the company would be submitted for consideration to a Parliamentary Committee before anything definite was done. Under these circumstances, he did not think there was much more work for the Conference to do. After all, a Conference of this sort was a demonstration, and it practically exhausted itself at the first meeting. That Conference had had the effect, so far as they could judge, of at least preventing the Government from giving an excessive price for the interests of the Telephone Company. He did not know that any of them objected to the purchase of the company so far as London was concerned as long as it was at a fair price. With regard to trunk lines, they had extracted a satisfactory reply from the Postmaster-General, and the only thing, he thought, that could be done was to pass one or two resolutions that had been prepared.

Mr. Deputy TURNER (City Corporation) then moved the following resolution:—"That the Postmaster-General, Lord Stanley, be thanked for his communication and be informed that the resolution of the Conference of representatives of the local authorities in the London area on May 18th was only intended to apply to the London area."

This was seconded and carried unanimously.

Mr. HUDSON (City Corporation) next moved:—"That a copy of the Postmaster-General's letter of June 6th be sent to each of the local authorities in the London telephone area, and that they be requested to bring the matter to the notice of their representatives in the House of Commons with a view to the interests of the telephone users and the taxpayers being properly protected."

This also was carried unanimously, as was a further resolution that a copy of the Postmaster-General's letter, as well as the minutes of this meeting, be sent to all the members of the Conference.

After some discussion, the following further resolution was carried:—"That this Conference do now adjourn, and that the City Corporation be requested to call another meeting of the Conference when the matter is again before Parliament."

A vote of thanks to the City Corporation for the loan of the Guildhall and to the Chairman for presiding closed the proceedings.

NATIONAL TELEPHONE CO.'S STAFF DINNER.

The eleventh annual dinner of the staff of the National Telephone Co. was held on Thursday evening last at the Trocadero Restaurant, London. Mr. Wm. E. L. GAINE (general manager) presided, and was supported by the Right Hon. Sir Henry Fowler. M.P. (president), Mr. George Franklin (vice-president), Lord Harris, Sir Albert Rollit, M.P., Sir Cuthbert Quilter, M.P., Sir J. T. Woodhouse, M.P., Mr. Charles S. Agnew and Mr. W. A. Smith, directors of the company. Among the guests were Mr. Henry Fedden, Mr. T. C. Jenkin, Mr. T. A. Welton, Mr. H. H. Lawless, Mr. D. Sinclair, Mr. H. H. Gaine, Mr. A. Dudgeon, Dr. Grosvenor, Mr. A. St. G. McA. Laurie, Mr. P. Hammarskjold, Mr. Max Byng and Mr. H. S. J. Booth. The officers of the company present included Mr. Albert Anns (secretary), Mr. Frank Gill (engineer-in-chief), Mr. S. J. Goddard, Mr. C. B. Clay, Mr. R. H. Claxton, Mr. A. Coleman, Mr. J. C. Chambers, Mr. F. D. Watson, Mr. R. Shepherd, Mr. C. J. Phillips, Mr. F. Cowley, Mr. A. Cotterell, Mr. T. A. Prout, Mr. W. W. Cook, Mr. L. H. Lowe, Mr. W. V. Morten, Mr. W. A. Valentine, Mr. E. J. Hidden, Mr. C. M. Bailey, Mr. R. C. Bennett, Mr. G. Hooper, Mr. A. Perkins, Mr. C. H. Sibley and Mr. J. Scott, and many others. The entire staff of the company now numbers nearly 13,000 members.

After the loyal toasts had been honoured,

The CHAIRMAN proposed the toast of "The National Telephone Co.," and gave a short history of its progress. They had, he said, now at work throughout Great Britain and Ireland 1,095 exchanges, an increase of 45 during the past year, while the number of subscribers who had joined their system in the same period had risen by nearly 40,000 to a total of 300,000. In his last report to Parliament, the Postmaster-General stated that 84,000,000 inland telegrams were sent during the year. This company's messages increased during the year by 94,000,000, the aggregate number sent being at the rate of 938,000,000 per annum. Comparing the position of the business 10 years ago with to-day, he said that during that period their exchanges had increased by 103 per cent., their subscribers by 275 per cent. and the number of messages sent by 283 per cent. The cost of the messages (and this was a significant figure) had been reduced from 0·72d. to 0·41d. Whereas the company's gross revenue was about £750,000 10 years ago, it was now just on £2,000,000. They had had many difficulties to contend against, but he thought that the record of the past year's working was nothing to be ashamed of. As to the future, it was difficult to say much in view of certain things which were going on. This company had succeeded, in spite of many impediments, in placing the telephone service of the United Kingdom well to the fore among the great countries of Europe. He was bound to acknowledge, however, that it was behind the great Republic on the other side of the Atlantic. That was no fault of theirs; it was the fault of those who expected them to make bricks without straw. In his humble judgment the company was never better organised or in a sounder financial position than to-day, and, given reasonable conditions for doing their work, the public would have no reason to complain that it was unable to bear its full share in the development of the telephone service (cheers).

Sir HENRY FOWLER, M.P., in responding, said that he agreed with every word of the chairman's marvellous story as to the company's progress. There was one respect in which he thought it was not maintaining its former standard. Up to, perhaps, this year the company was the most abused and most hated company in the kingdom, but he believed that the tide had turned and that its unpopularity was subsiding (hear, hear). That was due, of course, not so much to those who directed it as to those who carried on the business and provided an improved and efficient service. They could not forget the unfair way in which the company had been treated over a long series of years. But he knew of no competitors who were supplying a better or cheaper service than they were supplying, and he could give figures to show that, contrasting the cost of installation, the cost of management and of distribution the National Telephone Co. stood at the top of the tree so far as Europe was concerned. He concurred in what Mr. Gaine had said as to America. The telephone was a success there for two reasons. In the first place, the law and the Government did not attempt to thwart and throttle the industry, but granted it those facilities which such an undertaking had a right to demand. Another reason was that the American people found the money with which to carry on and develop the service. That was not so easy a task in this country. At this moment the company had thousands upon thousands who were crying out in different districts to be put on the service, and the only thing which prevented that being done was a question of pounds, shillings and pence. This great telephonic system, which had now become one of the necessaries of life, could not be developed without the expenditure of a largely-increased capital. The board considered that the present position of the company was satisfactory, but it must rest with the public, through its representatives in Parliament, to determine what its future was to be (cheers).

Mr. GEORGE FRANKLIN, who also responded, said he attributed the success of the company to the untiring zeal of the staff, whose interest in its affairs had been more than that which was met by the annual compensation awarded to them. What was wanted in the telephone service of this country was less red tape, a fair field and no favour.

Mr. W. A. VALENTINE proposed the toast of "The Directors and other Guests," and

Lord HARRIS, in reply, made a sympathetic reference to the death of Mr. J. Staats Forbes, and warmly eulogised his services to the company as its president. His lordship also expressed regret at the death of Mr. Heyworth, and spoke of his useful work as a member of the board. With regard to the suggested purchase of the company's undertaking by the Government, he said that if anything of the sort should take place, he was certain that the Post Office would not be able to dispense with the services of Mr. Gaine (hear, hear), and he felt sure that the business would not be better done without the assistance of the company's staff. Of course, the directors would have to disappear if the undertaking were acquired; but unless cash was more abundant than it seemed to be just now, he did not see how the shareholders were to be got rid of (laughter). The information which Mr. Gaine had brought home from his visit to the United States had made him (the speaker) doubt whether, after all, the best way of developing the telephone service of this country would be by its being monopolised by the Government (hear, hear).

Sir ALBERT ROLLIT, M.P., also responded to the toast in a humorous speech.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Emanation and Radiation.—M. Berthelot puts down some considerations on the subject of the new emission discovered by Blondlot which are intended to guide further research into the field of emanations in general. He points out that many of the so-called emanations may be due to gaseous matter condensed on solids, and which can only be discovered by the most delicate chemical reactions. Volatile substances contained in the atmosphere may be condensed at the surface of bodies, or emanations may proceed from traces of organic matter derived from living organisms. Some of these organic matters adhere in an unaltered state. Others produce phenomena of hydration, oxidation and chloridation such as may be demonstrated in the case of metals and alloys placed in contact with alcohol, ether or chloroform. The emanations observed may be of complex structure. Thus the emanation of phosphorous, the best hitherto known, contains not only phosphorous vapour but also the vapour of several of its oxides, ozone, water and nitric acid. One of the difficulties of modern research is that the imponderable reactions are becoming more numerous and more delicate, and cannot be followed up by means of the balance, to which chemistry owes its rank as an exact science.

[BERTHELOT, *Comptes Rendus*, June 20, 1904.]

Time Signals by Wireless Telegraphy.—G. Bigourdan makes a proposal for the wireless distribution of time signals, which he has already subjected to some satisfactory tests. The directing clock, which breaks an electric contact every second, works a relay which, in its turn, sends a current into the primary circuit of an induction coil furnished with an oscillator. The secondary circuit of the coil thus provides an oscillating discharge of very short duration, which passes regularly every second. One of its poles is earthed, while the other is connected with an antenna several metres high. The author tried two different receivers, one of them being a Popoff-Ducretet radio-telephone, while the other was an ordinary wireless receiver provided with a band chronograph passing 1cm. of band per second. He obtained satisfactory transmissions over a distance of 2km. In view of the accuracy of modern chronometers, the author does not consider it necessary to number the minutes, but he would make an interruption at every tenth second. He points out the advantages which a general use of such a system of distribution would confer upon watchmakers and the makers of scientific instruments of precision.

[G. BIGOURDAN, *Comptes Rendus*, June 27, 1904.]

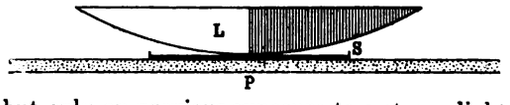
Radio-activity of Fango.—Fango is a fine mud which collects about the thermal springs of Battaglia, in Lombardy. Its emanation is used for curative purposes on account of the stimulating action it appears to exert upon the circulation. F. Müller has examined it for a possible radio-activity which might account for the stimulating action observed. He first tested the fango cellar itself, and found a radio-activity considerably in excess of that ordinarily prevalent in cellars. He then sucked air through the fango, and discovered a considerable activity, which decreased with the time. The rate of decrease resembled that of radium more than any other rate, but did not completely correspond to it.

[F. MÜLLER, *Physikalische Zeitschrift*, July 1, 1904.]

Photographic Records of N-Rays.—R. Blondlot describes minutely an improved method of recording N-rays by photography which should enable everyone to satisfy himself of their objective existence. N-rays from a Nernst filament are concentrated upon an electric spark-gap by means of an aluminium lens, focussing being done by watching the brightness of a piece of ground glass illuminated by the spark. The spark terminals, which are of platinum, should have a regular convexity, and should be exactly opposite each other. To get a sensitive spark, the terminals are placed in contact, and then slowly drawn apart until the spark begins to diminish in brightness. At this maximum of brightness the spark also possesses its maximum of sensitiveness. The sensitive plate is placed behind the ground glass, and the latter is covered with black paper in which is cut a hole some 18mm. in diameter. With the same exposure two different impressions are taken, one with the N-rays and one without. When the plate is developed the N-ray exposure comes out first, and if a slow developer is used it is possible to so arrange the development that only one impression shows in the final result. A good expedient for eliminating heat effects is to make exposures with the N-rays screened off with moist cardboard, and then repeating the exposure with cardboard soaked in a saline solution, which transmits the rays. The author says he has performed these experiments a great many times without a single failure, and in presence of a number of physicists who visited his laboratory to test his results.

[R. BLONDLOT, *Comptes Rendus*, June 27, 1904.]

Radiation from Zinc.—J. Blaas and P. Czermak describe some new photographic effects from zinc which they attribute to a radiation rather than a chemical action. In the most significant experiment described, a glass lens, L, with one half of its surface covered with black paper, is placed on a sensitive plate, P, and between the two is laid a circular plate of zinc, S. This plate is covered with black paper below, and also round the rim on the top. After 24 hours' exposure the plate shows on development a semicircular blackening outside the circle where the zinc lay, but only on the side where the lens has not been covered with black paper. The authors conclude that the radiation which produced the blackening must have been reflected by the clear glass, and that it is, therefore, not an emanation. They claim to have proved by the interposition of coloured screens that the radiation belongs to the blue end of the spectrum. The action is greatly increased by covering the zinc with a thin layer of glycerine and then smoking it. They have discovered a similar activity in a large number of sub-



stances, but only on previous exposure to a strong light. One of the best is yellow packing paper. They call these substances "photechic" substances. The action is always accompanied by the evolution of ozone.

[BLAAS and CZERMAK, *Physikalische Zeitschrift*, July 1, 1904.]

The Ponderable Emission.—The emission discovered by Blondlot behaves like an electric convection current, and can, therefore, be deflected by electric and magnetic forces. The discoverer describes several experiments to illustrate this fact. A five-franc piece is suspended horizontally, and a sulphide screen is placed 50cm. below it. The luminosity of the sulphide screen is increased by the impact of the ponderable emission as it falls down through the air in a vertical line. If now a magnet is brought near that vertical line, the luminosity decreases again, although the direct effect of the magnet upon the screen, according to Gutton, is an increase of luminosity. In repeating the experiment under more rigorous conditions, the author allowed the emission to fall between the poles of two bar magnets cased in lead. The field due to the magnets was not more than 100 units. He thus obtained, not one, but three jets of emission, one travelling along the vertical as before, and the others deflected in the plane normal to the lines of force. The deflection, after a fall through 64cm., amounted to about 11cm. for both jets. The effect is easily explained by supposing that the emission consists of a jet of mixed particles, some of which are positively and some negatively electrified, while others again are neutral. This is confirmed by the fact that one of the jets is attracted by a rubbed glass rod and the other by rubbed resin, while the central one is attracted by neither. The magnetic deflection is in a sense which accords with the above explanation. The author also announces that a slight irregularity of the path of the jets was found to be due to currents of air. This means that the air is capable of conveying the emission. Hence, also, the emission can exert a drag upon the air, and, therefore, experiences a frictional resistance in passing through it. This accounts for the fact, already specified, that the parabola described by a jet projected horizontally is not perfect, but has a vertical asymptote, like the path of a projectile shot horizontally in a resisting medium.

[R. BLONDLOT, *Comptes Rendus*, June 27, 1904.]

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THE SUPPLY OF ELECTRICITY BILL.

Four out of the 14 clauses of the Supply of Electricity Bill were passed by the House of Lords Committee on Monday. The first clause is an important one dealing with the compulsory acquisition of land for generating stations, and its effect will be to put electricity undertakers in a better position than hitherto with regard to actions for nuisance, and prevent a repetition of the series of applications for injunction which have been made in connection both with company and municipal-owned electricity works during the past few years. As the law stands at present, an electricity undertaker working under an ordinary Provisional Order must acquire the site for his generating station wherever he can obtain it, and is frequently unable to buy the neighbouring property. When the works are started, the occupants of the neighbouring houses are in a position to apply for an injunction against the owners of the electricity works if they can prove that the works create a "nuisance" by reason of noise, vibration, smell or other causes, and these wily neighbours can continue this persecution until the electricity undertakers consent to buy them out at an exorbitant price, a process which one of the counsel in the Committee room on Monday described none too harshly as blackmail. Under the first clause of the new Bill, the undertaker will be able to apply to the Board of Trade under the usual Provisional Order procedure for power to acquire land compulsorily or for power to utilise for a generating station land already owned by the undertaker, but employed for other purposes. Moreover, in addition to being given a means of buying by compulsion neighbouring property which might be affected by the running of the works, the supply undertaker's position is to be made still more secure by a new sub-section to the clause, passed on Monday, to the effect that, when land is acquired under these conditions, the undertaker will not be liable to action for nuisance unless it can be proved that he has been carrying on his undertaking negligently in this respect.

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Consideration of the second clause, authorising the grant by Provisional Order of powers to break up streets outside the area of supply in order to connect up outside generating stations, was deferred, but a lengthy discussion took place on clause 3. This clause, in the same way as the two preceding ones, is to enable procedure by Provisional Order instead of by special Bill in the case of certain additional powers. By the clause the Board of Trade will be empowered to grant to a company a Provisional Order authorising it to supply "in bulk" to other companies, persons or local authorities. The local authorities desired to have similar powers, but it was pointed out that it would not be advisable to make it easier for a local authority to obtain permission to supply electric power in bulk to companies outside its area, as this would be trading pure and simple outside the local authority's own district. The provision of the clause was, however, extended to a local authority desiring to supply neighbouring local authorities. This addition was strenuously opposed by the gas interests, it being argued, not without some degree of justice, that a local authority should not be allowed to extend its trading powers outside its own area to the smallest extent without seeking the consent of a mass meeting of ratepayers. It is necessary to call such a meeting before the promotion of a special Act, but not in the case of a Provisional Order. Clause 8, to rationalise the law as to the certification of meters, was explained by Mr. A. P. TROTTER, the electrical adviser to the Board of Trade. As there was no opposition to it, it was taken out of its turn and passed with merely an unimportant verbal amendment.

The fourth clause excited much opposition. Its first sub-section gave the Board of Trade power to dispense with the 42 years' purchase clause of the 1888 Act when granting Provisional Orders, and it was passed by the Committee in view of this alteration in the law having been so distinctly recommended by Lord CROSS' Joint Committee of 1898. The second sub-section related to cases in which the purchase clause applied. At present, if a company supplies a district from a generating station outside the area, the local authority can buy the part of the undertaking within its area at the end of 42 years on "tramway terms"—*i.e.*, without allowance for goodwill, &c.—but has no claim on the external generating station. The sub-section under consideration was for the purpose of extending this power of purchase to the external generating station, when the station supplied not more than one local authority's district, and did not supply "in bulk" only, in which category, however, all existing outside stations would be excluded from the new provision. At the instance of the London County Council, however, the Board of Trade consented to modify the clause by the addition of a proviso that when the station supplied the districts of two or more local authorities, the Board of Trade might grant these authorities a Provisional Order giving them permission to buy the station on the above terms. Naturally, the large London companies now supplying under these conditions objected to this, as it would make them liable in 1931 to sell the large stations they had built under special Acts which did not include the purchase clause. They said that they preferred to do without the other beneficial provisions of the Bill altogether rather than submit to this, and the Committee at once took them at their word and amended the much-discussed clause as suggested by the Board of Trade, with the addition that any existing companies which would be affected by the clause might, on giving notice to the Board of Trade within six months of the passing of the Act, take none of the benefits and incur none of the liabilities of the Act.

These four clauses have been passed, and although the Parliamentary Session is drawing to a close and 10 more clauses and several propositions for additional clauses remain for consideration, the Committee adjourned for a week. Moreover, it is by no means sure that they will complete their deliberations on the Bill in one or even two more sittings, as there will be stern opposition to some of the clauses, notably to clause 6, which is to give the Board of Trade power to dispense with the consent of the local authority in granting Provisional Orders. An amendment has been conceded by the Board of Trade, but it will not give the local authorities all they want. As we pointed out last week, it is improbable that the Bill will pass this session as business in the House of Commons is in a congested state. Its only chance would be in the event of all parties affected by the Bill agreeing to abide by the decision of the House of Lords Committee and to allow the Bill to go forward as a non-contentious measure through the Lower House. In any case, however, the work of the House of Lords Committee is not being entirely thrown away, as, if the Bill fails to pass this session, the Board of Trade will, doubtless, adopt the various amendments when bringing up the Bill again next session.

TESTS OF WILLANS ENGINES WITH HIGHLY SUPERHEATED STEAM.

We referred briefly in a note last week to an interesting pamphlet issued by Messrs. Willans & Robinson, of Rugby, in which they set forth some valuable technical information with regard to their well-known central-valve engines working with superheated steam. In the following will be found a brief résumé of the contents of the

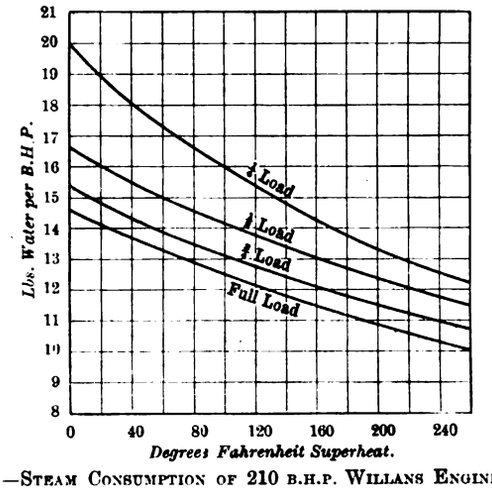

FIG. 1.—STEAM CONSUMPTION OF 210 B.H.P. WILLANS ENGINE AT VARYING LOADS AND DEGREES OF SUPERHEAT.

Triple expansion, condensing; 400 R.P.M.; 185lbs. B.P.; 28in. vacuum.

pamphlet, together with a diagram showing the splendid results which the firm has achieved with very high superheat. It appears that a number of Willans engines have been running for some years past with superheated steam, the results, however, are only now being made public—*i.e.*, after prolonged tests have satisfied the makers that high temperatures have no detrimental effect upon the working parts of their engines. Many machines, it is said, have been running in stations using steam at a temperature of 600°F. with perfectly good results, and careful tests have been made up to temperatures of 700°F. in order to ascertain their behaviour under any exceptional fluctuations of temperature. These tests, we understand, have been equally satisfactory. It is interesting to note that the firm have observed that the quantity of lubricating oil used is usually less than with saturated steam. The price of the special oil used appears to be moderate. It is claimed that the symmetrical form of the Willans cylinders and the absence of irregular-shaped valve chests, of heavy flanges, &c., renders distortion under high temperatures impossible; also that the absence of white metal or soft metal packing in the glands removes one of the most frequent sources of trouble with superheat. The glands are packed with phosphor-bronze or cast-iron rings. The gland rings, piston rings

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and valve rings are all spring rings, not solid rings; consequently, while always remaining tight, they always have sufficient clearance at all temperatures, and work equally well however much the temperature may vary, an important point in view of the difficulty of maintaining a constant superheat. Engines with solid valves must have them fitted to give a working clearance at the highest temperature required, and at lower temperatures there is leakage. The rings and springs being of cast iron, are not in any way affected by high temperature as is the case with steel springs. They do not, therefore, lose their efficiency under superheat, and the fact that they are steam packed is an additional guarantee of tightness under all conditions.

Fig. 1 gives some steam consumption curves of a 210 H.P. triple-expansion Willans engine.

MOTOR STARTING SWITCHES AND RESISTANCES.*

BY F. O. HUNT.

It is well known that in a general way the subdivision of a starting resistance should follow a geometric law. The quantities which require special attention are—the current increment at the instant of passing from one stud to the next, the "sparking voltage" between successive studs, and the connection of these with the constant ratio of the geometric progression and the figure representing the fraction of the whole armature-input which is lost in the armature windings. It has been shown that, if a limitation on the increment of current-demand is fixed by the suppliers, the current curve in starting up the motor must be of the form shown in Fig. 1; and that to obtain a current-fluctuation over a constant range in the "saw-tooth" portion of the curve, the resistances connected to those studs of the starter must be arranged in a descending geometric progression. Let V = Volts of supply; P = H.P. of motor; η = Efficiency of the motor, stated as a decimal; $\lambda = C^2R$ loss in armature, stated as a decimal (*i.e.*, the fraction of the armature-input at full load, which is lost in the armature conductors); n = constant in the geometric progression; s = number of contact

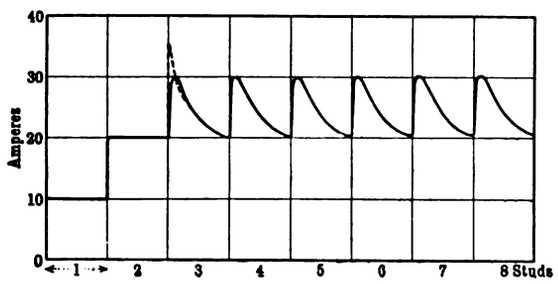

FIG. 1.

studs in the speeding-up portion of the switch; c_1, c_2 = final back E.M.F. of armature with switch on successive studs; C_s = steady value of current on any of the speeding-up studs; C_i = current increment on passing from one stud to the next; r_1, r_2, r_3 = resistance in circuit when switch-blade is on successive speeding studs.

Assuming that the law of geometric division on the speeding-up studs is established, and that we are considering a case in which the torque required from the motor is approximately the same at all speeds, we have for the first term of the geometric progression

$$\frac{V}{P \times 746/\eta V} = \frac{\eta V^2}{P \times 746},$$

and for the last term (*i.e.*, the resistance of the armature)

$$\frac{V\lambda}{P \times 746/\eta V} = \frac{\eta V^2 \lambda}{P \times 746}.$$

But the ratio last term/first term $= n^{(s-1)}$,

$$\therefore \quad n^{(s-1)} = \lambda \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (I.)$$

or

$$s = 1 + (\log \lambda / \log n) \quad . \quad . \quad . \quad . \quad . \quad . \quad (II.)$$

It may be noted in passing that λ is a quantity which has only a comparatively small range of variation. From 5 H.P. to 50 H.P., at ordinary speeds, this factor varies from about 0·04 to 0 02.

Now consider the nature of the current increments during the speeding-up of the motor. To obtain the true values of these would be an exceedingly complicated matter, owing to the effect of self-induction in the armature; but we can quite simply obtain an expression for their utmost limiting value on the assumption of no self-induction in the armature, and get at the actual relation between this and the true effective value by direct experiment. If r_1 = resistance in circuit when switch is on first speeding stud, then $r_2 = nr_1$ = resistance in circuit when switch is on second speeding stud. Evidently the limiting value of current on the blade touching the second stud $C_2 = (V - e_1)/nr_1$, but $C_s = (V - e_1)/r_1$, therefore $C_s/C_2 = n$, or $C_2 = C_s/n$. Therefore current increment $C_2 - C_s = (C_s/n) - C_s$, therefore $C_i = C_s(1-n)/n$. Now, since the current increment is often specified, we may write

$$n = C_s/(C_s + C_i) \quad . \quad . \quad . \quad . \quad . \quad . \quad (III.)$$

Substituting this value in (II.)

$$s = 1 + \frac{\log \lambda}{\log\left(\frac{C_s}{C_s + C_i}\right)}. \quad . \quad . \quad . \quad . \quad . \quad (IV.)$$

This gives at once a means of determining the number of studs to fulfil a given specification, provided we have been able to experimentally determine the proportion existing between the calculated increment and the actual value as modified by the inductance of the armature, for the kind of load with which the motor is to be used. Thus, supposing this ratio to be, say, 7 to 5; when a 5-ampere limit is imposed, a motor giving 25 H.P. at about 850 revs. per min. on 440 volts would require about 28 studs in the speeding-up portion alone.

There remains another quantity which, while not affecting the working of the starter at any particular time, has a very serious effect upon the lasting capabilities of the switch—viz., the "sparking voltage" between studs. This quantity is evidently the drop of volts which takes place over the section of resistance between the two studs concerned. In the speeding-up portion these are $C_s(r_1 - nr_1) = C_s r_1(1-n)$; $C_s(nr_1 - n^2 r_1) = C_s r_1(1-n)n$; $C_s r_1(1-n)n^2$, &c. Obviously, since n is fractional, the worst condition is that expressed by the first term, and since $C_s r_1$ = the supply voltage, it is easy to see which is the earliest term which will comply with a given limit of sparking voltage. Up to that point, of course, the resistance sections must be made equal to this section, thus increasing the number of studs necessary for the accommodation of the required total value.

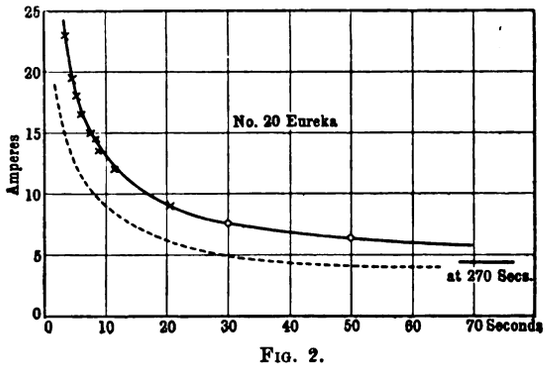

FIG. 2.

If full-load current is not allowed to pass through the motor, with the switch-blade on the first contact stud, there still remains for consideration the question of how the additional resistance shall be subdivided. Obviously, if we only have to comply with a current-increment limit, the simplest plan is to divide it equally so as to give the limiting increment at each contact; but here again a consideration of the sparking voltage compels an increase in the number of studs. Calling these initial studs *a*, *b*, *c*, &c., and using the letters as subscripts to indicate the currents, resistances and sparking voltages occurring at those studs, we have for sparking or "flashing voltage" on stud *b*,

$$f_b = C_a r_a - C_a r_b, \qquad f_c = C_b r_b - C_b r_c, \qquad V = C_a r_a = C_b r_b,$$

$$\therefore \quad f_b = V\left(1 - \frac{r_b}{r_a}\right) \quad \text{and} \quad f_c = V\left(1 - \frac{r_c}{r_b}\right), \quad \therefore \; r_b/r_a = r_c/r_b.$$

That is, r_a, r_b, r_c, &c., are in geometric progression between the limits V/C_a and V/C_s, the constant factor being

$$= \frac{(V-f)}{V}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (V.)$$

It would appear to be likely to lead to greater satisfaction on the part of the users if specifications were made to include a limit on the sparking voltage.

With regard to expression (V.), since the sparking voltage is usually only troublesome when the contact-maker is drawn back, the increase in the number of studs might be avoided by the construction of a switch, on which any retractile movement of the starter contact should cause the circuit-breaking member of the switch to come into action. This could also be made to yield a further assistance by allowing the resistance winding to be made up in an inductive form, and so make that property assist in reducing the current peaks during the speeding-up; but so far as the writer is aware no maker has as yet adopted any such device.

* Abstract of a Paper read before the Birmingham Local Section of the Institution of Electrical Engineers.

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If it be assumed that the temperature of "just-visible-red" is that at which destruction of the resistance material begins, it is of value to know what time it takes a given wire at various currents to get up to that temperature. Fig. 2 is a record of some experiments in this direction. The wire under test, as an open coil, was supported by its ends in an absolutely dark cupboard, and readings were taken of the time during which a certain current had to flow through the wire in order to raise its temperature from that of the atmosphere (say 12°C.) to the temperature of "just-visible-red" (say 500°C.). The dotted curve is suggested for practical use. Curves such as these having been obtained for all necessary sizes of wire, under the same conditions as those present in the starter, it is possible to lay out the starter windings with some definite idea of the same degree of safety being obtained in all parts of it. A few representative values are given in the table below.

Table I.

S.W.G.	12	16	20	S.W.G.	12	16	20
Time in sec.				Time in sec.			
2	124·0	55·5	17·6	14	66·5	26·3	7·7
4	114·0	47·6	15·0	20	56·2	21·7	6·4
6	101·0	39·0	11·6	30	45·5	17·8	5·15
8	87·5	33·1	10·0	50	35·3	13·8	4·22
10	77·5	30·5	9·0				

DISCUSSION.

Mr. BORNAND, in a communication, said that the author's remark that it might be advantageous to use resistance winding to be made up in inductive form for reducing the current peaks during the speeding up, was at first sight a very tempting one, but the important question of space and cooling prevented the arrangement of the resistance coils in such a way as to produce an appreciable amount of inductive effect. To his knowledge there was a certain make of starter in which flat strips were wound on iron cores with asbestos insulation, and some small inductive effect had been noticed.

Mr. H. W. W. DIX said he had found in designing standard starters not made to any particular specification, that if they were designed for about 0·6 full load it made the rushes of current at each step reasonable whether you started the motor at full load or, say, down to a quarter load. It might be noted that the formula in the Paper was for starting against full load, and that its value would have, of course, to be varied for starting against loads other than this. He thought sparking could be overcome, even with a moderate number of contacts, by good mechanical design. The switch shown in Fig. 3, which he had recently designed, was of a simplified drum type the drum being worm-shaped and geared with a rack to give the slow motion. The circuit breaker, A, which was provided with a magnetic blow-out and made and broke the circuit, could only be closed with all the resistance in circuit, this being effected by winding the drum into "all in" position when the lug B engaged with the lever A. The resistance was prevented from being left in circuit by the auxiliary switch C, which always short-circuited D unless it was held off by hand or until the motor was brought up to full speed, when the drum held it in the off position. While starting C was held off by the left hand until all the resistance was cut out, but should the operator leave any of the resistance in circuit, the motor stopped directly he released C. This auxiliary switch was a weak point in the design, but practical experience with it had demonstrated that it was quite simple to use, and, as it was a simple mechanism free from large range springs, it was considered to be quite justifiable. The design had been tested on a 50 H.P. 460-volt motor, starting against full load, with very satisfactory results, the switch being found easy to handle and free from burning at any of the contacts.

Mr. GOTT remarked that with regard to sparking, he might say his own practice for four or five years had been to sub-divide starters in this way: The total resistance was divided into three parts. The first part, starting at the armature, was divided geometrically into sections, and was carried up to a point at which the resistance within the section contained the maximum difference of potential allowed. The second part contained equal sections, and was taken up to the point at which the maximum current only would flow with stationary armature, and from that point to the end was the third section, which consisted of a geometrical division with a new factor, that factor being found by the ratio of the last equal section to the total resistance then in circuit. The resistances plotted out to scale followed a curve with "geometrical" ends merging into a straight line centre. The values of total resistance to any section was easily found by the usual slide rule methods, but the actual factor of increment and sparking potential difference allowable was very largely a matter of compromise to suit the total number of section connections in the switch, owing to the cost being a limiting factor to the number adopted. His own practice with regard to the "sparking voltage" had been 30 to 35 volts with a current of 100 amperes, but he had used as low a value as 25 volts with 100 to 200 amperes and about 60 resistance sections to satisfy rigid specifications.

Dr. W. E. SUMPNER thought that it had not been stated sufficiently clearly by Mr. Hunt that his law of determining the different steps of the resistance depended on the assumption that there was a fixed current corresponding to the normal torque of the motor. But the law would depend upon the starting current, and the starting resistance would thus have to be designed for the particular load against which the motor started. He did not think the current rush in a motor could be measured except by an oscillograph. The definition of the sparking voltage seemed to him wrong, and he thought that the C.R. drop of volts was only the minimum value of the sparking voltage. The most important source of the sparking voltage was the self-induction effect owing to the sudden change of current. That made him rather doubt the value of the suggestion of making up the resistance winding in an inductive form.

Mr. R. A. CHATTOCK said he had never found the life of the motors suffer from faulty design or construction of the starters. One very great fault in them was that the wires burnt out, and that was due chiefly to the nature of the wire used. He had always specified German silver or other wire that was not affected by oxidation, and he had never had any real trouble with starters built in that way. A specification for a motor starter should include the maximum current per stop.

Dr. T. TORDA-HEYMANN mentioned the case of a three-phase motor starter, the flat strip resistance coils of which had been wound on an iron core and were insulated with asbestos. Each coil was covered with projecting iron rings which were ribbed to assist the cooling. The inductive effects of the resistance coils caused more trouble than advantage. He suggested the following maximum permissible temperatures for materials such as German silver, &c.:—For switches for starting up only, 300°C.; for switches on intermittent work, 250°C.; for speed regulators if placed separately, 200°C.; for speed regulators if placed on the switchboard, 100°C.

Mr. FORSTER said it was a fact that an increased sparking voltage could be obtained between the contacts if these were designed more heavily and disposed of in such a way as to admit of the heat being easily dissipated. By dividing the sliding contact into a number of fingers or laminations, making contact simultaneously on the block, the quality of the contact surfaces was greatly improved and the sparking due to mechanical causes was reduced.

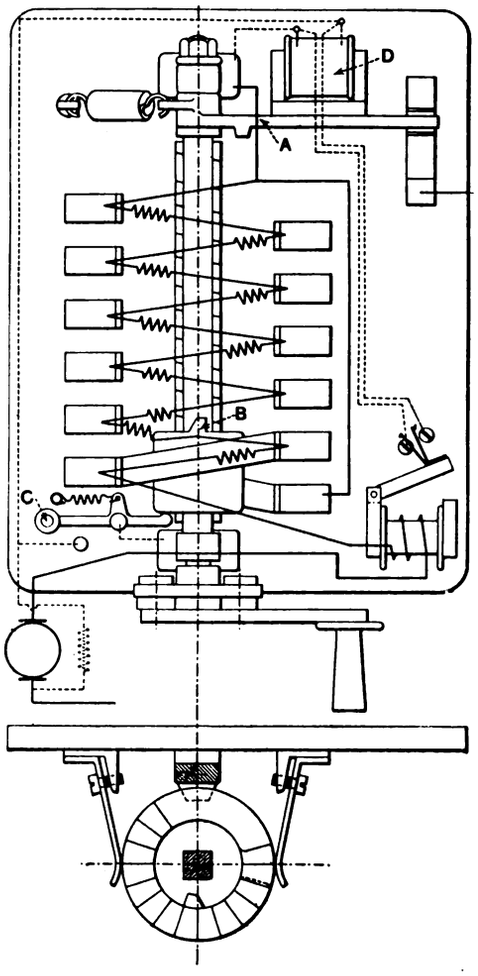

FIG. 3.

Mr. HUNT, in reply, agreed that the sparking trouble was possibly largely a mechanical matter and that it was to some extent a question of weight of metal tn the studs. With regard to inductive winding of the resistances, the idea was, of course, only applicable, as stated in the Paper, to those cases where there was a non-return action on the switch. He wished all station engineers would take note of Mr. Chattock's recommendation of 10 amperes per stud as a satisfactory limit on 440 volts, and would forthwith abandon the "5-ampere" specification. Referring to Mr. Foster's question whether the rounding or levelling of the top of the curve (Fig. 1) was really due to self-induction, or whether it was the result of the starting characteristic of the motor, he might say the results were obtained on a motor running light. The load was simply that due to the flywheel effect of the armature and pulley, this being chosen because its effects were the most suitable for record by the oscillograph.

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Mr. J. K. Catterson-Smith has sent the following communication with regard to Mr. Hunt's Paper.

At the conclusion of his Paper, Mr. Hunt has very kindly referred to some experimental work upon which I have been engaged. Fig. 4 was obtained with the aid of an oscillograph, and is the current taken by a direct-current motor starting against no load. The motor tested was a standard type Westinghouse 7½kw. four-pole 110-volt rotary converter run as a shunt motor. The poles were fitted with copper damping pieces. The

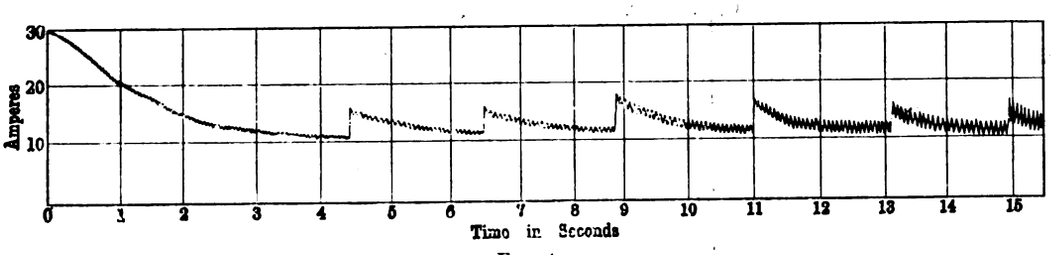

Fig. 4.

resistance of the armature, brushes and connections was 0·084 ohm; that of the oscillograph shunt, 0·060 ohm; that of the leads, &c., 0·290 ohm, giving a total of 0·434 ohm. Current was taken from a battery, the voltage used being 92, so that the speed was 1,200 revs. per min. The starting resistance, kindly lent for the experiments by Messrs. Bray, Markham and Reiss, was of the ratchet type. It had eight "speeding up" contacts, the resistance on each contact being given in the table. The current curve traced by the oscillograph was photographically recorded on a film, carried by a drum rotated slowly by hand gear. Intervals of time were marked on the edge of the film by arranging a pendulum contact to cause a small glow lamp to give a flash of light every half-second, this being focussed as a dot on the film. It will be noticed that the time base is not uniform, and the curve given is for this reason to some extent distorted. The maximum oscillograph deflection is normally small. In order to double the deflection an auxiliary voltage, sufficient to produce the maximum negative deflection, was permanently inserted in the oscillograph circuit, so that it was possible to work with a main shunt of double the value without injuring the oscillograph. The current peaks, calculated as in Mr. Hunt's Paper, and the actual values shown by experiment, are given below:—

Contact. No.	Resistances (ohms).		Current peaks (amperes).	
	Starter.	Total.	Calculated.	Actual.
1	2·64	3·07	30·0	30·0
2	1·66	2·09	14·7	14·7
3	1·13	1·56	14·7	14·7
4	0·60	1·03	16·7	17·0
5	0·315	0·75	15·1	15·1
6	0·182	0·62	13·3	13·2
7	0·090	0·52	13 1	13·1
8	0·045	0·48	12·0	12·0

The actual current peaks were obtained by averaging the values of three separate experiments, one of which is given in Fig. 4. The close agreement between calculated and actual values of the current peaks shows that the armature self-induction does not affect the peaks in the way suggested by Mr. Hunt. Armature self-induction, as applied to the problem of starting currents, should apparently depend upon the amount of distortion of the main magnetic field per unit increase of current in the armature. Owing to the "stiff" field of this machine, this effect seems to be small. Examination of the current curve, Fig. 4, shows that it is subject to a periodic fluctuation. While the resistance in the circuit is still large, this fluctuation is very small, but after the starting resistance is cut out, the amplitude increases to from 20 to 25 per cent. Measurement shows that this fluctuation corresponds in period to the revolutions of the armature. It was thought at first that this oscillation might be due to vibration of the frame or armature shaft, but it was finally found to be due simply to an excess of ampere-turns on one pole, the oscillation being suppressed altogether by reducing the ampere-turns of this particular pole by 5 per cent.

CORRESPONDENCE.

A NEW SINGLE-PHASE MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In *The Electrician* of May 13th I find a publication of the patent specification of the new single-phase motor manufactured by Messrs. Crompton & Co. (Ltd.), and in the issues of June 17th and 24th remarks on this subject by Mr. Schüler and Prof. Elihu Thomson, which indicate that the specification is not sufficiently detailed to enable the new features of the motor to be clearly understood.

The speciality which distinguishes the new motor from the original repulsion motor of Prof. E. Thomson is the fact that each rotor coil is short-circuited independently of all others, whilst it moves from the neutral position to the middle of the pole—that is, in a two-polar motor, over 90deg. *This angle is not affected by the number of rotor coils.* In Prof. E. Thomson's patent ordinary commutators are adopted, the number of segments being equal to, or a multiple of, the number of the rotor coils. For instance, in the case of three rotor coils, and, say, six segments, each segment would comprise one-sixth of the circle. In the "Crompton" motor the segments must cover 90deg., *and thus would have to overlap one another.* This leads to the use of *a separate commutator, or, rather, slip-ring, with interruptions for each coil.* Three coils would mean four slip-rings, the coils being star connected, and the fourth ring (a plain slip-ring) being common to all three. In actual practice the fourth ring is avoided by connecting the neutral point to the body.

The fact that each coil is dealt with individually—as regards short-circuiting and opening—*enables the motor to be designed* so

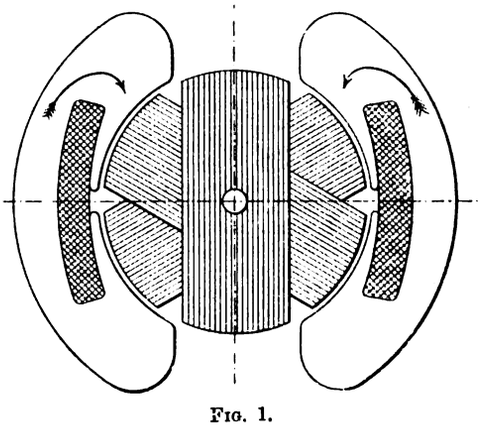

Fig. 1.

that—as our tests show—*it runs sparklessly over the whole speed range and starts against full load torque with less than normal current.*

Mr. Schüler will find that, by making the segments so long that the coils are short-circuited over 90deg., and by using a neutral point connection even with an ordinary three-phase rotor, dead points are entirely avoided. Furthermore, Mr. Schüler will see from Fig. 1 that by inserting a gap in the middle of the pole slightly wider than the coil width, the coil is not exposed to any induction whatever whilst being opened.

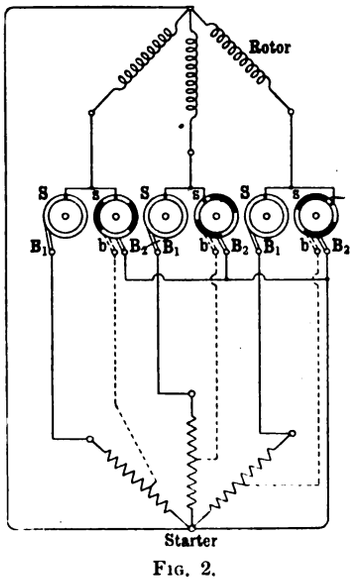

Fig. 2.

With ordinary induction motors, which are to start as repulsion motors, sparking is entirely suppressed by the arrangement shown in Fig. 2. SSS are ordinary slip-rings connected to the starter; *sss* are slip-rings with interruptions. By this way of connection the rotor coils are never entirely interrupted, but during part of the rotation connected to a resistance, the other part being short circuited. With a little extra starting current we can achieve absolutely sparkless running.

Applying the small extra brushes *bbb* connected to the middle of the starting resistance, the inserting of the resistance can be done quite gradually, and there is as little danger of

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sparking as if the resistance were put in by hand on the starting switch. As the motor gets up to speed the starter is gradually short-circuited.

In actual practice the rings S and *s* are joined in one and the brushes B_1 and B_2 are replaced by a single brush.

As, therefore, the motor differs from an ordinary induction motor only in the modification of the slip-rings, the price is only *slightly increased*, and certainly is far from that of a commutator motor.—Yours, &c., RUDOLF GOLDSCHMIDT.

Chelmsford, July 11.

A FERRARIS FIELD DETECTOR OF HERTZIAN WAVES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. L. H. Walter's letter, published in your issue of June 24th, referring to my detector of Hertzian waves, may I be allowed to make the following remarks:—

My experiments were not performed with an alternating induction, but with a system of polyphase currents, which give rise to a rotating flux (Ferraris field) of constant strength. Ewing and Walter, by surrounding the magnetic substance with a spiral trough which conveyed the high-frequency oscillations, observed a reduction of hysteresis; but with the conditions under which my experiments were performed there was an increase of hysteresis, as verified by two other observers who worked with the same magnetic substance, but whose apparatus was not so simple as mine. In my case, the magnetisation due to the oscillations act only on the steel disc, longitudinally, and for that reason I suggested that the physical explanation offered at the end of Ewing and Walter's Paper was not correct.

On the other hand, if my experiments are to conform with preceding researches, I can only think that, owing to the Hertzian waves, the cyclic area of hysteresis becomes sharpened, but at the same time the permeability of the steel increases in such a manner as to lengthen the curve, whose area thus becomes greater. But this does not suffice to clear up the reduction of hysteresis noted in Ewing and Walter's first experiments.

I have communicated a Paper containing the results of new and interesting researches on this subject to the Italian Institute of Electrical Engineers, and it was discussed on May 25th.—Yours, &c., Prof. RICCARDO ARNÒ.

Milan, July 6.

STIRLING BOILERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We note that in the description of the new two-phase station at Sheffield in your issue of the 18th inst., on p. 466, you intimate that two Stirling boilers installed at this station were built by the Stirling Co. We beg to point out, however, that these boilers have not been supplied by us, and are not of our standard design. In our design there are three steam and water drums, and only one mud drum, all connected by three banks of tubes instead of four banks, as described in your article. Your insertion of this correction in your next issue will much oblige.—Yours, &c.,

THE STIRLING COMPANY,
E. G. Constantine, Manager, British Branch.

Manchester, July 11.

[The boilers at the new Sheffield station were of the five-drum type, supplied by the Stirling Boiler Co. of Motherwell.—ED. *E.*]

ON THERMO-GALVANOMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I be permitted to correct the following errors in my letter of June 4th (*The Electrician*, June 24, 1904.)

Fifth paragraph, line 8. For "compression and expansion of the wire by the sound waves" read "compression and expansion of the *air* by the sound waves."

Third paragraph, line 2. Instead of "constantan or German silver," read "platinum."

At the time of writing I was under the impression that we had used a high resistance alloy of this type, but my assistant has reminded me that these were not found satisfactory, and that platinum and platinum-alloys were used instead.

In paragraph 6, line 3, insert the word "probably" between the words "can" and "be obtained," as I am not sure that trumpets were ever actually used in the experiments.—Yours, &c., REGINALD A. FESSENDEN.

Washington, D.C., July 5.

PARLIAMENTARY INTELLIGENCE.

SUPPLY OF ELECTRICITY BILL.

Lord Wolverton's Committee of the House of Lords resumed consideration of the clauses of this bill on Monday. It will be remembered that the preamble has already been passed. The bill was published in our issue of May 6 (p. 102), and a report of last week's proceedings in Committee will be found in our last issue.

The Hon. T. H. W. PELHAM, for the Board of Trade, said that he had had a conference with the Municipal Corporations' Association and the electric lighting companies with regard to a suggested amendment to clause 1. After carefully considering the matter, the Board of Trade had, therefore, suggested the three following amendments, which met with the approval of all the parties concerned:—

Clause 1, sub-sec. 1, after "compulsorily" insert "or to use."

Clause 1, sub-sec. 3, leave out "take land compulsorily," and insert "acquire compulsorily or use land for the purpose of a generating station."

Clause 1, new sub-section: "(4) The incorporation of the provisions contained in the schedule to the Electric Lighting (Clauses) Act, 1899, with a provisional order authorising the compulsory acquisition or use of land specified in the order for the purpose of a generating station, shall not have the effect of incorporating sec. 81 of that schedule with so much of that order as authorises such acquisition or use."

Lord STANLEY OF ALDERLEY asked if these amendments shut out a neighbour from compensation in respect of nuisance as well as preventing him from obtaining an injunction?

Mr. PELHAM said he thought it would.

Mr. FREEMAN, K.C., for the St. Pancras Borough Council, said that he did not want to be relieved from having to pay compensation if the work was carried on negligently; he only wanted to be relieved from blackmail.

Mr. SYDNEY MORSE, for the electric lighting companies of London, thought that with these amendments undertakers would not be liable either to actions in respect of nuisance or to compensation.

Mr. FREEMAN said he did not have much doubt as to what the effect of the amendment would be so long as the work was not carried on negligently; if it was, he thought it could be taken as undisputed that neighbours would be entitled to compensation for damage.

After a little further discussion the amendments were agreed to. Under the clause as it now stands, therefore, the Board of Trade may grant an undertaker a provisional order, authorising him to acquire compulsorily under the Land Clauses Act a new site for generating stations or sub-stations, to utilise for this purpose land already occupied by him for other purposes and to have exemption from clause 81 of the Electric Lighting (Clauses) Act, which at present renders him liable to action for nuisance, even if he can prove that he has not been negligent in the manner he is conducting his undertaking.

Mr. C. C. HUTCHINSON, on behalf of the Gas Companies' Protection Association, asked leave to withdraw the amendments which that body had submitted, and to bring up a new clause embodying them all later on.

The CHAIRMAN said the Committee had considered the position of the gas companies, and were quite agreed that some protection should be given to them. He would, therfore, be glad if Mr. Pelham and the Association would agree upon a clause based upon the amendments which had already been submitted.

The consideration of clause 2 was deferred.

Clause 3, relating to supply in bulk, was next considered.

The Hon. J. D. FITZGERALD, K.C., for the Municipal Corporations' Association, asked for the insertion of the words "local authorities" before the word "company" in the first line of sub sec. (*a*) of this clause. He said the object was to place municipalities in the same position as companies with respect to supplying electricity in "bulk" outside their areas. The Board of Trade had submitted an amendment to authorise local authorities to supply electricity in "bulk" to any other local authority, but he looked upon this as being too restrictive, and therefore asked to be placed in the same position as a company under this clause.

Mr. SYDNEY MORSE, on behalf of the London electric lighting companies, opposed the amendment proposed by Mr. Fitzgerald. He said the point here was to authorise the principle to grant local authorities that power which Parliament in every case hitherto, with one small exception, had refused to grant. On no less than five occasions had applications to this effect been made during the present session, but each one had been refused. He suggested that no special circumstances were suggested nor any special reasons given for the insertion of this power. The whole question of municipal trading was admittedly raised by the proposed amendment, but it had been held objectionable by Parliament that municipalities should have the power to raise rates upon their districts and risk them in trading outside their districts. Further, if the amendment were carried it would place local authorities in competition with the large power companies round about the districts, and thus expose the ratepayers' money to further risk. More than this, however, the local authorities refused to allow a company to supply in their districts, and yet they wanted to go outside and supply in competition with the companies. He also objected to the amendment of the Board of Trade, which gave a local authority power to supply another local authority. If this were allowed it opened up the way, possibly, for the formation of one of the largest power schemes in the country, and the insertion of the amendment in the bill would be a prima facie case for a large number of local authorities to combine to carry such a scheme

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into effect. No such thing was contained in the report of the Joint Committee of 1898, and he opposed both amendments.

Mr. CLEASE, for the Notting Hill Electric Light Co. and the Kensington & Knightsbridge Electric Lighting Co., opposed the amendments referred to by Mr. Morse for the same reasons.

Mr. C. C. HUTCHINSON, on behalf of the Gas Companies' Protection Association, also opposed these amendments. He said it was altogether objectionable to give local authorities such an unfettered trading power without being required to call the ratepayers together, which would be the case under a provisional order scheme such as was proposed. It would result in a considerable extension of the duties of a municipality under the Public Health Acts. He contended that it was never present in the minds of Parliament when electric lighting powers were granted to local authorities that the local authorities should be enabled to use them in order to engage in trading operations outside their district.

M. FITZGERALD, in reply, contested the statement by Mr. Morse that power to supply outside their district had never been granted to municipalities. He had been handed a list of five cases, and he also knew that it was contained in the Birmingham Act of last year.

Mr. PELHAM, for the Board of Trade, said that the point raised by Mr. Fitzgerald was not included in the report of the Joint Committee of 1898. The Board of Trade thought that to make it a general policy to allow local authorities to supply in "bulk" outside their districts to anyone would be dangerous, and that was the reason why they proposed to limit the supply to the neighbouring local authorities. If a municipality required to go in for anything bigger they should go to Parliament. The question of a general supply in "bulk" outside its district by a local authority placed the Board of Trade in a difficult position with regard to municipal trading, and he would rather Parliament decided the matter.

After consultation,

the CHAIRMAN said that Mr. Fitzgerald's amendment must be rejected, and the Board of Trade amendment accepted. There were four members in favour of this decision and one against.

The remainder of clause 3 was then considered, and several amendments submitted, including one by the Board of Trade defining a "bulk" supply authority.

Lord ROBERT CECIL, for the London borough councils, opposed, because he said it would introduce competition between companies and corporations.

Mr. SYDNEY MORSE, for the London electric light companies, said that the definition of a power company or a person authorised to supply in bulk had never been limited in the sense proposed by the Board of Trade amendment.

Mr. PELHAM said that it was important that bulk schemes should have a pretty wide field of operation. There was no intention, however, that power companies should supply anybody separately except those who had statutory powers to generate electricity for themselves.

After consideration,

The CHAIRMAN said that the Committee had decided to leave these sub-sections of the bill as it was originally drafted.

Clause 8 "Certification of Meters" was next considered.

Mr. A. P. TROTTER, said that the Electric Lighting Clauses Act, so far as meters were concerned, was drawn up before many of the present dry meters were in use and many of the provisions of the act were now obsolete. Very few meters had been properly certified, and it was proposed to amend clause 8 to remedy this state of affairs and to simplify the certification of meters.

The clause was then passed.

Clause 4, "Provisions as to the Right of the Local Authority to Purchase"

Mr. FITZGERALD, for the Municipal Corporations' Association, moved the deletion of sub-sec. 1, which gave the Board of Trade power to exclude the right of purchase by the local authority. He said that hitherto all undertakings authorised by provisional order were subject to purchase, and this power had hitherto been looked upon as the safeguard of the local authority. This was essentially a matter that ought to be dealt with by Parliament in every case.

Lord ROBERT CECIL, on behalf of the London borough councils, supported the amendment proposed by Mr. Fitzgerald.

Mr. LEWIS COWARD, for the London County Council, asked that London should be exempted from the operations of this clause.

Mr. SYDNEY MORSE, for the London electric supply companies, thought that as the Board of Trade had power to authorise "bulk" schemes under clause 3 they should have the power to dispense with the power of purchase asked for under clause 4.

Lord STANLEY OF ALDERLEY pointed out that the power to dispense with the right of purchase in clause 4 did not apply only to "bulk" schemes. It applied to any electric lighting undertaking.

Mr. PELHAM said there was no objection to London being dealt with separately.

Lord STANLEY: Are you willing to limit clause 4 to "bulk" schemes?

Mr. PELHAM: Yes; but I do not think it will remove all the objections.

Mr. FITZGERALD said that this would make an improvement, but he could not accept it, even with that modification.

The CHAIRMAN said the Committee were inclined to support the recommendations of the Joint Committee which were embodied in clause 4.

Mr. TALBOT, for the London County Council, then moved the omission of sub-clause (2) of clause 4 and the insertion of the following:—

"The power of the local authority to purchase an undertaking under sec. 2 of the Electric Lighting Act, 1888, both as respects undertakings authorised before the passing of this act and as respects undertakings authorised after the passing of this act:—

"(*a*) shall extend so as to authorise the purchase of any generating station, mains or other works used solely for supplying electricity for the purpose of the undertaking, notwithstanding that the station, mains or works are situated outside the area of supply or outside the district of the local authority; but

"(*b*) shall not extend so as to authorise the purchase by a local authority of any generating station situated in their district which is not used for the supply of electricity within some part of the district."

The bill at present laid down a different procedure where the works were situated within the area of supply than when they were situated outside, if more than one local authority was supplied, and the object of the bill was to remedy this.

Mr. PELHAM said the question raised in this case—viz., the generating station being outside the area of supply—was one that the Board of Trade felt could be dealt with by giving them power to issue a new provisional order authorising purchase, but he did not think the power to purchase should be included in the bill. He therefore proposed the following addition to the clause:—"And where any generating station, mains and other works are used solely for supplying electricity within the districts of two or more local authorities, but are not situated within any of those districts, the Board of Trade may, on application of all or any of those authorities by provisional order, make such alterations in this provision as the circumstances of the case may require."

Mr. E. MOON, K.C., for the Metropolitan Electric Supply Co., said he had no objection to clause 4, nor to the amendments, if they were not to be applied to existing undertakings. But he protested against any alteration in the position of his company under the terms of his concession, so far as his Willesden works were concerned.

Mr. PELHAM replied that such a station as that at Willesden could only be bought up by two or more local authorities after a provisional order had been granted by the Board of Trade.

Mr. MOON said he would rather be left alone, as he objected to any alteration of the conditions upon which existing companies had received their charters. If his request for the exclusion of all existing companies went too wide, he should ask for the exclusion of the Metropolitan Electric Supply Co. At the present moment the Willesden station of that company could not be purchased, but if purchase were sanctioned under clause 4 and the amendments, he would not have had the full concession of 42 years, as the station was only authorised in 1898, and it would be purchaseable in 1931 at the time when all the London electric supply undertakings would be bought up. Further, the undertaking would be purchaseable under the terms of the Electric Lighting Act, 1882, and not under the Lands Clauses Act, which took goodwill into consideration. He would, therefore, much rather prefer to be left with his Willesden generating station, because he had a business to carry on apart from the supply of electricity to the districts for which he possessed provisional orders. He could supply electricity from the Willesden station to anybody who cared to take it, provided they had power to break up the roads. For instance, the London & North-Western Railway Co. was at their very doors, and now that the electrification of railways was so much under discussion, it was possible that after 1931 he could arrange to supply an enormous amount of electrical energy to the London & North-Western Railway Co.

Mr. PELHAM again pointed out that the company could not be compelled to sell without a special provisional order was granted by the Board of Trade. Sub-sec. 2 of clause 4 only applied to stations supplying one district.

Mr. MOON replied that the Board of Trade had not that power now. Once the local authorities found it possible to buy the Willesden works there was not much doubt that they would endeavour to do so, and he would be harmed in the way he had indicated. It was not too much to say that the company would not have spent 1½ millions of money upon the works if they had known of the possibility of this act coming into existence. The London County Council had endeavoured to get a purchase clause inserted in the Act of 1898, but it had been refused. The Committee then held that the Willesden business was an entirely different business to that of supplying the various parts of London for which the company already had powers.

Mr. CLEASE, for the Notting Hill Electric Lighting Co. and the Kensington & Knightsbridge Electric Lighting Co., said that the joint station owned by these companies was probably the only other one in London in the same position as the Willesden station of the Metropolitan Electric Supply Co., and he would, therefore, adopt the arguments made by Mr. Moon. He did not want to part with his generating station under any circumstances or under any conditions. Should the clause and the amendments be adopted, however, he should ask that the purchase should take place under the Lands Clauses Act and not under the Electric Lighting Acts.

Mr. SYDNEY MORSE, for the other London electric supply companies, objected to the amendment of the London County Council and preferred the clause as it stood.

After consideration,

The CHAIRMAN announced that the Committee had agreed to strike out the amendment of the London County Council and to accept the Board of Trade amendment, with the following proviso:—"That any existing company which could come under the operation of this clause may, within six months of the passing of this act, by resolution of the company forwarded to the Board of Trade, take none of the benefits and incur none of the liabilities created by this act." This, he said, related to sub-sec. 2 of clause 4, and he would leave it to the parties to put the wording into a better form.

The Committee then adjourned until Monday.

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LONDON COUNTY COUNCIL (TRAMWAYS AND IMPROVEMENTS) BILL.

A Committee of the House of Lords, presided over by Lord Hampden, commenced consideration of this bill on Friday last week. Full particulars of the proposals of the bill were given in our issues for April 29, May 6 and May 13, when the measure was under consideration by Mr. Compton Ricketts' Committee of the House of Commons. Since, then, however, the tramway down Tottenham Court-road as far as Francis-street, which was sanctioned, has been struck out of the bill as the result of a discussion upon third reading in the House of Commons (see *The Electrician*, June 17. p. 359). The only opposition now is at the instance of a number of frontagers along a few of the tramways. Mr. Lewis Coward, K.C. and Mr. Roskill, K.C., represented these opponents, whilst Mr. Erskine Pollock, K.C., Mr. E. Moon, K.C., and Mr. Du Cane appeared on behalf of the London County Council.

Mr. E. POLLOCK, in opening the bill so far as the opposed tramways were concerned, said that tramway No. 11 began at Forest Hill railway station and terminated at a point in the Lewisham High-road, where it effected a junction with No. 12. The length of the line was 2 miles 5 furlongs, and the estimates for the construction amounted to £109,710. The street improvements would cost £104,000. Tramway No. 12, which was 1¼ miles long, ran from the termination of No. 11 in the Lewisham High-road to New Cross. The construction of this line would cost £58,000 and the necessary street widenings £17,200. Tramway No. 13 also started in the High-road, Lewisham, and connected up with the Lee High-road at the point where the Blackheath and Eltham roads crossed. The line was about 1 mile in length. The estimated costs in connection with this line were: Tramway £45,000, widenings £131,000. In all cases the local authorities could contribute one-third of the coast of the road widenings.

Mr. MAURICE FITZMAURICE, chief engineer to the London County Council, confirmed the engineering evidence given before the other House, and also stated that the total amount of money which it was asked should be authorised under this bill was £1,048,000.

Mr. J. A. BAKER, chairman of the Highways committee of the London County Council, gave evidence on the financial side of the Council's tramway undertaking. Last year's working had resulted in a profit of £8,000. For interest and sinking fund over £100,000 had been put aside.

Mr. A. L. C. FELL, general manager of the Council's tramways, gave evidence as to the proposed service.

On Monday,

Mr. LEWIS COWARD, representing 350 petitioners against tramways Nos. 11, 12 and 13, addressed the Committee. After pointing out that the tramways were unnecessary, owing to the district being already well supplied with tramways and omnibuses, counsel strongly criticised the finance of the proposed lines as well as the results of the lines already working. He contended that the result of the working of the southern lines last year was a deficit of over £8,000. The total cost to the Council of tramway No. 11 would be £180,000 for only 2 miles of line running through a sparsely populated district. Upon the Council's own estimates of receipts and expenditure there would be a deficit of nearly £7,000 per annum, and upon the same basis he calculated a loss of nearly £3,000 per annum on the other two lines.

After hearing a large amount of local evidence against the lines,

Mr. E. MOON, replied for the London County Council. He admitted that upon the Southern tramways last year there was a deficit, but upon the Council's tramway undertaking, as a whole, there had been a profit of between £8,000 and £9,000. The reason for the deficit on the southern lines was the stoppage of traffic due to the reconstruction of the lines for electric traction, and it was common knowledge that a profit was not anticipated at the commencement of a new undertaking.

The Committee passed lines No. 11, 12 and 13.

On Tuesday, tramway No. 4, a double line from Grove Vale along East Dulwich-road and terminating at the eastern corner of Peckham Rye Common was dealt with. It is also proposed to make short connections with other tramways of the Council, which will give direct communication with the three bridges at Waterloo, Westminster, and Blackfriars.

Mr. MAURICE FITZMAURICE, the engineer to the Council, said that the cost of the line would be £42,050 and street improvements £15,000.

Mr. ROSKILL, K.C., on behalf of the frontagers along Peckham Rye Common, contended that since 1901, when a similar proposal was rejected, no special circumstances had arisen to justify the construction of the line on the north side of Peckham Rye.

The Committee decided to pass tramway No. 4.

Tramway No. 10 was then dealt with. It is a double line 1¼ miles long from Lordship-lane in Camberwell to London-road, Lewisham. It is estimated that the cost will be £51,000 and the cost of the necessary street improvements £21,500.

Mr. C. W. TAGG, town clerk to the Camberwell Borough Council, said his Council were the road authority for the greater part of this tramline, and were unanimous in supporting its construction. The proposed line would run over a portion of the tramways now owned by the London, Camberwell & Dulwich Tramways Co., but from 1896 to 1901 this company had run an intermittent service of single-horse cars. Since 1901 the service had ceased altogether, and it was only on account of continual pledges having been given by the company that they would put the line into working order that the Board of Trade had not ordered the removal of the line. This year the company promoted a bill for acquiring further powers, but it had been rejected by a House of Commons Committee.

After hearing further evidence against the tramway,

Mr. ERSKINE POLLOCK, K.C., for the London County Council, said that an arrangement had been come to between the County Council and the London, Camberwell & Dulwich Co., whereby the undertaking of the latter should be purchased by the former for £6,500 and a clause giving effect to this agreement would be inserted in the bill.

After a short consultation the Committee passed tramway No. 10.

The further consideration of the bill was postponed until to-day (Friday).

LIGHT RAILWAYS BILL.

This bill was read a third time and passed in the House of Lords on Friday last week. The text of the bill was given in our issue of July 1. The measure has still be considered in the House of Commons.

OTHER ELECTRICAL BILLS.

In the House of Lords on Thursday last week the *Leyton Urban District Council Bill* was read a second time. The *Soothill Nether Urban District Council Tramways* and the *Doncaster Corporation Bills* were read a third time and passed. On Friday the *North-Western Electricity and Power Gas Bill* was read a third time and passed. On Monday the *Charing Cross, Euston and Hampstead Railway Bill* was read a third time and passed. On Tuesday the *Rotherham Corporation Bill* was read a second time.

In the House of Commons on Thursday last week the *Clyde Valley Electric Power* and the *Southport-Lytham Tramroad (Extension of Time) Bills* were read a third time. On Friday the Lords' Amendments to the *London County Council (Money) Bill*, the *Plymouth Corporation Bill* and the *Wolverhampton Corporation Bill* were considered and agreed to. On Monday the *Loch Leven Water Power Bill* and the *Barrow-in-Furness Bill* were read a third time, and the following were read a second time:—*Bridlington Corporation*, *Bristol Tramways (Extensions)* and the *Manchester Corporation (Tramways)*. On Wednesday the *Ilford Urban District Council Bill* was read a second time.

The Swindon Corporation Bill was passed by the unopposed Committee of the House of Lords yesterday. The bill is an omnibus measure, and electrical clauses were given in our issue for June 17, when it was being considered by the Police and Sanitary Committee of the House of Commons. The chief point of interest then was the refusal of the Committee to insert the "Bermondsey" clause at the instance of the Swindon Gas Co.

The *Newcastle Corporation Bill* which seeks to extend the boundaries of the City to include certain neighbouring districts was passed by a Committee of the House of Commons on Tuesday. The electrical interest in the bill is the withdrawal of the opposition of the Newcastle Electric Supply Co. upon the Corporation agreeing not to supply electricity in Walker.

MOTOR CARS IN LONDON STREETS.

In the House of Commons on Thursday last week,

Mr. C. WASON asked the Secretary of the Local Government Board if any suggestion had been made by any of the London street authorities as to the regulation of the speed of motor cars in crowded thoroughfares.

Mr. GRANT LAWSON said that an application had been made by the City Corporation for a regulation restricting the speed of motor cars within the City to 10 miles an hour, and this was under consideration. No similar application nor suggestions had been made by any other London authority.

LEGAL INTELLIGENCE.

Metropolitan Electric Supply Co. (Ltd.) v. London County Council.

In the Chancery Division on Friday last Mr. Justice Kekewich heard an action brought by the Metropolitan Electric Supply Co. (Ltd.) claiming a declaration that, upon the true construction of sec. 55 of the London County Council Improvements Act, 1899, the defendants were bound, within three years from the passing of the act, to acquire the freehold and all other interests in the whole of the new site therein specified and in the events which had happened to convey to the plaintiffs the freehold of the whole of the new site; also to pay to the plaintiffs the sum ascertained under certain sections of the act. Plaintiffs further asked that such other orders might be made as would provide for the carrying out of the obligations imposed on the defendants under sec. 55 of the act.

Mr. CRIPPS, K.C., for plaintiffs, said there were three matters involved in the case which were partly under a section of the Act of Parliament and partly on arbitration between the parties. Two of these points, concerning the period when the conveyance to the reinstated site should be made and concerning interest, he thought could be settled without troubling his lordship, but on the third point the opinion of the Court would have to be taken. In connection with the new site the Supply Company had been given a road which was not the road they were entitled to under the act. Plaintiffs said they were entitled to access in a straight line along Little Wild-street into the new street known as Kingsway. Defendants, on the other hand, were giving them access to the new street by a circuitous route. The act provided that the defendants must maintain a public street—not less than 25ft. in width—along the northern boundary of the property, leading into the new central street. The street which had been given by the Council was not in direct connection with the new street, but was a street which ran along the northern boundary into another street, which other street led in turn into a third street, which third street leads into the new central street.

Mr. STEWART SMITH, K.C., for defendants, submitted that the act gave the Council liberty within reasonable limits to make a connection

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between the street border and the proposed new site on the north of Kingsway, and did not force them to do it in any particular method.

His LORDSHIP said his difficulty was to give the words "leading into the new central street" any other construction than leading directly into the new central street. Little Wild-street extended the whole length of the northern boundary of the property, but the street to be given by the Council was to be not only a street along the northern boundary, but a street leading directly into the new central street. He thought the meaning of the section was that the street should be one leading directly into the new central street. The street proposed to be given was not one which seemed to him to comply with the terms of the act. He made a declaration accordingly.

Mr. CRIPPS afterwards intimated that it had been arranged the mutual conveyances as between the parties in order to carry out the exchange of the sites should be completed within a month. The question as to interest was also arranged.

Norwich Corporation v. Norwich Electric Tramways Co. (Ltd.)

Mr. Justice Phillimore, in the High Court on Wednesday, delivered judgment in this action, heard at the late Norwich Assizes and reported in our issue of June 17. The action was nominally to recover £53 odd paid by the Corporation for the repair of roads said to have been injured by the company.

His LORDSHIP, in his judgment, said that in addition to £53. 13s. 10d. claimed by the Corporation, both parties sought a declaration from him as to their respective rights under sec. 57 sub-sec 5 of the Norwich Tramways Act, 1897. By the Tramways Act, 1870, sec. 28, the tramways company had to keep in good condition and repair to the satisfaction of the local road authority (1) so much of the road as lies between the road lines of the tramway; (2) if there were two tramways belonging to the same company within 4ft. of each other, the portion of the road between these two tramways; (3) so much of the roadway as extends 18in. beyond the rails on each side of any such tramway. By the same section, if the tramway company failed to comply, the Corporation might, after seven days' notice, open and break up the road and do the necessary work at the expense of the Tramways Co. with interest at 5 per cent. The Norwich Act of 1897 incorporated these provisions of the general act and also contained certain provisions which probably were the result of a Parliamentary bargain between the city of Norwich and the tramways company. Sec. 53 provided that whenever the road authority (the Corporation in this case) altered the level of any road on which the tramline was laid, the company should at the same time alter its rails, so that the surface of the rails should be on a level with the altered surface of the road. If this were not done, and the lines of rails got out of level so as to be a danger to public traffic, a penalty of £5. 10s. a day could be imposed. It was further provided that when the street was so narrow that there was a less space than 3ft. between the footpath and the tramway rails, the company should pave and maintain the road. This imposition of a penalty and the obligation in the case of narrow streets were additions to the law under the general act. There were provisions also that if the company failed to maintain and keep in good condition to the satisfaction of the Corporation (1) so much of any road whereon any tramway belonging to them is made as lies between the lines of the tramway; (2) the portion of the roadway between the tramways where the lines of the tramways are laid by the company in any road; (3) so much of the roadway as extends 18in. beyond the rails of, and on each side of, any such tramway; (4) the whole width of the tramway where any tramway shall have been constructed in any street so that a less space than 3ft. intervenes between the outside footpath at either side of such street and the nearest rail of such a tramway; (5) the junction of the paving laid and maintained by the company, with the surface laid and maintained by the Corporation, the Corporation may, if they think fit, themselves, at any time after seven days' notice to the company to do the work necessary for the repair and maintenance of the road, and the expense reasonably incurred by the Corporation in so doing shall be repaid to them by the company with the addition of 5 per cent. of such expense. The state of things to which he was asked to apply the sub-section was this: The tramways in some cases were laid in streets paved with wood, and about these no question arose. In other cases the roads were made with macadam, the tramways being laid in granite setts which had a line of granite setts next the road. The life of a granite sett was about 20 years, and that of a macadam road averaged four years, so that at the point where the macadam became worn lower than the granite a ridge or trough was formed, into which the wheels of vehicles went and formed a trough in which water accumulated, making the macadam rotten and soft. The Corporation had to repair these ridges, &c., but the tramways company said it was necessary to do the repairs because the surface of the macadam was bad and the whole of it was in need of repair. In some cases he was satisfied that the macadam might have been in better repair, but in the greater number of cases it was in sufficiently good repair. The sum in dispute for the work done by the Corporation was small, but the present object was the ascertainment of a principle to guide them in future. What they had to consider was what was to be done when the macadam had still some years of life but was worn down appreciably below the surface of the setts. The Corporation said the company should pay the cost of the repairs in such cases, but the company said the roads should be maintained by the Corporation in such circumstances. The sub-section was certainly difficult to construe, but on the whole he thought that the fact that macadam wore away more quickly than granite had been considered in the legislation that had been carried out, and that it was intended to throw upon the tramway companies, as a condition of the privileges given them, the duty of maintaining the even contour of the road by a proper junction of the two surfaces. He therefore gave judgment for plaintiff Corporation for £53. 13s. 10d., with 5 per cent. interest. As to the proposed declaration, he had asked each party to forward him in writing the form they wished it to take. Having read these forms of declaration, his Lordship said he should make a declaration in favour of the Corporation, in terms slightly altered from the form proposed by them. It would read as follows:—"That the obligation of the company, under sec. 57 sub-sec. 5 of the Norwich Electrical Tramways Act, 1897, to maintain and keep in good condition the junctions therein mentioned extends to cases where, by reason of the presence of the tramways in a road, the traffic in such road has caused the surface laid and maintained by the Corporation to become worn down below the level of the paving laid and maintained by the company, and involves the maintenance by the company of a uniform and unbroken contour of such surface immediately adjoining such paving, or the lowering of the pavement itself."

On the application of Mr. Low, K.C., for the company, stay of execution was granted on the usual terms.

Sheffield v. Storey.

At Rhyl County Court last week, before his Honour Sir H. Lloyd and a jury, Messrs. A. Sheffield & Son sued Mr. W. Good Storey. The claim was for £93. 5s. 6d. balance due for work done and materials supplied in connection with the installation of electric light, electric bells, telephones, &c., at the Claremont Hydropathic, of which defendant is lessee.

Plaintiffs said they tendered for the work, but after seeing defendant, who told them he had another tender for £200, they lowered their price somewhat, and agreed to do the work for £200, the money to be paid on completion. As the work progressed, plaintiffs found that they would lose on the transaction, and they inquired of the firm who were stated to have sent the tender for £200 as to their tender, and found that the said firm had sent in a higher tender than plaintiffs'. When those facts came to the plaintiffs' knowledge they wrote to defendant that he had obtained a reduction in their price upon a misrepresentation, and they should claim for the work done a sum based upon the price of their original tender, and that was the basis of the present claim.

Defendant repudiated the £200 tender statement, and denied plaintiffs' statements generally.

The jury found that Mr. Storey told Mr. Sheffield that a £200 tender had been received, and they returned a verdict for plaintiffs for £76.

Counsel for defendant submitted that, notwithstanding the verdict of the jury, his client was entitled to judgment.

His Honour reserved judgment.

Kay v. British Westinghouse Co.

At Manchester Assizes on Monday (before Mr. Justice Jelf and a jury), Thos. Kay, an iron turner, sought to recover from the British Westinghouse Electric & Mfg. Co. compensation for injuries received whilst in their employ. From the evidence it appeared that at 5:30 on Feb. 22 last, on the sounding of the buzzer announcing that work should cease, plaintiff and a number of other workmen left their lathes and went the usual way towards the door. In the rush plaintiff was knocked against some electrical apparatus, fixed 5ft. above the floor. His face was severely burnt, and his right arm burnt. The plaintiff, who, it was alleged, was incapacitated from further work, earned 35s. a week.

For the defence, Col. MONTAGU CRADDOCK, a director of the company, said the real attitude of the company was that excessive damages were claimed.

The jury found for plaintiff for £850 damages, and judgment was given for this sum.

Semmence v. Chatham & District Light Railways Co.

At Kent Assizes on Friday last, Mr. H. Semmence sued defendants for damages for injuries alleged to have been received owing to one of defendants' motormen neglecting to stop, but only slowing down, at a regular stopping place, and then suddenly quickening speed, resulting, it was alleged, in plaintiff being thrown from the step of the car and receiving serious injuries.

The conductor of the car having made a false report on the accident, the company withdrew their plea of "contributory negligence," and a verdict was entered for plaintiff for £333 damages, including £33 doctor's fees.

Workmen's Compensation.

In the Glasgow Sheriff Court last week, Sheriff Fyfe issued an interlocutor in a case under the Workmen's Compensation Act, which raised the question whether an electric tramway system was a railroad within the meaning of the act. Franklin, a linesman in the employment of Glasgow Corporation, was engaged repairing an overhead wire, and was standing on a tower waggon platform about 16ft. from the ground, when the trolley pole of a passing car struck the platform, throwing him to the ground. He sustained injuries from which he died the same day, and an action was raised on behalf of his widow and nine children.

His LORDSHIP, in awarding £280, found that when the casualty occurred Franklin was engaged in engineering work upon a railroad.

Electrical Machinery and Apparatus for India.—We have to go far from home for news. According to "La Metallurgie" (Paris), when the new generating station of the Bombay municipality is completed and working there will be a great demand for electric fans, ventilators and other apparatus in Bombay, which city, it is further stated, is the centre whence Arabia is chiefly supplied with machinery, more especially with pumps and apparatus for well boring.

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MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Library and Technical Instruction committee of Belfast invite applications for the following positions in the Municipal Technical Institute:—(*a*) Head of Mechanical Engineering department, salary £500 per annum; (*b*) Head of Textile department, £350 per annum; (*c*) assistant lecturer Physics and Electrical Engineering, £160 per annum; (*d*) assistant lecturer Practical Mathematics, £160 per annum. All particulars from Mr. Fras. C. Forth, Director of Technical Instruction, the Institute, Belfast, to whom applications by noon July 26. See also advertisement.

Applications are invited for the position of assistant town treasurer in Durban, Natal. An experienced accountant is essential, and he must be thoroughly well acquainted with municipal book and account keeping. Salary £600 per annum. Applications to the agents of the Corporation (Messrs. Webster, Steel & Co.), 8, East India-avenue, Leadenhall-street, London, E.C., by Wednesday, Aug. 3. See also advertisement.

A technical assistant, with a thorough college training and some practical experience, is required in a well-known consulting engineer's office. See advertisement.

An assistant electrician is required for experimental work in Messrs. Crompton & Co.'s instrument department at Arc Works, Chelmsford. See advertisement.

There are vacancies in a large Continental factory for one or two young engineers, who have completed their apprenticeship, to train for erection service abroad. See an advertisement.

A junior electrician is required for the foreign department (in Berlin) of the Allgemeine Elektricitäts Gesellschaft. See advertisement.

Marylebone (London) Borough Council invite applications for the following positions in connection with their electricity undertaking:—(1) Resident engineer, (2) mains superintendent, (3) meter department superintendent, (4) installation inspector, (5) accountant in electricity department. Applications to Mr. James Wilson, Town Hall, Marylebone-lane, London, W., by 8 p.m. July 20.

The Council of the University of Birmingham, invite applications for the Chair of Electrical Engineering. Stipend £1,000 per annum. Applications to the secretary (Mr. Geo. H. Morley) by Aug. 1.

Mr. H. Ade Clark, late assistant lecturer in engineering at the University of Leeds, has been appointed head of the engineering department at the Northern Polytechnic, Holloway, London, N. Mr. Clark was Ramsbottom scholar at Owen's College, Manchester, is a Whitworth scholar, and is an associate of the Royal College of Science. His practical experience was gained first as a mechanical engineer and afterwards as an electrical engineer with the London & North-Western Railway.

Mr. R. R. Williams, of Manchester, has been appointed charge engineer at Bristol.

Mr. F. J. Hughes, late clerk-in-charge of H.M. Posts and Telegraphs, Gold Coast Colony, West Africa, and formerly of the Great Western railway telegraph staff, has been appointed H.M. telegraph inspector, Southern Nigeria.

Mr. Percy W. Turner has been appointed lecturer and demonstrator in electrical engineering at the Mechanics' Institution, Stratford, Essex.

Mr. Gallinagh has been selected by Limerick Electric Lighting committee for the position of borough electrical engineer at a commencing salary of £160 per annum. There were 85 applicants.

Aspull.—The Board of Trade have been asked to grant an extension of 12 months for carrying out the provisions of the Council's electric lighting order.

Bath.—An official inspection of a new electric tramway route took place on Wednesday.

Batoum (Russia).—The harbour of Poti, in this district, and the main thoroughfare from the harbour are now lighted electrically, and the installation is about to be extended to other parts of the town.

Belfast.—The accounts of the municipal electric light fund for the year ended March show the total capital expenditure to be £236,529. 2s. 8d., an increase of £14,810. 13s. 11d. for the year.

Receipts from sale of current to private consumers reached £26,878. 7s. 3d., for motor rents £472. 4s. and £106. 6s. 1d. for current for public lighting, the total receipts being £27,532. 6s. 3d. Working expenses were £10,008. 11s. 9d. The gross profit was, therefore, £17,523. 14s. 6d. Adding to this the balance from last year (£2,254. 14s.) and bank interest (£156. 1s. 6d.) and deducting £2,000 for depreciation, the disposable balance was £17,934. 10s. Dividends on stock absorbed £5,964. 8s. 4d., stock redemption £4,470. 9s. 5d., and other interest, &c., charges were £1,151. 4s. 7d., leaving £6,348. 7s. 8d. as net profit to be carried forward. 2,457,364 units were generated (against 1,905,500 in previous year), and 2,255,579 were sold (against 1,665,560). 19,431 were supplied to public lamps (against 12,598) and the remainder to private consumers at prices varying from 6d. to 1¾d. per unit for lighting and from 3d. to 1d. for power. Generation costs were 1·065d. and total costs 2·281d. per unit sold (compared with 1·297d. and 2·872d.) and the average price obtained was 2·929d. (against 3·247d.). The total maximum supply demanded was 2,190kw. (against 1,968kw.). There were 171,845 8 c.p. lamps connected (against 122,000).

Last week the Tramways committee unanimously agreed that the city surveyor (Mr. H. A. Cutler) and the electrical engineer (Mr. V. A. H. M'Cowen) should prepare a joint report as to the relative merits of the various systems of electric traction, to be submitted to the next meeting of the committee.

Bradford.—The Electricity committee recommend the Corporation to purchase 30,500 incandescent lamps required for free distribution to customers during the current half-year.

Brighton.—The following terms have been agreed upon for the supply of electricity in bulk by Brighton Corporation to Hove Town Council for the Aldrington district:—

Hove Corporation to take all electricity required by them for the supply of or use in the parish of Aldrington at 4½d. per unit for the first 365 hours' use of the maximum demand, and 1½d. per unit after, such electricity to be supplied at a pressure of 440 volts. Hove Corporation to have the option, on giving 6 months' notice, expiring on June 30 or Dec. 31, in any year, of taking future supply for the remainder of the period of the contract at 5d. per unit for the first 365 hours use and 1d. after. Contract to be for nine years or such other date about that time on which Hove Corporation have power to take over the Hove Electric Lighting Co.'s undertaking. Hove Corporation to carry out the supply of electricity in accordance with the terms of the Aldrington electric lighting order and any regulations of the Board of Trade made thereunder. Brighton Corporation to be empowered to disconnect the supply in the event of such terms and regulations not being complied with, but only during such period as default continues.

Broughty Ferry.—The debit balance in the past year's working of the electricity department was £666. 5s. 6d., and the estimates for the current year show a further debit of £215. 1s. 4d.

Chelmsford.—Application has been made for sanction to a further loan of £16,500 for electric lighting extensions.

Croydon.—At last week's meeting of the Corporation the report of the borough electrical engineer (Mr. A. C. Cramb) on the seventh year's working of the electricity undertaking was presented.

The total capital expenditure at March 31 last was £271,258. 6s. 11d., an increase of £39,915. 6s. 5d. during the year. The total annual receipts were £46,596. 5s. 3d. (against £40,156. 18s. 7d.), including £26,265. 19s. 11d. from private consumers, £12,297. 2s. 8d. from traction, £7,357. 16s. 11d. from public lighting (against £7,126. 5s. 3d.), and meter rents £521. 12s. 10d. (against £411. 1s. 6d.). Generation expenses were £17,252. 15s., distribution costs £1,301. 7s. 10d., and management expenses £2,816. 5s.—total expenses £25,538. 4s. 2d., leaving a surplus of £21,000, besides £58. 1s. 1d., which has been carried to next account. Interest required £7,540. 11s. 8d., sinking fund £6,705. 3s. 4d., leaving £6,754. 5s. net profit. Adding to this the surplus to March, 1903 (£4,773. 5s. 4d.), there was a disposable balance of £11,527. 10s. 4d. £2,120. 1s. 6d. was placed to reserve and £1,000 voted in relief of general rate, leaving £8,407. 8s. 10d. 4,463,343 units were generated (against 3,889,794 in the previous year), 656,905 supplied to public lamps (against 630,921), 1,500,687 to private consumers (against 1,189,943), and 1,475,656 to tramways (against 1,310,977). There are 1,721 private consumers connected, with the equivalent of 115,461 8 c.p. lamps (against 1,378 and 96,479 respectively last year). 410 arcs and 67 incandescents are in use for public lighting (against 392 and 26). The total maximum supply demanded was 2,161kw. (against 2,127). The average price obtained of current for private lighting was 4·17d. per unit (against 4·34d.) and for public lighting 2·69d. Generation and distribution costs were 1·213d. per unit (against 1·27d.), and the total working costs 1·589d. (against 1·556d.).

Darlington.—There was a net profit of £568 on the past year's working of the electricity department.

Edinburgh.—The municipal balance-sheet was presented on Tuesday. In the electric lighting accounts for the year ended May the estimated revenue was put at £108,035, but the actual amount was £116,178. The expenditure was estimated at £94,660, the actual was £92,181. The estimated balance available for appropriation was £14,175, but the actual was £23,997.

The maximum to which their reserve fund might be built up on the present capital expenditure was £84,000. At present it amounted to £43,000, so that the transfer of £24,000 would bring the reserve to £67,000, and in the year which they had now entered upon the Electric Light committee estimate that, after reducing the price of current, there would be a balance at the close of the year of £17,000, which, apart from accumulations of interest on reserve fund investments, would next year virtually bring the reserve up to its maximum.

Treasurer Brown thought that, as there was a balance in hand of more than one-fourth the total maximum reserve required, the balance should be placed to other uses. If the electricity undertaking had had to raise its capital on the security of it own revenues alone, without the security of the rates behind it, it would have had to pay on its capital debt of £700,000 not less than 4½ to 5 per cent. interest, so the security of the rates had been the

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means of reducing the charge for interest by £10,000 or £12,000 last year, and the Council might well consider whether, when the balance available for appropriation was sufficient to place to reserve the amount estimated (£14,175), the excess should not be applied otherwise than to reserve. He would make a proposal to this effect at the next meeting of the Council.

Mr. Stevenson has been appointed convener of the Electric Lighting committee in succession to ex-Bailie Mackenzie.

Electric Motor Driving.—We have to acknowledge receipt of an interesting pamphlet describing a number of installations of electric motors for power in Sheffield, current being taken from the Corporation mains, and a large portion of the plant having been put in under advice from the Corporation electricity department over which Mr. S. E. Fedden presides. Mr. Fedden has prepared this pamphlet for the special purpose of appealing by ocular demonstration to the numerous engineering and other manufacturing houses in the Sheffield district who will find the electric system of driving simple, effective and economical. The illustrations show the uses to which the electric motor has already been put in this town and the special adaptability of this power for driving the numerous classes of machinery in use in this important industrial centre. The pamphlet should prove instructive to all who can apply electric power to the driving of their works under the liberal conditions prevailing at Sheffield.

Electric Power for Heavy Machinery.—From the British Power Co., 5, Great George-street, Westminster, London, S.W., comes a publication dealing with the application of electric power to large machine operations. The book is devoted in the main to describing briefly a number of large machines in actual operation, including mining winches, colliery main winding gear, huge ventilating fans for colliery main shafts, rotary rock drills driven by portable motors and flexible shafts, brick-making machinery, drainage plants, Goliath cranes, pumps, large portable saw benches, portable drilling machines, laundry machinery, power hammers, coal cutters, rolling and blooming mills, shipyard tools, boring machines, telfer lines, &c. As a record of some of the big plants which have been put down of late years for electric driving the book will be found very useful for reference, and will, besides, serve to point the way to extended trade in this direction.

Electricity on Steamships.—On the new Cunarder "Caronia" launched on Wednesday, a very complete electric lighting installation has been fitted, and the principle of driving the auxiliary machinery by electric motors has been adopted so far as possible.

Failsworth (Lancs.)—The District Council have decided to borrow from Manchester Corporation £12,656 on account of tramways purchase and £13,870 on account of tramways reconstruction

Fulham (London).—On Wednesday the Electric Lighting committee reported to the Council that in April the electrical engineer (Mr. Fuller) recommended an immediate extension of the undertaking, involving a considerable outlay, with a view to making provision for the coming winter's demand.

It was decided to order a 750kw. turbo-alternator, at an estimated cost of £7,000, as a first instalment, and Mr. Fuller was to prepare a comprehensive scheme dealing with probable future requirements for the next five years. Mr. Fuller had now submitted a report as to plans of a scheme which he thinks it will be necessary to carry out in sections during the next five years, at an estimated cost of £129,000—viz., first section £42,000, second section £32,000, third section £25,000, mains, sub-stations, &c., £10,000, house connections, meters, &c., £20,000. The first section, which he recommends should be authorised at once, comprises the following, viz.: Engine-room plant—one 750kw. turbo-alternator (already ordered) £7,000, one 1,000kw. Belliss set, complete with condensers, pumps, &c. (to be ordered), £8,947, one exciter set £500, switchboard additions £500. Boiler house—four boilers with accessories £4,340, coal bunkers, elevators, &c., £2,230, economisers £1,075, boiler pumps £250, wiring, motors, &c., £200, condenser, steam and other pipes £3,000, condenser, sump and river work £2,000, chimney £4,000, boiler house building and alterations £7,500, contingencies £500, for connections £6,000, extra buildings £4,000, total £52,042.

The Committee considered that the first part of the scheme should be sanctioned and they had, subject to confirmation, appointed a sub-committee to confer with Mr. Fuller on the subject.

The committee's report was adopted.

Glasgow.—The report of the general manager of the Corporation tramway department (Mr. John Young) as to the limits of age, &c., for tramway employés was discussed at the last meeting of the Council and adopted.

In this report Mr. Young states that the only limit laid down as to age was that applicants must be over 21 years old. No standard of height was fixed, but, in the interests of public safety, it was essential that it be such as to give the man proper command of brakes and controllers. The men selected for duty were trained (at the expense of the department) first as conductors, and, after a short period of satisfactory service, they went through a regular training as motormen, so as to fit them for duty at either end of the car, an advantage which had been frequently proved. It was his duty, in the public interest, to select, for the exposed and responsible work of operating the electric cars through the city, the fittest and most suitable men which the wages and conditions of service fixed by the Corporation commanded—men who, in the ordinary course, gave promise of lengthened satisfactory service. That meant that they should be comparatively young and of sound physique. There was no other way of maintaining the efficiency of the department. The medical examination and other tests for sight, hearing and general intelligence were not more stringent than the nature and exigencies of the work demanded. Although no limit of age was laid down, a little consideration would show that efficiency could not be maintained if the department started to train middle-aged men for work of that special nature, for which the necessary nerve only came with early training.

In presenting the accounts of the tramways department (abstracted in our last issue), Mr. Paton said that last year the revenue was £724,851, against £656,572. The increase would have been greater but for the rough weather experienced. The expenses had been £496,266, against £431,870. This was not so satisfactory a feature of the year's work. Last year they ran 2,282,332 additional miles on a gross mileage of over 16,000,000 miles, and the drawings had been lower by about ½d. per car-mile. The increase of expenditure was due to additional wages and shorter hours of the men, increased mileage of the outward traffic and the largely increased service given during the last nine months of the year. They had a balance this year of £80,790, after paying £25,000 both this year and last to the common good. The profits worked out much the same as last year. They were paying large sums to mileage, renewal fund and to depreciation. The ordinary depreciation was £78,619. 8s. 7d., all taken out of revenue. To renewals there had been added £60,827. 5s. 5d. from revenue, and to sinking fund £45,552. 17s. If any company held the Glasgow tramways in perpetuity as the Corporation did they would have a depreciation fund and a renewal fund, but they certainly would have no sinking fund. During the past year they had paid £131,851 in making new lines, &c., and their debt at the end of the current year was £1,830,894, or £58,417 less than at the same time last year. They had £193,005 at the credit of the renewal fund, they had been able to add to reserve £33,008, and they had a balance on the year of £80,790. They considered the depreciation fund ample, and he believed there was no Corporation in England or Scotland that had such a large depreciation fund. They had decided to place £22,000 to building fund, as they had a number of buildings not now wanted for purely tramway purposes. £30,000 was appropriated under the head of ducts and manholes, feeder cables, overhead wires, poles and rosettes.

After a brief discussion the accounts were adopted.

Glasgow-Paisley Tramways.—As Glasgow Corporation have been unable to agree upon terms as to running powers over a portion of the Paisley District Tramway Co.'s line, the Board of Trade have been asked to appoint an arbitrator.

Hackney (London).—The Works committee have approved the recommendation of the Electricity committee to substitute 30 7-ampere arc lamps in three streets for 66 gas lamps. The annual cost of maintenance will be £271. 3s 10d., against £202. 16s. 2d. for gas, but the illuminating power will be 14,100 c.p. compared with 1,852 c.p. The capital cost of the lamps, standards, cables, &c., is £2,031.

Halifax.—The Corporation have purchased two single-deck tramcars (for short-stage traffic) on the Raworth automatic regenerative principle.

Harrogate.—The charges for electric current will in future be 6d. per unit for the first hour's maximum demand and 2½d. after, instead of 5½d. and 3d.

Hastings.—An unopposed inquiry was held here last week into the application of the Council for sanction to borrow £3,416 for electric lighting extensions.

Heywood.—The Council have applied for an extension of 12 months to construct the authorised local tramways.

Hornsey (Middlesex).—During the year ended March the capital expended was £16,746. 10s. 6d., bringing the total to £90,080. 10s. 6d.

Sale of current by meter (at an average of 4·664d. per unit) produced £4,698. 7s. 6d., and £1,236. 15s. 5d. was received for public lighting, and miscellaneous items made the total receipts £6,068. 2s. 3d. Generation costs were £1,704. 4s. 8d., management expenses were £745. 16s. 7d., the total working expenses being £2,942. 10s. 3d. £4,396. 0s. 8d. has been taken from the local rate. Interest came to £2,818. 3s. 10d., and £2,100. 3s. 2d. has been applied to redemption of loans, the balance (£2,583. 5s. 8d.) being carried forward. 447,774 units were generated, 99,447 units were supplied to public lamps, and 241,781 to private consumers. The total maximum supply demanded was 340·5kw.

Hospital Lighting.—The work of wiring and fitting up for electric lighting Haslar Hospital, Portsmouth, has been commenced. Current will be obtained from an independent generating station to be erected in the gunboat yard.

Ironmongery, Hardware, Electrical and Allied Trades Exhibition and Mart.—There is being held at the Agricultural Hall, London, N., up to July 22, an exhibition comprising items of electrical interest which mainly appertain to domestic uses. This is the fifth annual exhibition of the kind, and the exhibitors include the British Prometheus Co., Davis Electric Lamp Co., Electrical Accessories Supply Co., F. A. Glover & Co., Lister Electric Mfg. Co., Wallach Bros., and other firms who deal largely in electrical accessories and sundries.

Japan.—A report by Mr. G. Barclay, secretary to the British Legation at Tokio, on the trade of Japan for 1903, shows that the total imports of machinery into that country for the year was valued at £830,000, of which the United Kingdom supplied exactly

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one-half, a better showing than that for 1902. The value of electric motors imported was £85,000, of which the United Kingdom supplied £19,000, America £53,000 and Germany £12,000. Of the total electric light apparatus imported, valued at £28,000, the United Kingdom was responsible for £5,000, America for £15,000.

Electric tramways are in course of construction in all parts of Japan, but the bulk of machinery and apparatus required for these lines is being supplied by America. The Tokio Electric Railway, a new undertaking chiefly financed by British capital, has placed its orders in Great Britain.

Johnstone.—The local electric tramways were opened for traffic on Tuesday.

Light Railways.—The Board of Trade have confirmed the Southend-on-Sea and District Light Railways (Extensions) Order, authorising light railways in Southend and Shoeburyness.

London County Council.—At Tuesday's meeting, the Highways committee submitted the balance-sheet of the Council's tramways undertaking to March 31, referred to in the last issue of *The Electrician*.

Mr. GASKELL called attention to the great difference between the estimate and the actual result. When the estimates were before the Council it was estimated that the net receipts would be £146,939, of which £126,770 was expected to come from the electrical portion. As a matter of fact, the net receipts were £94,452. Seeing that the Council expected so much from the electrical system, this was disappointing, and he considered that the conduit system had been a failure.

Mr. H. P. HARRIS criticised the accounts in the light of the pamphlet issued by the chairman at the beginning of the year that the electrical tramways in the south were a success.

Mr. ALLEN BAKER (chairman of the committee), in reply, said that when the estimates were before the Council full explanations were given of the reasons why they were not able to anticipate large receipts. There were the delays and also the disadvantages which were not to be got over where they were reconstructing a large portion of the system. Too often the dates at which they expected to open lines were exceeded, and when the lines were open they were not able to run a full number of cars owing to insufficient power. It was expected that there would have been a loss of £15,000, but that had been reduced to £8,000, and this was done in spite of the fact that they had had to pay heavy charges for interest and sinking fund before the tramways began to earn profits. If a company had been operating the lines there was no doubt they would have felt justified in declaring a 5 per cent. dividend on the results of the past year's working, but the committee were building up funds and paying capital charges, and they were providing for the repayment of the whole cost of installation in 25 years. Now, they were getting rid of the horse traction, which did not pay, and increasing the electric traction, which did pay. With regard to the cost of power, they were being supplied from three stations, and if they had had their own electric generating station at work in the past year it would have made a difference of £15,000. With regard to the conduit system, it had to be remembered that the lines were laid in possibly the most difficult streets in the world, and if they had adopted the overhead system he believed the estimated cost would have been largely exceeded. As it was, the maintenance would not be so large as the overhead system, and they would not have to reconstruct overhead wires in three years, as was the case with the overhead systems in large provincial towns.

The report was adopted.

It was agreed to lend £20,000 to Poplar and £9,958 to Shoreditch, for electric lighting purposes.

London County Council Tramways.—On Monday a service of the Council's Greenwich electric cars commenced running to and from Southwark Bridge via Old Kent-road, Great Dover-street, Marshalsea-road and Southwark Bridge-road.

Louth.—Messrs. Handcock & Dykes have been appointed consulting electrical engineers to the Council.

Maesteg (Glam.).—Mr. G. B. Fowler offers, on behalf of a syndicate, to take a transfer of the Council's electric lighting order.

Metropolitan Asylums Board.—On Saturday the board accepted the offer of the Charing Cross & Strand Electricity Supply Corp. to supply electrical energy for lighting the offices on the Embankment for three years, at 3d. per unit, compared with 4d. less 5 per cent. at present paid to the same company.

Marylebone (London).—We referred in our last issue (p. 497) to the proceedings at the last meeting of the Borough Council and to the difficulty which had arisen in connection with the form of receipt required by the Council from the Metropolitan Electric Supply Co. in exchange for the amount handed over in terms of the recent award. The document has a certain historical interest, and we therefore give it in full below:—

THE METROPOLITAN ELECTRIC SUPPLY COMPANY (LTD.), 1903, M. No. 442.

THE MAYOR, ALDERMEN, AND COUNCILLORS OF THE METROPOLITAN BOROUGH OF ST. MARYLEBONE.

The above-named Company (hereinafter called "the Company") hereby acknowledges that the above referred to Mayor, Aldermen and Councillors (hereinafter called "the Borough Council") have this day paid the sum of £1,238,347. 13s. 7d. in the following manner (namely) the sum of £135,100, part thereof, by the direction of the Company, into the London Joint Stock Bank, into the joint names of Sir R. G. W. Herbert, Sir James Pender, Baronet, Daniel Meinerzthagen, Lord John Hay, and F. G. L. Smith, and the balance of £1,103,247. 13s. 7d. to the Company. Such sum of £1,238,347. 13s. 7d. being made up in the following manner (namely):—

Award (£1,212,000, less £10,000 as below)	£1,202,000	0	0
Capital expenditure to 30th April, 1904, less £80,000 already paid	20,953	16	6
Estimated capital expenditure for May and June and to date hereof, say	12,500	0	0
Interest to date hereof on capital expenditure to 30th April, 1904, say	864	17	9
Interest to same date on estimated expenditure for May, say	25	0	0
Amount in respect of costs of action and of deducing title and completing purchase (including releases from Trustees), say.....	1,200	0	0
Amount in respect of apportionment of outgoings (calculated at present to 30th June, 1904, only)..	803	19	4
	£1,238,347	13	7

Such sum is paid and received in respect of the moneys payable by the Borough Council to the Company under the provisions of the Electric Lighting Order Confirmation (No. 1 Act, 1901), the notice to treat dated the 1st day of November, 1901, the award dated the 4th day of February, 1903, the judgment of Mr. Justice Buckley in the above action dated the 7th day of August, 1903, and the orders made in such action dated the 11th day of December, 1903, and the 26th day of February, 1904, and the 6th day of May, 1904, for or in respect of the purchase by the Borough Council of the St. Marylebone undertaking and business of the Company as defined by the said Act of Parliament (except as therein excepted). The above receipt is given and the above payment is made on the conditions following, namely:—

1. The figures above mentioned for capital expenditure and estimated capital expenditure and interest thereon respectively, and for costs and for apportionment of outgoings are provisional and tentative only, and shall not be taken in any way as amounting to any admission of claim by the Borough Council, or to any limitation of claim by the Company, and any other head of claim by either party against the other party shall not be in any way prejudiced or affected hereby. The exact sum due from the Borough Council to the Company as on completion under the Judgment and orders aforesaid as on the 30th day of June, 1904 (but subject to a retention of a sum of £10,000 only by the Borough Council instead of a sum of £50,000, and subject also to the date hereof being substituted for the 30th June, 1904), shall be ascertained as soon as possible, all proper steps being taken forthwith to enable the same to be ascertained. If such exact sum, when so ascertained, shall exceed or fall short of the total amount so paid as above mentioned, the Borough Council shall forthwith pay the excess to the Company, or the Company shall forthwith repay the deficiency to the Borough Council, as the case may be, together with, in either case, interest on the amount of such excess or deficiency, as the case may be, at the rate of 4 per cent. per annum.

2. The Borough Council having retained from the principal sum payable by them under the aforesaid award the sum of £10,000 only, instead of the sum of £50,000 mentioned in the aforesaid Judgment, shall be liable to pay into Court the sum of £10,000 only instead of the sum of £50,000. Application shall forthwith be made to the Court by the Borough Council, and concurred in by the Company, at the expense of the Borough Council, for an Order to pay in the sum of £10,000 accordingly, and immediately thereafter the said sum shall be paid in by the Borough Council.

3. The inquiries directed by the Judgment of the 7th day of August, 1903, shall be prosecuted as quickly as possible, and, as soon as completed and binding, the like provisions shall apply as to the payment to the Company of the aforesaid balance of £10,000, and as to the dealing with the sum of £10,000 lodged by the Borough Council in Court, as are in the aforesaid Judgment contained with reference to the payment to the Company of the balance of £50,000 therein mentioned, and the dealing with the sum of £5,000 thereby directed to be lodged in Court.

4. The Company shall retain the profits of the St. Marylebone undertaking and business down to the date of these presents, instead of down to the 30th day of June, 1904, as provided by the said Judgment and Orders, in lieu of interest on the purchase-money, and the provisions of the said Judgment and Orders as to capital expenditure and the recoupment thereof to the Company, with interest, shall be continued from the 30th day of June, 1904, until the date of these presents, but with such variation as to the ascertainment of the amount thereof as hereinafter provided.

5. As to the said capital expenditure up to the end of April, the documents in respect whereof have already been delivered, and also as to the said estimated capital expenditure for the months of May and June (the accounts whereof are to be delivered as soon as reasonably practicable), and also as to any capital expenditure between the 30th June, 1904, and the date of these presents, the Borough Council shall make any objections thereto through their Accountants in writing, given to the Accountants of the Company, as to the accounts already delivered, within 21 days of the date hereof, and as to accounts to be delivered within 21 days from the delivery thereof, and in default of such objections (if none) and subject only to such objections (if any) shall be deemed to accept the said accounts and shall be bound thereby. The subject matter of any such objections shall be dealt with and disposed of, so far as may be by agreement between the said Accountants, and if, and so far as they are unable to agree shall be referred to the arbitration of some third person, to be appointed by them. The provisions of this clause shall be in lieu of any vouching or other proceedings in Chambers that might otherwise be necessary under the aforesaid Order of 11th December, 1903.

6. It is hereby acknowledged and agreed that as on and from the date of these presents transfer of the St. Marylebone undertaking and business has been and is made from the Company to the Borough Council, and that and as from the date hereof actual or physical occupation of the Company

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and their servants of the St. Marylebone undertaking and business is only as Agents and Contractors of and for the Borough Council, and by virtue of the provisions of a Working Agreement dated the same day as these presents, and made between the Borough Council of the one part and the Company of the other part.

7. Except as far as hereby expressly or necessarily varied, the respective rights of the Borough Council and the Company under the aforesaid Act, Notice to treat, Award, Judgment, and orders shall be and the same are hereby preserved, and in particular these presents and the transfer hereby acknowledged are to be without prejudice to the lien of the Company on the said undertaking and business for the payment to them of any balance that may be ultimately payable.

Dated the 5th day of July, 1904.

The Common Seal of the Metropolitan Electric Supply Co., Ltd., was hereunto affixed in the presence of
W. HARRISON CRIPPS, *Director*.
E. CUNLIFFE OWEN, *Secretary*.

Seal.

Municipal Telephony.—In presenting the accounts of the telephone department last week, the convener of the Glasgow Telephone committee (Mr. J. ALEXANDER) said that at the committee meeting at which the accounts were considered some little friction occurred in regard to the disposal of the surplus.

He was glad they had a surplus, considering that the department had met with so much opposition. This surplus was steadily growing. In the first year it was £398, last year £1,694, and now £3,650. The surplus had been carried to depreciation. Some experts held that £3,000 should be set apart for preliminary expenses. The depreciation fund now amounted to £5,743. He held that the enterprise of the Corporation had made Glasgow the best telephoned city in the world. They had telephones now at 25s. which at one time cost £25.

Mr. RUSSELL moved that the accounts be sent back. At the end of the year the capital expenditure of the telephone department was £320,782. That had been watered to the extent of £17,000 for preliminary expenses; £16,110 had been written off as sinking fund, and they had created what was called a depreciation fund of £5,743. Taking the sinking fund and the amount at credit of depreciation they got £21,853, and deducting from that £17,000 of preliminary expenses, there remained only £4,851, which he maintained was all the depreciation and sinking fund they had provided against their total capital expenditure. According to the accounts this year 11,405 instruments were in operation, whereas the revenue-earning direct lines only numbered 9,040. As an illustration, he stated that he had three private rooms in his office with table instruments, and, in telephone phraseology, he would be counted as having four completed instruments, while in reality he had only one. He contended that from the first the construction of the telephone system had been most faulty. Why was not the direct-call system adopted from the first? He understood that while three-fourths of the system was on what he might term the "ancient call-wire system," they were experimenting at some of the sub-exchanges with different kinds of systems, so that even yet the committee seemed undecided as to which system to adopt. He understood, too, that these experiments were giving a great deal more satisfaction than the system at present in operation over the bulk of the service. Averaging the different items, he made out a fair depreciation of 7½ per cent., or £24,000 per annum on present capital. That the plant was seriously depreciating and some of it no use was shown by the sale in three years of scrap to the value £432. What had realised only £432 doubtless originally cost £10,000. Their sinking fund and surplus revenue this year amounted to £11,994 4s. 6d., or only equal to 3¾ per cent. on their capital. He urged that only by the appointment of an expert or of a committee of inquiry could they bring out all these important points.

Mr. GRAY said the auditors had certified the accounts, subject to sufficiency of the provision for depreciation. The accounts should not pass the Council until the auditors were asked to give an explanation of what was meant by proper depreciation.

Mr. W. F. ANDERSON said that Mr. Russell had made a distinct charge that thousands of pounds charged to capital ought to have been charged to revenue, and he should be given an opportunity of proving the charge. The reason why a portion of Mr. Bennett's salary was charged to capital was because it was a "structural" charge. Mr. Bennett was employed as a structural engineer. Parliament recognised the principle that when an undertaking was in process of formation it was perfectly legitimate to pay interest out of capital. He contended that the accounts as submitted were fairly stated. Exception was taken to the committee charging a reasonable proportion of the salaries to capital, but the principle had been recognised by Parliament that while a commercial undertaking was in process of being constructed it was perfectly right and proper to pay interest out of capital.

On a division, two members voted for the amendment, and the accounts were then approved.

On the presentation of the minutes of Portsmouth Telephone committee on Monday, the chairman of the Telephone committee (Councillor Dittmann) said there were 42 call offices in the town, and only two persons had withdrawn their applications.

Nelson.—Sanction to a loan of £25,000 for electric lighting has been obtained by the Council.

Newport (Mon.)—The Council have applied for sanction to borrow £17,825 for new generating plant and the laying of new feeders and cables.

North Metropolitan Tramways.—Trial runs are being made on the electric tramways from Finsbury Park to Wood Green, and also from Finsbury Park to Seven Sisters Station on the Edmonton section of the Metropolitan Electric Tramways Co.'s newly electrified system in the north of London. These trial runs are, however, only of "special cars," to give the motormen the opportunity of acquainting themselves with the route. The Board of Trade inspection is due to be made in a few days, and it is anticipated that regular traffic will commence next week between the two points above indicated (Finsbury Park to Wood Green and Finsbury Park to Seven Sisters Station).

North Wales Electric Power and Traction Scheme.—We are informed that the 10,000 H.P. hydraulic station is well under way, and 18 miles of new railway line are in course of construction. The pipe line and dam works are in full swing, and it is expected that current will be ready by the end of the year. A considerable portion of the 10,000 H.P. to form the first installation has been already booked. The whole contract, including the supply of six 1,000kw. 10,000-volt turbo-alternators, 10 250 H.P. locomotives, the whole of the rolling stock for the new line, the complete erection of the hydraulic works, transformer stations and over 100 miles of high-tension transmission lines is being proceeded with by the sole contractors, Bruce Peebles & Co.

Northampton Institute.—The annual dinner of the day students of the Northampton Institute took place on Friday last at Anderton's Hotel, Fleet-street, London. The chair was taken by one of the students (Mr. W. Stanley Lonsdale), and among the guests present were the principal (Dr. R. M. Walmsley), Dr. C. V. Drysdale, Mr. C. E. Larard, Mr. S. Field, with their respective senior lecturers and assistants, numbering altogether 42. After dinner an excellent programme was gone through, toasts and musical items being interposed. In reply to the toast of "The Institute," the principal gave some good advice to the leaving students, especially as to what could be learnt in works by practical men. Dr. Drysdale, replying for the electrical department, corroborated Dr. Walmsley's remarks, and made some humorous allusions to the "Self induction and Resistance" of students. Mr. Larard, for the mechanical department, also made a humorous speech, and Mr. Field, in replying for the chemical department, pointed out the importance to the engineer of a good knowledge of electro and metallurgical chemistry. The students themselves contributed naturally to the musical side of an enjoyable function.

Oulton Broad (Norfolk).—The Council have decided to obtain a report on electric lighting. The Council's order will probably be taken over by the Oulton Broad Electricity Co.

Perth.—Attempts are being made to revive a scheme (estimated to cost £17,000) to construct an electric tramway from Scone-road to Kinnoull Hill, about 1¾ miles. The line would be constructed entirely on Lord Kinnoull's land.

The municipal authorities who have acquired the local tramways are experimenting with a petrol car.

Poplar (London).—The Electricity committee have provisionally accepted an offer of a freehold site in Elinga-place, Wick-lane, for the proposed northern sub-station at £1,400. It is recommended that the credit balance of £4,474. 2s. 9d. on the past year's working be carried to reserve.

Portland (U.S.A.).—One of the most complete electric railways in this country is owned by the Oregon Water Power & Railway Co. It is 67 miles long, standard gauge, 56lb. rails, and carries both freight and passengers. The terminus at Portland is a large wharf where deep-sea vessels can discharge and load. The freight equipment includes six motors of 300 H.P., 76 flat cars, 10 box cars, and 4·55 foot combination passenger and express cars, having capacities ranging from 30,000lb. to 50,000lb., and all equipped with patent couplers and air-brakes. In addition there is a passenger car equipment of 21 cars and 12 trailers. The company is erecting a power plant on the Clackamas River, and expects to supply 10,000 H.P. of electric power. 54 miles of electric tramlines have been added during the year to the systems in Portland and vicinity, the total mileage now being 163 miles.

Portsmouth.—The Tramways committee have applied for sanction to a further loan of £23,882, to meet excess in contracts executed and to defray cost of laying high-tension main, &c., for supplying current to the Horndean light railway.

Presentation.—Last week Mr. F. W. Taylor, Reading district manager of the National Telephone Co., was presented by the local staff with a silver tea service, on the occasion of his leaving to take up the post of district manager at Brighton. Mr. Taylor will be succeeded by Mr. J. Sinclair Terras.

Rating Appeals.—At Liverpool County Sessions on Tuesday a number of rating appeals were mentioned in which the New St. Helens Tramways Co. were appellants, and the Assessment committee of St. Helens Union respondents.

Mr. Greer, representing appellants, said that the appeals had resulted in a case going to the High Court. That case had been decided with the result that the gross assessment had been reduced from £3,165 to £1,500, and the net assessment from £2,110 to £1,000. The amount which had been overpaid in the meantime while that case had been pending would

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be repaid to appellants. In the case of other portions of the tramway equipment against the assessments of which the company had appealed, the amounts had been reduced as follows:—Eccleston, from £420 gross to £200, and £280 net to £133; Whiston, from £280 gross to £134, and £187 net to £80; Prescot from £146 gross to £69, and £97 net to £46; Rainhill, from £284 gross to £135, and £190 net to £90.

Raworth's Traction Patents.—The New South Wales Railway Commissioners have decided to make a trial of the automatic regenerative system of control under the supervision of Mr. Oswald Haes.

Reading.—On the recommendation of the engineer and manager of the Corporation tramways (Mr. W. Binns), the Council have decided to introduce a system of parcels delivery on the tramways.

St. Pancras (London).—The Electricity committee recommend that private consumers of electric current for lighting be given the obtion of a flat rate of 4d. or the maximum demand system at 6d. and 1½d., and that current for motors be charged at 1d. per unit.

Salford.—The report of the borough electrical engineer (Mr. C. D. Taite) states that during the year ended March the whole of the machinery installed had been taken over from the contractors.

The driving of the air pumps by spur gearing having been found unsatisfactory, five of the gears were replaced—two by chains and three by ropes - all of which are satisfactory and practically noiseless. The maximum lighting load was 1,800kw. and the maximum traction load 1,400kw. By reducing the quantity of air admitted to the boiler furnaces and by working with thicker fires an increase of from 6 to 8 per cent. evaporation per pound of coal has been effected (equal to a saving of £450 per annum), the attention required by the fires has been diminished, and it has been found possible to use one boiler less than formerly at times of maximum load. With the exception of the Newcastle-on-Tyne Co. there is no other undertaking which shows a lower cost of coal per unit sold than that now reached at Salford—viz., 0·225d. Considerable damage (covered by insurance) was done to the traction switchboard by fire last January (continues the report) and this was made good by the Corporation's own employés. Two three-wire reversible boosters have been installed at Frederick-road sub-station with excellent results, having since December taken the peak load nightly, thus further relieving the boilers and permitting the plant to be shut down several hours nightly and on Sundays. 7,321yds. of new distributing mains have been laid. 156 new consumers (equal to 19,009 8 c p. lamps) have been connected to the mains and 997 H.P. in motors. Contracts have been entered into for the supply of current to about 600 H.P. of motors for the Broughton Copper Co., and for the supply of current for power purposes equal to about 3,000 H.P., as well as for supply for lighting at the Manchester Ship Canal Co.'s new dock. The demands at this dock will, it is estimated, amount to not less than 1¾ million units per annum at the end of five years. There are now 105 motors on hire, equal to 954 B.H.P. (against 39 and 336 B.H.P. last year). The total capital expenditure is £530,416. 18s. 1d., an increase of £42,738. 11s. 2d. for the year. The receipts were £66,813 (against £45,224), the working costs £23,952 (against £21,179), and the capital charges £31,085 (against £26,439), leaving net profit £11,774, of which £8,000 has been placed to depreciation and reserve, £2,394 applied to meeting debit balance from previous year, and £1,380 goes to reduction of rates. Only three towns have shown lower generation costs than those incurred at Salford (0·579d. and 0·75d. per unit sold respectively). 8,735,174 units were generated (against 5,804,861); 1,140,244 of these were supplied to private consumers for lighting (against 908,354) and 911,236 for power (against 334,507). 179,082 were used for street lighting (against 150,328) and 5,251,055 supplied to tramways (against 3,370,434). There are 870 private consumers (against 714) with the equivalent of 109,582 8 c p. lamps (against 90,573), and 2,002 H.P. of motors connected (against 1,005 H.P.). The load-factor was 26·6 (against 21·9), and the maximum load was 3,200kw. (against 2,490kw.).

Salford-Bury Tramways.—The Salford and Bury Tramways committees have arranged terms for mutual running powers over their respective tramway systems.

Sheffield.—On Wednesday the chairman of the Tramways committed (Ald. Clegg) made a statement as to the tramway accounts for the past year.

The lines carried 56,812,049 passengers in 1902-3, and last year 61,450,993, an increase of 4,638,944. Last year's receipts were £216,308, this year they were £235,981, an increase of £19,623, or over 9½d. per car-mile run, against about 10½d. the previous year. Working expenses were last year £144,351, or 6·64d. per car-mile run, and for the previous year £156,402, or 6½d. per car-mile, a decrease of £3,340. Working expenses were gradually being reduced, as in 1900 they were 10·9d. per car-mile. Since the tramways became Corporation property they had handed over £50,620 to relief of rates, and had given away about 58,000 tickets to philanthropic, medical and nursing institutions, and had also frequently granted free cars to take children from the slums into the country. The gross profit for the year was £79,578. 17s. 8d., against £71,957. 8s. 9d., and, after deducting interest and sinking fund, the net profit was £27,309. Repairs to track, which the previous year were £3,400, had gone up to £8,500. He suggested the desirability in the near future, of the tramways department taking the track paving under their own control to avoid difficulties of overlapping, and of adjustment of charges between the tramways department and the Highway committee. The problem of dry seats had, he thought, been solved by the covered double-decked cars, 30 of which were already in use and 42 more were on order. These cars had, on an average, earned £1 a week more than the ordinary double-decker. In regard to suggested extensions he suggested the desirability of experimenting with motor omnibuses to cultivate the traffic from points near the termini in various outlying districts. The cost of motor omnibuses would be from £950 to £1,000 each, and working expenses about double those of electric traction, so that some charge would have to be made for motor omnibuses. The accumulated surplus to date was £143,369. 18s. 8d., and the present net available surplus about £51,000.

South Shields.—*Correction*—An error occurred in our note on p. 498, last issue, in regard to the net profit of the electricity undertaking. Instead of the total net profit being £1,303. 16s. 8d., this should have been stated as £1,603. 16s. 8d. from which £300 was carried to district rate fund and the balance to reserve.

Spain.—During the temporary sojourn of the Spanish Court at San Sebastian the Inter-urban Telephone Co. has established a special service for the rapid transmission of telephoniegrams, representing a combined use of stenography and typewriting machine. This special arrangement has already been adopted at Madrid, Viteria, Bilbao, San Sebastian, Pamplona and Zaragoza with good results.

Spennymoor.—The Council have accepted the tender of the Northern Counties Electricity Supply Co. for the electric lighting of the district at £2. 7s. 6d. per 16 c.p. lamp per annum.

Stockton-on-Tees.—The question of extending the electric lighting mains to Hartburn, Norton and Eaglescliff has been referred to the borough electrical engineer (Mr. J. J. Smith) for report.

Sunderland.—Tenders for additional plant for the electricity department were submitted to the Electricity and Lighting committee last week. The tenders from German firms were stated to be lower than those from British manufacturers. With a view to coming to terms with one of the home tenderers, the tenders were referred back.

Swansea.—Electric current was supplied for the first time to the Port Tennant district last week.

Taunton.—At Monday's Council meeting the borough electrical engineer (Mr. E. B. Thornhill) and the chairman of the Electric Light committee (Ald. Potter) presented a report upon a system of fire alarms estimated to cost £150, with £10 for annual upkeep.

Tramway Award.—The arbitrator appointed to determine the purchase price of the Bury, Rochdale and Oldham Tramways, which are being acquired by the local authorities through whose districts the lines run, has issued his award at £159,075.

Tramways in the Black Country.—A conference relating to the tramways in the Black Country took place at Birmingham last week between representatives of the British Electric Traction Co. (Mr. E. Garcke, Mr. J. A. Lycett) and the municipal authorities of Dudley, Tipton, Coseley, Wednesbury, &c. The principal subjects for discussion were the stoppage since June 15 of the tramways between Dudley and Wednesbury and Wednesbury and Darlaston and the reconstruction of the lines for electric traction

Wakefield.—The total capital expenditure of the electricity department to March last was £58,722. 19s, an increase of £6,779. 2s. 2d. for the year to that date.

Income included £7,287. 16s. from private consumers, £842. 7s. 10d. for public lighting, miscellaneous receipts bringing the total to £8,419. 5s. (against £6,669 in previous year). Generation expenses were £1,865. 1s. 9d., management expenses £375. 7s. 7d., and special charges £559. 12s. 11d., other items bringing the total to £3,195. 1s. 8d, leaving gross profit £5,224. 3s. 4d. Interest and sinking fund absorbed £3,330. 4s. 10d., leaving net profit £1,893. 18s. 6d. Adding to this £1,480. 2s. unappropriated at March, 1903, the total surplus is £3,374. 0s. 6d. 742,266 units were generated (against 544,107 in previous year), and 672,722 sold (against 489,455). There are 435 private consumers, with the equivalent of 36,713 8 c p. lamps (against 377 and 29,433) and 40 motors connected of an aggregate of 282 H.P. The maximum load demanded was 610kw. (against 496kw.). The works costs were 0·69d. per unit (against 0·80d.), and the total costs 1·02d. (against 1·25d.). A Lancashire boiler, Bennis stoker and surface-condensing plant were added to the plant during the year. The new 700 H.P. generator, for which the foundations are being prepared, will bring the total capacity of the works to 2,650 H.P. The charge for current to private consumers for lighting has been reduced from 4½d. to 4d., and meter rents have been abolished. Nernst lamps have been tried, and are reported as giving the same candle-power as electric incandescents at less than one-third the cost.

The city electrical engineer claims that the cost per unit for production at Wakefield is lower than has ever been shown by any other undertaking with the same output and without a traction load.

Walsall.—The Electricity committee has fixed the charge for electric energy for traction at 1½d. per unit as from 1st inst., compared with 2d. hitherto.

The chairman of the Electricity committee (Ald. W. Brownhill) stated, at the Council meeting on Monday, that the price agreed upon was not so low as the Tramways committee desired it to be, but the Electricity committee felt it would not be fair for them to conduct the undertaking on lines which would not yield a fair profit, and the reduced charge would be lower than that fixed in 33 of the great towns of the country. While, however, last year the Electricity committee generated 400,000 or 500,000

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units, this year they would generate 1,100,000 or 1,200,000 units, and, although last year the profit made was only £350 on a capital of £78,000, the working of the tramways had so reduced expenses that the Electricity committee decided on the reduction stated as a measure of justice.

The committee's recommendation was approved.

Warrington.—An extension of time for constructing the Padgate-lane and Manchester-road tramways has been applied for by the Council.

West Ham (London).—On Tuesday the electrical engineer (Mr. Bullock) presented a report showing the financial result of supplying electric current to the municipal artisans' dwellings in the district.

Altogether 282 tenements are connected with the mains, and the average price per unit obtained was 4·37d. The total revenue for the past year was £246. 4s. 7d. The expenditure for lamp renewals, wages, reading, fixing and removing meters, &c., amounted to £97. 3s. 7d., leaving £149. 1s. to meet capital charges, generating costs, &c. 13,522 units were consumed, which, at cost price (2·74d. per unit), came to £154. 7s. 6d., leaving a loss of £5. 6s. 6d. It was resolved to continue the supply at present rates for 12 months.

In regard to complaints as to emission of black smoke from the generating station, Mr. Bullock reported that the three principal factors which determine the quality of smoke are (*a*) the class of fuel used, (*b*) the type of boiler and (*c*) the method of firing. With regard to fuel, the department was now using Powell Duffreyn Welsh washed nuts at 14s. 9d. per ton. If they used a large Welsh coal, costing 18s. to 22s. per ton, that would add largely to fuel costs owing to the present coal hoppers being constructed to deal with small coal. By a costly structural alteration the hoppers could be arranged to deal with large Welsh coal. The type of boiler installed at the station when fired by hand was notoriously a smoky one. All the boilers at present installed at Canning Town were hand fired. The remedy he proposed was the adoption of a mechanical under-feed stoker. The first cost would be about £370 per boiler. The proposal to adopt a mechanical under-feed stoker was agreed to by the Council.

The electrical engineer further reported that a draft agreement had been come to with the Thames Ironworks Co., the company agreeing to take a minimum of 250,000 units per annum, increasing to a maximum of 500,000. The estimated cost of laying cable was £488. The draft agreement was approved and the estimated expenditure sanctioned.

Westhoughton.—The Council have decided to take immediate steps to formulate an electric lighting scheme, and offers to lease the order are being considered.

Willesden (London).—A special meeting of the Council was held on Monday to consider the report of a special committee as to the management of the electricity undertaking.

The chairman of the Council (Mr. SEXTON) moved the adoption of the report and said that in January a letter was received from the North Metropolitan Electric Power Supply Co. inquiring whether arrangements could be made with the Council whereby the electrical engineer (Mr. E. T. Ruthven-Murray) should continue in charge of the power station, the company paying to the Council a proportion of the engineer's remuneration. It was agreed by the Council that Mr. Murray take temporary charge of the station as requested. In May the company proposed that Mr. Murray should be appointed engineer to the company, and should be at liberty to advise the Council in a consultative capacity, at any rate for the term during which the company has made itself responsible for any deficiency which the Council may have in working. The committee had finally decided to submit the following resolution as a recommendation:—"That the Council, in the event of the company appointing Mr. Murray as their electrical engineer, agree to their suggestion that he should act for the Council in a consultative capacity on terms to be arranged."

Mr. PINKHAM, chairman of the Electricity committee, said that although they had sold portion of the undertaking, they had still interests to the amount of £60,000 or £70,000. It was essential for the well-being of the concern that a hold should be retained upon the services of the originator of the scheme.

Opposition was offered to the recommendation, but the committee's report and recommendation were ultimately adopted by 10 votes to 6.

Mr. PINKHAM then moved that Mr. Murray's remuneration as consultative engineer be fixed at £300 per annum, and that his appointment be for three years.

This proposal caused considerable discussion, but ultimately was carried by 9 votes to 6.

Wireless Telegraphy.—Reuter's Agency states that the reason given for the rejection by the Argentine Government of the Marconi Company's proposal to erect a radiographic station in the Republic is that the Government considers the terms proposed by the company too high, and that the Technical department of the Argentine telegraph service advised the rejection of the proposals on the ground that the benefit derived from the station would not compensate for the cost of its installation.

It is stated that a wireless telegraph station is to be erected on the summit of Mont Blanc, the Marconi system having been selected for the purpose.

Wolverhampton.—At Monday's Council meeting Mr. Gough Allen moved the adoption of the report of the Electric Lighting committee for the past year, which states that there has been a gross profit of £11,495. 7s., out of which interest (£3,839. 1s. 6d. net) and sinking fund (£4,881. 1s. 3d.) have been met, leaving £2,775. 4s. 3d. net profit.

This result has been attained notwithstanding substantial reductions in price of current, the reduction for street lighting alone accounting for a diminution of £1,400 in revenue. The cost of production and distribution was less than in the previous year, though the output had increased by over 21 per cent. There are 739 private consumers, with the equivalent of 64,382 8 c.p. lamps connected, compared with 655 and 54,578 respectively in the previous year. The output for motive power has increased by 55 per cent. The report was adopted.

Ald. Mander moved the adoption of the Tramway committee's report, and Ald. Craddock, in seconding, praised the Lorain surface-contact system adopted at Wolverhampton, and expressed the opinion that by next July the loss incurred on the horse traction system would be wiped off. They could not, of course, expect to make a large profit on a new system which had not yet been properly developed. The report was adopted by 15 votes to 8.

Yarmouth.—The Tramways committee have been authorised to construct an additional electric tramway at a cost of £2,200.

Outing.—Tunbridge Wells electricity works employés had their annual outing at Eastbourne last week. Mr. Horace Boot (borough electrical engineer) presided at the dinner at the Continental Hotel. Mr. J. K. Brydges (borough electrical engineer of Eastbourne) was present. Mr. Boot praised the loyalty and industry of his assistants and Mr. A. R. Walter (mains foreman) acknowledged the compliment. The visitors inspected Eastbourne electricity works before leaving.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Hackney (London) Guardians invite tenders for fitting up a system of electric fire alarm bells at their Homerton establishments. Forms of tender, &c. (prepared by Mr. W. A. Finch, architect, 76, Finsbury-pavement, London, E.C.), can be obtained from the clerk, Mr. Frank R. Coles, Sidney-road, Homerton, N.E., to whom tenders by 2 p.m. July 27. See advertisement.

The Lighting Committee of *Islington* (London) Borough Council invite tenders for supply of a 25 B.H.P. single-phase 50-period 200-volt alternating-current motor with all starting gear, &c., complete, and for the supply of three sets of tail-rods and bearings for 1,000 B.H.P. engines. Specifications, &c., from the borough electrical engineer (Mr. Albert Gay), 50, Eden-grove, Holloway. Tenders to the town clerk (Mr. Wm. F. Dewey), Town Hall, Upper-street, N., by noon July 27. See also advertisement.

Rochdale Corporation invite tenders for supply and erection of two steam turbines direct-connected to two three-phase alternators, or for alternators connected to high-speed triple expansion engines; also for one motor-driven three-phase alternator. Tenders by 18th inst. to the town clerk (Mr. James Leach), Town Hall, Rochdale.

Rochdale Corporation also invite tenders by noon 18th inst. for extension of engine room at electricity works.

Metropolitan Asylums Board invite tenders for the installation of fire alarms at Darenth Asylum, *Dartford*, and for telephones at the Eastern Hospital, *Homerton*, and the Western Hospital, *Fulham*. Tenders by 10 a.m. 20th inst.

St. Pancras (London) Council invite tenders for main switchboard at King's-road power house. Tenders to the deputy town clerk (Mr. H. T. Richards), Town Hall, Pancras-road, N.W., by noon July 19.

Wigan Corporation invite tenders for hand reversible three-wire battery booster and switchboard, compound-wound double-field balancer and cables. Tenders to town clerk (Mr. Harold Jevons) by noon 19th inst.

Walthamstow District Council invite tenders for supply, delivery and laying of cables, troughing, boxes, &c., for two years. Tenders to the clerk (Mr. C. Sydney Watson) by 5 p.m. 22nd inst.

Wimbledon Council require tenders by 10 a.m. on 25th inst. for extensions to the present refuse destructor adjoining their electricity works.

Lincoln Corporation want tenders by 10 a.m. 18th inst. for traction switchboard and tramway feeder cables.

Dublin Corporation invite tenders for 12 months' supply of machinery oils for their electricity works. Tenders by noon July 22.

Finchley District Council require tenders by 5 p.m. 22nd inst for supply of Welsh coal to the electricity works.

Exeter Corporation invite tenders by noon 30th inst. for the erection of a car depot.

Salford Corporation invite tenders by July 23 for wiring Pendleton Town Hall.

Preston Corporation invite tenders by 18th inst. for machine tools for their tramway power station.

The Deputy Postmaster-General, *Hobart*, Tasmania, will receive tenders until noon Sept. 30 for supply and delivery at Hobart of a

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multiple metallic branching switchboard. Tenderers must state the country in which the switchboard will be manufactured. Specifications, conditions, &c., can be obtained from the General Post Offices at Hobart, Melbourne, Sydney, Adelaide, Brisbane and Perth.

TENDERS RECEIVED AND ACCEPTED.

St. Pancras (London) Council received nine tenders from eight firms for the supply of cables, and recommended that the lowest (that of Messrs. W. F. Dennis & Co.) at £800. 15s. 6d. be accepted. At the Council meeting on Wednesday Mr. Kibblewhite moved that the lowest British tender (Callender's Co.) be accepted. A long discussion ensued, and ultimately the committee's recommendation was adopted by 25 votes to 21.

Hackney (London) Borough Council are recommended to accept the tender of the British Insulated & Helsby Cables (Ltd.) for electricity supply mains at £8,749. 13s. 8d. There were seven tenders, varying from £8,713. 15s. 1d. to £9,820. 14s. 11d.

Hornsey (London) Council have accepted the following tenders:
Isaac Storey & Sons, condensing plant, £1,813. 10s.
Klein Engineering Co., water cooling apparatus, £500. 12s.
John Spencer (Ltd.) pipe work and valves with "Baker" oil separator, £1,024.
Masson, Scott & Co., water softening and purifying apparatus, £544. 8s.
Ferranti Limited, switchboards, £1,243. 19s.

East Ham District Council have accepted the tender of W. J. Fryer & Co. for wiring the new Technical College, Barking-road, at £679.

West Ham Corporation has accepted the tender of Fowler Bros. to paint 165 incandescent lamp posts for £10. 6s. 3d., and 40 arc lamp posts for £13.

London County Council have accepted the tender of the Alliance Electrical Co. for the installation of the electric light at Poplar Technical Institute at £666.

Hackney (London) Borough Council have placed an order with Reavell & Co. for an air compressor (with B.T.-H motor) at £83. 9s. 6d.

Colchester Corporation have placed an order with Davey, Paxman & Co. for one 550 H.P. Peache steam engine at £1,320, and with W. T. Henley's Telegraph Works Co. for cables at £1,369. 10s.

St. Pancras (London) Council received 14 tenders for carbons, varying from £229. 0s. 6d. to £366. 11s. 5d., and the lowest, that of Veritys Limited, was accepted.

Burslem Council have accepted tenders for electric lighting plant amounting to £15,671. The tender of Heenan & Froude for a refuse destructor at £3,095 has also been accepted.

West Ham Borough Council received 30 tenders, varying from £320 to £960. 10s., for wiring and fitting up the West Ham Park elementary schools for electric lighting, and the lowest (that of the District Electric Co.) was accepted.

BUSINESS NOTICE.

The address of the Hunter Electric Candle Co. (Ltd.) was given in our last issue (p. 502) as 17, Newman-street, Oxford-street, London, W. The number should have been 77, Newman-street.

BANKRUPTCIES, LIQUIDATIONS, &c.

The report of the senior official receiver (Mr. G. S. Barnes) upon the affairs of the Automatic Telephone Co. (1903), Ltd., states that the company was registered on Jan. 10, 1903, as a reconstruction of the Automatic Telephone Co. (Ltd.), formed in July, 1897, as a reconstruction of the Apostoloff Automatic Telephone Parent Synd. (Ltd.), which was promoted in November, 1895, by Mr. Max Margowski to acquire the invention of Mr. S. B. Apostoloff for an automatic telephone exchange.

The nominal capital was £10,000 in 400,000 6d. shares. The nominal capital of the Automatic Telephone Co was £100,000 in 5s. shares, and in the case of the 1903 company the nominal capital was £100.000 in 47,940 preference and 752,060 ordinary shares of 2s. 6d. each. The plant and machinery were erected by Mr. Margowski at Greenwich, and on the winding-up order being made, Mrs. Margowski claimed to be in possession of the machinery under a mortgage. The company's rights in a tool holder and an electric chuck invented by Mr. Margowski are returned at £1,100, and the company's half-share in an improved portable electrical ventilating fan is valued at £3,000. The Apostoloff patents are not included as assets, as most of them have lapsed. Other assets total £4,183. 12s. 6d. Unsecured debts amount to £275, so that a surplus of £3,899 in assets over liabilities is shown, but the account with the contributories shows a deficiency of £10,051. Mr. Barnes states that he will probably apply for an order for a public examination.

The first meeting of creditors of Henry Binko, electrical engineer, &c., 34, Leadenhall-street, London, E.C., was held last week. Liabilities £4,914. 1s. 5d., £4,515. 9s. 5d. expected to rank, with an estimated surplus of £9,008. 12s. 3d.

Debtor began business as an electrical engineer 35 years ago, with £2,000 capital. For the past 20 years he has carried on business at 34, Leadenhall-street, and at one time traded in partnership with another under the style of Binko, Ridsdale & Co. (Ltd.), lamp and fittings makers. That company was wound up. He has failed on two previous occasions, and attributes his present position to financing two companies of which he was a director. His assets included a claim for £10,000 against one of the companies.

The meeting was adjourned until 28th inst. pending the hearing of an action to which debtor is a party. Debtor, if successful in this action, considers he will be in a position to pay his liabilities in full.

The liquidator (Mr. Brougham, Carey-street, London, W.C.), in the winding up of the Electric Lamp Regenerating Co. (Ltd.) has been released.

The Electric Extension Co. (Ltd.) is to be wound up voluntarily, and Mr. C. E. Ruckley has been appointed liquidator.

Meters for Sale.—Dundee Town Council are prepared to receive tenders for the purchase of Ferranti continuous-current meters. The meters can be seen and full particulars obtained of the city electrical and tramways engineer (Mr. H. Richardson), Dudhope Crescent-road, Dundee, to whom tenders. See also advertisement.

Sale by Treaty.—Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., have for sale by private treaty the works, roads, lands and water power owned by the Royal Ballincollig Gunpowder Factories, which it has been decided to close. The waters of the River Lee give a reliable 400 H.P. continuously. Some further particulars will be found in an advertisement on another page.

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 30, Birley-street, Blackpool.

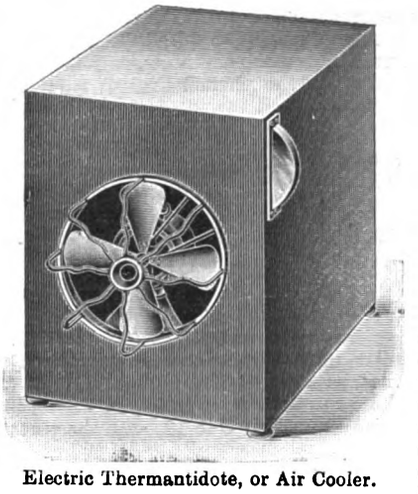
Two Westminster dynamos, direct coupled to two Robey engines, and two 16 N.H.P. boilers are for sale by R. H. Longbotham & Co. (Ltd.), Wakefield. See advertisement.

A complete secondhand electric lighting plant, suitable for an installation of 200 lamps (14 H.P. Crossley gas engine, 70-ampere dynamo, switchboard, &c.), is advertised in another column. Full particulars from Mr. W. P. Adams, M.I.E.E., 35, Queen Victoria-street, London, E.C.

To Let.—In the important business district of Tabernacle-street, Finsbury, London, E.C., Messrs. B. Brampton & Co., Finsbury House, Finsbury-square, E.C., have to let two floors in eligible warehouse premises.

Land to be Let or Sold.—Messrs. Walfords, 27, Bolton-street, Piccadilly, London, have some exceptionally eligible land at Stamford, Lincs., for sale or to be let. Stamford is connected with three railway systems, and is within moderate distance of the Midland coalfields.

Electric Air Coolers.—The Improved Electric Glow Lamp Co., 7, Great Newport-street, London, W.C., are placing on the market a new electric thermantidote (or air cooler) designed for hospitals, sick rooms, theatres, and similar places. As shown in the illustration, this thermantidote consists of a square cabinet open at both ends. At the front is fixed a 12in. porthole fan which exhausts the air in the cabinet and creates an inward rush of air at the other end. Over this opening is placed a rolling screen or curtain of rough coarse netting which is revolved by friction gear run by belt or from the fan spindle in a trough of water, with the result that the air drawn in and out of the cabinet passes through a water screen and becomes moist and cool. Scents or disinfectants placed in the trough will, in a few minutes, impregnate a moderate-sized house or large room.



Electric Thermantidote, or Air Cooler.

Catalogues, &c.—The Electric & Ordnance Accessories Co. have ready a new catalogue dealing with "Stellite" S.D. telephones, especially designed for use with existing electric bells and for general short distance and domestic work. The S.D. telephone in its simplest form is a handset with receiver and transmitter and special speaking key. This speaking key is an important item, as it obviates the danger of conversations being overheard through the

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telephone being, inadvertently or otherwise, left off the hook. With the Stellite instrument it is impossible for any conversation to be transmitted unless the speaking key is depressed. When the hand is removed from the handset the key automatically breaks the battery circuit, thus preventing the cells unnecessarily running down or wasting. The new list contains concise directions for fitting these instruments to existing bell circuits. A domestic instrument is also supplied without speaking key for kitchen and similar purposes. Numerous patterns of portable and other telephones are also listed, some of these designed for special work. There is described, for instance, a special type of intercommunication telephone comprising the same handset as previously described. When the conversation is finished this handset is hung up, causing the selector to return to its normal position, and the instrument is then ready for a further call. These telephones are supplied at very reasonable prices, and the trade can obtain copies of the catalogue on application.

The Langdon-Davies Motor Co., 101, Southwark-street, London, S.E., have ready two new sheets of prices of single-phase motors, with spur gear speed reduction attached and also with friction clutch attached. The spur gear gives a cheap and compact method of speed reduction, and the special pattern of friction clutch enables the load to be thrown on and off the motor as gradually as may be desired. In certain classes of work the friction clutch will be found especially advantageous.

Amongst the new Westinghouse literature just published is circular B 1,070, describing and illustrating C. and C.B. types of Westinghouse polyphase induction motors for constant speed. We have also received a copy of the Westinghouse "Diary and Notebook," containing a quantity of information useful to engineers, as well as a section of squared paper.

Price-list sheets of D.P. two-way knife switches have been issued by Ernest F. Moy (Ltd.) of Camden Town, London, N.W.

A new list of electric cranes, winches, capstans, &c., has been issued by John Abbot & Co., Suffolk House, Laurence Pountney-hill, London, E.C. In this list are illustrations of a 10-ton fixed pedestal electric jib crane, a 2½-ton movable pedestal crane with luffing jib, a 30-cwt. portable electric jib crane with grab, and other machines.

Edward G. Herbert (Ltd.), of Rosamond-street East, Manchester, have a catalogue ready of metal sawing machines, machine tool accessories, &c. The list of large users of these tools comprehends many of the leading electrical firms of this country.

Messrs. John J. Griffin & Sons, Sardinia-street, London, W.C., have sent us part 3 of their illustrated and descriptive catalogue of scientific apparatus. This part contains an extensive list of electrical apparatus and materials used in connection with experimental work, lectures, small installations and for purposes of amusement. Among the apparatus we notice a cheap line of moving coil voltmeters and ammeters; also some Nernst lampholders for use in projecting and enlarging. An addition to the catalogue is a modification of Prof. Elihu Thomson's electromagnet and ring apparatus for demonstrating electromagnetic repulsion. This instrument is arranged for working with continuous current, which is made pulsatory by an electrolytic break. The list also contains descriptions and particulars of small transformers and motor-generators, as well as a set of instruments for demonstrating the phenomenon of wireless telegraphy. There is also a well-chosen series of mathematical tables and electrical data.

A new set of leaflets and catalogue No. 59, all relating to circuit-breakers, is issued by R. W. Blackwell & Co., 59, City road, London, E.C.

An advance copy of the 1904 catalogue of Marsh, Son & Co., 15, Gerrard-street, Soho, London, W., reaches us and forms a comprehensive list of electrical accessories, &c. Attention is called to the reduction in price on many of the goods listed.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from July 6 to 12, with the ports of destination:—

***Africa*—Alexandria, £32; Cape Town, £483 (including £147 telegraph material); Delagoa Bay, £28; Durban, £2,842; Port Elizabeth, £79. *Argentina*.—Buenos Ayres, £218; Santa Cruz, £27. *Australasia*—Auckland, £2,273; Otago, £197; Perth, £1,140 (including £22 telegraph material); Rockhampton, £10; Sydney, £717; Wellington, £497; *Brazil*—Rio Janeiro, £40. *Canada*—Toronto, £11. *Ceylon*—Colombo, £154. *Chili*—Antofagasta, £150; Valparaiso, £150 (telegraph apparatus). *China*—Shanghai, £25. *Denmark*—Copenhagen, £62. *Germany*—Hamburg, £170 (telegraph material). *Gibraltar*, £236. *Holland*—Amsterdam, £190. *Hong Kong*, £27. *India*—Bombay, £334; Calcutta, £1,796. *Mexico*—Vera Cruz, £198. *Norway*—Christiana, £70. *Russia*—St. Petersburg, £755 (including £85 telegraph material). *U.S.A.*—New York, £20. Total £12,931, against £18,952 in the corresponding week last year (July 8 to 14).**

COMPANIES' MEETINGS AND REPORTS.

Telegraph Construction & Maintenance Co. (Ltd.)

A half-yearly general meeting of this Company was held on Tuesday, July 12, Sir Robert G. W. Herbert, G.C.B., presiding.

The SECRETARY (Mr. E. Dickens) read the notice calling the meeting.

The CHAIRMAN said: Gentlemen, at these half-yearly meetings there is never any really important business to transact, because the accounts of the Company are made up to the end of the year. We have, perhaps, less to tell you in the way of news connected with the Company on the present occasion than on a good many recent occasions. We have not since we last met made any considerable contract for the construction or the laying of cables, and we have been taking advantage of the opportunity afforded us by the comparative cessation of work to continue the renovation and re-adaptation of our factories and keeping everything in good order. We have had certain routine work—not inconsiderable—in the way of repairs, and the supply of stock cable to telegraph companies and our ships have been employed in repairing sea cables. The whole of the ships and factories are in excellent condition, and we are ready for any work that may present itself at very short notice. We have disposed of the steamship "Britannia," one of our old ships, which we have sold to our friends, the Eastern Telegraph Co., and we have entered into a contract with Messrs. Swan, Hunter and Wigham Richardson to build a new cable ship to replace her and also to replace the "Scotia," which, as you know, we have parted with. In the place of these two older vessels, we shall have one very efficient and all-round useful ship in the vessel which is now being built for us. Her tonnage will be about 1,800 tons, and our fleet will be at once more economical and more efficient, I think. With regard to the pension fund, the trustees have now got everything into thorough order. I am pleased to inform you that there have been no demands as yet by members of the Company's staff entitled to make application to go upon the pension fund, and we are glad that such applications should be postponed as long as possible. There is no other news, and no news is good news.

Mr. GIBSON said it was very pleasing to hear the statements which had been made by the Chairman. The Company seemed to be in a position to take up any business which might be tendered to them, and to be in a stronger position than most similar undertakings. The shareholders were very much indebted to all concerned for the success of past years and especially for the successful completion of the recent enormous contracts, which were a standing recommendation of the Company's work. They had not only to thank the Chairman and the Board of Directors, but all concerned in the management of the affairs of the Company. He desired to move a vote of thanks to the Chairman and Directors, the Manager, the Secretary and the staff, so that every member might know that not only in the minds of the Directors but also in the minds of the shareholders their services were appreciated.

Mr. HENRY ROBERTS seconded the motion, which was carried by acclamation.

The CHAIRMAN: On behalf of the Directors and the whole of the staff—including, of course, those who are at sea as well as those who are on shore—we thank Mr. Gibson for the kind and sympathetic manner in which he has recognised the efforts which are made to maintain this Company in good order, and we are much obliged to him for the terms in which he has included the Company's employés and staff. The fact will be communicated to them, and they will be very grateful for that expression of goodwill from a very old shareholder. I should mention that we have given instructions for the payment of the usual dividend of 5 per cent. for the half-year.

The proceedings then terminated.

Electric Construction Co. (Ltd.)

The eleventh annual general meeting was held yesterday, Mr. James William Barclay presiding.

The SECRETARY (Mr. David Willock) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: Gentlemen, the decrease in our profits is unsatisfactory, but, on the other hand, the financial position of the Company has greatly improved, and gives increased confidence in its future. The general outcome is, including the balance brought from last year, an amount of £19,167. 15s. of profits available for dividend, and your Directors recommend that, after paying the dividend on the preference shares, a dividend of 4 per cent. be paid on the ordinary shares on July 30 and £2,000 added to the reserve fund, leaving a balance of £3,805. 3s. to be carried forward. The whole 4 per cent. ordinary dividend is to be paid on July 30, instead of one-half then and the other on January 30, as formerly. This change has been made in deference to the wishes of shareholders, but I must warn you that no interim dividend for next year will be paid, because we think it injudicious to pay any dividend from profits until the accounts made up at the end of the financial year show what profits have been earned. The profit and loss account shows a decrease of £6,643 in manufacturing profits, brought about by the excessive competition we have had to meet during the last year, and an increase of £103 from other sources. The total expenditure on the debit side of the account shows a small decrease of £576. The fact is, economies had previously been carried so far that little scope remained for proceeding further in that direction, and our great aim has been to increase the output of the works, and in this respect we have been to some extent successful, for we have turned out a larger volume of work during the year than ever before. The important feature in the balance-sheet is the reduction of the loan from the Company's bankers from £60,000, as appeared in last year's accounts, to £10,000 in those now submitted, and, further, that balance has since been paid.

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This result has been reached by selling the Company's interest in the Crystal Palace and District Electric Supply Co., which formed part of the assets of the old Electric Construction Corporation; while the Madras electric tramway undertaking has been transferred to the Madras Electric Tramways (1904), Ltd., in consideration partly of cash and partly of shares. The price was fixed on the basis of last year's tramway profits, which showed equal to a dividend of 5 per cent. on the shares of the new company, and, as this is an improving property, the Directors expect that this dividend will be at least maintained. Realising the two properties has, on balance, resulted in a loss of about £4,000, and this loss has been debited to the general reserve fund, reducing its amount to £30,000. But to continue the policy of the last few years it is proposed to appropriate £2,000 of the profits of this year to the reserve, and thus, practically the reserve fund is reduced by only £2,000. As stated in the report, we have granted, as usual, a bonus to those of our employés who have given us 12 months' good and faithful service, but at a reduced rate in proportion to the dividend. The bonus is based on the amount of the dividend. I have now dealt with the accounts, but shall be pleased to give further explanations, and will now offer a few remarks on the trade position and prospects of the Company. We have experienced excessive competition during the last year, especially during the last six months, and the competition still continues. This statement may appear somewhat vague, but I have had some figures prepared which will enable you to realise for yourselves the position of the electrical manufacturing business. These figures show that the prices of certain classes of electrical machinery are on an average 40 to 50 per cent. less than they were in 1900—that is, a fall of nearly one-half in four years. And when I tell you that the cost of raw material is very little less now than it was then, you will appreciate more fully the skill in design and economy in processes that has enabled us to earn any dividend at all. The orders on hand include, amongst others, important contracts with the London County Council and with the Great Western Railway Co. for their new electrical installation at Park Royal. I attach much importance to this contract with the railway company because I have no doubt traction by electric power will be more and more largely adopted by railways, and I have no doubt our engineers will give satisfaction in this department, as they have in the past. If we have not had a larger share of recent railway equipments it is probably because several of the more important contracts have been combined with financial operations, into which we decline to enter. You will probably ask how long this competition is to last. I am sorry to say that is a question I cannot answer. I may, however, tell you that it is not foreign competition that has brought prices down to their present level, for they are now lower than any prices of Continental or American manufacturers quoted in this country. Within the last few years new factories have been established both in England and in Scotland, and although I look for a large development in the use of electric power, we must expect and be prepared for keen competition for some time. We are well equipped for the struggle. Our works are up to date, we spare no expense in adopting labour-saving machinery, we have full confidence in the skill of our engineers and in the zeal and ability of our employés. There must be a time of stress, but the fittest will survive, and I will only add that we mean to be of the number. I now move the adoption of the report and accounts.

Mr. PHILIP E. BEACHCROFT seconded the motion.

Mr. BALL asked whether it was the intention of the Board to retain the Madras shares as a permanent investment.

The CHAIRMAN: Not longer than the time when we can sell them at a fair profit.

The motion was carried.

The retiring Directors (Sir H. C. Mance and Mr. J. Irving Courtenay) were re-elected, and Messrs. James Meston & Co. were re-appointed as Auditors.

A vote of thanks to the Directors terminated the proceedings.

Electrical Power Storage Co. (Ltd.)

The fifteenth ordinary general meeting was held yesterday (Thursday) under the presidency of Mr. J. Irving Courtenay.

The SECRETARY (Mr. David Smith) read the notice calling the meeting.

The CHAIRMAN then said: Gentlemen, it is a pleasure to me to be able to report good results from the past year's working, in spite of the fact that the general trade of the country has been of a somewhat unsatisfactory character. We again recommend a dividend of 6 per cent., and at the same time further consolidate the company's position by transferring £3,500 to reserve and £1,000 to contingent fund. Our capital remains unaltered, and while the reserves are larger by £4 500, sundry creditors are somewhat less. We have expended £1,459. 6s. 5d. in equipping the property with further plant and the latest labour-saving appliances, besides thoroughly maintaining the works out of revenue and providing £1,603. 12s. 6d. for depreciation. The stock we have on hand is well chosen, and in every way suitable for the company's business. Sundry debtors are about £2,000 larger than at May 31, and full provision has been made against bad and doubtful debts. Investments are unaltered, and cash and bills receivable are increased by about £1,500. Competition has been more severe than ever, and the cutting of prices is a marked feature of the year's business. We are meeting this competition by unremitting attention to economies in production, and we have no anxiety as to the result. The works are very busy, and although the actual turnover is rather smaller than that of the previous year, the value of orders received is larger. This of itself is strong testimony to the efficiency of E.P.S. batteries, and I think, therefore, we are warranted in looking forward with hope and confidence to the future. Our orders include batteries for some 18 central stations in various parts of the country and abroad, amongst others being orders for Heysham, Gibraltar, Walsall, Haslar, Todmorden, the Metropolitan Electric Supply Co. (two batteries), the St. James' and Pall Mall Electric Co., Acton, Gloucester, Poplar, Devonport, Tynemouth, Sunderland and Kettering. I think you will agree that that is a very good list.

At our last meeting I alluded to the sensational notices regarding what was called the Edison battery. The experience of the 12 months that have since elapsed confirms the doubts I then expressed as to the excessive merits claimed for it. This type of battery has been given an extended trial in a vehicle in this country. It took up more space and was approximately the same weight as our own lead battery, but after a run of about 3,000 miles I am informed that it has been sent back to its native land—presumably because the roads and climate of the British Isles did not quite suit its constitution. It is important to remember that no inventor in particular has a monopoly of these accumulators with alkaline electrolyte. Experiments in alkaline batteries are being pushed on by ourselves, and we feel confident that if a successful battery is to be made this company will not be behind others in putting one on the market. During the year there has been no relaxation in our efforts towards the improvement of the batteries, both for traction and other purposes, and no trouble or expense is spared, under Mr. Butler's supervision, in testing and ascertaining the value of all improvements or reputed improvements that are brought to our notice. Our staffs—both technical and commercial—are fully alive to the position, and devote their best energies to the work. Several alterations have also been carried out during the year at the Millwall works with the object of assuring greater comfort and health to our workmen. I now move the adoption of the report and accounts.

Sir JAMES PENDER, Bart., seconded the motion, which was carried unanimously; and resolutions were afterwards passed re-electing the retiring director, Sir J. Pender, and the auditors.

Mr. J. W. BARCLAY congratulated the directors on the satisfactory statement of accounts submitted. There were, he thought, very few similar companies to their own which would be able to present such satisfactory accounts. He was sure the shareholders had been deeply interested at what had been said with regard to the Edison battery. The conclusion he had arrived at from the chairman's remarks was that there was no better battery than that which the company themselves were able to make; and he had no doubt, from what he knew of the care and vigilance of the management, that if anything good was going, the company would at least know about it. He proposed a vote of thanks to the chairman, directors and staff.

Col. BUTTANSHAW seconded the motion, which was carried unanimously.

The CHAIRMAN having replied, the proceedings terminated.

British Electric Traction Co. (Ltd.)

The eighth ordinary general meeting was held on Monday, Sir Charles Rivers Wilson, G.C.M.G., C.B., presiding.

The SECRETARY (Mr. Charles H. Dade) read the notice convening the meeting and the auditor's report.

The CHAIRMAN said: Gentlemen, it will be seen from the report that the accounts are given in much fuller detail than previously. The net profit for the year to March 31 last before paying debenture interest was £249,817, against £222,836 for the preceding 12 months. This increase in profits is entirely represented by the increased productiveness of our investments in the associated companies. This is a very satisfactory feature, for it is mainly in this direction that we shall have to look for our profits in the future. The total amount received this year, in respect of dividends on shares, interest on debentures, consols, loans, deposits, and on purchase money unpaid is £171,369, against £138,000 last year. (The chairman then went fully into the items showing the net profits of the Croydon, Barrow, Brighton, Mumbles and Pontypridd undertakings, which are not yet worked as separate companies. The net surplus was £3,879.) The next item, £51,250, represents profits made on the sale of undertakings and sundry rights and interests to new or established associated companies. The following item, profit on hire of rolling stock and rent, is £2,305, and represents the profit from certain rolling stock temporarily loaned at a rental to our companies. Then the net profit on sales and investments has been £1,375, and the net profit on engineering and other services rendered was £2,941. We have also received £10,365 in respect of fees and commissions for provision of office accommodation and services of staff and £2,632 for pupils, transfer and guarantee fees. The last credit item is the net profit on shares and debentures underwritten and taken up by others (£25,312). This is a financial profit which varies from year to year according to the state of the money market and the success which we have in getting shares and debentures of the associated companies underwritten or taken up by others.

Turning to the debit side the first item is £9,371, the balance management and general expenses. The total expenses of administration of the company amount to £82,095, and of this amount items aggregating £13,557 have been charged to other companies, £37,174 has been deducted from various branches of gross profits, and £21,992 has been charged to undertakings and works in progress. Deducting these items, the balance of £9,371 is carried to debit of profit and loss. £10,115 has been paid for interest on loans from bankers and on moneys deposited with us, we have lost £1,019 on realisation of stores and materials, and £6,925 on undertakings not proceeded with and written off. In regard to this latter item, it has been our practice to write off all expenditure on Parliamentary bills, &c., which we have no reasonable hope of making productive; but the fact that the amounts so written off are not irretrievably lost is shown by the item of £4,433 in the accounts, which represents expenditure previously written off and since recovered. Sundry losses (£10,607) is exceptional, and arises mainly out of the experiments which

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we have thought it advisable to make in connection with the new motor haulage industry. It is necessary, having regard to our large interest in traction undertakings, that we should watch carefully all new developments, and be prepared to adopt any methods of traction which offer advantages over those at present employed, and we have made sundry investments and experiments in connection with motor haulage vehicles and motor omnibuses, and these expenses have been written off. Superannuation fund contributions amount to £616, and £507 off furniture account is the usual 10 per cent. £4,575 has also been written off licences account, which is now entirely wiped out. This money was spent on experimental work in previous years. After deducting these debits we have a balance of £249,817, besides £24,912 brought forward, making £274,730, from which has to be deducted interest (£63,704), against £44,165 in the preceding year, and preference dividend (£92,896), against £74,760. The interim ordinary dividend absorbed £39,990, leaving £78,138. The directors propose to pay a further dividend at the rate of 6 per cent. per annum on the ordinary shares, making 6 per cent. for the year, the net balance (£38,148. 9s. 9d.) to be carried forward, against £24,912. This carry forward is £13,236 larger than last year, but the dividend on the ordinary shares is 2 per cent. less. The chief reason we have recommended the payment of a smaller dividend is that, although the amount received in respect of dividends and interest on investments shows a satisfactory increase, there is still a large proportion of capital which has not yet had time to become revenue-earning. But great progress has been made. We are now operating nearly 400 miles of tramway, light railway and omnibus routes, against about 200 miles five years ago. We are carrying about 220,000,000 passengers per annum, against 55,000,000 in 1899, and our total traffic receipts are £1,162,000, against £315,000 in 1899. In 1899 we carried per route mile 255,000 passengers and the receipts were £1,455 per mile. For the past year the passengers were 554,000 and the receipts close on £3,000 per route mile. In 1899 the majority of the lines were worked by steam and horses, but in 1903 the majority of the lines were worked by electricity. (The chairman then briefly referred to the various items in the balance-sheet, and reviewed generally the operations of the company and its affiliated undertakings for the past year.)

Ever since the formation of the company Mr. Garcke had acted not merely as managing director but, on behalf of this company, as chairman and director to a large number of associated companies. This was unavoidable at the time. Mr. Raworth, Mr. Hilton and Mr. Madgen took seats at the board of the associated companies, and Mr. Raworth was appointed technical director in 1901, and acted as chief of the inspection department, but resigned his position in March last, though he remains a director.

I now only need call attention to the Superannuation Fund and the Friendly Society. Both these are doing extremely well. The Superannuation Fund has a membership of 183, and 12 new contributing companies have joined the fund during the last year, the most important being the City of Birmingham Tramways Co. The total number of contributing companies to Dec. 31 last stood at 45, and the investments of the fund have risen from between £4,000 and £5,000 to between £7,000 and £8,000. The Friendly Society has now a membership of nearly 2,000, an increase of some 17 per cent. There are 28 branches at work in various parts of the country, and other branches are in process of formation. The income of the society is about £70 a week, and the weekly sick pay averages about £45 a week.

We have felt it our duty to associate with Messrs. Smith & Co., the auditors, who have conducted the audit up to the present time, another large and important firm of auditors, in consideration of the great increase in the work, and we have selected Messrs. Deloitte, Dever, Griffiths & Co., a very eminent firm, to join Messrs. Smith in the examination of the accounts. I should, in conclusion, like to add that I consider the position of the company is very good, and that our prospects are excellent. I now move the adoption of the report and accounts.

Mr. E. GARCKE seconded.

Mr. F. HORRIDGE: There is one matter which deserves serious consideration, and that is the amount of the dividend. The three items mentioned by the chairman come to about £94,000. We must be prepared to see this disappear entirely, I suppose, in a year or two's time. £94,000 is a very large sum. Will this £94,000 be counterbalanced by the further developments of the company's business? Until the directors have gone into this question thoroughly I would say they are not in a position which would justify them in declaring so high a dividend. I believe sincerely that the future of this company mainly and chiefly depends on the attitude of the directors on this point, and I see no policy more likely to increase the intrinsic and market value of the shares than that of making present sacrifices for future good.

Mr. LEA-SMITH: I think the satisfactory statement made by the chairman to-day is that he has arranged for all the finances of this company. I have great confidence in this board, and although I have seen the price of my shares fall, I look on that as only temporary; and if the shareholders in this company loyally support the directors, I think the statement that the chairman made that our company will eventually become a very successful undertaking will be fully borne out.

Mr. KITCHIN: What is being done with regard to the loss incurred on the Birmingham tramways?

The CHAIRMAN: I feel very gratified with the impression this meeting has brought to mind. I am especially pleased to see the conservative tone of the meeting. I am entirely with you as regards a smaller dividend, and I am with Mr. Horridge in what he says about a 5 per cent. dividend But I think we have done reasonably well. No doubt some of our sources of profit will not crescendo. But on the other hand, the more we go on with our work, and the more extensive becomes the electrification of the lines, the greater will become the resources which we shall obtain from the associated companies, so that what we lose on the one hand we shall more than make up on the other.

Mr. GARCKE: I am able to allay Mr. Kitchin's anxiety with regard to the Birmingham undertaking. Our interest in Birmingham and district consists of upwards of 90 miles of tramways and light tramways and only about 25 miles is inside the city of Birmingham, so the larger part of our undertaking is in no way affected by the municipalisation of the tramways within the city. The City of Birmingham Tramways Co. are making very ample reserves in view of the expiry of the lease. We are, of course, sorry that the Birmingham Corporation decided to municipalise the tramways within the city, but it is no loss in the sense in which Mr. Kitchin understands it.

Mr. P. M. HANSEN, who is in this country on a visit from Auckland, made a statement as to the position of the Auckland electric tramways. Some five years ago (he said) he arrived in London and advised the British Electric Traction Co. to buy up the Auckland tramways undertaking, which was then in liquidation and unable to keep its head above water. They took up the scheme and bravely proceeded with it, with the result that they had converted an undertaking which was unable to yield any interest whatever upon the small capital of £40,000 into an undertaking which already pays interest and dividends on almost £600,000, and which promises very handsome returns in the future.

The Hon. Sir C. W. Fremantle, K.C.B., was re-elected a director and both firms of auditors were re-appointed. A cordial vote of thanks to the chairman, the directors and the staff terminated the proceedings.

EDMUNDSON'S ELECTRICITY CORP. (LTD.)—The directors' report states that including £11,733 from last year, the net profit, after payment of interest, is £64,405. Deducting preference dividends paid and accrued (£15,544) and an interim ordinary dividend at rate of 5 per cent. (£8,750) there remains £40,111. It is recommended that a final dividend on the ordinary shares at the rate of 9 per cent. per annum (making 7 per cent. for the year) be paid, to write off goodwill £5,000, add to reserve £5,437, leaving to be carried forward £13,923. The following central stations have been erected and opened since last report:—On account of local authorities, at Surbiton, Frome and Dorking; on account of Urban Electric Supply Co., at Caterham, Glossop and Berwick; on account of Isle of Wight Electric Light & Power Co., at Ryde. The only towns for which the company possesses statutory powers and which have not yet been dealt with are Ramsgate and Inverness.

GREENWOOD & BATLEY (LTD).—At the meeting on Saturday, Mr. J. H. Wurtzburg, who presided, said the net profits were £6,800 more than in the previous year, and well above the average of the past five years. The company's electrical department continued to make good progress. They were now in a position to manufacture all the component parts of the De Laval turbines in all sizes and varieties. The company's holding in the English De Laval Steam Turbine Co. (Ltd.) was represented by 3,004 shares of £10, but as the profits derived from the sole selling agency had been devoted to writing down the value of those shares they stood in the books at only £21,674. Their prospects for the coming year were distinctly hopeful. The report was adopted, a donation of £500 to Leeds University was authorised, and a dividend of 5 per cent. on the ordinary shares was declared.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—An extraordinary general meeting has been called for the 19th inst. (1) to consider and confirm a resolution of the directors for the payment to holders of ordinary shares out of the profit on capital account made by the sale of the Marylebone undertaking of a bonus at the rate of £6 per share; (2) to consider a resolution for the payment to the directors of a bonus out of undivided profits by way of extra remuneration for special services in relation to the sale; (3) to consider a resolution amending clause 40 of the articles of association. At the same time the chairman will explain to the shareholders the views of the board as to the best method of dealing with the balance of the purchase-money.

NATIONAL TELEPHONE CO. (LTD.)—The report of the directors for the half-year ended June 30 states that the income accrued amounts to £984,600. 8s., compared with £894,583. 8s. 5d. for the corresponding period of 1903, an increase of £90,016. 19s. 7d. Working expenses were £567,071. 18s. 6d., compared with £509,414, an increase of £57,657. 18s. 6d. The net result for the half-year (after deducting Post Office royalties, £90,702. 18s. 7d.) is a profit balance of £326,825. 10s. 11d., compared with £303,156. 19s. 7d. for the corresponding period of 1903, an increase of £23,668. 11s. 4d. Rentals carried forward for unexpired terms of running contracts amount to £937,296. 16s. 1d., compared with £874,383. 1s. 10d., an increase of £62,913. 14s. 3d. Out of the available balance of £258,286. 9s. 10d., the board recommend payment of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, of 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock and 5 per cent. per annum on the deferred stock (less tax in all cases). The board also propose to transfer £100,000 to reserve, and to carry forward £9,369. 16s. 6d. £394,654. 4s. 9d. has been expended on capital account during the half-year in the erection of 19,615 additional exchange and private stations and in the construction of underground works.

PEARSON FIRE ALARM (LTD.)—At the meeting on Tuesday the chairman (Mr. W. Chamberlain, J.P.) said that, after over a year's experience in the working of the company, he came before them with a confidence, which was entirely unabated, in the future of automatic fire alarms. For a large part of the past year they were occupied in clearing decks for a new campaign. With regard to the thermostats and their systems generally, shareholders might have heard that the company had made great changes, but that was not the case. The system of thermostat they had taken over was one of fusible metal and open and closed circuits, and it had worked satisfactorily. The standard system which they took over was still in good work, and they had no fault to find with it. It took the

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only gold medal at Earl's Court Exhibition; but they had found it a system difficult of demonstration and expensive in installation; consequently, it was only suited for crowded localities, where a great many instruments could be grouped in one centre. They wanted something more flexible in their system to be able to take the instruments to any position and under any circumstances. Improvements had been made in the system by their engineers, and then they cast about for thermostats of a different kind. There were a great number on the market, and they were acquainted with most of them; but he might say that there were none more efficient than, and very few which could claim equal efficiency for simplicity, reliability and neatness with, those which they imported from Germany. They had made satisfactory arrangements for the rights in this country, payments being by royalty only. The greatest difficulty they had to contend with was the innate conservatism of the British people and their dislike to new things until they had ceased to be new. The apathy of public authorities was to him simply amazing. In America fire alarms had come largely into use, and they were recognised as a valuable ally by insurance houses.

STATUTORY RETURNS, LIENS REGISTERED, &c.

STATUTORY RETURNS.

HARRINGTON ELECTRIC LIGHT CO. (LTD.)—In return to May 12 the capital is £5,000 in £1 shares, of which 3,900 shares have been taken up. £3,900 has been paid. Mortgages and charges, nil.

SIEMENS BROTHERS & CO. (LTD.)—According to return to June 14 the capital is £600,000 in 120,000 shares of £5 each, all of which have been taken up and paid for in full. Mortgages and charges, £150,000.

WEST COAST OF AMERICA TELEGRAPH CO. (LTD.)—The return to May 17 gives capital as £132,520 in 53,008 shares of £2. 10s. each, of which 45,008 have been taken up. £2. 10s. per share has been called up on eight shares and £20 has been received. £112,500 is considered as paid on 45,000 shares. Mortgages and charges, £170,000.

MORTGAGES AND CHARGES.

CUTTING BROS. (LTD.)—£4,000 debentures, created June 20, 1904, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

INGLETON ELECTRIC LIGHTING & POWER CO. (LTD.)—A debenture dated June 21, 1904, to secure £600, charged on company's undertaking and property, present and future, including uncalled capital, subject to debentures dated June 22, 1900, June 31, 1901, Jan. 29 and Aug. 8, 1902, securing £1,200, £800, £200 and £400 respectively, has been registered. Holder, J. C. Walker.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26¼d. per oz. (July 14). Consols 89⅞—89⅞ for money, 89⅞—89⅞ for account; 2½ per cent. annuities 89—89½ (July 14). Consols Pay Day, Aug. 4; Stocks and Shares Continuation Days, July 26 and Aug. 10; Ticket Days, July 27 and Aug. 11; Pay Day, July 28; Mining Share Carry-over Days, July 25 and Aug. 9.

DIRECT UNITED STATES CABLE CO. (LTD.)—It has been resolved by the directors to recommend a final dividend of 3s. per share (tax free) payable 30th inst., making, with the three interim dividends, a total distribution of 3 per cent. for the year ended June 30. After placing £6,000 to reserve, about £2,168 will be carried forward. The transfer books will be closed from 12th to 26th inst. inclusive.

EASTERN TELEGRAPH CO. (LTD.)—Subject to final audit, the accounts show, after payment of interest on the 4 per cent. mortgage debenture stock, the 3½ per cent. preference stock dividend to March 31, and the interim dividend of £1. 5s. per cent. on the ordinary stock to December 31 last, an available balance sufficient to pay a final dividend of £1. 5s. per cent. and a bonus of £2 per cent. (both tax free) on the ordinary stock, payable 22nd inst., making 7 per cent. on that stock for the year ended March 31. The transfer books of the ordinary stock will be closed from 15th to 22nd inst. inclusive.

ELECTRIC SUPPLY CORP. (LTD.)—The list of subscriptions for the issue of 46,600 ordinary shares of £5 each at par by this company closes to-day (Friday).

ELECTRIC TRACTION CO. (LTD.)—The directors of this company, which was the promoting syndicate for constructing the Central London Railway, have issued a circular announcing the distribution of the company's assets. The return is at the rate of £17. 5s. for each ordinary share of £10 and £43 for each deferred share of £1. It is expected that there will be a further distribution of £1 on the ordinary shares and £7 on the deferred. The capital of £300,000 is divided into £298,800 in ordinary £10 and £1,200 £1 deferred shares.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—A quarterly interim ordinary dividend of 2s. per share is announced.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The share transfer books will be closed from 16th to 30th inst., inclusive, preparatory to payment of interim dividend on the ordinary and preference shares for the half-year ended June.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed July 20 a special settling day in £350,000 4½ per cent. debenture stock of the *Metropolitan Electric Tramways (Ltd.)* and July 27 a special settling day in a further issue of 25,000 £1 fully-paid shares of *Marconi's Wireless Telegraph Co. (Ltd.)* and have ordered the former to be quoted. The committee have been asked to allow £50,000 5 per cent. debenture stock of the *Madras Electric Tramway (1904), Ltd.*, and £200,000 first mortgage debenture stock of the *Urban Electric Supply Co. (Ltd.)* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	...	...	...	...	...	...
Airdrie	July 1	221	...	21	4,088	...
Ayr Corporation	,, 9	360	+ 1	8	2,703	- 58
Barnsley	,, 1	155	- 41	26	4,319	- 297
Barrow	,, 1	198	...	21	3,851	...
Bath Electric Trams, Ltd.	,, 6	682	...	27	15,742	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	...	...	...	...	...	...
Birmingham Corporation	,, 9	846	...	15	8,782	...
Birmingham Tramways Co.	,, 9	5,798	+ 661	1	5,798	+ 661
Blackburn Corporation	,, 8	998	+ 115	15	14,563	+ 1,110
Blackpool Corporation	,, 7	1,149	+ 58	14	12,550	+ 665
Blackpool and Fleetwood	,, 9	870	+ 59	2	1,126	- 184
Blackp'l, St. Anne's & Lytham	,, 7	540	+ 27	26	9,308	+ 5,767
Bolton Corporation	,, 10	2,151	+ 186	15	27,874	- 47
Bournemouth Corporation	,, 6	1,052	- 6	‡14	15,258	+ 794
Bradford Corporation	,, 9	4,979	+ 1,100	14	65,974	+ 11,316
Brighton Corporation	,, 10	1,188	+ 206	14	13,854	+ 466
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage	,, 8	5,433	+ 346	7	37,657	- 1,096
Buenos Ayres & Belgrano	June 12	3,185	+ 278	8	26,784	+ 676
Burnley Corporation	July 9	1,024	+ 172	15	15,687	+ 3,803
Burton Corporation	,, 10	387	...	¶14	5,000	...
Calcutta Tramways Co.	,, 9	R28,820	+ R4,891	2	R28,820	+ R4,891
Camborne-Redruth	,, 11	118	- 13	10	1,167	- 84
Cardiff Corporation	,, 9	2,126	- 418	14	29,619	+ 624
Carlisle Tramways Co.	,, 9	212	- 7	27	5,231	+ 309
Central London Railway	,, 11	6,414	- 510	1	6,414	- 510
Chatham & Dist. Lt. Rys.	,, 7	701	+ 89	27	15,283	+ 2,028
City & South London Rly.	,, 10	2,386	- 137	2	4,847	- 81
Cork Electric Trams Co.	,, 7	611	- 76	27	11,998	- 966
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 1	574	+ 59	26	13,224	+ 2,139
Dover Corporation	,, 9	271	- 103	15	3,219	- 245
Dublin & Lucan Railway	,, 8	161	+ 66	1	161	+ 67
Dublin Southern District	,, 8	1,143	+ 19	} 1	6,057	- 247
Dublin United	,, 8	4,188	- 264			
Dudley—Stourbridge	,, 1	909	- 88	26	21,325	+ 687
Dundee Corporation	,, 6	856	+ 9	...	...	...
East Ham Council	,, 9	778	+ 80	14	11,082	+ 2
Gateshead & Dist. Trams	,, 1	855	- 5	26	23,144	+ 1,054
Glasgow Corporation	,, 9	13,794	+ 750	¶6	83,458	+ 490
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 1	283	- 30	26	6,197	+ 693
Gt. Northern & City Rly.	...	...	...	...	...	...
Greenock & Port Glasgow	,, 1	688	- 52	26	13,208	+ 579
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 1	854	+ 20	26	7,195	+ 695
Huddersfield	,, 9	1,408	+ 137	14	19,311	+ 760
Hull Corporation	,, 9	2,181	+ 300	14	30,600	+ 3,576
Ilford District Council	,, 9	528	- 24	15	7,137	+ 498
Ilkeston Corporation	,, 7	142	- 50	...	...	...
Ipswich Corporation	,, 9	564	...	14	7,572	...
Isle of Thanet Co.	,, 9	1,124	- 51	1	1,124	- 51
Kidderminster & District	,, 1	151	- 15	26	3,018	- 135
Kirkcaldy Corporation	,, 6	240	- 28	27	5,265	...
Lanarkshire Trams Co.	,, 7	664	...	27	16,618	...
Leeds Corporation	,, 9	6,131	+ 590	16	82,668	+ 5,100
Leicester Corporation	,, 9	1,133	...	8	9,027	...
Liverpool Corporation	,, 2	11,843	+ 222	27	270,255	+ 5,807
Liverpool Overhead Rly.	,, 10	1,672	- 46	28	3,361	+ 29
*London County Council	June 25	18,400	+ 2,186	§13	143,602	+ 24,317
Lowestoft	July 9	255	...	¶50	9,666	...
Manchester Corporation	,, 9	18,216	+ 1,007	14	173,035	+ 4,709
Mersey Railway	,, 9	1,439	+ 87	1	1,439	+ 87
Merthyr	,, 1	197	- 14	26	5,201	+ 167
Middleton	,, 1	387	- 88	26	8,079	+ 85
Nelson Corporation	,, 9	129	+ 51	15	1,741	+ 752
Newcastle-on-Tyne Corp.	,, 9	3,542	+ 804	1	3,542	+ 104
Newport (Mon.)	,, 9	542	+ 48	14	7,333	+ 1,776
Oldham, Ashton & Hyde	,, 1	576	- 56	26	13,905	- 853
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams.	,, 8	1,286	+ 203	27	36,177	+ 4,817
Peterborough	,, 1	171	- 17	26	3,559	- 174
Poole and District	,, 1	324	- 11	26	7,168	- 12
Portsmouth Corporation	...	...	...	...	...	...
Potteries	,, 1	1,869	+ 14	26	43,365	+ 3,450
Reading Corporation	,, 7	677	...	1	677	...
Rochdale Corporation	,, 11	179	+ 14	15	2,186	- 187
Rothesay	,, 1	198	- 58	26	2,337	- 51
Salford Corporation	,, 11	4,451	+ 803	15	60,274	+ 4,993
Sheerness	June 29	93	- 25	26	1,414	- 893
Sheffield Corporation	July 10	4,924	+ 185	§15	71,484	+ 2,093
Southampton Corporat'n	June 30	1,143	- 19	} ...	...	...
	July 7	892	- 229			
Southend Corporation	,, 6	435	+ 26	14	4,648	+ 257
Southport Tramways	,, 1	408	+ 46	26	7,816	+ 434
S. Staffordshire Trams.	,, 1	765	- 330	26	20,182	- 1,499
Stockport Corporation	,, 8	658	+ 202	14	8,493	+ 3,580
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	,, 1	691	- 4	26	18,838	+ 797
Taunton Trams	,, 1	55	- 15	26	1,349	- 108
Tynemouth and District	,, 1	370	- 47	26	6,865	- 365
Tyneside Trams Co.	,, 6	881	+ 67	27	9,883	+ 1,784
Wallasey District Council	,, 9	850	+ 75	§14	10,669	+ 543
Walsall	...	...	...	...	...	...
Warrington Corporation	,, 7	407	+ 81	14	4,580	+ 709
West Ham Corporation	,, 7	1,106	...	19	14,330	...
Weston-super-Mare	June 29	196	+ 1	26	1,886	- 6
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	July 1	483	...	26	9,784	- 203
Worcester	,, 1	356	+ 171	21	6,182	+ 2,620
Wrexham	,, 1	115	- 33	26	2,854	- 315
Yorkshire Woollen District	,, 1	622	+ 197	16	14,964	+ 6,419

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 8 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., July 13.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business, Week to July 13. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	5 —5¼	4 15 3	April, Oct	5 7/32	5 1/16
St.	6%	Do. Permanent 6% Deb. Stock	137 —141	4 5 0	..	139½	139
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	98 —100	5 0 0	..	99¼	98⅞
10	6%	Barcelona Tramways Ord.	7½—8½	3 10 8	..	..	..
10	6/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	93 —98	4 13 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 —100	5 2 0	..	..	..
1	..	Bath Elec. Trams Pref. Ord	11/16—13/16	..	..	..	..
1	..	Do. 5% Cum. Pref.	⅞—1	..	..	15/16	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96 —101	4 9 3	..	..	—
10	8%	Bristol Tramways and Carriage Ord.	18½—19½	4 2 1	Feb, Aug	..	..
10	4%	† Do. Cum. Pref. (fully paid)	10 —10¼	3 16 2	..	..	..
St.	4%	† Do. 4 per Cent. Debs.	106 —108	3 15 3½	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100 —103	5 16 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	99 —102	4 18 6	..	99¾	99
10	5/0	Do. 5% Cum. Perp. Pref.	10¼—10¾	4 12 10	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103%—105%	4 6 2	..	104½	104
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	8¾—9¼	8 12 11	..	9½	9
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—11	5 9 1	Feb, Aug	11	10¾
St.	5/0	Do. 5 per Cent. Perpetual Debs	116 —119	4 5 1	..	..	..
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	95 —98	..	..	..	..
5	3/0	Buenos Ayres and Belgrano Ord.	2⅞—3⅜	4 16 0	..	..	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼—5¾	5 4 4	—	5½	..
5	3/0	Do. "B"	5 —5½	5 9 1	—	..	..
St.	5%	Do. 5 per Cent. Debs.	105 —108	4 12 8	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	101 —104	4 16 6	—	102	101¼
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	94 — 99	5 1 0	..	..	..
5	3/6	Calcutta Tramways	7 —7½	4 0 0	—	..	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 3 3	..	106	—
1	1/0	Cape Electric Tramways Shares	1⅞—2⅛	8 0 0	..	1⅞	..
St.	4%	Central London Ordinary Stock	90 —93	4 6 0	June, Dec	92½	91
St.	4%	Do. 4 per Cent. Pref. Stock	102 —105	3 17 3	..	..	..
St.	4%	Do. Deferred Stock	79 —82	4 17 7	..	..	..
100	4%	Do. 4 per Cent. Debs.	109 —111	3 13 5	..	110	106
5	2/6	City of Birmingham Trams.5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2%	City and South London Rly. Con. Ord.	47 —49	4 16 11	Feb, Aug	48⅜	48⅜
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —126	4 0 0	Feb, Aug	125½	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 —109	3 13 5	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 10	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8¾	Gt. Northern & City Rly. Prf. Ord. (4%)	4 —5	..	—	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	18 —19	5 5 3	Mar, Sept	..	..
10	6%	‡†Do. 6 per Cent. Pref.	13¾—14¼	4 2 10	Mar, Sept	..	..
St.	4½%	‡†Do. 4½ per Cent. Debs.	107 —109	4 2 8	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 —91	4 7 11	..	..	..
10	1½%	Liverpool Overhead Railway Ord	3¾ —4	3 8 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10½—11	4 10 1	..	10¾	10⅝
St.	4%	Do. 4% 1st Mort. Deb. Stock	102 —104	3 16 11	..	103	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅛—¼	..	..	⅛	..
1	0/6	Do. 5% Cum. Pref.	⅞—1	5 0 0	..	15/16	⅞
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 —105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs.(1922)	105 —107	4 5 0	..	..	..
5	..	New Gen. Tract. 6 per Cent.Cum. Pref.	1 —2	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	99—102	4 18 1	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	89 — 92	3 7 11	June, Dec	91½	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	97 —101	3 19 2	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	12/6	Anglo-American	46 —49	5 18 0	F,My,Ag,N	47¼	46½
St.	25/0	Do. Preferred	91 —93	6 3 6	F,My,Ag,N	92½	91⅞
St.	2/0	Do. Deferred	6½—7	1 8 7	F,My Ag,N	6 13/16	6½
100	$2	Commercial Cable Capital Stock	170 —190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93 —95	4 2 6	Jn Ap,Jy,O	93½	93¼
10	5/0	Cuba Submarine Ord.	6½—7½	8 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98%—101%	4 9 2	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10½	6 4 0	Ja,Ap,Jy,O	10 5/16	10⅛
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	99 —101	4 9 2	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	126 —131	5 7 0	Ja,Ap,Jy,O	130¾	128½
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —90	3 17 9	Ja Ap,Jy,O	89½	87½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 6	May, Nov	105	..
10	6/6	Eastern Extension	12 —12½	5 12 0	Ja,Ap,Jy,O	12 5/16	12
St.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 15 0	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	99 —102	3 19 0	Feb, Aug	100¾	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99%—102%	3 18 9	May, Nov	..	..
10	5/0	Gt. Nrthn.(of Copenhagen) excoupon61	25½—26½	5 13 2	Jan, July	25¾	..
100	4½%	Halifax & Bermuda4½%1stMt.Db. (red.)	99 —101	4 9 2	June, Dec	..	..
25	37/6	Indo-European	42 —45	5 11 2	May, Nov	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	6/0	West African Telegraph Shares	6 —7	5 14 3	..	..	..
2½	..	West Coast of America	1/16—3/16	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅜—½	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6¼—6¾	8 17 9	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 —102	4 18 1	Jan, July	..	..
10	3/0	Western Telegraph	12½—13	5 7 8	Mr,Jn,O,D	12 11/16	12½
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 16 3	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	99 —102	3 18 5	—	..	..
		FINANCIAL, INVESTMENT &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 14 4			
10	5/0	Globe Telegraph and Trust			—	..	..
10	3/0	Do. 6 per Cent. Pref.	8¾—9¼	5 19 0	Ja Ap.Jy O	9	8¾
8	4/0	Reuter's	13 —13½	4 8 11	Ja Ap,Jy,O	13½	13⅛
100	6%	Submarine Cables Trust	6½—7½	5 6 8	April, Oct		

Share.	Last Dividend	Name.	Price Wed., July 13.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to July 13. Highest.	Lowest.
		TELEPHONES.					
5	8/0	Chili Telephone (fully paid)	5 —5½	5 9 1	August ..	..	..
1	7½	Monte Video Telephone Ord.	⅜—½	..	..	..	..
St.	6%	National Co. Pref. Stock	106 —108	5 13 9	..	105¾	04½
St.	5%	Do. Def. Stock	89 —92	5 11 2	..	8 ¼	88
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 —13	4 12 4	Feb, Aug	12 3/16	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	12 3/16	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅛—5⅜	4 13 0	Feb, Aug	5 7/32	5 3/16
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 —99	3 10 8	June, Dec	97⅝	97¼
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 —105	3 16 2	..	103¼	..
..	5/9	Do. Do. Prov.Certs.35%tobepd.	64 —66	..	..	..	..
1	0/8¾	Oriental	1 1/16—1 3/16	6 6 3	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	6 4 6	..	1⅛	..
5	5/0	United River Plate	6 —6½	6 3 3	July......	6 5/16	6 3/32
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	June, Dec	5 1/16	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 —106	4 14 4	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich.Dist.Ord.(f.p.)	⅝—⅞	..	—	..	..
1	0/8¾	Do. 7% Cum. Pref.	1⅜—1⅝	5 1 9	—	..	..
St.	4½%	Do. 4½ 1st Db. Stk.Prv.Cts.(rd.&con.)	122 —127	3 11 5	—	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	9⅞	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	—	..	..
5	..	Bromley (Kent) El. Lt. & Power Shares	5½—6	..	..	..	..
St.	4½%	Do. Do. 1stDebs	100 —103	4 7 5	—	..	..
5	5/6	Brompton & Kensington Elec.Sup.Ord.	10¾—11¼	4 8 11	..	11⅛	11
5	3/6	Do. 7 per Cent. Pref.	10¼—10¾	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7 —7½	4 13 4	..	7⅜	..
St.	4%	Central Elec. Sup.Co.4%Guar.Db.Stock	105 —108	3 14 1	..	..	..
5	4/0	Charing Cross & Strand Electric Sup...	7½—8	5 0 0	Feb, Aug	7 13/16	7½
5	2/3	Do. 4½ per Cent. Pref.	5⅛—5⅝	4 3 6	Feb, Aug	5 11/32	5⅜
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	..	5 11/32	..
5	2/3	Do. Do. (1903)	4¾—5	..	..	4 27/32	..
St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 0	..	..	..
5	3/6	Chelsea Electric Supply Ord.	6¼—6¾	4 1 6	March ..	6 9/16	6⅜
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 2 6	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	11 —11½	4 7 0	Feb, Aug	13 3/16	13½
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	120 —125	4 0 0	Jn, Dec ..	—	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	103½	..
10	4/0	County of London Elec. Supply Ord.	7½ - 8½	4 14 3	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	11⅜	11
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	104 —107	4 4 0	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	100 —103	4 8 0	..	101¾	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 —93	5 7 6	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 8	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 8 0	..	..	—
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	—
5	5/0	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
St.	4½%	I of W.Elec Lt.&Power4½%Db St (red.)	101 —103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	13/32—15/32	..	..	..	..
5	7/0	Kensingtn & Knghtsbdge Ord.	12 —13	4 12 4	..	12½	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg.Co. &NottingHill Co. (Joint Station) 4% Deb. Stck.(red.)	102 —105	3 16 6	..	..	..
3	..	London Electric Supply Ord.	1¼—1¾	..	..	..	..
5	8/0	Do. 6 per Cent Pref.	4¾—5¼	5 14 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	94 —97	4 2 11	Mr,Jn,S,D	..	..
10	9/6	Metropolitan Electric Sup. Ord.	21 —22	3 19 7	April, Oct	21⅞	21 5/16
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5½	4 1 10	Jan. July	5 7/16	5 5/16
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	108 —112	4 0 4	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 —99	3 10 6	..	..	..
100	4½%	MidlandElec.Corp.for P.D.1stMort.Db.	93 —96	4 13 9	..	94½	..
10	6/0	Notting Hill Electric Ord.	13 —14	4 5 8	March....	13½	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	100 —103	3 18 3	..	100¼	..
5	4/0	Oxford Electric Ord.	5½ - 6	5 8 4	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 3	..	..	..
1	..	Rand Electric	1 — 1⅛	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 —103	4 7 9	April, Oct	..	..
5	9/6	St. James' & Pall Mall Elec. Ord.	14½—15½	4 13 7	Feb, Aug	15	..
5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	96 —99	3 10 6	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord...	2¾ - 3¼	6 3 1	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	3/0	South London Electric Supply Ord.	3¾- 4¼	3 10 7	..	4 1/16	..
5	2/6	Urban Electric Supply Ord.	4½ 5	5 0 0	..	..	..
5	2/6	Do. 5% Cum. Pref.	4½—5	5 0 0	..	4¾	4 23/32
5	7/0	Westminster Electric Supply Ord.	12½ - 13½	5 0 0	Mar, Sept	13 1/16	12 15/16
5	2/6	Do. 5 per Cent. Cum. Pref.	6¼—6¾	3 14 0	..	..	..
		ELECTRIC MANUFACTURING &c.					
1	..	Aron Elec. Meter 6% Cum. Pref.	¼ - ⅜	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾—6¼	6 8 0	July, Feb	..	—
5	3/0	Do. 6 per Cent. Pref.	5¾—6¼	4 16 0	Jan, July	5 15/16	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 7	..	..	..
St.	4½%	British Thoms'n-Houst'n4½%1st Mt.Db.	101 —103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	3½—3¾	8 0 0	..	3 5/16	3¼
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	85 —88	4 10 11	..	..	..
2	..	Brush Electrical Engineering	½—1	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	¾—1¼	9 12 0	Mar, Sept	15/16	27/32
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	71 —76	5 18 4	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½—10½	5 14 3	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 6 11	Jan, July	5½	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	102 —106	4 4 10	Nov, May	..	..
1	2⅔d.	Castner-Kellner Alkali Co. (fully paid)	⅝—⅞	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
1	1/2¾	Chadburn's (Ship) Telegraph Ord.	⅞—1⅛	8 0 0	..	15/16	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¾—2¼	6 13 4	Jan, July	1⅞	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	93 —96	5 4 1	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	8 —8½	..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
St.	4½%	Do. 4½% Deb. Stock	103—105	4 5 9	..	..	..
5	..	Edison & Swan United("A"Sh.)(£3 pd.)	⅜—⅝	..	Feb, Aug	13/32	..
5	..	Do. (£5 paid)	1 —2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb.Stock(rd.)	76 —81	4 18 9	June, Dec	80	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	75 —79	6 11 8	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5⅞—6⅛	5 14 3	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5¾—6	5 0 0	..	5⅞	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	107 —110	4 3 3	..	..	..
2	1/2¼	Electric Construction Co.	1⅜—1⅝	7 2 10	Jan, July	1 5/16	1 3/16
2	2/9¾	Do. 7 per Cent. Cum. Pref.	2¼—2¾	5 2 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 —9½	5 5 3	—	9 5/16	9 1/16
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	11½	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort.Deb.Stock(rd.)	107 —111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 6	Feb, Aug	..	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 —103	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
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THE ELECTRICIAN:

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NOTES.

THE Supply of Electricity Bill has now been reported for third reading in the House of Lords, the remaining clauses having been disposed of somewhat more rapidly than was expected, owing to the fact that a number of amendments which had been submitted on the later clauses were covered by previous decisions. One important decision was given by the Committee in respect of clause 4, which relates to purchase. At the conclusion of the previous sitting it was decided to give an opportunity to all companies having generating stations outside the area of supply, and coming under this clause, to give notice to the Board of Trade within six months of the passing of the Act that they wished to be excluded from its operations. Mr. PELHAM, for the Board of Trade, however, strongly objected to this, on the ground that it would introduce several undesirable anomalies. Naturally this objection was opposed by the electric supply companies, but after consultation the Committee modified its previous decision to the effect that only existing companies working generating stations outside their areas of supply under special Acts could exempt themselves from the purchase clauses. They thus remain liable to all the other conditions of the Bill. This decision narrows down the undertakings which have the option of coming under the purchase clause to practically one or two companies in London. The other clauses in the Bill went through with but little opposition.

WHILE "events" connected with wireless telegraphy are now of comparatively rare occurrence in this country, quite the reverse is the case in America. It appears that the *New York Herald* has, for some time, employed a wireless telegraph signal station on the Nantucket lightship for the purpose of receiving and sending news from and to liners when the latter are still some distance from shore. The United States Lighthouse Board recently suggested that the practice be abandoned, and the wireless service has therefore been discontinued. According to the New York correspondent of the *Daily Telegraph*, a letter was written by the German Ambassador to the United States to the Secretary of State at Washington, calling attention to the fact that German vessels fitted with German wireless telegraph systems were precluded from communicating with the wireless station on the Nantucket shoal. The letter continued, "As far as is known to the Imperial Government, the Marconi Company has no right in the United States of America to refuse to communicate with vessels by means of other systems."

NEGOTIATIONS were then carried on between the United States Government and the Marconi Company with a view to obtaining the co-operation of the latter in effecting an interchange of messages with German apparatus, but the Company were of the opinion that the difficulties were "insuperable," and that it did not see its way clear "to overturn its system and undo the work of years for sentimental reasons." Whatever may be the motive of the German authorities in taking up their present attitude, it certainly is regrettable that some means cannot be found whereby a service, to which wireless telegraphy is so admirably suited, cannot be continued. The state of affairs emphasises more strongly than ever that there is urgent need for international control of wireless telegraphy, and it is to be hoped that definite steps in this direction will be taken at the forthcoming international wireless telegraph conference, which, we are able to inform our readers, will be held early next October, the place of meeting being probably Berlin, as before.

To be in a state of preparedness for this conference, the British Government has introduced a bill "To Provide for the

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Regulation of Wireless Telegraphy," the text of which will be found on another page of this issue. A memorandum on the face of the bill explains that its object is to give the Government control over wireless telegraphy, in order to preclude its improper use in time of war or in any other national emergency, and to provide for Government regulation of the working of different stations in such a manner as to secure the greatest efficiency of communication between all stations. A perusal of the bill will show that, if it becomes law, a licence will have to be obtained before any individual or company can carry on wireless telegraphy or erect apparatus, and its provisions are to stand good not only on shore and within the three-mile limit at sea, but also on board British ships. Moreover, in granting licences the Government reserves the right to stipulate the conditions under which stations shall be worked. Experimental apparatus will also have to be licensed. The importance of the step which the Government has taken in introducing this bill can scarcely be over-rated. It demonstrates what we have maintained from the first: that the country cannot reap the full benefits of wireless telegraphy while it is being practised in the present indiscriminate and aimless fashion.

OUR Canadian correspondent, in a recent letter, calls our attention to the remarkably small, and by no means increasing, number of English electrical engineers who are employed in various electrical undertakings in Canada. It appears that the United States are doing their utmost to secure the control of large engineering enterprises, with the result that most of the important positions will be held by Americans, who will employ their own countrymen in preference to Englishmen. He quotes the case of a large electric lighting company in Montreal, the staff of which is entirely composed of Americans, and he is aware of only three graduates of the Central Technical College besides himself who are at present engaged in electrical engineering work in Canada. Perhaps the solution to the problem lies in the fact that a large proportion of Canadian schemes are worked in conjunction with water power, and English engineers lack practice in this direction; at the same time, there is no reason why they should not, by going to Canada, gain the necessary experience. One thing the colony possesses in common with the mother country—low salaries; just as here, a man must prove himself worthy before he receives recognition, but it seems that the way to the top of the ladder is rather easier and there is not quite so much jostling at the lower rungs.

SOME interesting photometric tests on the Cooper-Hewitt mercury vapour lamp were recently carried out at Delaware College, Newark, U.S.A. It appears that the life of one lamp was 800 hours and the ultimate cause of its failure was the breaking down of the vacuum through leakage at the leading-in wires. Another lamp was still running at the end of 1,000 hours, but unfortunately no data are given as to its efficiency at the end of that period. In fact the value of the tests is seriously affected owing to the observations having been made when the lamps were quite new and not having been continued over a longer time. Curiously enough, the lamps displayed a similar characteristic to that exhibited by ordinary incandescent lamps towards the end of their life. First a greyish film formed on the interior of the familiar long tube, and this afterwards turned to black, cutting off a good deal of the light. The efficiency in watts per candle was certainly very high and quite beyond that of any commercial form of incandescent lamp.

IN the light of recent events there is every reason to be satisfied with the efforts now being made by Parliament to improve legislation regarding the electrical industry. Apart from the new Electricity Supply Bill and the Light Railways Bill, which are making fairly satisfactory progress, matters of detail concerning private Bills are now being watched by the Unopposed Committees of both Houses of Parliament with a keenness hitherto almost non-existent. The proceedings before the Unopposed Committees are but infrequently brought to the notice of the public, but on more than one occasion this session promoters have experienced some difficulty in convincing the Unopposed Committees that certain clauses with which opponents have expressed agreement tend to the good of the undertaking and, consequently, to the public benefit. It is common knowledge that promoters frequently buy off opposition by granting protective clauses, which, in many instances, go far beyond the protection afforded by the general law. A case in point is reported in our Parliamentary columns this week. The Lothians Electric Power Co. inserted a special clause giving the County Councils within their area protection against electrolytic damage to water and gas pipes which went further than that given by the Electric Lighting Acts and the Board of Trade regulations, under which the company has to operate. On the advice of counsel to the Chairman of Committees in the House of Lords, the clause was very properly struck out. The promoters, however, reintroduced the clause when the Bill came before the Unopposed Committee of the House of Commons. It is true that the latter, after some discussion, passed the Bill with the clause embodied, but it still remains for the House of Lords to agree to the amendment. Whatever the result in this particular case may be, this greater vigilance in the matter of unopposed Bills should tend to greater uniformity and should also protect promoters against having to insert these special clauses, possibly to the detriment of the undertaking. This action of the Unopposed Committees strengthens the case for expediting the passage of the Electricity Supply Bill through Parliament this session, as the Bill makes for the abolition of the local consent and at the same time gives an opportunity for all parties to express their views.

Institution of Electrical Engineers.—The following are the names of the gentlemen who have been appointed by the Institution as delegates to attend the International Electrical Congress to be held at St. Louis:—Mr. R. Kaye Gray, president; Col. R. E. Crompton, C.B., past-president; Prof. John Perry, F.R.S., past-president; Dr. R. T. Glazebrook, F.R.S., member of Council, and Mr. H. E. Harrison, B.Sc., B.A. Mr. W. Duddell will act as hon. secretary to the delegation. The two last-named gentlemen have previously served on the Council of the Institution. The congress will open on Monday, September 12th, and will meet daily until Friday the 16th.

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Obituary.—Mr. A. H. Allen, public analyst for the West Riding of Yorkshire, the city of Sheffield and other municipalities, and also a founder of the Institute of Chemistry, died on Thursday last week.

Utilisation of Water Power in France. — According to *L'Eclairage Électrique*, there are in France 46,000 works which utilise the power of 49,000 waterfalls of non-navigable streams, the power thus available aggregating 500,000 H.P. Only 1,500 works make use of the power of navigable rivers, obtaining from them 86,000 H.P. The power of the non-navigable rivers ranges from 37,000 H.P. downwards, more than half a-dozen yielding powers in excess of 10,000 H.P.

Cable Interruptions and Repairs.

	Date of Interruption	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Dakar—Konakry.....	May 13, 1904 ..	May 20, 1904
Chio—Tenedos	June 21, 1904 ..	June 27, 1904
Cayenne Paramaribo	July 13, 1904 ..	—

Large Steam Turbines for Vienna.—According to the *Zeitschrift für Elektrotechnik*, the Corporation of Vienna has decided to extend the plant of the municipal electric generating station by the addition of two 10,000 H.P. turbo-generators. While the dynamos are to be supplied by the Austrian Siemens-Schuckert Company, the contract for the Parsons turbines was obtained by the Ersten Brünner Maschinenfabrik-Actiengesellschaft. It is expected that these new sets will be running by the autumn of 1905.

Annual Convention of the Verband Deutscher Elektrotechniker.—The Verband Deutscher Elektrotechniker held its 12th meeting from June 23rd to the 26th at Cassel. From the annual report it appears that the number of members increased by 163 during the year, the total membership being 3,421 and the capital in hand amounting to about £7,000 on June 10th. Reports of the various committees, instituted to consider special subjects such as reforms and alterations in specifications, regulations, &c., were read, and the committees themselves re-elected for another year. A new committee was appointed to consider the question of urging the Government to frame legislative measures which would permit of the compulsory acquisition of land for purposes of power transmission, and to consider the form of such a law. After a long discussion, the Verband decided not to accept the proposals advanced by the American Institute of Electrical Engineers with regard to the adoption of new units and the nomenclature of electric dimensions. In view of this decision, the Verband is abstaining from sending an official delegate to the International Congress at St. Louis, where the matter is to be discussed.

Losses in Steam Turbines.—In a very interesting article in the *Street Railway Journal* of June 25th, Mr. H. F. Schmidt gives an analysis of the various losses occurring in steam turbines. From tests on a 500kw. Curtis turbine at Newport (U.S.A.) station, it appears that the losses were distributed as follows:—Work available at shaft, 56 per cent.; loss in final velocity of steam, 14 per cent.; friction of wheels in chambers, 6·20 per cent.; nozzle losses, 6 per cent.; losses in buckets and spreading and leakage, 14·80 per cent.; radiation, 3 per cent.; total, 100 per cent. For a 1,250kw. Westinghouse-Parsons turbine, used in connection with the lighting of the New York subway, the corresponding figures were approximately as follows:—Energy available at turbine shaft, 62·80 per cent.; friction of drum and buckets, 6·30 per cent.; radiation, 7 per cent.; loss by final velocity of steam (assumed), 12 per cent.; losses in buckets and guides, friction and leakage, 11·90 per cent.; total, 100 per cent. The reason that the loss by final velocity of the steam is marked "assumed," is that in the Parsons type of turbine this loss cannot be even approximately calculated; and as it cannot be easily determined by experiment, it was necessary to assume it. Consequently, whatever error has been made in this assumption will also be present in the bucket loss which is obtained by subtraction. It is probable, however, Mr. Smith continues, that this figure is not far from correct.

The Tottenham Court-road Tramway.—At the St. Pancras Town Hall on Monday, a meeting was held to protest against the action of the four members of Parliament for St. Pancras who opposed the London County Council's proposal to lay a tramway along Tottenham Court-road. It will be remembered that the original proposal was to run a line from the existing terminus at Hampstead-road along Tottenham Court-road to its junction with Oxford-street. The House of Commons Committee which first considered the bill stopped the tramway at Francis-street, and when the bill came up for third reading in the House the remainder of the line was rejected. The meeting above referred to was called at the instance of the Borough Council, and the Mayor of St. Pancras, Mr. T. H. W. Idris, presided. He said that the tramway in question was supported by practically the whole of the borough, and he moved a resolution condemning the action of the four St. Pancras members of Parliament who opposed the third reading. Mr. John Burns, M.P., supported the resolution, and stated that all experience at home and abroad proved the fact that tramways benefited the streets through which they passed. No matter from whom opposition came, the London County Council meant to pursue its present policy with regard to tramway development, and it would be possible, within a very short time, to travel from Hampstead Heath to Croydon by electric tramcars for a few pence. One or two of the audience opposed the resolution, which, however, was eventually carried by a large majority.

Electricity in the Construction of the Railway around Lake Baikal.—It appears from a note in the *Western Electrician* that the good results obtained elsewhere by the use of electrically-operated drills encouraged the Russian engineers who had charge of the construction of the railway around the southern part of Lake Baikal to employ the same method, in order to facilitate the difficult construction work on the new line. In one portion of that railway, 16 miles in length, the contractors were obliged to build 13 tunnels, 2½ miles in total length, besides making numerons cuttings in the rocky soil of that region. A central power station was established at the middle point of the section, and high-tension cables extended on both sides along the tracks. The station contains a boiler house and a generating set of 120 H.P. output. A three-phase generator produces alternating current at a pressure of 2,200 volts. The high-tension cables convey the current to four sub-stations, each of which contains an alternating current motor coupled to a dynamo. Some of the dynamos generate alternating current at 110 to 130 volts, while others produce continuous current for driving pumps and ventilators and also for lighting purposes. The alternating current is distributed over the whole plant, 25 to 30 electric drills being constantly in operation. From the continuous-current machines current is supplied to eight arc lamps and 200 incandescent lamps. The continuous current is also employed for driving six rotating pumps and six ventilators, which are employed for air purification after each explosion in the tunnels. Notwithstanding the temperature of 14deg. below zero, the installation was completed in less than three months.

A 1,500-H.P. Motor Starter.—This apparatus, recently described by the *Electrical World* of New York, has been designed for starting a 1,500-H.P. 500-volt motor at frequent intervals under full load, and it is probably the largest motor-starting rheostat ever constructed. The starter has a number of switch levers mounted on a slate panel, each lever being used for cutting out a portion of the resistance, and it is similar in design to the Cutler-Hammer multiple switch type. Each of the nine switches employed is quite similar to a circuit-breaker, having laminated leaf main contacts, an auxiliary copper bar contact and a renewable carbon block for taking any arc which might form at this point, but the tripping coil is omitted. The switches are so interlocked mechanically that they can be closed only in their proper order. By the use of the Cutler-Hammer release device each switch is returned automatically to the starting position when the current supply is interrupted. While it would be possible to construct a starter of the sliding-contact type for, say, a 1,500-H.P. motor, the apparatus would require a small motor

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to turn the rheostat lever. The multiple switch type obviates this difficulty, and, moreover, affords protection by the automatic no-voltage release feature. For the sole purpose of reducing the sparking which occurs when moving a sliding contact from one segment to the next the sliding-contact type of starter would call for a constantly increasing number of steps as the motor increases in size, while with the type described the number of resistance steps used may be greatly reduced, due to the elimination of the sparking. With the usual sliding contact type there is nothing to prevent the operator from moving the starting lever with great rapidity, causing injury to the starter and the motor and drawing excess current from the line. With the present type, however, the numerous switches cannot be closed with sufficient rapidity to cause the flow of abnormal currents under normal load conditions. In building starters of very large capacity it is the practice of the Cutler-Hammer Mfg. Co. to employ iron pipe for the starting resistance, using water in the pipe to carry off the heat developed. The closing of the first switch opens a valve mounted on the back of the switchboard, and thereby admits water to the pipe. When the current is interrupted the first lever flies open and closes the water admission valve, and the last lever similarly opens the water exhaust valve, automatically placing all mechanism in position for another start.

Electric Power in Japan.—In a recent issue of the *Electrical World* of New York, there is an interesting article on the development of electric power schemes in Japan. The hydro-electric power installation in Iyo makes use of the various rapids in the River Ishite, of which Wakigafuchi is the highest. The quantity of water varies from 40 cubic ft. per second at low water to 100 cubic ft. at high water, the mean flow being about 50 cubic ft. per second. The 260kw. of power developed is obtained from an actual head of about 100ft., with a steady flow of about 50 cubic ft. per second. In spite of many difficulties the hydraulic installation was completed in six months. Across the stream is placed a straight stone weir 132ft. long, which dams up the water to a height of 4ft. from the canal bottom. The water enters the canal about 3,000ft. from the reservoir, which is located near the plant. Along the cliff at a distance of about 300ft. from the entrance is placed on wooden sleepers a semicircular steel flume 45ft. in diameter, which connects with the canal. The canal is 4ft. wide at the bottom and 5ft. in height. The reservoir is 10ft. wide, 15ft. long and 5ft. high. It contains an iron rack which rests on the bottom and is inclined at an angle of about 60deg., in order to arrest all floating material, such as logs, leaves, &c. A steel pipe line, 230ft. long, connecting with the reservoir, runs to the foot of the mountain, where the power station is located. The pipe is 3ft. in diameter throughout its whole length, and is built of steel plates $\frac{3}{16}$in. to $\frac{5}{8}$in. in thickness, according to the pressure it sustains at different points along the line. At the end of the pipe there are provided a safety valve and a manhole to permit of periodical cleaning and draining. The power house is a brick building, 24ft. wide and 34ft. long, with the roof truss 16ft. above the floor. At present there are in the station one water wheel, an electric generator and a switchboard. The water wheel, supplied by J. M. Voith, Heidenheim, Germany, is a spiral casing Francis turbine with horizontal shaft, and develops 380 H.P. at 600 revs. per min., a suction pipe 15ft. long being used. Regulation of speed is accomplished by Voith's governor to within 3 per cent. The turbine is connected directly through a leather coupling to a three-phase generator of the revolving field type, developing 260kw. at 3,500 volts, the frequency being 60~ per second when running at 600 revs. per min. The exciter is wound for 110 volts and is placed on the same shaft with the generator. Part of the electrical energy is transmitted from the Yunoyama power station to Matsuyama, 3·3 miles distant, and from there it is distributed to two sub-stations, one situated in Mitsu, 5 miles from Matsuyama, and the other in Dogo, about 1 mile from the first sub-station. The three-phase transmission line consists of No. 3 B.W.G. wires, fixed to petticoat insulators. Telephone wires are also strung on the poles. The first transformer chamber designed in Japan was erected in Dogo Park. It is a brick building, 12ft. high, having an iron pipe reaching 20ft. above the top of the tower. Both the primary and secondary wires enter by way of the pipe. In the chamber are two 10kw. transformers, and it is intended to equip it later on with a switchboard. For every 16 c.p. lamp 2s. 8d. per month is charged, and 2s. 6d. per month for each outdoor lamp, fixtures being supplied by the company. About 50kw. of the energy generated is used for power purposes, the charges for which vary from about 33s. per month for 1 H.P. to £40 per month for 30 H.P.

Institution of Civil Engineers' Visit to America.—A provisional programme of the arrangements which are proposed by the American Society of Civil Engineers and by the Canadian Society of Civil Engineers for the entertainment of the Institution of Civil Engineers has now been issued. In connection with railway transport, the Erie Railroad Co. and the Milwaukee and St. Paul Railway Co. will give free transportation over their entire systems, as far as may be desired, to every member of the party, during the period of the visit. The party, leaving Liverpool by the Cunard ss. "Etruria" on September 3rd, may expect to reach New York on September 10th, and the main features of the programme for the week proposed to be spent in New York are the following :—

Tuesday, September 13th.—A formal reception of the visitors by the American Society of Civil Engineers will probably take place at the Society's house in the morning, and, after luncheon there, a visit may be paid to the City Hall, where, it is hoped, the members will be received by the mayor and other officials. The party will subsequently inspect the Rapid Transit Subway, New York. *Thursday*, September 15th.—An all-day excursion up the Hudson River to West Point is proposed, the return journey being made by the West Shore Railroad. *Friday*, September 16th.—It is proposed that the visitors be entertained this evening at dinner by the American Society of Civil Engineers.

No programme has yet been made out for Monday, Wednesday, Friday or Saturday; but it is intended to arrange for visits of smaller parties to inspect a number of points of interest in the vicinity of New York on those days, as it is realised that there will be, naturally, much diversity of interest, and that some time should be allowed for the pursuit of individual inclinations. Leaving New York on Monday, September 19th, the party will travel by special train over the New York Central and Hudson River Railroad to Montreal, to fulfil its engagement with the Canadian Society of Civil Engineers. A week will be spent in visiting, under the guidance of the Society, some of the principal objects of interest in the east of Canada. The programme for the visit to Canada is outlined by the Canadian Society of Civil Engineers as follows :—

Tuesday, September 20th.—Visit to the Canadian Pacific Railway workshops at Montreal. Luncheon at the works. In the afternoon a drive through the city and the Mountain Park. *Wednesday*, September 21st.—Visit by steamboat to the Soulanges Canal, and return to Montreal by the Lachine Rapids. Luncheon on the steamer. Reception at the McGill University in the evening. *Thursday*, September 22nd.—Visit to Ottawa by the Canadian Pacific Railway, and return by Canada Atlantic Railway. Travel to Quebec during the night by the Intercolonial Railway or the Grand Trunk Railway. *Friday*, September 23rd.—At Quebec. Inspection of the Chaudière Power Development and of the bridge in course of construction over the St. Lawrence. *Saturday*, September 24th.—Travel from Quebec to Toronto. *Sunday* and *Monday*, September 25th and 26th.—At Toronto. *Tuesday*, September 27th.—Visit to Niagara Falls. Inspection of power developments and allied industries at the Falls on both the Canadian and United States sides, leaving in the afternoon for Chicago by way of Port Huron or Detroit. *Wednesday*, September 28th.—Arrive at Chicago. The remainder of the day and the following day will be given to an inspection of objects of interest there. *Friday*, September 30th.—The party will travel by special train over the Wabash Railroad to St. Louis.

The programme of the visit to Chicago has not yet been prepared, but will be undertaken as soon as definite settlement of the details of the preceding period enable it to be dealt with. No general programme has been proposed for the period to be spent at St. Louis (where the attractions of the exhibition will probably sufficiently occupy the time at disposal) or beyond it; but the visiting members are cordially invited to attend the International Engineering Congress, which will be held at St. Louis from October 3rd to 8th, under the direction of the American Society of Civil Engineers. There is no proposal that the organisation of the party should continue after St. Louis is reached. A list of hotels and their charges is given in the programme, and those members of the Institution who have not already booked outward passages should do so at once.

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GLASGOW CORPORATION TELEPHONE ACCOUNTS.

We referred briefly in our last two issues to the third annual report and accounts of the Glasgow Corporation Telephone Department, and we have now been able to obtain a full copy of the accounts.

There is actually a surplus of £3,650. 17s. 10½d. on the year's operations, which has been carried to general depreciation fund, the total capital expenditure up to date being £320,782. 12s. This represents 1·1 per cent., which is, of course, entirely inadequate for depreciation of plant used for a telephone exchange system, even when account is taken of the fact that a sinking fund has to be provided for as well.

The net revenue account shows that £8,537 has been paid as interest, £8,343 as sinking fund, and, as already stated, £3,650 as depreciation fund. These figures are respectively 2·7, 2·6 and 1·1 per cent. of the total capital, or 6·4 per cent. in all.

The total capital expenditure up to May 31, 1904, has been apportioned as follows:—

Underground construction	£168,944 14 9
Overhead construction	47,428 8 8
Central exchange construction	32,982 12 11
Sub-exchange construction	9,670 1 0
Instrument account	47,937 0 10
Public telephone offices	2,088 14 11
Stores, John-street	43 10 5
Furniture and fittings	1,735 1 0
Preliminary and general expenses	9,957 7 6
	£320,782 12 0

The number of lines connected to the exchange is 9,054, this figure including 82 party lines, and 235 public telephones, so that the capital expenditure works out to £35. 8s. per subscriber, but taking the capital expenditure per telephone station, 1,872 extension lines and 377 private lines must be added. Then the capital expenditure per telephone station comes out at £28. 8s. Comparing these figures with those of the Portsmouth exchange, viz. £23. 1s. and £19. 5s. published in our analysis of these accounts on June 17th, it will be seen that this completely bears out our contention that the capital expenditure per line on a large exchange is considerably greater than on one of smaller capacity, and that estimates based upon a strict proportionality between the number of lines and the capital expenditure must necessarily be fallacious.

We give below the particulars of the expenditure and income taken from the revenue account:—

EXPENDITURE.

Inspection and Repairs—Wages	£4,814 1 10	
Materials, &c.	2,118 12 5	
		£6,932 14 3
Reconstruction—Wages	506 18 4	
Materials, &c.	66 8 10	
		567 7 2
Post Office Commission—Amount of commission paid to Postmaster-General for moneys collected by him		27 1 6
Post Office royalties		5,007 1 1
Trunk and Terminal Fees Accounts—Fees written off		33 7 4½
General Expenses—Miscellaneous		559 2 1
Town clerk's fee fund for secretarial work	150 0 0	
Auditor's fee	31 10 0	
Wayleaves	274 19 10	
Salaries, wages and allowances	9,581 16 8	
		10,038 6 6
Printing, stationery and advertising		1,102 11 4
Rents, Rates and Insurance	3,498 16 7	
Proportion carried from last year	52 9 10	
		3,551 6 5
Fuel and light		342 2 11
Terminal Fees Account—Fees paid and outstanding		958 2 4
Balance carried to net revenue account		20,519 18 2½
		£49,639 1 2

REVENUE.

Exchange rentals	£46,796 3 0
Private rentals	716 11 10
Local tolls	258 16 6
Public telephones	776 15 10
Shifts and sales account	173 19 3
Post Office Commission Amount received from Postmaster-General on trunk fees collected by this department	167 3 7
Directory insertions	61 10 0
Commission received on insurance	28 14 5
Terminal Fees Account—Fees received and outstanding	659 6 9
	£49,639 1 2

It may be pointed out incidentally that the inspection and repairs of lines and reconstruction during the year have cost £7,500, representing 2·3 per cent. of the total capital expenditure, which is practically the same as that which has been expended at Portsmouth.

We also take the following statistics from the report:—

Statistics.

	1901-2.	1902-3.	1903-4.
Switch Rooms in operation	9	17	19
Stations in operation—			
Direct lines to the exchange	4,718	7,322	8,737
Party line	—	13	82
Public telephones	27	115	235
Service telephones	42	60	68
Extensions outside	198	611	791
Extensions inside	412	811	1,081
Private lines	80	184	377
Sundry lines	2	6	34
	5,479	9,122	11,405
Junction lines	306	494	627
	5,785	9,616	12,032
Mileage of Metallic Circuits inside Switch Rooms and Subscribers' Offices—			
In switch rooms ..... miles	306½	997	1,287½
In subscribers' offices ..... ,,	221½	338½	449½
Mileage of Metallic Circuits outside Switch Rooms and Subscribers' Offices—			
In underground cable ..... miles	11,061½	14,029½	17,597
In aerial cables ..... ,,	26	32½	35½
In leading-in cables ..... ,,	317½	506½	574
Overhead open wires ..... ,,	370½	791½	995½
Particulars of Outside Construction—			
Underground pipes from exchanges	126	135	150
Pairs of wires from exchanges	14,572	18,171	22,243
Underground cables from exchanges	60	78	92
Distributing points	982	1,422	1,631
Manholes built	98	107	116
Junction pillars erected	—	11	17
Poles erected in ground	691	1,799	2,544
Standards erected on roofs	228	243	239
Fixtures to buildings	6,342	9,370	11,671
Trench opened ..... miles	94	128	143
Pipes laid ..... ,,	104·350	127·321	140·031
Armoured cable laid ..... ,,	53·271	66·915	80·250
Cable drawn into pipes ..... ,,	60·408	95·745	125·500
Employés—			
Officials	11	12	12
General office	22	25	30
Stores office	8	8	7
Operators	121	192	243
Canvassers	5	8	9
Engineers and draughtsmen	19	14	11
Clerks in engineers' offices	12	10	10
Cleaners	9	9	9
Fitters, inspectors, and boys in inside superintendent's department	106	105	108
Inspectors, foremen, wiremen, labourers and boys in engineers' department	315	213	132
	628	596	571

Copper Production in 1903.—The following figures are quoted by the *Electrical Review* of New York from a recent consular report. In 1903 the total output was 565,820 tons. It was 541,295 tons the preceding year. Of the total copper output, the United States is credited with 53 per cent., and North America with 64·7 per cent. Europe follows with 16·5 per cent., the most important European copper-producing countries being Spain and Portugal. Asia contributed 10·7 per cent., this coming from Japan and Australasia. South America contributed 7·1 per cent., three-quarters of this coming from Chili.

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THE NORTH-EASTERN RAILWAY AND CARVILLE POWER HOUSE.

(Continued from page 515.)

High-tension Cables.—On leaving the switchboard at Carville, three-phase current at 6,000 volts and a frequency of 40 ∿ per second is conveyed by three-core cables to the various sub-stations. These cables are worked with the neutral point of the system insulated from earth; they are laid chiefly along the railway company's property, but partly along the public roads and partly along the private footpath of the Tyneside Tramways and Tramroads Co. From Carville there are three 0·25 sq. in. cables to Neptune Bank, two 0·25 sq. in. to Pandon Dene sub-station, two 0·2 sq. in. to Cullercoats sub-station, two 0·2 sq. in. to Benton sub-station and two 0·1 sq. in. to Kenton sub-station. In addition to these, there are also eight 0·034 sq. in. three-core cables for the lighting of the stations along the line, but the potential of the current carried is only 2,000 volts for this purpose. Then, of course, there are numerous pilot and telephone cables. Where possible, all cables have been laid on the solid system, in the same trench, but in circumstances where this is not possible they have been laid in iron troughing, as described on p. 470 of *The Electrician* for July 8th, or suspended by brackets on the wall, as shown in Fig. 11. This has been the case where there was insufficient space to allow of the top of the protective cover of the troughs being more than 15in. below the surface of the ground or below the bottom of the sleepers when the cables run within 12in. of the ends of the sleepers. When crossing the track, at level crossings, and at certain other places the troughing is 24in. below the surface. Where cables run under the track, small wooden posts, painted white, have been erected to indicate their course. The high-tension cables are lead-covered, but the current-carrying capacity of the lead is reinforced by a copper sheathing, which is connected to earth plates at the generating stations and sub-stations.

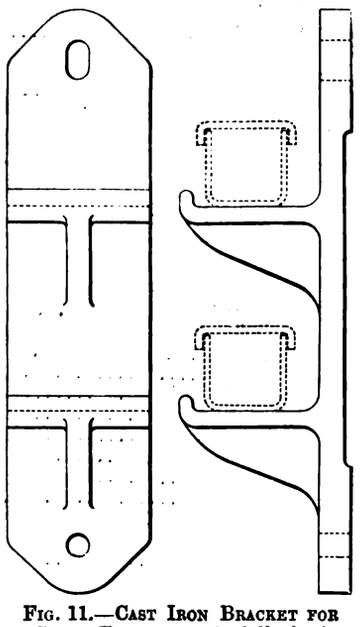

FIG. 11.—CAST IRON BRACKET FOR CABLE TROUGHS. (⅛ full size.)

Fig. 12 shows one of the right-angled three-way dividing boxes which are buried outside the sub-stations. It will be remembered that the three-core cables are taken quite up to the Carville switchboard, but in the case of the sub-stations they are divided up outside the buildings and three single cables taken in to the boards. This dividing-box is constructed in a very excellent manner; it will be observed that the glands are machined and that, by means of a lead washer, an absolutely water-tight joint is secured. On the outside of the box there is a thimble carried on a copper ring which is held between the clamping ring and the machined surface of the box. The part of the sleeve projecting into the box is spread out slightly, as may be seen from our illustration; the copper sheathing of the cable is then doubled back on to this projection, bound with wire and the whole sweated into a solid mass. This operation is repeated when the single cables leave the box, and thus the continuity of the sheathing is assured, in addition to a very efficient connection to earth being secured, via the copper ring and thimble. The section at YZ shows how the three cores are held apart by an ebonite distance piece, and after all connections have been made inside the box it is filled with compound. As the top and bottom halves of the box are duplicates, it may be used for dividing either to the right or left-hand.

Each drum of cable was specified to be tested with an alternating pressure of three times the working pressure between any core and the lead and between any two cores for a quarter of an hour after immersion in water for 24 hours, and similarly, after laying, each cable was tested with alternating current at a pressure of twice the working pressure.

Sub-stations.—Current is supplied to the North-Eastern Railway from no fewer than nine sub-stations, irrespective of a number of small transformer stations for lighting purposes. The largest sub-station is that at Pandon Dene, where the original generating station of the Supply Company was situated. This sub-station contains four 800kw. Westinghouse rotary converters for supply to the North-Eastern Railway, fed from 12 300kw. Berry transformers, one 200kw. 6,000-volt to 2,000-volt Berry transformer, with a Siemens-Schuckert induction regulator for lighting supply to the railway. There are also two 500kw. asynchronous A.E.G. motor-generators and one 1,000kw.-hour Tudor battery with a Crompton reversible booster for supplying the three-wire network of the Supply Company. As mentioned before, the nominal full-load output of each rotary converter set when three-phase current is supplied at 5,500 volts and a frequency of 40 ∿ per second is 800kw. at 600 volts continuous current. The sets run under

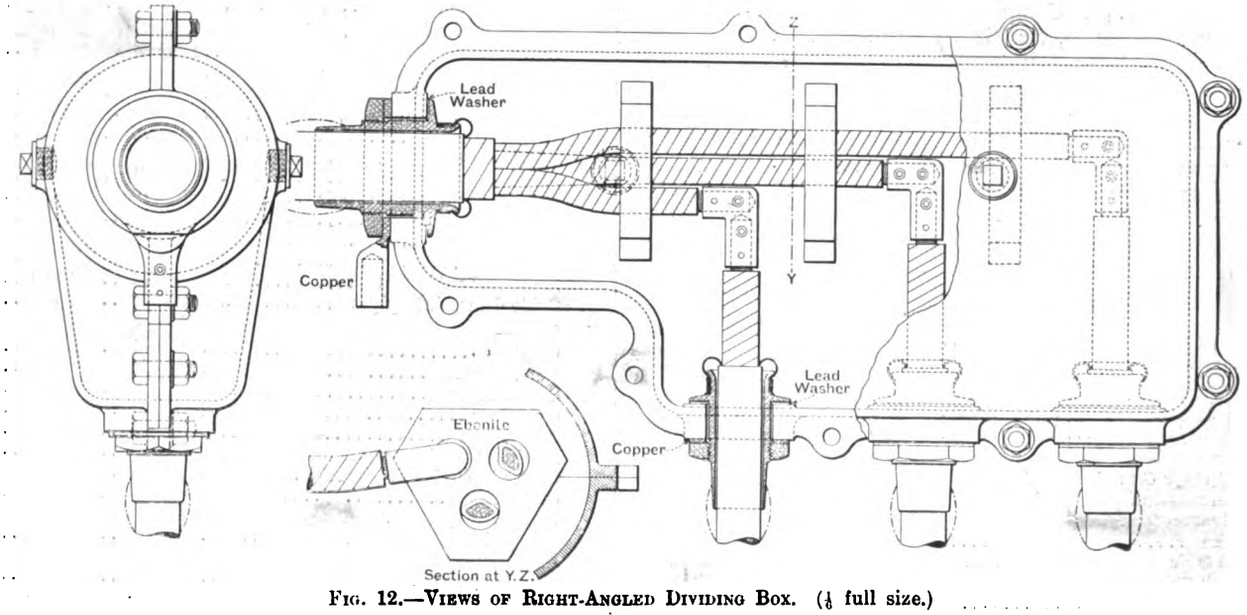

FIG. 12.—VIEWS OF RIGHT-ANGLED DIVIDING BOX. (⅛ full size.)

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working conditions with a power-factor of not less than 90 per cent. at any load from quarter-load to 100 per cent. overload. Although the normal voltage on the sub-stations is 5,500 volts, arrangements are made for meeting a 5 per cent. variation of this pressure. According to the specification no part of the rotary converters (except the commutators), static transformers and reactances in continuous running at the nominal full output may rise in temperature more than 35°C. above the surrounding air at 25°C. It is stipulated with regard to overload that, immediately after a continuous run at nominal full load, each converter set shall be capable of running at an overload of 50 per cent. without a rise of temperature in any part exceeding 60°C. after three hours for the rotary converters and 65°C. after one hour for transformers and reactances. A further condition is that the rotaries shall not fall out of step with a momentary overload of 200 per cent. when the pressure of the three-phase supply is 5,000 volts or above. They are supplied with both shunt and series field windings, and the latter are arranged so that the rotaries run, under ordinary working conditions, in the sub-stations, level compounded up to full load, and either level compounded or with a drop of not more than 5 per cent. up to 100 per cent.

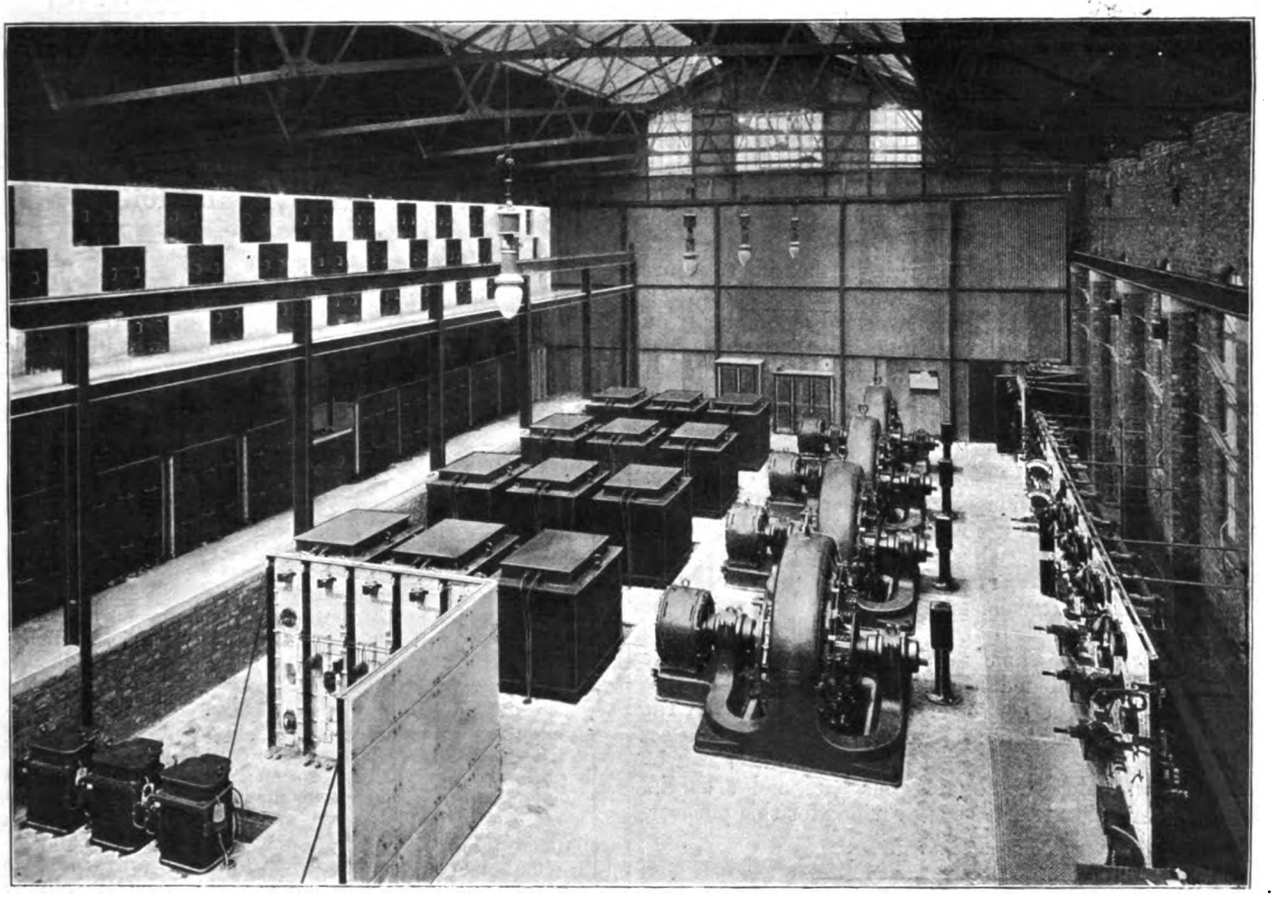

Fig. 13.—Interior of Pandon Dene Sub-station.

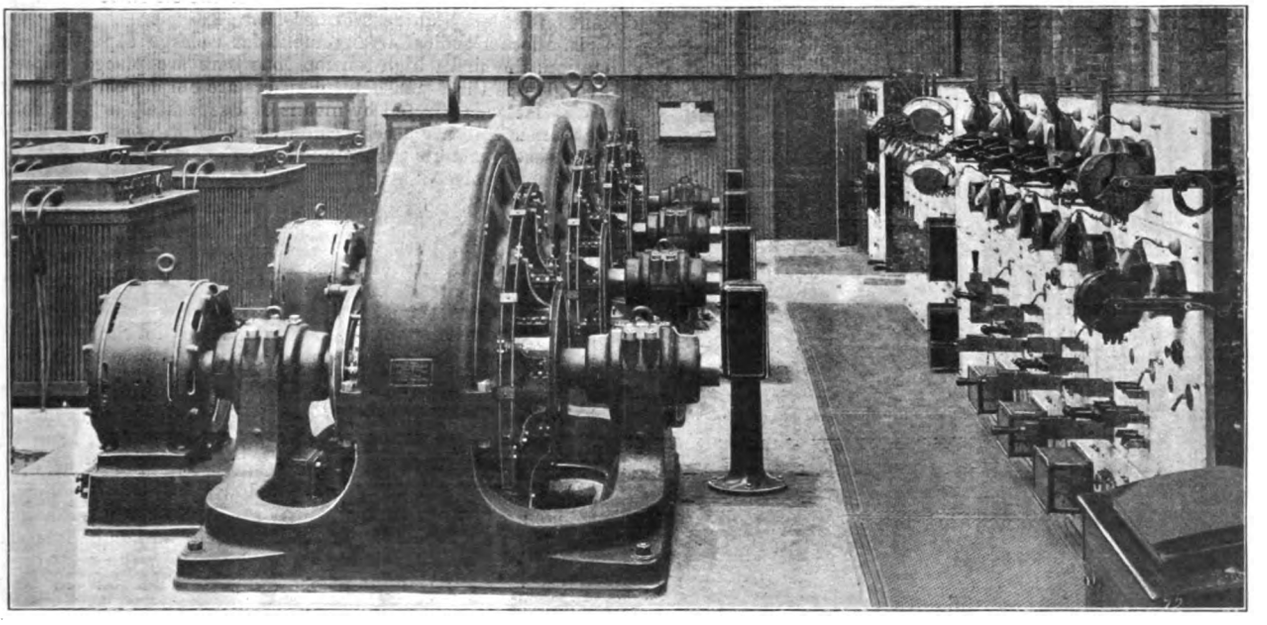

Fig. 14.—Rotary Converters and Low-tension Switchboard at Pandon Dene.

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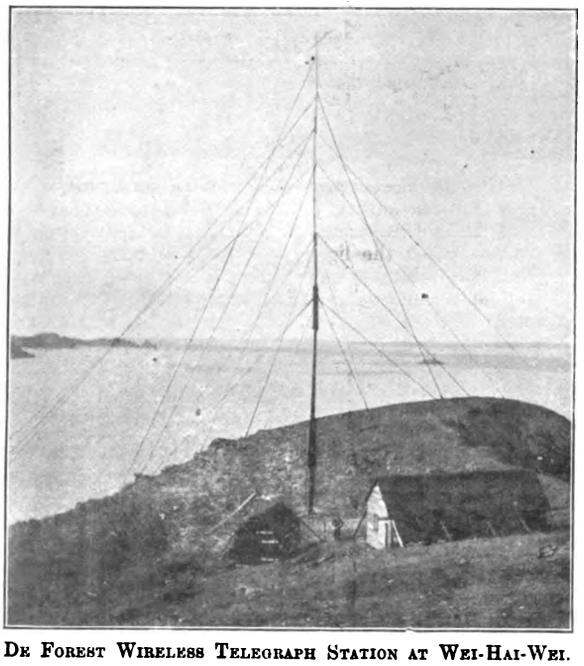
overload, allowance being made in the design for variation of drop in the high-tension feeders.

The shunt windings, field rheostats, &c., are so arranged that the low-tension voltage can be kept by hand at any pressure within 3 per cent. of 600 volts by means of the shunt rheostats, when operating at 100 per cent. overload, when the frequency is anything between 39 and 41 ∿ per second, when the high-tension voltage is anything within 3 per cent. of the normal for the particular sub-station, and when the windings and apparatus are either hot or cold. Not only is it possible to effect the hand regulation under any one of these conditions but also if they all exist simultaneously; the variation of voltage per step of the rheostat does not exceed 1 per cent. The 800kw. rotaries run without sparking and without shifting of brushes from no load to 50 per cent. overload, and they are specified to run without sufficient sparking or heating to injure or burn the brushes and commutator up to 100 per cent. overload for 10 minutes or 200 per cent. overload momentarily on a fluctuating load. From the high-tension three-phase terminals of the transformer to the low-tension continuous-current terminals of the rotary, the combined commercial efficiency of each set is 82 per cent. at quarter-load, 87 per cent. at half-load, 90 per cent. at three-quarter load, 92 per cent. at full load, and 92 per cent. at 50 per cent. overload. The power absorbed on the high-tension side, in order to run any converter set at no load, does not exceed 35kw. As may be seen from Figs. 13 and 14, each rotary converter set is started from the high-tension 'bus bars by means of a small induction motor mounted on an extension of the armature shaft. These starting motors are supplied from a set of special starting transformers having the same ratio of transformation as the main transformers and fed through high-tension switches similar to those for the converter sets and feeders. If the starting transformers break down, taps are provided on one set of main transformers by means of which the latter can be employed for supplying the starting 'bus bars, and a special plug-interconnecting board has been provided for this purpose.

(To be continued.)

THE DE FOREST WIRELESS TELEGRAPH STATION AT WEI-HAI-WEI.

The accompanying illustration possesses more than ordinary interest, owing to the fact that it has been reproduced from a



De Forest Wireless Telegraph Station at Wei-Hai-Wei.

photograph of the De Forest wireless telegraph station at Wei-hai-Wei, which station is used for the transmission of war news in the Far East to *The Times*. Unfortunately, it has not been possible to obtain much technical information regarding the equipment of the station. The top of the cliff is about 150ft. above sea-level, and there is a hill on one side higher than the mast itself. The latter permits of the use of about 150ft. of air-wire, and the soil is of a hard, rocky nature. It is said that communication with the station, which is on an island, is easily possible up to 150 miles. A full description of the De Forest system appeared in *The Electrician*, Vol. LII., p. 240, and a letter from the operator of the station to *The Times* was given in our issue of June 17th.

POLYPHASE SUB-STATIONS.*

BY S. L. PEARCE.
(Chief Electrical Engineer, Manchester.)

(*Continued from page 521.*)

Examples of Rotary Equipment.

In a typical rotary sub-station in connection with the electrical equipment of the North-Eastern Railway, the size of rotaries employed is 800kw. with three-phase connections.† All the high-tension gear is placed down one side of the station, and the low-tension gear on the opposite side, with the rotaries and their accompanying transformers between. The incoming high pressure feeders are fitted with spark-gaps, provision being made by means of isolating switches to allow of their inspection while the feeder is alive. The feeder switches are of the oil type, capable of breaking the maximum current of the station, and electrically operated from the low-tension board. In connection with these switches are reverse current relays, which automatically open the switch should the current reverse. The main high-tension 'bus bars are placed on the top gallery and enclosed in fireproof cubicles – the main switches being situated on the intermediate gallery—the fireproof wall supporting the high-tension gear being built of cement blocks, with partitions between each phase and each circuit. Electrically-operated switches are placed in the circuit between the high-tension 'bus bars and the primaries of the transformers, fitted with time-limit overload cut-outs, the secondaries being connected straight on to the three slip-rings of rotaries. Provisions is made for all high tensisn circuit-breakers to be inspected and cleaned with safety by means of isolating switches.

The main transformers are of 280kw. each, with a voltage ratio of 5,500/360 working at a frequency of 40. They are oil-insulated, of the self-cooling type, and are connected up in "delta." The rotaries are started up by means of induction motors mounted on an extension of the armature shaft, separate step-down transformers being provided for the supply to these motors. The machines have an efficiency of 93·44 at three-quarter load to 93·94 at 1½ times full load.

The low-tension switchboard, besides containing the ordinary panels for operating the direct current side of the rotaries, comprises the panels for the operation of the oil switches on the high-tension feeders and transformers.

In another typical arrangement for a large capacity rotary sub-station, the main high-tension 'bus bars are placed below ground floor, single three-phase tranformers are employed, and the cooling of the latter is effected by means of a separately-driven blower set. Reactance coil· are used in conjunction with the rotaries for traction purposes to obtain the compounding effect; these reactance coils would be replaced by induction regulators (which enable the impressed E.M.F. on the rotary slip-rings, and, consequently, the direct-current voltage, to be varied at will), if the machines were used for lighting purposes. The low-tension switch-gear is similar in all respects to that of an ordinary direct-current station. In the case of a purely traction system the switchboard proper would only contain one pole, the remaining switches and 'bus bars being placed in the vicinity of the machines themselves in the same way that equaliser switches and bars are now placed in many large direct-current traction stations.

The negative pole of the rotary being directly connected to the negative bar and earth without introducing any switch, the secondary of the transformer is permanently earthed through the machine, and forms a safeguard in case the high-tension winding of the transformer should break down on the secondary. This arrangement very much simplifies the switch gear, as the equaliser switch is mounted on the rotary itself, the equaliser bar and negative bar being placed in a pit close below the rotaries, leaving only the positive single-pole switch and 'bus bar to be placed behind the switchboard proper.

* Paper read before the Incorporated Municipal Electrical Association, June 30th. Slightly abridged.

† [A drawing and brief description of this sub-station will be found in *The Electrician*, Vol. LI., p. 237. The same drawing was used as an illustration in the present Paper, but we do not reproduce it as it was published in *The Electrician* so recently.—Ed. *E.*].

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It is preferable that the high-tension transformers in sub-stations of this type should be placed in the same room as the rotary converters themselves. The great advantage of having them continually under observation, in the author's opinion, outweighs the argument that the safest position for the high-tension apparatus of this nature is under lock and key. It is quite possible for a serious fire to start without the fact being known when the transformers are contained in a separate compartment, whereas, when they are readily seen, they can be cut off from the line on the slightest indication of a fault.*

Examples of Motor-generator Equipments.

Figs. 3 and 4 show two typical equipments for the sub-stations of the Manchester Corporation. The Polygon is one of 10 stations, the general design in each case being the same, although the size and arrangement are modified to suit local conditions. The building is divided into two bays, the larger containing at the one end the traction motor-generators, also the separate high and low-tension switchboards. At the other end are placed, similarly, the lighting motor-generators and balancing sets, and the corresponding high and low-tension switchboards In the second bay provision is made for extension sets.

Each traction set consists of a synchronous motor operating direct at 6,500 volts, and coupled to a 220kw. continuous-current compound-wound generator, the exciting current for the motor field being obtained from an exciter mounted on an extension of the shaft, or, as an alternative, from the lighting 'bus bars. Each lighting set similarly consists of a synchronous motor direct-coupled to a 220kw. continuous-current shunt-wound generator to give 420 to 430 volts across the outers of a three-wire system, and they are also so arranged as to give 210 volts on either side of the middle wire. The exciting current for the motor is taken from the terminals of the low-tension generator, or, as an alternative, from the lighting 'bus bars. The balancing sets, one of which is provided in each sub-station, consist of a 125kw. three-phase induction motor direct-coupled to two 52kw. continuous-current shunt-wound generators, placed one at each end of the motor shaft, supplying current at about 205 volts, as balancers on the lighting system, or for starting or exciting the traction motor-generators.

Two high-tension switchboards are placed on galleries, one at each end of the main bay, and two low-tension switchboards are placed on galleries along the front side of the main bay, both being used for traction and lighting respectively. The high-tension boards are arranged in three tiers. On the lower or basement level are placed the sealing and dividing boxes, into which are brought the high-tension feeders from the power station, the spark-gaps, feeder and motor duplex fuses, field-regulating resistances, liquid starters, and stator transformers for the induction motors. On the main platform are placed the switch panels with all the necessary instruments. The third or upper gallery carries the duplicate high-tension 'bus bars and selector switches. Means are provided for inter-connecting the 'bus bars of the two boards, so that traction sets can be run from lighting feeders and vice versa. The low-tension boards are arranged in two tiers, the various resistances and starters being placed on the basement level, but, as in the case of the high-tension boards, they are operated from the main gallery. The high-tension cable work in the station is almost entirely three-core, armoured throughout, cleated to the floor and run in earthenware pipes through the beds where necessary, suitable tail-end boxes being provided at the terminals.

The second type of sub-station is represented by "Oldham Road," which is typical of the second 10 stations; with the exception of two, all are arranged for both lighting and traction. Each station is arranged in one bay, with the high-tension switchboards on one side and the low-tension on the opposite side, the machines being placed in pairs down the centre, provision being left at one end for considerable extensions. The equipment, consisting of synchronous and induction motor-generators, is very similar to the previous type, their outputs varying from 250kw. to 104kw. The low-tension generators of each set are, however, compound-wound, and are, therefore, available for either lighting or traction purposes. A saving in spare plant and space is thereby effected as against the use of separate sets for each purpose.

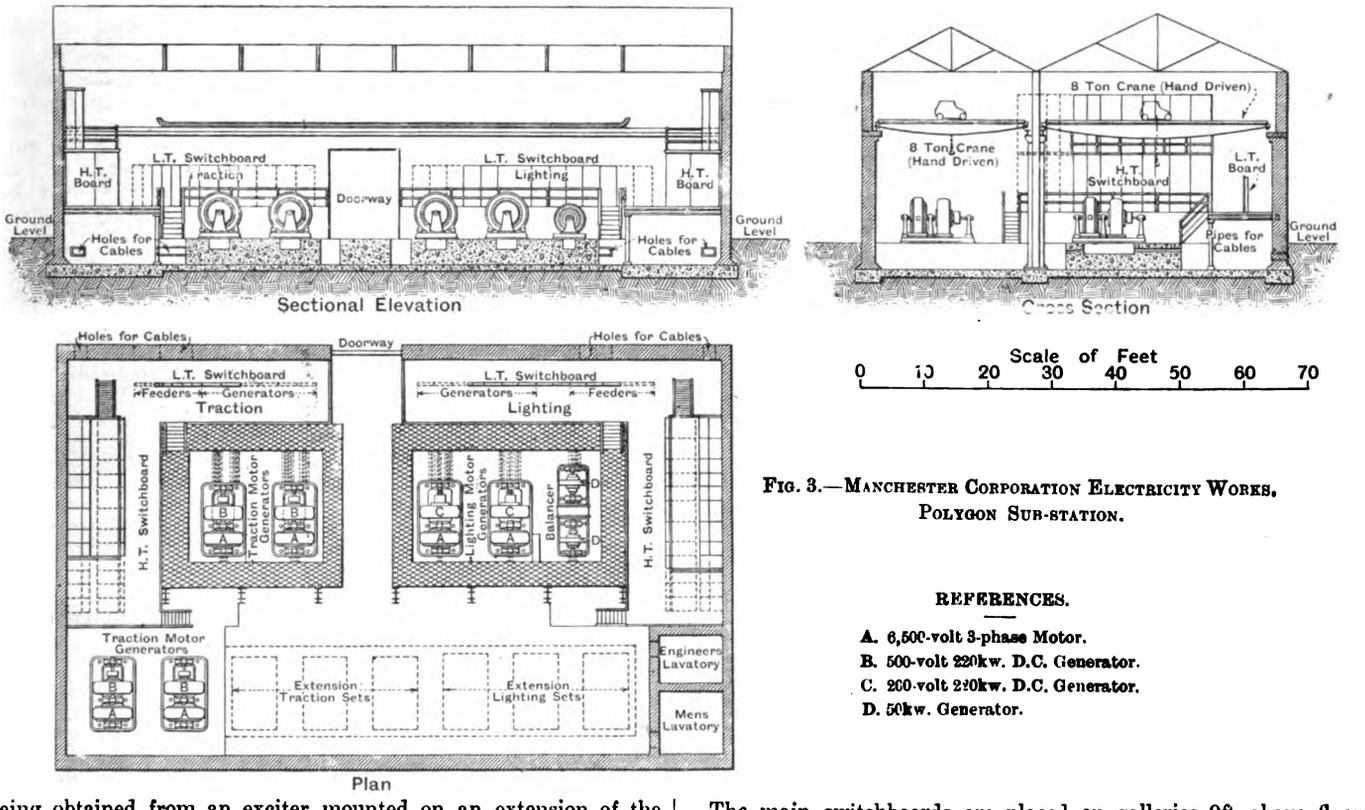

Fig. 3.—Manchester Corporation Electricity Works, Polygon Sub-station.

REFERENCES.

A. 6,500-volt 3-phase Motor.
B. 500-volt 220kw. D.C. Generator.
C. 200-volt 220kw. D.C. Generator.
D. 50kw. Generator.

The main switchboards are placed on galleries 9ft. above floor level. The high-tension board controls the incoming and outgoing feeders and the synchronous motors, and is provided with two sets of 'bus bars to which the lighting and traction feeders are respectively connected. But as each motor is provided with a change-over switch, and can therefore be run off either set of bars, the arrangement is practically equivalent to a "duplicate set." Frequently lighting and traction sets are run off the same 'bus bars, and the varying load of the latter has not been found to interfere with a steady voltage being obtained from the former. This would appear to raise the question as to whether separate lighting and traction 'bus bars are really a necessity. Under the main gallery and on the floor level are placed the various resistances, starters and feeder chargers, the latter consisting of three separate water tanks, forming a non-inductive resistance. This arrangement has been found preferable in every way to the choking coil or separate motor-generator type.

A cable subway runs the whole length of the building on each side, and receives the high and low-tension cables as they come in from the streets, and also carries the machine leads. The latter are single conductor cables throughout drawn through Doulton ducts between the machines and the subways.

Static Transformer Equipments (Beyer-Peacock's).

Fig. 5 shows the general arrangement and diagram of connections of a sub-station recently equipped for Beyer, Peacock & Co., Gorton,

*[A description was then given of one of the sub-stations of the Liverpool-Southport Railway, a more detailed description of which was published in *The Electrician*, Vol. LII., p. 898.—Ed. *E.*]

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Manchester. The transformers are of 60kw. capacity, six of these being banked together in "mesh" to form two groups of 180kw. each. The ratio of voltage is 6,500-220. They are of the natural ventilation type. The switchboard is of the multi-frame order, and has panels controlling the two high-tension feeders, two high-tension transformer panels and two low-tension distributing panels. The current is metered on the primary side of the transformers, and a recorder is fixed on the low-tension panels reading direct in horse-powers. Provision is made for extension, the above instalment representing rather more than one-third of the capacity of the works. The efficiency of the transformers has been guaranteed for 98·5 per cent. at full load, with a drop of not more than 4 per cent. when working on any power-factor.

Working of Sub-stations.

Starting Up.

(*a*) *Rotary Converters.*—There are three possible ways of starting up a rotary converter:

(1). From the alternating-current side by switching it straight on to the supply lines. This method was adopted, and, as far as the author knows, is still in vogue on the Central London Railway system, and on the Liverpool and Southport line, in the case of the first rotary to be started up each day. It is necessary to have a field-splitting switch in order that the shunt winding may be opened before starting, otherwise they would break down owing to the excessive E.M.F. induced at the moment of closing the A.C. main switch. Further, if the rotary be compound wound, the series field windings must be open-circuited. All switches on the direct-current side must be left open before switching the rotary on to the line. By reason of the hysteresis lag in the poles, and in a lesser degree due to the eddy currents set up, the rotary will start as soon as the alternating-current switch is closed, and will immediately run up to synchronous speed. As soon as synchronism is attained, the field-splitting switch and direct-current field switch can be closed. With self-exciting sets care must be taken to see that the latter is closed as the machine is building up on the right polarity, which can be done by closely observing the direct-current voltmeter. If this is not done, the polarity on the direct-current side of the rotary will be reversed.

The rotary will now be running in synchronism with the main generators, and can be paralleled on the low tension 'bus bars in the usual way. Although this method may be unavoidable in some cases, it has serious disadvantages, chiefly on account of the large current at low power-factor wh ich it draws from the supply lines, and the possibility of the rotary building up on the wrong polarity. For traction work this method may be employed, but not for lighting purposes.

(2). Starting up from the direct-current side is a far simpler operation, and presents no difficulties of operation, and can usually be followed in most instances where a supply of direct current in the sub-station is available. In the case of the Central London Railway this method was always adopted for all sets after the first. For lighting systems the starting current required for large units might occasion a heavy drop on the distributing mains, and it will become necessary either to provide an induction motor-generator set to supply the necessary direct current, or, better still, the following, third, method may be usefully employed.

(3). This consists in coupling on to an extension of the rotary shaft a small three-phase low-pressure induction motor, the capacity of which should be approximately one-tenth of the full load output of the rotary. By means of this starting motor, the whole set may be brought up to synchronous speed, the alternating-current and direct-current fields adjusted, and then synchronising the alternating-current side of the rotary on to the line, afterwards cutting out the starting auxiliary unit.

(*b*) *Synchronous Motor-generators.*—The starting up of synchronous motor sets presents no difficulties, and is usually from the direct-current 'bus bars, and synchronising on the alternating-current side in the usual manner. It is, however, absolutely necessary that provision be made in every sub station for the plant to be started up from the alternating-current side in the event of a possible shut-down of the lighting or traction systems. Such means are to hand in the employment of induction motor sets, which in lighting sub-stations are frequently coupled up to the balancers. Their value in this respect forms an additional reason, in addition to those previously set forth, why a combination of induction and synchronous motor sets is desirable. If battery power is available, this will provide the alternative direct-current supply,

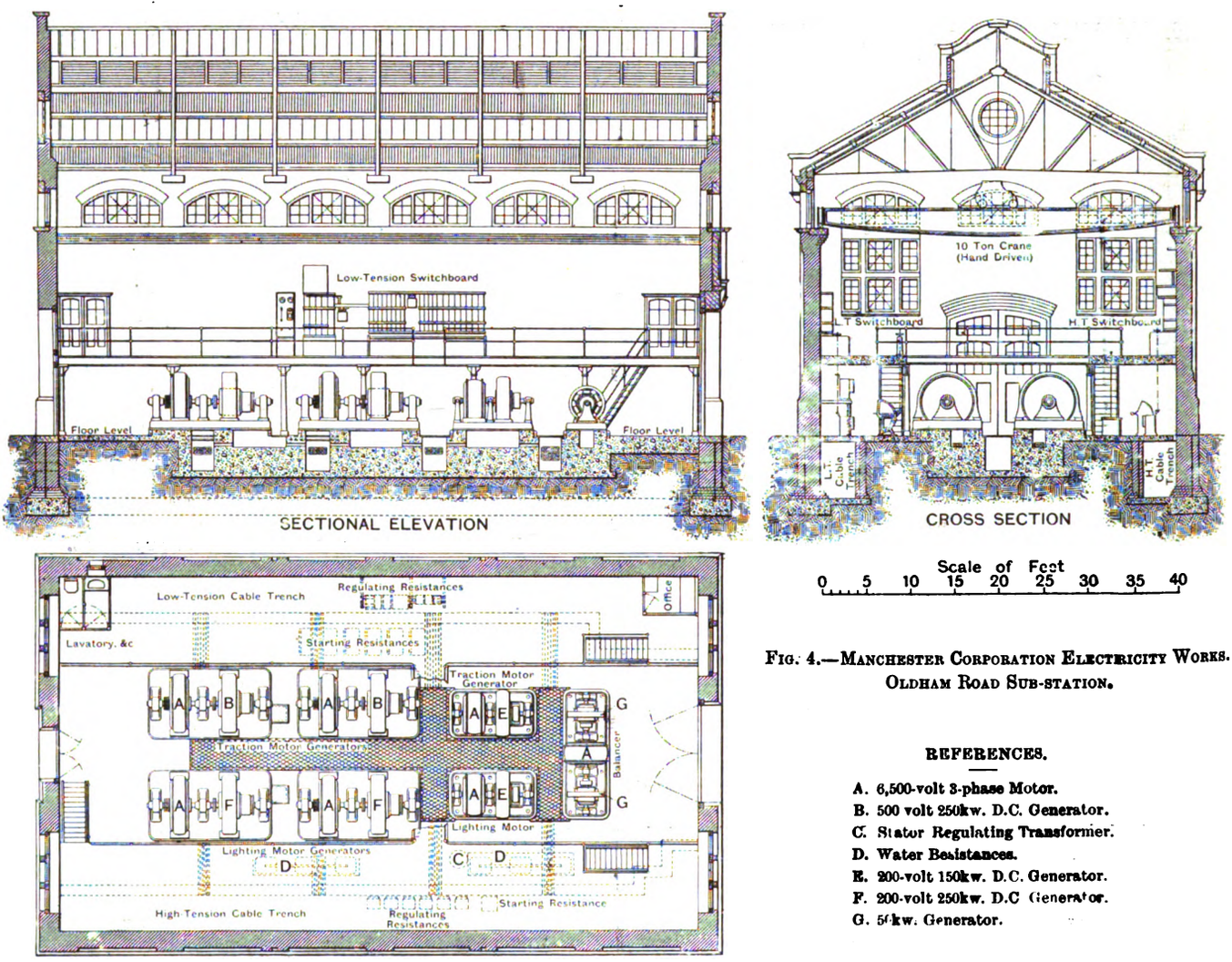

FIG. 4.—MANCHESTER CORPORATION ELECTRICITY WORKS. OLDHAM ROAD SUB-STATION.

REFERENCES.

A. 6,500-volt 3-phase Motor.
B. 500 volt 250kw. D.C. Generator.
C. Stator Regulating Transformer.
D. Water Resistances.
E. 200-volt 150kw. D.C. Generator.
F. 200-volt 250kw. D.C Generator.
G. 50kw. Generator.

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but it rarely happens that battery stations and polyphase sub-stations are combined.

(*c*) A method of starting up applicable to both rotaries and synchronous motor-generators is shown in Fig. 6, and is a slight modification of the first method described for the starting up of the former. The compensator shown reduces the primary voltage to one half; the double throw oil switch, which is fitted with an overload device, is thrown down on to the bottom contacts. Half-voltage is thus impressed on the rotary or synchronous motor, and, the field switch being left open, the machine runs up on an induced field. When full speed is attained, and the field built up in the right direction, the field switch is closed, the oil switch is thrown over on to the top contacts—*i.e.*, on to the full voltage bars, and the starting high-tension oil switch is withdrawn.

suitable design of three-phase stator starter to be used for the purpose is shown in Fig. 7. It consists of three coils arranged in a triangle, and carefully insulated by cylinders of mica. Each coil is provided with an adjustable core consisting of a large number of iron sheets $\frac{1}{16}$in. thick. The three iron cores are attached to a round disc, which is held by a three-armed cast-iron holder, through the middle of which runs a screw, and the three iron cores can thereby be raised and lowered. The three coils are switched in series with the corresponding phases of the motor which is to be started up. Before switching in, the iron cores are lowered into the coils so that on first switching in only a small current goes into the stator of the motor. The cores are then gradually raised out of the coils, the inductive resistance being thereby gradually lessened, and finally the coils are short-circuited. A water resistance or other

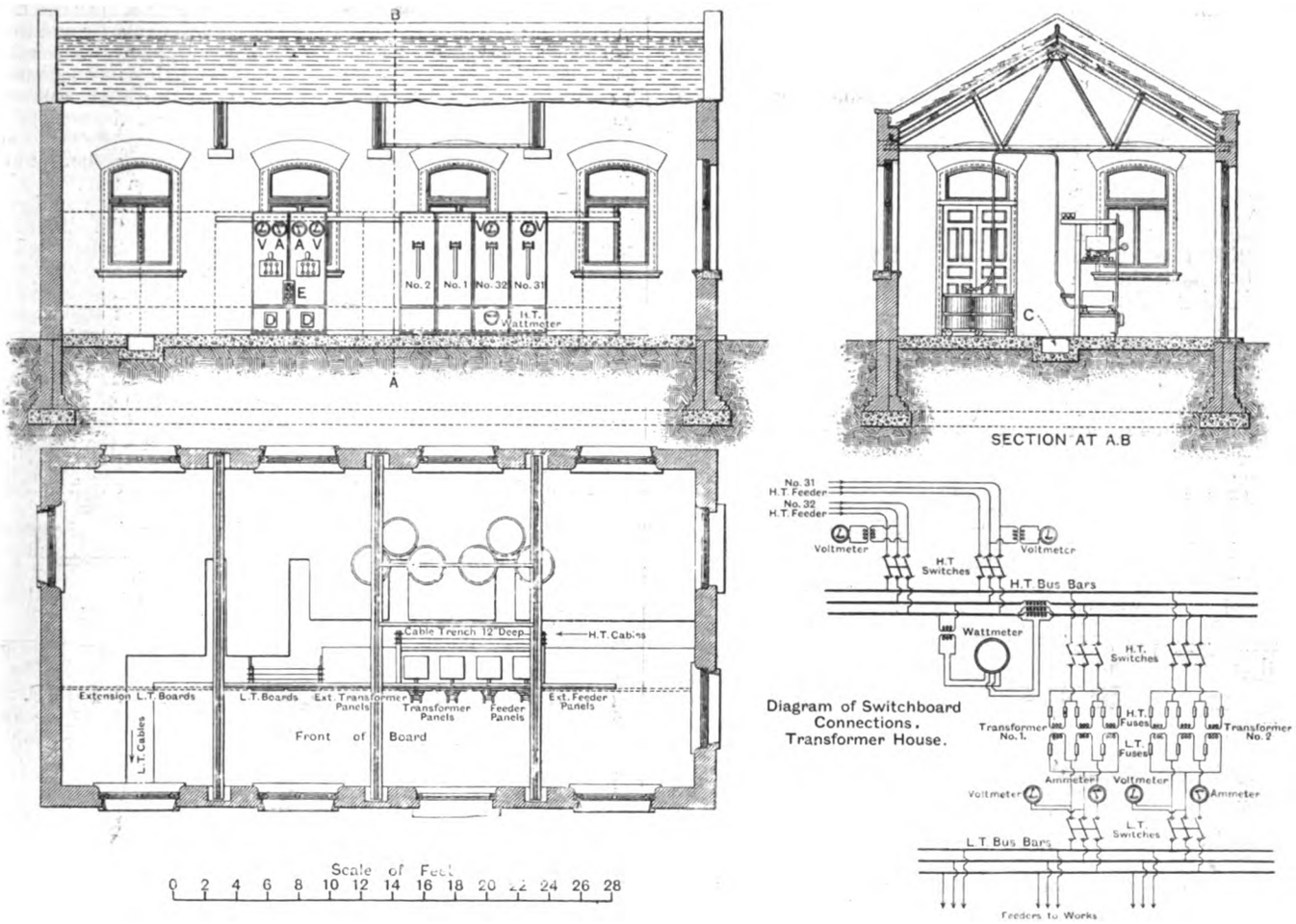

FIG. 5.—MANCHESTER CORPORATION ELECTRICITY WORKS. TRANSFORMER HOUSE.
A. Ammeters. V. Voltmeters. C. Cable Trench covered with $\frac{1}{4}$in. steel plates. D. Fuses. E. Recording H.P. Meter.

The motor-generator with induction motor is the simplest of all types of sub-station equipment to start up. With long feeders it is desirable that the pressure on the feeders should be applied

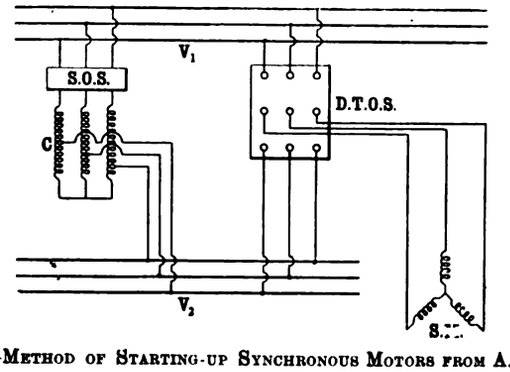

FIG. 6.—METHOD OF STARTING-UP SYNCHRONOUS MOTORS FROM A.C. SIDE.
V_1.—Full Voltage 'Bus Bars. D.T.O.S.—Double Throw Oil Switch.
S.O.S.—Standing Oil Switch. S.M.—Synchronous Motor.
C.—Compensator. V_2.—Half-voltage 'Bus Bars.

gradually to the stator of the induction motor, as any throw-up in the voltage due to the capacity of the feeder at the moment of switching in might break down the insulation of the motor. A suitable form of starter is inserted between the slip-rings of the rotor, and short-ciruited as soon as the set is up to speed, when the machine can be paralleled in the usual manner on the direct current side. On account of the heavy rotor cables with large units, it is desirable, to avoid expense, that the rotor starter should be placed as near the machine as possible, and a convenient arrangement is to operate it by means of bevel gearing from the front of the switchboard platform.

EXCITING.

Rotaries are invariably self-excited for obvious reasons. There is one strong disadvantage, however, with this method, consequent on the possibility of the rotary reversing whilst under load. This happened on two or three occasions on the Central London Railway system, and is a possibility to be reckoned with. If the rotaries are excited from the 'bus bars, then a battery connected across the bars becomes imperative. For synchronous sets employed on traction circuits, a separate exciter mounted on the end of the shaft is probably the best method of exciting the high-tension motor fields. Although it occupies extra space, it provides an alternative method of excitation from the lighting 'bus bars where a mixed system is supplied. In any case, it is desirable that the excitation for the traction sets should be independent of the lighting system, and this can best be obtained by the use of a separate exciter, or a method to be described later on under "Balancing." For synchronous sets on lighting networks, excitation from the D.C. terminals or L.T. 'bus bars will probably be

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found sufficient. The author considers that the question of excitation is of importance, and should be well considered.

Balancing.

The effective balancing of a three-wire lighting network from sub stations can be secured by the use of an induction motor coupled to two generators giving about half the pressure across the outers, the whole combination forming an auxiliary set for the supply of direct current necessary to start the larger synchronous units. It is, however, desirable that additional means of balancing should be provided, either by the use of double-wound armatures with the synchronous sets or other methods. An alternative arrangement has been used extensively in the Manchester sub-stations, and emanates from the Allgemeine Company. This apparatus is essentially a choking coil, the ends of which are connected up by means of two slip-rings to the armature of the continuous-current dynamo. The slip-rings are connected up to the armature at such points that a normal alternating current at the frequency corresponding to the number of pole-pieces and the revolutions is circulating in the equaliser. The middle wire of the system is connected up to the middle point of the choking coil. If the load on each of the two net-halves is unequal, the overload on one will pass through the middle wire into the respective side of the equaliser, and through the slip-ring belonging to it back into the armature. This method also provides another supply for exciting current, and if all the synchronous plant in each sub-station is so arranged, it is evident that each set will be self-excited. An out-of-balance current up to 25 per cent. can be dealt with under this arrangement without the difference in voltage exceeding 2½ per cent. of the mean voltage.

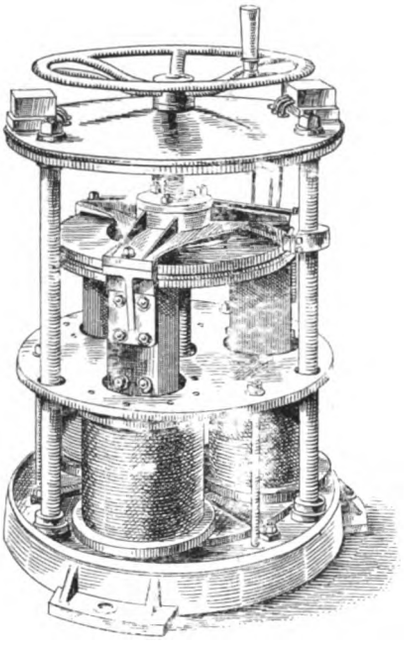

Fig. 7.

Hunting.

To ensure satisfactory parallel running and immunity from what is known as "hunting," it is necessary that every detail of the system should be very carefully considered. Troubles from this source are almost entirely associated with rotary equipments. If the frequency of the supply system be not uniform—that is, if the variations in the velocity of the main generators during one revolution exceed a definite and certain limit—the rotary converters tend to follow, and vary in accordance with the power-house generators. If these variations occur rapidly, it is impossible for the converters to keep in step, and "hunting" ensues. But this trouble can be set up independently of the power-house engines. Oscillations may be set up from a variety of causes within the rotaries themselves, which, if not checked, will spread over the whole system. It is necessary, therefore, in the first place, to provide suitably but not too well governed engines in the power house, and, secondly, to attach special devices to the rotaries themselves to check any oscillations that may be set up. For this purpose "damping coils" are used, which usually take the form of copper plates which bridge over the space between the pole tips. The eddy currents produced in the latter tend to restrain or counteract the distortion of the magnetic field due to the armature oscillations. This tendency to instability of rotaries, however inappreciable for traction work, has, in this country, at any rate in the past, placed them at a disadvantage for lighting work. With synchronous machines the author has never experienced any trouble from this source, and given suitable engines at the power house there should be no possibility of hunting. The armature reaction of the high-tension motor is considerable, the fields being excited at a constant pressure, and independent of the feeder pressure.

Synchronising.

It is of greater importance that the machine should be as nearly as possible in phase than at the same voltage. A synchroniser so arranged as to indicate the relative speeds of the incoming machine and those already on the load will be found a useful and time-saving device, and may be combined with the ordinary method of voltmeter and lamps. By the adoption of this type of synchroniser the machine can be synchronised in the shortest possible time and with the smallest interchange of current between the various machines.

General Conclusions.

For traction systems, very strong reasons must exist if the claim of the rotary converter operating at 25 cycles are overlooked. They are at least 5 per cent. more efficient than either of the other equipments; their ability to stand considerable overloads and the high power-factor at which they can be operated outweigh the disadvantages pointed out in the earlier part of this Paper.

For mixed lighting and traction, lighting considerations will probably settle the type of equipment, and for this synchronous motor-generators operating at 50 cycles appear to best fulfil the majority of conditions required—viz., ease of regulation of direct-current pressure, satisfactory parallel running, little or no variations in pressure; in short, they are not so sensitive as rotaries and they can also be worked at an equally high power factor. It is possible that the disadvantages of the rotary are sometimes exaggerated Their large use in the States and increasing use in this country point to the fact that under special circumstances their adoption may be deemed warranted.

In the case of direct-current lighting and power systems, most difficulty will, perhaps, be experienced in deciding on the respective merits of synchronous versus induction motors. As mentioned before, the drawback to the latter is the fact that the current is always a lagging current, and the smaller sizes have a relatively low power-factor. There is also a gain of 1 to 2 per cent. in efficiency in favour of the synchronous type, to balance which may be placed the extra complications in switch gear. For units of 500kw. and over the author considers that either type might be usefully employed, the increased cost of the induction type being balanced by the increased cost of switch gear with the synchronous type. For units of less than the above output, a combination of both types has worked with advantage, the leading currents of the one compensating for the lagging currents of the other, while the induction motors provide the necessary means of starting up the sub-station from the high-tension side in the event of failure on the direct-current side of the system.

In conclusion, the author would take this opportunity of expressing his thanks to those representatives of the British Thomson-Houston Co., the British Westinghouse Company, the Electrical Co. and Dick, Kerr & Co., who have kindly placed data at his disposal.

HIGH-SPEED ELECTRICALLY-DRIVEN PUMP.

On account of the difficulty of designing a pump to work satisfactorily at high speeds, it is usual to reduce the speed by means of

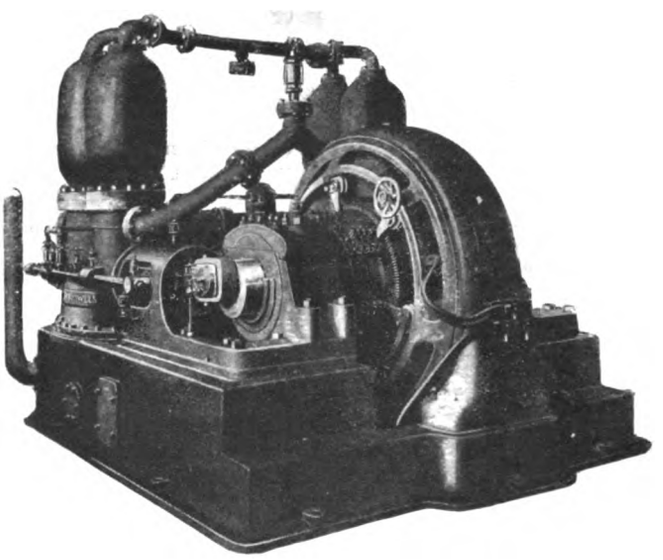

Fig. 1.—Pump Directly Connected to Electric Motor.

gearing or belting. Pumps driven without gearing are, however, much to be preferred for more reasons than one, and we give below some particulars of a recently-designed high-speed pump for which the Blake and Knowles Steam Pump Co., who are the makers, claim a high efficiency and the additional advantage of noiseless working. Fig. 1 shows a pump of this type, capable of delivering 250 gallons per minute, against a head of 1,000ft. when running at 300 revs. per min. It has two cylinders, one at each end of the motor, and the plungers, having a diameter of 3½in. and a stroke of 5½in., are

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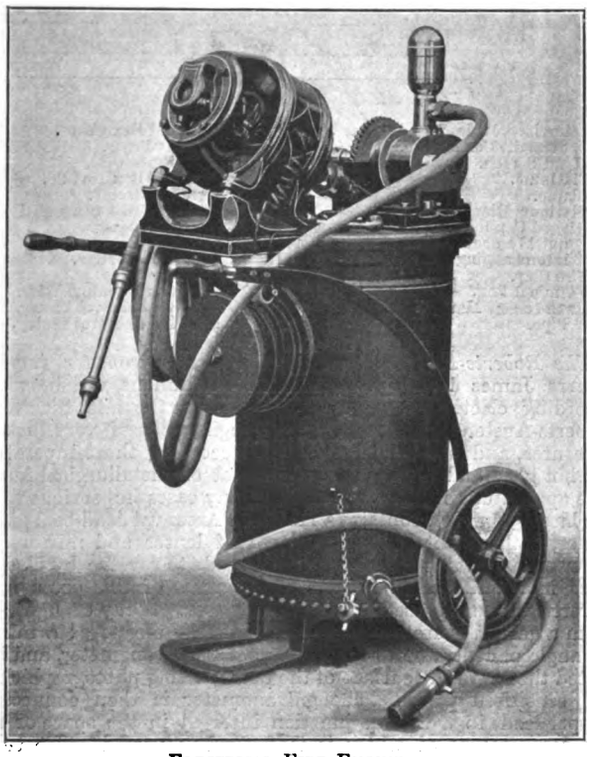
actuated by two cranks placed at the opposite ends of the motor shaft and set at right angles to each other. The plungers are of the outside-packed pattern, and the two plungers of each pump are connected by side-rods. In order to cause as little eddying as possible, the ends of the plungers are pointed. Automatically-operated valves are used throughout. They are of the annular type, with a cushioning device, and have a very large area but small lift. To this fact, and also to the careful design of the suction and discharge passages, which are exceptionally large, is attributed the efficiency and noiselessness of the pump. We are informed that pumps of the type described are built in capacities of from 200 to 4,000 gallons per minute, and for heads varying from 100ft. to 2,000ft.

The following table gives the results of some tests undertaken by the General Electric Co on the pump referred to above. The motor was a six-pole 100 H.P. 200-volt shunt-wound machine of the G.E. Co.'s make :—

Revs. per min.....	280	280	280	280	309
Motor input, kw.....	28·80	40·60	52·55	60·20	58·80
Gallons delivered	237	237	235	234	232
Pump pressure, lbs.	110	215	321	425	496
Pump H.P.	32·63	48·94	62·25	74·53	71·79
Efficiency of set, per cent...	78	82·2	84·4	84·3	83·3
,, motor alone ..	86·5	89 0	90·1	90·9	—
,, pump alone ..	90·1	92·36	93·66	92·74	—

AN ELECTRIC FIRE ENGINE.

The small fire engine which we illustrate herewith is the newest application of electricity to fire extinguishing, the apparatus having been made by Messrs. Merryweather & Sons. It consists of a cylindrical tank mounted on two wheels and provided with running



ELECTRICAL FIRE ENGINE.

handles, with an electric motor and pump fitted on a wooden cover. The motor is wound to run at 100 volts and gives half a horse power at a speed of 1,200 revs. per min. The pump, which is entirely of gunmetal, is of the rotary type and is driven by the motor through worm gearing at a speed of about 200 revs. per min.; it will deliver about 20 gallons per minute at 50lb. to 60lb. pressure and throws a powerful jet. By means of the suction pipe it is so arranged that the pump can draw from the tank or take its supply from a pond or stream through the flexible hose and strainer shown in the illustration. The tank holds about 25 gallons of water and the whole apparatus forms a handy and powerful portable fire engine suitable for use in a house or any other building wired for electric light. Electric cable is carried on a reel, with fittings to attach to a plug.

PYROMETERS SUITABLE FOR METALLURGICAL WORKS.*

At the Barrow meeting of the Iron and Steel Institute the suggestion was made that, in view of the growing importance of pyrometers to the steel industry, arrangements should be made to enable members to see the actual working of different pyrometers, in order to enable them to form their own opinions of the relative merits of the appliances available for metallurgical purposes. The council readily adopted this suggestion, and appointed a committee, consisting of Mr. R. A. Hadfield, vice-president, Mr. J. E. Stead, member of council, and Mr. B. H. Brough, secretary, to make the necessary arrangements for the exhibition.

The Baird and Tatlock Pyrometer† (made by Messrs. Baird and Tatlock).—This is a variety of thermo-electric pyrometer in which the E.M.F. developed by the difference in temperature of two similar thermo-electric junctions opposed to one another is measured. The Le Chatelier couple, consisting of a pure platinum wire and a platinum with 10 per cent. of rhodium or iridium wire, is used. For use at very high temperatures, the platinum and platinum rhodium couple is preferable on account of its greater durability. The platinum and platinum iridium couple gives a larger E.M.F., and consequently a more open scale. The measuring instrument is a portable form of high resistance dead-beat D'Arsonval galvanometer, the coil of which carries a long pointer over a graduated scale reading in degrees Centigrade or Fahrenheit direct. A special arrangement is adopted which prevents the pivots of the needle being damaged. In the stationary form of instrument the galvanometer is mounted on gimbals, and is therefore self-levelling. This form of instrument is very convenient when it is necessary to determine temperatures at different points in a large works. In both forms of instruments the moving part is a rectangular coil of fine wire delicately suspended between the poles of a powerful permanent magnet. The magnets, which are made from a special quality of steel, after being magnetised are very carefully tested for dead-beatness and permanency of readings before being made up. The thermo-couple wires are threaded through short lengths of double-bored porcelain tubes, which, in turn, are enclosed in an iron or steel outer tube. The instruments are very carefully calibrated before being sent out. The following is the method adopted:—The increments of current furnished by the couple for equal increments of temperature are determined. The current corresponding to the maximum temperature (1,600°C.) which the instrument is to measure being known, a current of, say, $\frac{1}{100}$th of the maximum is sent through the galvanometer, and the position of the needle is noted. The current is then increased by small amounts up to the maximum, and the position of the needle noted for each amount. In this way a scale corresponding to equal increments of current, and therefore to equal rises of temperature, is obtained. It then only requires the accurate determination of one point of the scale by a melting point temperature to render it an absolute temperature scale. The calibration of the instruments is not affected by being carried about. Two forms of recording instruments are also made, so that records of temperatures for lengthened periods of time may be obtained.

In the "pyrograph" a band of photographic paper is drawn at a suitable rate under a very fine slit in the dial. The slit is at right-angle to the motion of the paper, so that if the light of an 8 c.p. electric lamp is shining on the dial, some will pass through the slit and blacken the whole band as it is drawn past. The needle, however, of a dead-beat galvanometer actuated by the thermo-electric force of a platinum and platinum rhodium couple moves above the dial, and this casts a shadow through the slit on to the photographic paper, and when this is developed, the record is seen as a white line. The same clockwork which draws the paper also switches off the lamp for one minute every hour, and thus marks white hour lines across the record. A datum line, say at 1,000deg., is marked on the record by a hair laid across the slit at the point, and by applying a scale to this line on the record the temperature at any part can be ascertained.

In the automatic recorder the needle fixed to a dead-beat galvanometer coil and actuated by a thermo-junction plays between two rubbing contacts. The torsion wire supporting the coil is hung from a differential gear connecting two pieces of clockwork, and these are controlled by magnets worked by current sent through either of them when the needle completes a circuit through either of the rubbing contacts. The effect is to twist the torsion wire and bring the needle central between the contacts. A lever and pen is also connected to the differential gear, so that the amount of movement needed to bring the needle midway between the contacts is shown and recorded by the pen, which is arranged to write on a drum.

* Abstract of a report prepared by a committee appointed by the Iron and Steel Institute.

† This description has been prepared by Mr. A. Campion, Cooper's Hill.

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Callendar and Griffith's Thermometers, Thermo-couples, &c. (made by the Cambridge Scientific Instrument Co.).—In resistance thermometers the increase in resistance of a platinum wire with temperature is observed. The electric-resistance thermometer was first proposed by Sir William Siemens in the Bakerian Lecture in 1871, and it immediately came into general use for metallurgical work. Unfortunately it was found that small changes in the resistance of the thermometer occurred owing to the chemical action on the platinum of the silica in the porcelain bobbin on which the wire was wound. In 1886 Prof. H. L. Callendar showed that if the platinum is supported on a mica frame, in section that of a cross with equal arms, there is perfect insulation without any cause of alteration. Prof. Callendar also pointed out the importance of protecting the platinum from noxious gases, all volatile metals attacking platinum readily. The Callendar and Griffith's resistance thermometer consists of a fine platinum wire wound on a mica frame, and connected by means of stout copper or platinum leads to terminals in the head of the thermometer. Two similar leads, but unconnected with the coil, pass through the whole length of the thermometer and act as compensating leads. By this means no error is introduced by the variation of the temperature of the wires connecting the thermometer with the indicator or recorder. For reading temperature directly by means of a resistance thermometer, the Whipple temperature indicator is generally employed. It consists of a Wheatstone bridge, one arm of which is a long bridge wire wound in the form of a helix on an ebonite drum. A contact maker mounted on the inside of a drum can be rotated over this wire. A scale divided into degrees Centigrade or Fahrenheit is fixed on the outer surface of the drum. The four terminals of the resistance thermometer are connected by means of leads to the indicator, the resistance coil of the thermometer thus forming one arm of the bridge. By turning the handle, the contact maker is moved along the bridge wire until sufficient resistance is introduced to balance the resistance of the thermometer. The galvanometer needle shows when this electrical balance has been obtained. A pointer shows the temperature on the scale previously referred to. This instrument has been applied with considerable success to the measurement of the temperature of hardening baths, boiler flues, &c.

For recording temperature by means of an electric-resistance thermometer a Callendar recorder is employed. This instrument, which was designed by Prof. H. L. Callendar, consists of a Wheatstone bridge or potentiometer, in which the movements of the slider along the bridge wire is automatically effected by relays worked by the current passing through the galvanometer between the bridge-arms. According as the moving coil of this galvanometer is deflected in one direction or the other, a relay circuit is connected through one or the other of two electromagnets. Each of these magnets is mounted on a clock, the movement of which is prevented by a brake. When a current passes through a magnet this brake is lifted, allowing the clockwork to revolve. These clocks are connected by differential gearing with a recording pen, which is pulled in one direction or the other when the brake is lifted from the corresponding clock. The bridge slider moves with the pen and tends to restore balance. The thermometer employed in connection with the Callendar recorder is specially designed for measuring the temperature of anealing furnaces, and the recorder can be used for the determination of recalescent points, either by means of resistance or thermo-electric pyrometers. The direct-reading thermo-electric instrument consists of a sensitive D'Arsonval galvanometer, the coil of which carries a pointer reading on a scale divided in degrees Centigrade. By means of a simple switchboard several thermo-couples can be connected in turn with the galvanometer.

The Le Chatelier Pyrometer (made by W. C. Heræus, Hanau, Germany).—At the instance of the Royal Physical Technical Institute at Charlottenburg, Mr. W. C. Heræus, of the firm of platinum refiners at Hanau, undertook the manufacture of a pyrometer according to the principle of Prof. Le Chatelier, of Paris. The principle involved is the conversion of heat into an electric current and the determination of the degree of heat by a suitable device indicating the E.M.F. of such a current. A decided advantage which this pyrometer possesses over all others consists in its ease of application and convenience in handling, and in the fact that the temperature can be read off at almost any distance from the source of heat. The following is a description of the apparatus and of the method of operation:—Two wires, one of absolutely pure platinum and the other consisting of the same metal alloyed with 10 per cent. of rhodium, are fused together at one of their ends in the shape of a small ball (Fig. 1), and thus form a couple. This ball generates a slight electric current when heated, and, as ascertained by the Royal Physical Institute, by comparison with their celebrated air thermometer, such currents are proportionate to the heat applied. Each element is accompanied by a table of results determined in the same manner. To prevent injury to the wires by abrasion, injurious gases, and by alloying with other metals, they are usually enclosed in porcelain tubes, a small tube open at both ends being used to insulate the two wires and a larger one, closed at one end, covering the the whole. The Royal Porcelain Factory at Berlin prepares such tubes from an extremely refractory porcelain base, which resists a temperature of 2,920°F. or 1,600°C. These tubes can be made up to 50in. in length. The galvanometer used in connection with the pyrometer is of the D'Arsonval type, and is especially adapted to the measuring of thermo-currents. The current is transmitted to an armature, wound in quadrangular shape, through a fine wire of hard metal which does not oxidise. A small spring of the same material acts as a negative. A strong permanent magnet with iron pole shoes constitutes a magnetic field, and an iron cylinder in the centre concentrates the magnetic lines of force. The pointer moves over two scales, one of which denotes the E.M.F. of the current in micro-volts, thus making it possible to check the readings of the instrument; while the second scale gives direct readings of the degrees of temperature. On the side of the cylindrical casing of each instrument there is provided an adjustable thumbscrew, which secures the armature, thus avoiding the breaking of its delicate suspension wire while in transit.

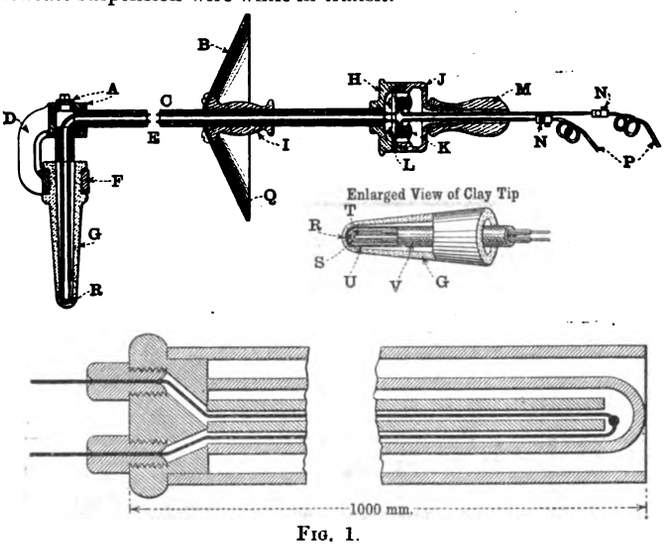

FIG. 1.

A. Interchangeable for Angular or Straight Connection.
B. Hand Screen.
C. Platinum.
D. Clamp.
E. Platinum Rhodium.
F. Hinged Cap locked by Cam Lever, quickly opened and closed for interchanging Clay Tip.
G. Fire Clay.
H. Terminal Box.
I. Hand-screen Handle moveable on Pipe.
J. Terminal Box Cover.
K. Binding Posts.
L. Hard Fibre Disc.
M. Terminal Box Handle.
N. Wire Connector.
P. Copper Wires connected to Galvanometer.
Q. Asbestos Lining.
R. Junction of Wires.
S. Platinum Wire.
T. Platinum Rhodium Wire.
U. Internal Asbestos Lining.
V. External Asbestos Lining.

The Roberts-Austen Recording Electric Pyrometer (made by Messrs. James Pitkin & Co.).—This instrument, which is of the recording electrical type, was devised by the late Sir William Roberts-Austen for the continuous registration of very high temperatures, and it is widely used for recording the temperature of the hot blast and for regulating the heat of metallurgical furnaces. The apparatus consists of two mahogany cases impervious to light, the larger of which contains a Holden d'Arsonval dead-beat galvanometer, with a suitable arrangement of lenses and mirrors. The other case contains a drum which is made to revolve by clockwork once in 24, 12 or six hours. The surface of this drum may be covered with sensitised photographic paper. A ray of light, either from a gas jet or from a lamp, is thrown by means of a mirror at an angle of 45deg. on to the mirror of the galvanometer, and is projected thence to the surface of the drum, acting photographically on the sensitised paper. The galvanometer is then connected by copper leads to a thermo-junction inserted in the space or object, the temperature of which it is desired to record. The thermo-junction may, for example, be placed in a hot-blast main or in the midst of a small mass of metal which is either being cooled from a high temperature or is being raised to a temperature below that of the melting-point of platinum. The heating of the thermo-junction causes a very small current to pass through the coil of the galvanometer, which is deflected, and the mirror attached to it projects a spot of light on the surface of the drum. The amplitude of this deflection indicates the temperature, and a continuous curve is traced on the photographic paper, which at once indicates what temperature is attained at any particular moment. A scale is also provided on which the temperatures can be read from time to time, without interfering in any way with the record. The most simple of the standard forms (pattern 1) is provided with a switch or handle, by means of which a record from any one of six furnaces or centres of heat may be obtained. The time devoted to the record of any of the six depends upon the length of time the handle is left at a

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definite part of the switch. The number of the particular furnace under examination is automatically registered on the drum. The second form of the instrument (pattern 2) enables two continuous and simultaneous records to be taken on the same drum from two furnaces, provision being made for distinguishing the curves. The change from one furnace to another is made automatically by means of clockwork. The third form (pattern 3) is for taking three continuous and simultaneous records.

Thermo-junctions have been used from time to time since 1826, when Becquerel advocated their adoption. Confidence in their indications was, however, only established when it became possible to obtain a good dead-beat galvanometer. The particular thermo-junctions to be used will vary with circumstances, and for many purposes the platinum platinum-*iridium* junction, first used by Prof. Tate in 1873, possesses many advantages over other thermo-junctions. Specially designed electric recording pyrometers are also constructed by the same makers for research work, similar to those used at the Royal Mint, where extreme accuracy is required in determining temperatures. In this pattern two galvanometers are employed, one of greater sensitiveness than the other, in a case impervious to light. A ray of light either from a gas jet or from a lamp is thrown, by means of a mirror at 45deg. (having been focussed by suitable lenses), on to the galvanometer mirrors, and is projected thence on to the surface of a photographic plate. This plate is raised at any desired speed by means of an accurately constructed clockwork train, and the rays of light from the galvanometer mirrors, reduced by means of a horizontal slot to mere points of light, fall on to the sensitised surface, which, being developed, gives an accurate record of the temperature at every instant of time. A dark slide or plate-carrier is provided for enclosing the plate, to enable it to be removed to the dark room for development.

The Siemens Electric Pyrometer (made by Messrs. Siemens Brothers & Co.).—The Siemens electrical pyrometer is a platinum resistance thermometer which has a coil of platinum wire wound upon a cylinder of refractory material, and fixed usually at the end of a long closed iron tube where it is protected by a platinum shield. To measure in actual practice the resistance of the coil and thus its temperature, two types of apparatus are employed. One of these, comprising a differential galvanometer and a set of resistance coils, gives readings in ohms, from which the temperatures are ascertained by means of special tables. The other is a combination of a small D'Arsonval galvanometer and a Wheatstone bridge of circular form with sliding contact, and gives readings directly in thermometric degrees. The first of these types is an instrument of great accuracy, and its determinations can be relied upon to agree within a fraction of 1 per cent. with those of an air thermometer. It is very simple in its arrangement and working, and may be entrusted to the care of any intelligent workman. It finds special application in works where it is necessary to ascertain from time to time the heat of furnaces, flues, &c., particularly those in which the processes demand the maintenance of a definite temperature during certain operations. It is employed in most of the principal steel works in the United Kingdom and on the Continent for determining temperatures during the manufacture of steel plates.

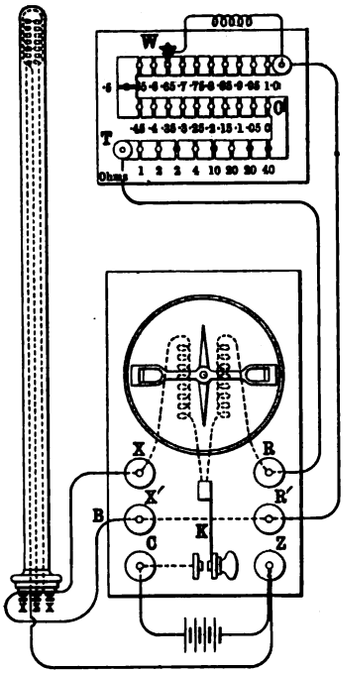

FIG. 2.

Fig. 2 is a diagram showing the pyrometer and galvanometer with resistance coils and battery connected up for taking a reading. The galvanometer is placed with its needle pointing to zero and the end of the pyrometer tube is inserted in the furnace the temperature of which is to be measured, the upper part of the tube being protected from the heat by fireclay or a sheet of iron. When the tube is thought to have acquired the temperature of the furnace, the key marked K is pressed down, causing the battery current to divide at the back of the key into two circuits, one of which includes one coil of the galvanometer and the pyrometer coil, while the other includes the other galvanometer coil and the resistance box. If the resistance of the pyrometer coil does not equal that of the circuit of the resistance box, the needle is deflected, and in order to establish a balance the holes in the resistance boxes must be plugged or unplugged, until the galvanometer needle returns to zero. The sum of the unplugged whole numbers of the resistance box, plus the decimal marked opposite the hole filled by the travelling peg, will then give the resistance of the pyrometer coil in ohms. In order to take a reading, the travelling peg connected with the terminal R^1 is inserted in the hole marked *o*, and the resistance between the fixed terminals T and *o* is unplugged until the galvanometer is balanced as nearly as possible, while the key K is continuously depressed. The travelling peg is then moved along the decimal coils of the resistance box until the point is reached when the galvanometer needle remains exactly at zero and the unplugged resistance between terminals T and *o* is then read off plus the decimal indicated by the travelling peg. The resistances between the terminals T and *o* are additive, while the decimal parts progress by 0·05 ohm from 0 to 1 ohm. Thus, if the holes 1, 2, 4 and 20 are unplugged, and the travelling peg is in the 0·65 hole, the resistance of the coil will be 27·65 ohms. The length of the wires A and B connecting the galvanometer to the pyrometer tube does not affect the reading so long as the wires are of equal resistance, as their resistances vary equally with variations of temperature and balance one another.

The second type, or direct-reading apparatus, comprises a Wheatstone bridge, one limb of which is an adjustable resistance formed out of a helical coil of wire arranged round the edge of a circular dial. The dial is divided into either Fahrenheit or Centigrade degrees as desired, and in the centre of it is a small D'Arsonval galvanometer, a type of instrument unaffected by external magnetic fields. A sliding contact with a pointer serves to adjust the resistance of the variable limb of the bridge, and at the same time to indicate on the dial the temperature of the coil when the balance has been obtained. The keys are combined and fitted to the arm of the sliding contact in such a way that by depressing the knob of the contact the battery is put into circuit with the galvanometer and pyrometer. The whole is mounted upon a tripod stand. To take a temperature, the pyrometer is connected by means of a three-cored cable to three of the terminals and the battery to two terminals of the instrument. The sliding arm is moved to some point on the scale and the lever depressed until the point is found at which depression of the key produces no deflection of the needle of the galvanometer. The pointer attached to the sliding contact will then indicate the temperature of the pyrometer coil. This type of instrument is quite as sensitive as the first type described, and it possesses a great advantage in avoiding the inconvenience and liability to error arising from the use of conversion tables. There is, moreover, only one piece of apparatus to be handled instead of two, and, unlike the other, it is not affected by external magnetic fields due to the proximity of dynamos or powerful electric currents, while its manipulation is even more simple.

THE KINGSLAND SURFACE-CONTACT SYSTEM.

The Traction Co. of the United Kingdom has drawn our attention to the latest design of the Kingsland mechanical surface-contact system which they are now bringing forward. This system, in its original form, was fully described in *The Electrician*, Vol. XLVII., p. 131, and a short reference to its later developments was made in *The Electrician*, Vol. LI., p. 47. It is being experimented with at present in Dresden on a line some 300yds. long, and if the experiments give satisfaction, we are informed that the system is to be applied to about 13½ miles of track in the centre of the town, which are now operated on the accumulator, conduit and trolley systems.

In principle the system has remained the same. The car carries two strikers, one at the front and the other at the back. When running along the track, the former switches the current on to the stud by depressing a switch lever placed in a slot at the side of the track, while the striker at the back of the car switches the current off again, thus leaving the studs which have been passed "dead." A light skate is suspended from underneath the car to pick up the current from the studs. Fig. 1 is a section through the track at a place where there is a stud. A slot, §in. wide, is formed between a guard rail and a track rail at the side of the track. The same illustration shows the position of the switch box and the switch lever. A short length of angle iron is fixed above this lever, so as to prevent it being tampered with. The striker on the car is suitably curved to avoid coming into contact with this piece of angle iron. The switch boxes are accessible through the removable cover of street boxes. Street boxes and the slot are drained in the usual manner. The studs are fixed in the middle of the track and are spaced at such distances that the skate never loses contact. The track is of the usual construction, the rails being bonded, as they form the return path for the current. No extra excavation is required on the line except that required for the switch boxes. The

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depth of these is 12in. from the bottom of the rail, and even this depth may, it is stated, be reduced in special cases. It is noteworthy that the studs are solid fixtures, containing no movable mechanism. As will be seen from Fig. 1, the stud consists of a block, made of paving concrete or granite, and a metal cap made of cast steel. The latter is rectangular in form, having a surface area, at road level, of about 23 sq. in. Before the stud is dropped into

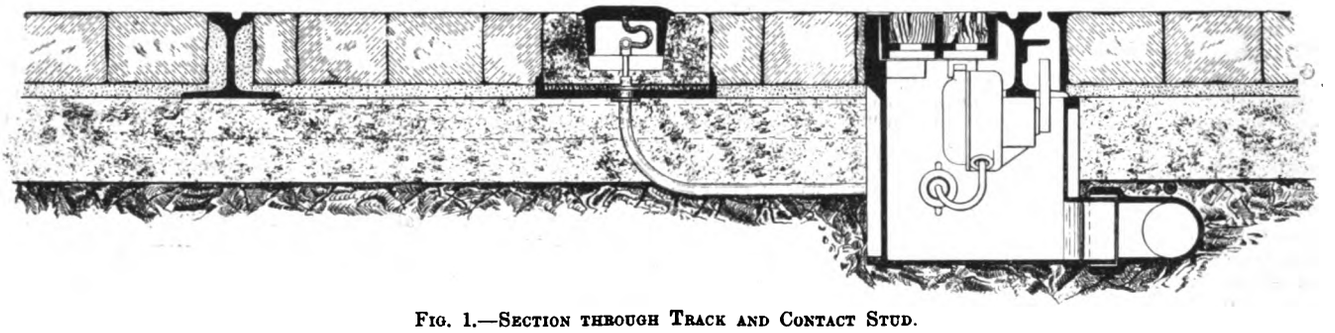

FIG. 1.—SECTION THROUGH TRACK AND CONTACT STUD.

place, just sufficient hot bitumen is poured into the tapered recess in the block to form an air and water-tight seal to the interior of the hollow stud. Electric connection between this and the switching mechanism in the switch box is made by a short length of flexible cable.

Fig. 2 is a section through the switch box, and Fig. 3 is a view of the switch proper. With reference to the latter *b* denotes the

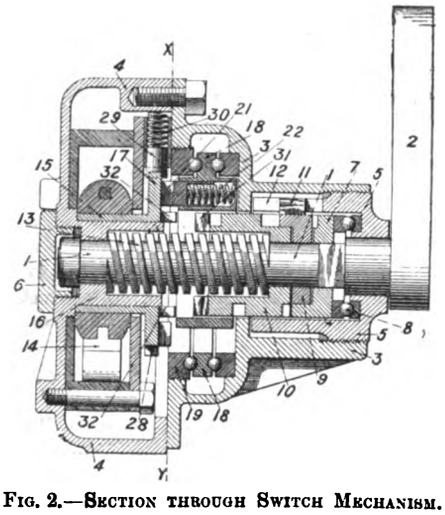

FIG. 2.—SECTION THROUGH SWITCH MECHANISM.

three spring contacts which are fixed to the three arms of a metal ring. This is embedded in insulating material, shown shaded in the illustration. A is an outer case of insulating material, into which the two metal blocks DD are let. One of these is connected by a flexible conductor to the main cable, while the other is in elec-

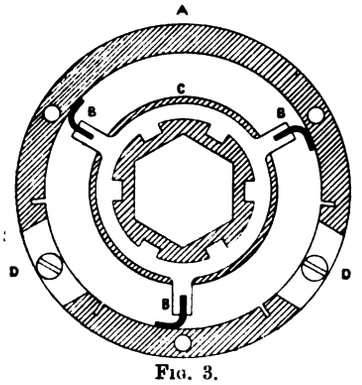

FIG. 3.
SWITCH IN CONTACT BOX.

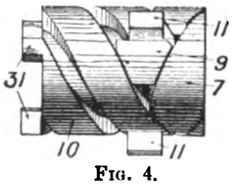

FIG. 4.
DOUBLE RATCHET ARRANGEMENT.

trical connection with the stud. By means of the mechanism shown in Figs. 2 to 5, the switch contacts *b* are rotated 60deg. in one and the same direction whenever the lever 2 (Fig. 2) is depressed in one or the other sense. It is obvious, therefore, that the stud is alternately electrically connected with and disconnected from the main cable, the change taking place when the lever is actuated. No sparking occurs in the switch, as contact is first broken by the skate. When the lever 2 (Fig. 2) is depressed in either direction the part 10, being kept from rotating by lugs 11 sliding in grooves in the casing, is thrust forward against the pressure of a strong square-section steel spring, 13. This is brought about by a double ratchet mechanism, the constituent parts of which are 7 and 9. This part of the mechanism is shown in more detail in Fig. 4. Part 10 moves forward until the lugs 11, of which there are three, come to rest against the inner side of the slots 12. At this point the teeth 31 of part 10 engage with the teeth 32 of part 17, thereby locking the latter. Part 17 has a bush, 15, of hexagonal shape, which fits into

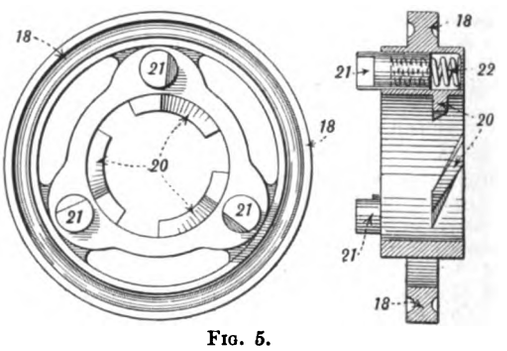

FIG. 5.

the hexagonal hole of the switch arm, described above and depicted in Fig. 3. In Fig. 2 this switch arm, together with one spring contact, is shown and is marked 14. A ring, 18 (Fig. 2), is mounted on ball bearings, and is made to turn when the lever 2 is

FIG. 6.—SECTION AND ELEVATION OF SKATE.

depressed by portions of three screw threads (Fig. 5) engaging with grooves in part 10 (Fig. 2). As is seen from Figs. 2 and 5, the turning motion of 18 is imparted to 17 and thence to the switch 14 by pawls 21, which engage with the teeth on 17. The part 17 carries a third set of teeth marked 28. These engage with pawls 29 and have the effect of preventing any backward motion of the switch. The action of the switch will now be clear:—When the lever 2 is pressed by the striker of the car out of its vertical position, the part 10 is thrust forward by the action of the double ratchet mechanism. In advancing, it causes the ring 18 to rotate, and this in its turn actuates part 17 and the switch contacts con-

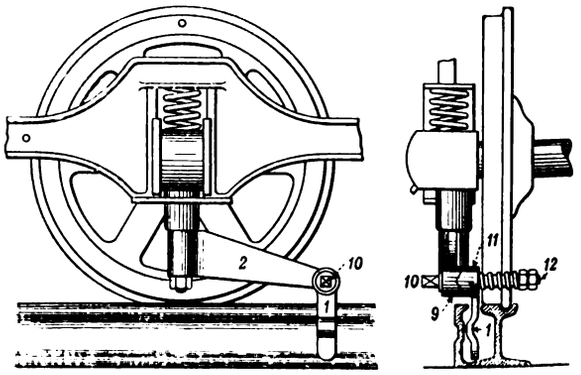

FIG. 7.—METHOD OF FIXING STRIKER TO CAR.

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nected to it. These, however, cannot overshoot their mark by reason of the side teeth of 10 engaging with the corresponding teeth of 17. Nor can the switch contacts move backwards from any cause. The movement of the switch contacts cause electrical contact either to be made or interrupted between the main cable and the stud. After the striker has passed, the spring causes the whole mechanism to regain its original position, and the lever, being again vertical, is ready to be struck by the striker at the back of the car. This takes place in the same manner as before and has the effect—under the assumption that the first striker switched the current on—of cutting off the current from the stud. The mechanism is protected by a water-tight cast-iron box, built in two parts. Ball bearings are used in two instances, and are said to obviate the necessity of lubrication. It is stated that even in the unlikely case of the spring breaking, the mechanism will still work satisfactorily.

Any car of standard design may be used for working on this system. All that is necessary is to have it fitted with a collecting skate (Fig. 6) and a pair of strikers, of which the design and method of attachment are shown in Fig. 7. The skate consists, preferably, of a steel tube of special section, suitably tapered off at the ends. As seen from Fig. 7, the striker is carried by the axle box and possesses a certain degree of flexibility. It is claimed for this system that the track construction is comparatively cheap, exceeding in cost that for a similar track with overhead equipment by about only £1,500 per mile. In favourable conditions this excess may, it is stated, be considerably reduced.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Electric Convection in Liquids.—A. Cotton and H. Mouton report some further studies of the transportation of ultra-microscopic particles in a liquid under the influence of an electric current. The velocity depends upon the dimensions of the electrolytic vessel employed, but for the same colloid the velocity in the central plane of a fairly thick layer is constant. For all the liquids studied, which were bad conductors, the velocity was of the same order of magnitude, being between 2 and 4 microns per second. The authors point out that the motion of the particles is determined by two factors, one of the factors being the charge of the particles themselves, usually negative, while the other is the motion of the liquid in the vicinity of the solid wall, which is already known as electric osmosis. Near the walls the latter factor becomes predominant. The authors obtained positive colloids by using colloidal iron hydrate, or acidulating dilute albumen, or adding a basic aniline to an emulsion of mastic.

[COTTON and MOUTON, *Comptes Rendus*, June 27, 1904.]

Non-uniformity of Temperature.—E. Solvay argues from certain phenomena observed in air compressors that it is impossible to discover the temperature of a body intimately mixed up with a large quantity of another body having a higher conductivity, and deduces from this fact certain novel considerations as to the origin of radio-activity. In one type of air compressors the heating of the apparatus is prevented by injecting cold water in a fine spray. Now, although the pressure curves indicate a very high temperature of the compressed air, the thermometer shows a heating of the walls amounting to only a few degrees. It is evidently only the temperature of the water that is indicated. Most telluric substances are of a heterogeneous structure, and it is possible that some minute portion of them may remain for a considerable time at a temperature greatly exceeding the temperature of the medium in which they are contained. This may account for forms of energy emanating from apparently cold bodies which are ordinarily associated with high temperatures only.

[E. SOLVAY, *Comptes Rendus*, July 4, 1904.]

Analogies between Radium Rays and N-rays.—J. Becquerel has discovered some remarkable resemblances between the penetrating radium rays and N-rays on the one hand, and between the non-deflected "polonium" rays and the N-rays on the other. These analogies appear in their respective behaviour to a sulphide screen. Both the former make the screen emit secondary N-rays, which stimulate the visual faculty, while the latter reduce the visibility of a cross or patch of the sulphide. That the sulphide emits N-rays under the influence of the radiation from uranium salts may be shown by the following experiment:—A cone of aluminium, such as is used for concentrating N-rays, is placed over some uranium salt. A sulphide screen placed at the apex then becomes slightly more visible, owing to the influence of the most penetrating rays. If now a little of the phosphorescent sulphide, without being artificially excited, is brought near the uranium salt, the screen at the apex becomes much more distinct, owing to the N-rays emitted by the sulphide below. That the N-rays emitted are secondary is proved by the fact that the effect upon the eye is almost completely intercepted by distilled water, but not by salt water. The reverse effect was observed by means of a preparation of active bismuth containing polonium, and having an activity of 60. On bringing the polonium near a small luminous cross of calcium sulphide, the luminosity of the cross was considerably reduced. This was, however, only the case with the heavy α-rays of polonium. On stopping up the bottle containing the preparation and again exposing the screen near the wall of the bottle, it was found that the luminosity was increased, owing to the action of the penetrating β-rays, which are already known to increase the phosphorescence of a sulphide screen. The author dwells upon the great importance of the phosphorescent screen as a detector of radiations. It gives a reaction where photography fails to show anything, and where even the electroscope shows no effect. He suggest that the increase of luminosity may in many cases be due to β-rays hitherto undiscovered. He promises further analogies between N-rays and Becquerel rays.

[J. BECQUEREL, *Comptes Rendus*, July 4, 1904.]

Vertical-force Magnetograph.—W. Watson describes a new quartz-thread vertical-force magnetograph which offers a simple compensation for temperature and also eliminates the knife-edge, thus preventing the irregularities produced by dust on the supporting plane. In principle the instrument resembles the quartz-thread gravity balance designed by Threlfall. The instrument consists essentially of a magnet suspended on a horizontal quartz fibre which is kept stretched by means of a quartz spring. The centre of gravity of the magnet and the torsion of the fibre are so adjusted that the axis of the magnet is horizontal. The balance of the magnet is so adjusted that the centre of gravity lies on the same side of the axis of the fibre as the south pole, the displacement being such that, to make the magnet lie with its axis horizontal, the fibre has to be twisted in the anti-clockwise direction. In this case, when the temperature rises, the north end of the magnet will tend to rise, owing to the decrease in magnetic moment, but will tend to fall owing to the increase in the stiffness of the fibre. Thus, by suitably adjusting the horizontal displacement of the centre of gravity of the magnet—that is, the initial torsion of the fibre—matters can be so arranged that the decrease in the couple due to the one effect is exactly equal to the increase due to the other; and so, changes of temperature do not affect the position of the magnet. In the instrument described, the horizontal displacement of the centre of gravity is effected by moving a small weight along the magnet, and the possibility of obtaining complete compensation depends on the fact that the coefficient of increase of the rigidity of the fibre is much greater than the coefficient of linear expansion of steel.

[W. WATSON, *Terrestrial Magnetism*, June, 1904.]

Conductivity of Radium Bromide Solutions.—F. Kohlrausch and F. Henning have experimented with radium bromide as an electrolyte, expecting that, either in consequence of its high atomic weight or its ionising action, it might show peculiar effects. This expectation was, however, not realised, since the salt was found to be quite normal as an electrolyte, and to take its place in the ordinary series of related elements. This is another instance of the rule that in the behaviour of the elements towards water the atomic weight plays no dominant part. The ionic mobility in water is 57 for radium, 56 for barium, and 53 for strontium or calcium. The temperature coefficient has also a normal value. The authors assumed Curie's value 225 of the atomic weight as a basis for their calculations. With Runge and Precht's value 258, the mobility would be 67. But even then it would be of the order of mobility of metallic ions.

[KOHLRAUSCH and HENNING, *Verhandlungen der Deutschen Physikalischen Gesellschaft*, VI., No. 5, 1904.]

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UNIVERSITIES AND STATE ENDOWMENT.

Although the subject of university education and the control and maintenance of the machinery by which it is carried out is of the greatest importance, yet it must be admitted that small service has been rendered to the cause by the deputation, organised by the British Association, which waited upon the Prime Minister last Friday. The British Association is an exceedingly powerful organisation, and when assisted by the universities of the country, as it was on Friday, its opinions and demands, if properly addressed, cannot fail to carry weight. But, unfortunately, the deputation was both mismanaged and ill-timed. The avowed object of the deputation was to lay before the Government the necessity of State aid for universities, assistance being especially required to advance the teaching of applied and pure science, and for the furtherance of scientific research, but a more inopportune moment could scarcely have been chosen, and the vague and uncertain manner in which views were advanced could not have but militated against a favourable outcome. Admittedly, the matter is one of some urgency, and nothing is to be gained by mere wilful procrastination on either side; but after a recent speech by the Chancellor of the Exchequer, in which it was pointed out that the finances of the country call rather for a diminution than an augmentation in the rate of increase of our national expenditure, it must be admitted that nothing would have been lost by patiently waiting until affairs show some improvement. Moreover, since there is every likelihood of the present Government vacating office at no distant date, the present appeal will have been made to a source from which it might have been anticipated no assistance could possibly come. In fact, Mr. AUSTEN CHAMBERLAIN practically told the deputation that, for the present, the matter would receive no consideration. As to what extent financial support was expected there was nothing put forward, and there were no statistics advanced to show in what condition the universities are at present. Briefly, the deputation went forward without a shred of evidence to

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support their ill-defined demands, and they laid nothing before the Government which might serve as a guide when considering the appeal.

The chief speaker was Mr. JOSEPH CHAMBERLAIN, the statesman who delayed the progress of the British electrical industry six years by giving us the unfortunate Electric Lighting Act of 1882, and who is now embarrassing the Government by his persistent advocacy, in season and out of season, of a change in its fiscal policy—far more in fact than he is likely to embarrass it by a half-hearted advocacy of State endowment for universities. Although the advocate was ill-chosen, he certainly spoke well, and, since he came prepared only with the old time-worn arguments with which to prove his case, it certainly needed a good orator to give effect to them. But something more than mere eloquence is required to influence a man of Mr. BALFOUR'S stamp. It is natural that Mr. CHAMBERLAIN does not possess sufficient leisure or opportunity to study the needs of the country with regard to scientific and higher technical education to the same extent as some of the eminent men of science who followed him. Unfortunately these gentlemen were relegated to the background, and their speeches are reported with comparative brevity in the daily papers. Leading journals of science and engineering were not invited to send representatives to accompany the deputation; our own reporter attended but was refused admission. This is regrettable, for surely it should have been the intention of the British Association to gain the sympathy of the section of the public representing scientific and industrial interests as well as to influence the Prime Minister and Chancellor of the Exchequer directly. It is another example of the bad manner in which the whole matter was organised.

Mr. CHAMBERLAIN called attention to the fact that, as far as the multiplication of universities is concerned, England is only following Germany, the United States and other countries. Quoting the instance of an American manufacturer who engaged an entire science graduate class from Columbia University, he said that if a manufacturer here desired to do that he would not find the men to his hand. Now, this is only true to a limited extent, as many graduates of our universities and high-grade technical colleges know only too well. Manufacturers in this country have not yet learned to place that amount of confidence in graduates which many of the latter doubtless deserve. But there are, unfortunately, many who do not merit such confidence, and the obvious inference is, therefore, that their training is not of the right kind. As Mr. BALFOUR pointed out, the standard of ability or "brains" of English students is neither deteriorating nor falling behind that of students of other countries, and the only thing at fault is the system of training. This, then, should be remedied before the State is asked to contribute funds to the universities. He evidently recognises clearly that there is such a thing as over-production, and quoted Germany as an instance; he is also of the opinion that manufacturers prefer men who have acquired their training by "actual day-by-day labour," rather than those who have been trained in the lecture rooms and laboratories of a university. Sir WILLIAM RAMSAY, as a member of the deputation, mentioned that it was possible for a professor in Berlin to make as much as £6,000 or £7,000 a year, but Mr. BALFOUR expressed a doubt as to the wisdom of offering such salaries as these, and advocated the establishment of positions which would content those whose "ambition is the highest of all ambitions—to add to the knowledge of mankind." But in making this remark he must have been under a wrong impression; Sir WILLIAM RAMSAY evidently referred to teachers, while Mr. BALFOUR was thinking of research scholarships, and, besides, the figures referred to must have included remuneration received for consulting work.

The CHANCELLOR OF THE EXCHEQUER, in defending the attitude of the State towards education, showed that, per head of the population, the United Kingdom spends more on education than the United States, France or Germany. This, however, is not necessarily a proof that more is being done by the State in this country than by the Governments of the countries mentioned. The question is not how much money is being spent, but to what extent the work is benefited by the expenditure. Of course, the huge sums spent on education by our own Government are largely swallowed up by primary and elementary education, only a very small fraction going towards secondary and university education. Then, dealing particularly with State aid to universities, he pointed out that this must mean State control, and he will doubtless find many supporters in his contention that such control would not prove an unmixed blessing. Naturally, the man who pays the piper has a right to call the tune, and the State would demand a voice in the government of the institutions at least in proportion to the amount of the grants. Hence the hint to the deputation that they should consider to what extent they were willing to submit to State control before asking for State aid.

It should not be inferred from any statements we have made in the above that we view with disfavour any proposed assistance which may be asked of and given by the State, but there can be no doubt that spasmodic agitations, such as last Friday witnessed, are not productive of beneficial results. That there should be a properly organised appeal, equipped with reliable data and made at an opportune moment, every right thinking person must agree; and it is our most sincere wish that such a movement will meet with the success it deserves. Any Government, whether Conservative or Liberal, must recognise the enormous influence which these new universities—and to a lesser extent the older ones, too—will have upon the future welfare of the great industries of the Empire, and when once it has been shown that they are doing work worthy of the recognition which they seek, there is not the least doubt that favourable consideration will be given to their demands.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

Liquid Fuel and its Combustion. By WM. H. BOOTH. (Westminster: Archibald Constable & Co.) 24s. net.

If the whole of the contents of this book specially relating to liquid fuel were eliminated, there would still remain a substantial volume which might bear some such title as "Fuel Economy in Steam Raising," as it deals with boiler setting, the chemistry of combustion, thermo-chemistry, the combustion of bituminous fuels (Mr. Booth's well-known views thereon), the purification of water, and so forth. The collection of facts and figures on these subjects is unusually complete, and by itself gives the book considerable value to boiler users and designers. A few cases of repetition and some small inaccuracies hardly detract from this value.

As regards the subjects directly indicated by the title, the book is fairly exhaustive as regards present practice, and enters sufficiently into the theoretical and practical requirements to guide would-be users of liquid fuel to a serviceable choice for their special requirements. It may be noted that the use of liquid fuel in internal combustion engines—its most promising field for power production—is not touched upon.

Unfortunately there is no immediate prospect that the subject will become of interest to the majority of steam users for the simple reason that the whole world's supply of fuel oils,

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including those used for illumination and for petrol engines, is but a small fraction of the total fuel supply now required. The author estimates it as equal to 20 million tons of coal annually, which is much less than the annual British export of coal alone. Further, the supply is practically controlled by a single organisation and there is no effective competition. It has consequently repeatedly happened that after arrangements have been made to use fuel oil for steam raising, the price of the combustible has been so much raised as to become prohibitive. So long as these conditions exist the use of oil fuel will necessarily be restricted to special localities and employments where local and other circumstances favour oil as against coal, and there Mr. Booth's industry should be appreciated.

The book is well got up and illustrated, and will be found useful for reference on many points connected with boiler and fuel work not treated in the majority of engineers' hand-books.

Messungen an Elektrischen Maschinen. By Rudolf Krause. (Berlin: Julius Springer.) 1903. 5m.

It is characteristic of the conciseness and clearness of this publication that its first two pages are given up to an exhaustive list of those symbols frequently made use of in the book. In the first chapter a critical summary is given of the more usual forms of measuring instruments for both continuous and alternating current. Then follows a clear exposition of the various methods and diagrams of connections for measuring the electrical energy and power-factor of alternating-current circuits. In the succeeding pages, all the well-known methods for determining resistances and temperature-coefficients are discussed. Amongst the various instruments for measuring the speed, slip and frequency of alternating-current machines described in the next chapter, there is a frequency-meter noteworthy for its simplicity. It consists of a piece of clock-spring, one end of which is rigidly fixed, while the other end (made plainly visible by a piece of paper attached to it) is free to vibrate. If the vibrating spring appears to be at rest when illuminated by an arc lamp fed from the alternating-current supply, then the natural period of oscillation of the spring coincides with the frequency of the current. The frequency of the spring is easily varied, and may be calculated from its dimensions. The following chapter deals with resistance and insulation measurements on electric machines, and the succeeding pages are devoted to magnetic measurements, the leakage and flux distribution in electrical machines being particularly referred to. The methods for carrying out efficiency tests, together with a short discussion on resistances for absorbing power, follow. A number of dynamometers and friction brakes are illustrated and explained. The separation of the losses into their components and the plotting of alternating-current waves are then dealt with, and the book concludes with a brief discussion on the general rules to be observed when taking measurements and the way to record same. The book is thoroughly practical, is clearly written and well illustrated. Some misprints of minor importance occur, and measurements of self-inductions are not included. The book can be recommended for laboratory and works.

Workshop Costs for Engineers and Manufacturers. By Sinclair Pearn and Frank Pearn. (London and Manchester: The Technical Publishing Co.) 1904. 21s. net.

The authors describe in this publication the methods of recording costs and time spent on the various parts of machinery in the engineering works of which they are directors. Their system has been in satisfactory operation at their works for some 20 years. In the first part they deal with the nomenclature and registration of patterns and materials. A simple system of designating the various pieces has been developed, and the signs used for this purpose, consisting of suitable combinations of letters and figures, are so chosen that corresponding parts of the various types of machines manufactured have similar signs. It is recommended that, whenever possible, these signs should be cast on to the rough castings, procuring thereby a permanent mark, and doing away with the unsatisfactory marking by chalk, &c. The second part of the book discusses the recording and analysis of labour, and describes in detail the self-checking system used in the works referred to. In the third part, the question of ordering for actual requirements and for stock are fully gone into, and workmen's "job tickets" and related subjects come in for discussion. Stores and assembly work is next treated, and the book concludes with a chapter on contract and special work. Numerous tables and sample sheets are given, and the subject is rendered quite clear by many examples.

These details of works management constitute one of the most important and difficult problems which confront the practical engineer, and we do not doubt that a perusal of this clearly-written publication will materially aid him in devising a simple and efficient system of management suitable for his own special branch of engineering.

Technological and Scientific Dictionary. Edited by G. F. Goodchild and C. F. Tweney. (London: Geo. Newnes, Ltd.). 1s. net each part.

This dictionary is published monthly and the whole work will comprise about 15 parts when completed. Parts 1 and 2 are distinctly above the average technological encyclopædia or dictionary, and if the succeeding parts attain to the same standard the work will be of much practical use to students and those who only possess an amateur's knowledge of the terms used in various professions and industries. Definitions are concise and as clear as one can expect considering the limited space at the disposal of the editors; naturally, they are neither as complete nor exact as those found in standard text-books. Among the subjects dealt with are: architecture, assaying, astronomy, chemistry, engineering (civil, mechanical and electrical), metallurgy, motor cars, photography, textile manufactures, watch and clock making, &c.

Calculating Tables. By Dr. H. Zimmermann. Translated from the German into English by L. Descroix. (London: Asher & Co.) 6s. net.

Yet another is added is added to the long and rapidly-growing list of calculating tables, and this particular specimen has been compiled with the avowed object of displacing logarithms, slide rules, calculating machines, &c. We have to congratulate the author on his patience and perseverance, for in his preface he says: "The laborious task of proof reading and the checking of the calculations occupied nearly a year. . . ." Moreover, if a user should be so astute as to discover an error, "the publishers of the book will pay him a reward of 10s. on confirmation of the mistake." The formidable collection of figures in the book, however, will deter most people from accepting such a challenge.

Electrical Engineer's Pocket Book. By Horatio A. Foster. 3rd edition. (London: E. and F. N. Spon.) 21s.

We reviewed the first edition of this book two years ago. The title page of the third edition conveys the information that the book has been corrected, but these corrections relate, apparently, to typographical errors only, as the contents have undergone practically no other alteration. Our previous criticisms still apply. The pocket-book—which is not a book for the pocket, however—contains some useful matter and also a number of reprints of trade publications and even price lists. It is of American origin, and will hardly appeal to English engineers.

THE WIRELESS TELEGRAPHY BILL.

The following is the text of a bill to provide for the regulation of wireless telegraphy, introduced by Lord Stanley, Postmaster-General, and read for the first time in the House of Commons on Monday and for the second time to-day (Friday):—

1.—(1) A person shall not establish any wireless telegraph station, or instal or work any apparatus for wireless telegraphy, in any place or on board any British ship except under and in accordance with a licence granted in that behalf by the Postmaster-General with the consent of the Admiralty, the Army Council and the Board of Trade.

(2) Every such licence shall be in such form and for such period as the Postmaster-General may determine, and shall contain the terms, conditions and restrictions on and subject to which the licence is granted, and any such licence may include two or more stations, places or ships.

(3) If any person establishes a wireless telegraph station without a licence in that behalf, or instals or works any apparatus for wireless telegraphy without a licence in that behalf, he shall be guilty of a misdemeanour, and be liable, on conviction under the Summary Jurisdiction Acts, to a penalty not exceeding £10, and on conviction on indictment to

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a fine not exceeding £100, or to imprisonment, with or without hard labour, for a term not exceeding 12 months, and in either case be liable to forfeit any apparatus for wireless telegraphy installed or worked without a licence, but no proceedings shall be taken against any person under this act except by order of the Postmaster-General, the Admiralty, the Army Council or the Board of Trade.

(4) If a justice of the peace is satisfied by information on oath that there is reasonable ground for supposing that a wireless telegraph station has been established without a licence in that behalf, or that any apparatus for wireless telegraphy has been installed or worked in any place or on board any ship within his jurisdiction without a licence in that behalf, he may grant a search warrant to any police officer or any officer appointed in that behalf by the Postmaster-General, the Admiralty, the Army Council or the Board of Trade and named in the warrant, and a warrant so granted shall authorise the officer named therin to enter and inspect the station, place or ship, and to seize any apparatus which appears to him to be used, or intended to be used, for wireless telegraphy therein.

(5) Secs. 684, 685 and 686 of the Merchant Shipping Act, 1894 (which relate to the jurisdiction of courts and justices), and sec. 693 of the same act (which relates to distress for sums ordered to be paid by masters and owners of ships), shall apply to the jurisdiction of courts and justices in respect of ships, and to distress under this act.

(6) The Postmaster-General may make regulations for prescribing the form and manner in which applications for licences under this act are to be made, and with the consent of the Treasury, the fees payable on the grant of any such licence.

(7) The expression "wireless telegraphy" means any system of communication by telegraph as defined in the Telegraph Acts, 1863 to 1904, without the aid of any wire connecting the points from and at which the messages or other communications are sent and received.

2. Where the applicant for a licence proves to the satisfaction of the Postmaster-General that the sole object of obtaining the licence is to enable him to conduct experiments in wireless telegraphy, a licence for that purpose shall be granted, subject to such special terms, conditions and restrictions as the Postmaster-General may think proper.

3.—(1) This act may be cited as the Wireless Telegraphy Act, 1904, and may be cited with the Telegraph Acts, 1863 to 1904.

(2) This act shall extend to the whole of the British Islands and to all British ships whilst on the high seas or in the territorial waters abutting on the coast of the British Islands, and the Royal Courts of the Channel Islands shall register this act accordingly.

CANDLE-POWER TESTS OF COOPER HEWITT MERCURY VAPOUR LAMP.*

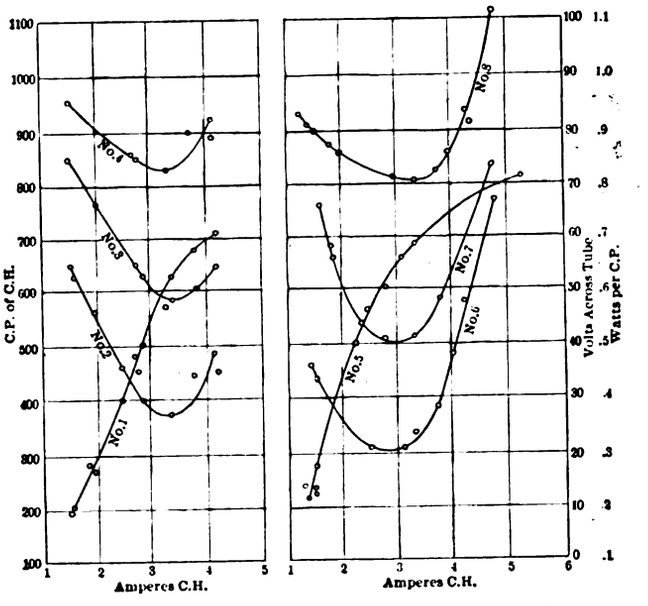
BY L. A. FREUDENBERGER.

The tests described below were made at Delaware College, Newark, Delaware, on a Cooper Hewitt mercury vapour lamp of the type known commercially as type H 4. The lamp, which is rated at 3 amperes and designed for a 110-volt circuit, has a tube diameter of $1\frac{1}{4}$in, and a length of arc of 45·67in.

The lamp was mounted at one end of a 5 metre photometer bar and enclosed in a long wooden box at right angles with the axis of the photometer bar. At the middle of the box, in line with the axis of the bar, was a 2in. by 2in. opening. The box was well ventilated so as to give conditions as near normal as possible. The illumination from a 2in. length at the middle of the Cooper Hewitt light was measured and the corresponding candle-power multiplied by the ratio 45·67/2, the length of the light-giving arc to the length of tube used. The lamp and box were inclined to the horizontal plane through the axis of the photometer bar by an angle of 11° 20′. The lamp was compared with a standardised 32 c.p. incandescent lamp. The screen used was a Lummer-Brodhun. The balance point on the photometer bar could easily be located within 1cm., although the two sides of the screen showed a great contrast in colour. In the course of taking readings the screen was, of course, reversed and the average reading taken.

In Fig. 1, curve 1 represents the variation of candle-power and current, curve 2 the variation of watts in lamp per candle-power, curve 3 the variation of total watts per candle-power with current, curve 4 the variation of current and volts across tube. In Fig. 2, curve 5 represents the variation of candle-power and current, curve 6 the variation of watts in lamp per candle-power and current, curve 7 the variation of total watts per candle-power and current, and curve 8 the variation of current and volts across the tube. In Fig. 3, curve 9 shows the variation of line voltage and current and curves 10 and 11 the relation of minimum watts per candle-power and current. The curves of Fig. 2 were taken when the lamp was new. The curves of Fig. 1 were taken after the lamp had been running about 24 hours. The reduction in candle-power noted is due to a coating, at first grey and afterwards black, which gradually forms all over the inside of the tube. No life tests of the lamps were made, but of two lamps which have been run continuously, one burned out after 800 hours and the other had not burned out after running 1,000 hours. The lamp that burned out blackened somewhat similar to an incandescent lamp. The immediate failure was due to the impairment of the vacuum, principally through leakage at the leading-in wires. For all curves the currents were read after the lamp had settled to steady temperature conditions, and the values used as abscissæ. All instruments were calibrated by means of standard cells and standard resistances.

Curve 6 on Fig. 2 was obtained by multiplying volts across the tube by current and dividing by the candle-power corresponding to the current. It represents the watts per candle-power consumed by the lamp itself. Curve No. 7 was obtained by multiplying line volts (assumed constant at 110 volts) by current and dividing by corresponding candle-power. The efficiency in watts per candle-power includes the loss in the ballast resistance in series with the lamp. The curves on Fig. 1 are precisely similar to the curves on Fig. 2, except that they were taken after the lamp had been running about 24 hours.



FIGS. 1 AND 2.—CANDLE-POWER TESTS OF VAPOR LAMP.

Curve 9 of Fig. 3 merits some explanation. A value of ballast resistance was chosen and the line voltage lowered slowly until the lamp went out. The line voltage and current were taken at the point where the lamp went out and plotted on curve 9. Curves 10 and 11 were obtained by calculating watts per candle-power, using the voltage given by curve 9. Curve 9 shows the minimum line voltage at which it is possible to run the lamp with a certain current. The difference in ordinates between curves 8 or 4 and curve 9 would give the drop in the ballast resistance under this condition. The above tests were submitted as a thesis in electrical engineering by Mr. F. Schabinger. Thanks are due to the Cooper Hewitt Electric Co. for furnishing the lamp, and also to Mr. H. Spoehrer, of the Brooklyn Navy Yard, for furnishing a standardised 32 c.p. lamp.

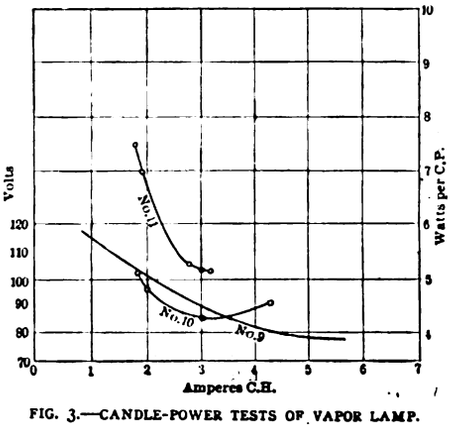


FIG. 3.—CANDLE-POWER TESTS OF VAPOR LAMP.

* From the *Electrical World* of New York.

Electric Mail Vans.—A number of electric motor vans for conveyance of mails between the post offices and the railway stations are to be employed in Paris. The vans are designed to carry 1,200lb. at about 12 miles an hour, as compared with 8 miles attained by horse-drawn vehicles. Each is equipped with 44 accumulators, and is able to cover 25 miles on one charge.

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CORRESPONDENCE.

THE UNITED STATES GOVERNMENT AND THE FESSENDEN WIRELESS SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you kindly permit me to make the following corrections to the statements made in your issue of June 24th, and which appeared in an article in the New York *Evening Post* under the title, "A Government Wireless Mix-up," as some of the statements contained therein would do us considerable injustice unless promptly corrected.

1. The Agricultural Department is not in any tangle with Prof. Fessenden, but on the contrary re'ations between the Department and Prof. Fessenden are entirely harmonious.

2. The statement that the Agricultural Department now claims, or has ever claimed in the past, to own the system of Prof. Fessenden, is a falsehood manufactured out of the whole cloth. No such claim has ever been made by the Department or any of its officials. The facts in the case are, that after Prof. Fessenden had been developing his system for a year or more in Pittsburg, the attention of the Agricultural Department was attracted by some of the experiments which he had made in operating across the cities of Pittsburg and Allegheny. A contract was, therefore, entered into according to which the Department, in return for the expenditure of some $15,000, obtained the right to use all of Prof. Fessenden's inventions which were invented up to July, 1902, "for its use in receiving meteorological reports and transmitting Weather Bureau information." Subsequently to July, 1902, the development of the system was carried on by Prof. Fessenden at a further cost of over $200,000. While, therefore, the Weather Bureau has made an extremely advantageous bargain for the Government in securing at cost of manufacture apparatus which would otherwise cost it some $500,000 or $600,000, the Department does not and never has claimed to have any right whatever to the Fessenden system, or any right to use the same for anything except the specific "transmitting of meteorological reports and Weather Bureau information." According to the contract, "All commercial rights and privileges in connection with this invention are reserved by said Fessenden."

3. This system was not invented by Prof. Fessenden while in the employ of the Agricultural Department. Prof. Fessenden worked on this system for over a year before he entered Government service, and out of the total six years spent in the work but two years were spent in Government service. Also, of the total sum expended in developing the system, less than 7 per cent. was furnished by the Government, the remaining 93 per cent. being furnished by Prof. Fessenden and his partners.

4. The Navy Department is not committed in any way to the Slaby-Arco system. At the time when the Slaby-Arco apparatus was first installed, the Navy Department held that the prices asked by the Marconi and Fessenden companies were too high, and never made any test of either of these systems. Tests were made of the Braun, Slaby-Arco, Lodge, De Forest and American Wireless systems. As a result, the Slaby-Arco system was adopted, but the fact should be clearly understood that neither the Marconi nor Fessenden apparatus was permitted to enter the competition on account of the prices asked. The apparatus purchased—*i.e.*, the Slaby-Arco—infringed the patents of both the Fessenden and Marconi Companies, but these companies had no recourse for the following reason:—It is impossible to sue Government departments except where a contract has been made. This question has been decided several times in the Court of Claims, and though several judges have pointed out the iniquity of the situation, the fact remains that the only remedy an inventor has, should the Government decide to use his inventions without paying for them, is by getting a special Act of Congress passed. This, of course, practically no company in the early stages of its formation is able to do, and, under the present laws, Government departments can and do habitually appropriate the property of inventors without the inventors being able to obtain any redress.

From one point of view the situation is not as outrageous as it seems to the inventors, for the reason that it is the function of a Department to carry on its work in the most efficient way possible, and it cannot be expected to take up legal questions. Again, in many cases the inventor has a recourse in being able to sue the party who sold the apparatus to the Government, and, if the seller is a responsible party, can recover damages. Therefore, on the whole there would be no objection to the Department acting in this way, *provided that they purchased apparatus only from responsible agents inside of the United States, and ones capable of giving bond to pay damages.* However, this was not the case with the Slaby-Arco apparatus, as the apparatus was purchased abroad through a foreign agent and imported free of duty. Under these circumstances, in spite of the fact that the Slaby-Arco Company infringed Prof. Fessenden's apparatus in several fundamental points, and, in fact, was merely a combination of the Fessenden and Marconi apparatus, neither of these companies had any recourse. These companies, therefore, laboured under the peculiar disadvantage that they were competing against a foreign company which manufactured its apparatus abroad, where the labour costs less than half what it does in the United States, which had its apparatus introduced in the United States duty free by the Government, and which, by candidly appropriating the Fessenden and Marconi inventions, was thereby relieved of the enormous cost of experimental investigations. The somewhat ludicrous situation is thus presented of a foreigner who had appropriated the ideas of an American inventor receiving decorations and grants of large sums of money from his own Government, while the American Government was purchasing this pirated apparatus and introducing it free of duty on the ground that the American inventor asked too much, and in spite of the fact that the American company had tendered exactly the same class of apparatus. The situation has, however, improved considerably of late. There is this to be said for the navy, that when the facts were finally placed plainly before the Department they realised at once the fact that the American company had not received justice in the matter, and it may be stated with some degree of certainty that the American systems will have an opportunity of showing what they can do, and that should any foreign apparatus be bought it will be bought of responsible agents residing in this country, and capable of paying damages should they be assessed against them by a court. The question of which system is to be adopted by the navy is at the present moment an open question.

5. The army is not experimenting with a combination of the De Forest and Signal Corps systems. The Signal Corps installed two stations at Forts Wright and Schuyler, and tried a number of systems, including the Lodge, Slaby-Arco and De Forest. None of these were successful, until the De Forest Company manufactured two liquid barretters of the type invented by Prof. Fessenden, whereupon immediate success was had. The De Forest Company had sold the liquid barretter to Gen. Greely before the National Electric Signalling Co. became aware of it, and immediately upon learning of it the National Electric Signalling Co. commenced suit against the De Forest Company, but the suit will not come up for hearing before October or November next. Gen. Greely thereupon took the position that he would decline to buy apparatus from any company until the ownership of the patents was decided, and meantime instructed his officers to arrange a system solely with a view to its utmost efficiency, stating that the Department would later compensate the inventors when the ownership of the patents was decided. The system in use by the army was, therefore, arranged by the officers of the Signal Corps, and is known as the Signal Corps' system. No company has any authorisation to use its name in connection with the Alaska apparatus, and in view of the fact that the system embodies the wave chute (rendered necessary by the frozen ground of Alaska), the multiple vertical, the high-frequency tuned steel guy supports, the tuned condenser circuit for prolonging the oscillations at the sending end, the liquid barretter and closed tuned circuit at the receiving end, &c., covered by the Fessenden patents belonging to the National Electric Signalling Co., if the name of any company is used it should be that of the National Electric Signalling Co.—Yours, &c.,

NATIONAL ELECTRIC SIGNALLING COMPANY.
Washington, July 7. H. J. Glaubitz, Manager.

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PARLIAMENTARY INTELLIGENCE.

SUPPLY OF ELECTRICITY BILL.

Lord Wolverton's Committee of the House of Lords completed the consideration of the clauses of this bill on Monday.

Hon. T. H. W. PELHAM, speaking with regard to the decision of the Committee exempting any companies who may make application from the operation of clause 4 (see *The Electrician*, July 15, p. 530) suggested to the Committee that they should reconsider the form of the amendment proposed. If carried out in the manner suggested by the Chairman it would result in companies being relieved from the obligation to sell, and also being deprived of certain advantages under other clauses of the bill. For instance, clauses 7, 8 and 10 altered the law on certain matters as regards companies, and it seemed to the Board of Trade that if these latter clauses were passed it would be desirable that they should apply to all companies as well as municipalities. Again, clauses 1, 2 and 3 gave certain other advantages to the companies, and they were proposed, not only for the good of the undertakers, but in the interests of the public. The Board of Trade thought it was desirable that the law should be as uniform as possible, although they did not wish to apply the clause to generating stations which had been built outside the areas of supply under special acts. It seemed very undesirable that the law affecting companies should be differently applied to different companies. Under the amendment proposed by the Committee the general public would not be aware what companies were working under the new conditions or what were not. He suggested that the procedure would be a little irregular because of the uncertainty which would be introduced. He therefore proposed the following alternative amendment to clause 4:—"Provided that this sub-section shall not, without the consent of the company to which they belong, apply to any generating station, mains or other works authorised by special act before the passing of this act." He believed that one or two of the companies preferred the original proposal of the Committee, because it exempted them from clause 4 of the bill, which enabled local authorities to purchase jointly. It might or might not be equitable that this should be so, although the Board of Trade did not see much in the objection.

Mr. MOON, on behalf of the Metropolitan Electric Supply Co., said that so far as the amendment related to the particular proposition in clause 4, it gave him the protection he asked for, but if this were passed he would have to ask for further protection on the same basis in respect of other clauses in the bill. He pointed out to the Committee that he already had under his special act all the advantages which it was proposed to confer upon him by this bill.

Mr. LEWIS COWARD, for the London County Council, opposed the proposed amendment, because it was not carrying out, either in form or substance, the decision of the Committee at the last sitting.

The CHAIRMAN said the Committee was inclined to adhere to the decision of the last meeting.

Mr. PELHAM pointed out that it would put everyone in a very difficult position with regard to knowing what companies were exempt and those that were not. If the Committee's first decision were adhered to, it would mean that any company could claim exemption, whereas, if his amendment now suggested was adopted, it would only apply to those companies who had powers under special acts for working generating stations outside the areas of the supply. He was surprised that the London County Council opposed it because, to his mind, it was going a long way in their favour.

Mr. BALFOUR BROWNE suggested that if the proposed amendment were added to clause 4 it should also be added to clause 5. This was practically the decision of the Committee.

After clearing the room,

The CHAIRMAN said that the Committee would accept the amendment proposed by the Board of Trade.

Mr. PELHAM then put before the Committee the following amendments drafted to meet the requirements of Committee. These were all adopted. Clause 4, p. 2, leave out from "by" in line 26 to "but" in line 34, and insert "provisional order authorising the company or person to supply electricity only in bulk, exclude the obligation of the power to purchase by sec. 8 (2) of the Electric Lighting Act of 1888 as respects the whole or any part of the undertaking authorised by the order."

New clause:—"Nothing in this act shall enable the Board of Trade by the provisional order to authorise the compulsory acquisition of any land which, at the date of the first publication of the notice for the order, belongs to a gas company and is used or intended to be used by them for the purposes of their undertaking."

Clause 8, p. 5, line 8, at end insert "and"

"(*d*) Sec. 51 of the same schedule (which requires inspectors to certify meters) shall be read as if at the end there were added 'and the inspectors shall on the like requisition and payment examine the manner in which any such meter has been fixed and connected with the service lines, and shall certify that it has been fixed and connected with the service lines in some manner approved by the Board of Trade, if he considers that it is entitled to be so certified.'"

Clause 8, p. 5, line 16, at end insert "and an electrical inspector, on being required to do so by the undertakers or by any consumer, and on payment of the prescribed fee by the party so requiring him, shall examine the manner in which any meter has been fixed and connected with the service lines, and shall certify that the meter has been fixed and connected with the service lines in some manner approved by the Board of Trade, if he considers it to be entitled to be so certified."

Further amendments to clause 4 were then taken.

The following amendment to sub-sec. 3, proposed by the London County Council, the Association of Municipal Corporations and the Conference of Metropolitan Borough Councils, was first taken—viz., omit "and with the consent of the company."

Lord ROBERT CECIL, for the Metropolitan Borough Councils, said that clause 4, sub-sec. 3, gave a local authority having power to purchase an undertaking belonging to a company within its district the right to transfer that undertaking to another local authority, with the consent of the Board of Trade and with the consent of the company. He strongly objected to the company having to give consent, because it mattered not to them whether the money with which they were paid came from one local authority or another.

Mr. LEWIS COWARD, for the London County Council, supported this view, and thought the Board of Trade consent was quite sufficient safeguard for the company.

Mr. BALFOUR BROWNE, for the London electric lighting companies, supported the sub-section of the clause as in the bill, because if the amendment was adopted the general law would be altered.

Mr. MOON and Mr. CLEASE, for the Metropolitan Electric Supply Co. and the Kensington & Knightsbridge Electric Supply Co. respectively, supported the contention made by Mr. Balfour Browne.

The CHAIRMAN announced that there were four members of the Committee for rejecting the amendment and one against. The amendment was therefore lost.

Mr. LEWIS COWARD, for the London County Council, then proposed the following amendment to clause 4, as a new proviso:—"Provided always that any local authority having power to purchase any part of an undertaking being wholly or partly within the administrative county of London may, subject to the provisions of this section, transfer such rights to the London County Council." In support of this, he stated that on two occasions conferences of the London boroughs had been held urging the London County Council to secure the powers asked for in this amendment, and it had been included in the two electric supply bills promoted by the Council in 1901 and 1902.

Mr. BALFOUR BROWNE, for the London electric lighting companies, opposed the amendment.

The CHAIRMAN pointed out that the amendment provided for the consent of the company being given to the transfer of the purchase powers by the borough council.

Mr. MOON, for the Metropolitan Electric Supply Co., contended that this was not clear in the proviso as it read by itself.

Mr. PELHAM said that the general principle was that the local authorities and not the county authorities should have the right of purchase. A possible case of injustice might arise as follows:—The London County Council might purchase the undertaking of a company in only one portion of the metropolis, and then, in the event of any rate having to be levied in consequence of the Council having acquired this undertaking, such a rate would have to be put upon the whole of the county. This would obviously be unfair, and he should ask that if any powers were given to the County Council they should be compulsory over the whole of the county.

Mr. COWARD pointed out to Mr. Pelham that the Council could not take over any undertaking without the consent of the Board of Trade.

Mr. PELHAM said he was quite sure the Board of Trade would never give consent.

The CHAIRMAN: We will accept the amendment proposed by the London County Council with the words "subject to the like consent" as in the new sub-sec. 3.

Clause 5, "Exercise of Electric Lighting Powers by Authorities Jointly."

Mr. MOON, for the Metropolitan Electric Supply Co., suggested the following amendment:—"But no such order shall be made affecting any area in which any company is supplying or authorised to supply electrical energy for power or lighting purposes otherwise than with the consent of such company."

Mr. FITZGERALD, for the Municipal Corporations Association, opposed the amendment, as also did Lord ROBERT CECIL for the London borough councils.

The CHAIRMAN said the Committee would leave clause 5 as it stood.

Clause 6, "Provision as to Consent of Local Authorities to Grant of Provisional Order" was then taken.

Mr. PELHAM, for the Board of Trade, moved the following amendment: "Provided that—

"(*a*) This sub-section shall not apply to any provisional order authorising a company or person to supply electricity otherwise than in bulk so far as the order relates to any district in which the local authority is authorised to supply electricity; and

"(*b*) A provisional order authorising the breaking up of roads outside the area of supply, shall not be granted by the Board of Trade except with the consent of the local authority in whose district the road is situate, unless the Board of Trade, in any case in which the consent of any such local authority is refused, are of opinion that, having regard to all the circumstances of the case, such consent ought to be dispensed with, and in that case they shall make a special report stating the grounds upon which they have dispensed with such consent."

Mr. FITZGERALD said he was content with the present procedure.

Lord ROBERT CECIL said he supported this contention.

After a little further discussion, the Committee passed clause 6 as in the bill, with the amendment proposed by the Board of Trade, but striking out the words "otherwise than in bulk" in sub-sec. (*a*).

Another amendment by the Board of Trade to leave out sub-sec. 2 of clause 6 was also carried.

Clause 7, "Revision of Maximum Price."

Mr. MOON, for the Metropolitan Electric Supply Co., suggested the following amendment:—

"This section shall not apply to any company authorised to supply electrical energy in any part of the county of London."

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Mr. BALFOUR BROWNE, for the London electric supply companies, also suggested an amendment as follows:—

"(3) If the Board of Trade consider any such representation of consumers to be frivolous or vexatious, they may direct the costs of the undertakers occasioned thereby to be paid by such consumers."

After a brief discussion, both were rejected.

Clause 10, "Supply of Electricity to Premises having Separate Supply."

Mr. LEWIS COWARD, on behalf of the London County Council, suggested the omission of the clause, but this was rejected by the Committee.

Mr. FITZGERALD, for the Association of Municipal Corporations, suggested the insertion of the words "or to continue to receive" after "demand" at the beginning of the clause.

The CHAIRMAN asked Mr. Pelham his views on this matter.

Mr. PELHAM said the clause would be a very great convenience and there was not much objection to the amendment just proposed.

The clause was then passed with the amendment.

Clause 11 "Provisions as to Contracts."

The two following amendments by the Board of Trade were passed without discussion:—

Clause 11, p. 6, leave out from beginning of line 6 to the end of line 8, and insert "so much of any."

Clause 11, leave out from "order" near end, to the end of the clause, and insert "or special act, or of the schedule to the Electric Lighting (Clauses) Act, 1899, as incorporated with any such order or act, as prohibits undertakers from associating themselves with any company or person for supplying energy under any licence, provisional order, or special act unless the undertakers are authorised by Parliament to do so, shall not be construed as prohibiting the undertakers from giving or taking a supply in bulk to or from any such company or person."

This completed the amendments to the clauses in the bill as originally drafted, and the Committee next considered a number of new clauses which had been proposed.

Mr. LEWIS COWARD, for the London County Council, suggested the following as a new clause to be inserted after clause 9:—

"1. If any auditor appointed by the Board of Trade to audit any accounts of any undertakers shall find such accounts incorrect in principle or in detail he shall require such undertakers to correct such accounts in such a manner as he thinks right, and no future dividend shall in any case be declared by any such undertakers until their accounts are certified by the auditor.

"2. If any undertakers think themselves aggrieved by an act or determination of the auditor, the matter in difference shall be referred to the determination of an arbitrator agreed on between such undertakers and the auditor, or in default of agreement appointed on the application of either party by the Board of Trade, and subject to this provision such undertakers shall observe and abide by the directions and determinations of the auditor."

At the present time, he said, auditors appointed by the Board of Trade had no power to enforce any objection which they might have. For instance, there were such matters as promotion money in respect of companies which might have been charged to capital account. In many cases companies had declined to comply with the suggestions of the Board of Trade auditors. So far as companies were concerned this matter was of great importance to local authorities. In view of the purchase of an undertaking by a local authority it was extremely important to see that the accounts were kept properly. Sometimes property altered in value to the extent of several thousand pounds from year to year and there was no means of checking this in any way. The new clause proposed was based upon secs. 40 and 42 of the Metropolitan Water Act of 1871.

Mr. BALFOUR BROWNE, for the London electric lighting companies, said that if this clause were passed the London companies would be subject to stricter audits than was the case at present in connection with local authorities.

Lord ROBERT CECIL pointed out that this was not so. A Local Government Board auditor had power to surcharge any amounts which he did not think legal.

Mr. BALFOUR BROWNE: Yes, but they are nearly always refunded.

Mr. PELHAM said he would not agree to increase the duties of the Board of Trade auditors.

The Committee refused to insert the clause.

Mr. MOON, for the Metropolitan Electric Supply Co., suggested the following new clause:—"Nothing in this act shall extend to or authorise the making of any provisional order which shall affect the undertaking, works, rights, powers or privileges of any existing company having powers under a special Act of Parliament."

The learned counsel was proceeding to lay before the Committee a lengthy statement as to the reason for this when the Chairman stopped him and said the Committee was not prepared to hear any more; the clause would not be allowed.

For the protection of the gas companies the following clause was then agreed to:—"This act shall not apply to any place within the County of London."

This concluded the consideration of the bill, which was ordered to be reported for third reading.

[The references to the clauses mentioned above relate to the printed bill and not to the reprint of it in our issue for May 6.]

TYNESIDE TRAMWAYS AND TRAMROADS BILL.

This bill came before the House of Commons Committee of which the chairman is Sir Edward Strachey on Tuesday. It will be remembered that the bill was recommitted, so far as the running power clauses were concerned, after a discussion in the House on June 29 (see *The Electrician*, July 8, p. 493). The bill came before the Committee again on July 6, and a suggestion was then thrown out by the chairman that an endeavour should be made to come to an agreement. An adjournment was then made until Tuesday with this object in view.

Mr. BALFOUR BROWNE, K.C., for the company said that he was glad that the Committee had not sat earlier, because it had given the two parties an opportunity to come to terms. Generally speaking, it might be said that the Newcastle Corporation had conceded what their Tramway committee agreed to concede on Aug. 26 last year. The Corporation had now agreed to adopt the report of the committee of that date, which, although not absolutely formal, was perfectly sufficient for the purpose. What he was most anxious about was that there should be no going back from this report either by the Corporation or the company, and what he proposed was that the heads of agreement drawn up upon the report in question should be scheduled to the bill.

Mr. LLOYD, K.C., for the Corporation, said there was no question of principle now between the parties. The only question was as to the most convenient way of carrying out that which had been agreed upon between the parties. There was no actual agreement drawn up yet, and the Corporation regarded it as unsatisfactory that the heads of the agreement should be scheduled to the bill. The view of the Corporation was that these heads of agreement should be put into a formal agreement, and that the agreement should be scheduled to the bill. There would be no difficulty about the Corporation agreeing to this, because the heads of the agreement had been finally adopted by them. Another point to which he wished to refer was as to the non-enhancement of the company's undertaking in the case of sale owing to the running powers. If this were included in the agreement between the two parties, and not inserted as a separate clause, the effect would be almost nugatory. The Newcastle Corporation was not the purchasing authority, and if this condition were included in the agreement it would confer no benefit upon the purchasing authorities. He thought it was the intention of the Committee that no extra value should accrue to the actual purchasing authority by reason of the running powers, and unless a separate clause were inserted this could not be effected.

Mr. BALFOUR BROWNE said he rather stuck to the view that the heads of the agreement should be scheduled. The agreement itself could follow as provided for in article 23 of the heads. With regard to the question of non-enhancement of the undertaking, it was stated distinctly in the heads of the agreement that the running powers were only to last for 10 years, or for such time as the tramways were in the hands of the company. This surely safeguarded the purchasing authorities, as, immediately the undertaking was sold, the running powers as well as the agreement ceased to exist.

Mr. LLOYD pointed out that, unless that provision was included in the bill, there was nothing to prevent the Corporation and the company agreeing otherwise.

Mr. BALFOUR BROWNE said that no new agreement could be entered into without the consent of Parliament.

Mr. LLOYD repeated his request that the agreement itself should be scheduled to the bill and that a new clause with regard to non-enhancement of the undertaking be inserted in the bill.

After the room had been cleared,

The CHAIRMAN said the Committee had carefully considered the two points raised by the Newcastle Corporation, and had come to the conclusion that it was desirable that the agreement itself should be embodied in the bill, and also that a clause as regards the non-enhancement of the value of the undertaking, owing to running powers, should be put into the bill. The Committee would adjourn until Friday in order to give time for the agreement to be drawn up. It must be clearly understood by both sides that the Committee intended to finish the bill on Friday and there would be no further adjournment of any kind.

The following are the heads of agreement referred to above:—

Heads of agreement between the Tyneside Tramways and Tramroads Co. (hereinafter called the "company") and the mayor, aldermen and citizens of the City and County of Newcastle-on-Tyne (hereinafter called the "Corporation").

Wallsend Traffic.

1. The Corporation to run a service of cars beyond the Wallsend boundary to Park-road, Wallsend, both the low line and the high line, retaining their own drivers and conductors.

2. The Corporation may increase the service to Wallsend at their option.

3. The Corporation to pay the company four-fifths of a halfpenny for every passenger carried on Corporation cars in Wallsend. This sum to be reduced pro rata in respect of workmen and children.

4. Fares charged by the company in respect of lines in Wallsend not to exceed the rate of ½d. for a distance of ½ mile. The Corporation not to be required to take a less fare than 1d.

Willington Quay and Shields Traffic.

5. The company to run a car (with a company's driver and a Corporation conductor while on the Corporation system) between Shields and Stanhope-street or some other point on the Stanhope-street route west of the centre of the city and vice versa every 16 minutes.

6. If the change of conductor at the Wallsend boundary proves unreasonable, wasteful or unworkable another arrangement to be mutually agreed upon.

7. The Corporation to retain the whole of the receipts taken on account of passengers carried in Newcastle, less 2d. per car-mile operating costs which will be paid over to the company.

8. The punctuality of the company's cars running between Shields and Stanhope-street to be to the reasonable approval of the Corporation.

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Gosforth Park Race Traffic.

9. The Corporation to run sufficient special cars to Gosforth Park during races as will reasonably meet the requirements of the travelling public, regard being had to the requirements of the whole tramway system of the Corporation and the number of cars for the time being owned by them. The Corporation to have the entire control of the Gosforth Park line during the races.

10. The Corporation to pay to the company seven-seventeenths of the through fare charged from the central station to Gosforth Park for every passenger carried by the Corporation cars at special fares on the company's line. Special fares between central station and Gosforth Park to be settled by agreement

11. The company to run their Shields and Wallsend through traffic up to Gosforth Park with their own employés during races, but on their own part of the line only, the service to be under the control of the Corporation, who, in exercising such control, are not to unreasonably interfere with the company's service.

12. During race weeks the company to run cars not exceeding four in number (in addition to through cars) over their line between the Corporation terminus at Gosforth and Gosforth Park to accommodate the local traffic. Such cars are not to turn upon the North-road in the district of Gosforth. The company to pay to the Corporation 1d. for every passenger carried on such local cars, at these times, on which the company charge a fare of 6d., and ½d. for every passenger so carried at lower fares, such fares to vary simultaneously with the special fares to be agreed under clause 10.

Gosforth Park Ordinary Traffic.

13. On ordinary days the Corporation to run an hour service to Gosforth Park or such other service as the traffic reasonably requires.

14. The Corporation to pay to the company two-thirds of all the fares taken by the Corporation with respect to the carriage of passengers on the company's line. Ordinary fares on the company's line not to be less than 2d. for any distance greater than 1 mile, and not to be less than 1d. for any distance less than 1 mile.

Gosforth Traffic.

15. All arrangements under this agreement for running powers over the company's lines in the district of Gosforth shall be terminable at the option of the company upon their giving six months' notice in writing to the Corporation, and shall also be subject to the approval of the Gosforth Council.

General.

16. The cars used by the company in the city to be as far as possible free from advertisements.

17. All employés to be under the superintendence and control of the inspectors of the party on whose lines the cars run, except as regards the Gosforth Park race traffic.

18. All cars to be maintained to the reasonable satisfaction of the party on whose lines they run.

19. The cost of making junctions to be borne equally by both parties.

20. Each party to supply all energy required by cars within their own area.

21. The party operating the cars to be responsible for accidents caused by or to the same.

22. Tracks and overhead equipment of the lines operated to be kept up to the satisfaction of the party operating.

23. Terms to be embodied in an agreement for a period of 10 years and for such longer period as the undertaking of the company shall belong solely to them.

24. During the continuance of this agreement, neither party, without the consent of the other, to make any application to Parliament or to the Board of Trade or to the Light Railway Commissioners in relation to running powers or traffic facilities over the lines of the other party now made, or which they now have power to make or for which they shall obtain power during the present session of Parliament.

25. After the expiration of the said period of 10 years and on every successive period of five years, either party shall be entitled to require a revision of any of the financial terms or conditions for the time being of this agreement, and failing agreement the matter or matters in dispute to be settled by a single arbitrator to be agreed between the parties, or failing agreement to be appointed by the Board of Trade.

26. In case of sale of the company's undertaking, or any part thereof, no increased value is to accrue in consequence of this agreement.

27. Clauses 15 and 16 in the bill to be withdrawn, and such modifications of clauses 17 and 18 made as may be necessary.

28. All questions arising between the Corporation and the company with respect to clauses 6, 13, 19 or 22 before mentioned, or as to the intent and meaning of this contract, to be settled by a single arbitrator to be agreed upon, or failing agreement to be appointed by the Board of Trade.

LEITH CORPORATION (TRAMWAYS ORDER CONFIRMATION) BILL.

This bill came before a Joint Committee of the Lords and Commons on Thursday last week, the Chairman being the Earl of Camperdown. Mr. C. C. Hutchinson appeared for the Leith Corporation and Mr. Balfour Browne, K.C., and Mr. Forbes Lankester for the Edinburgh District Tramways Co. which is opposing the order.

Mr. HUTCHINSON, on behalf of the Corporation, said that the object of the order was to confirm an agreement entered into between the Edinburgh District Tramways Co. and the Corporation of Leith for the purchase of the part of the latter company's undertaking inside the borough of Leith, and its reconstruction for electric traction. The order had already been considered by the Commissioners appointed under sec. 9 of the Private Legislation Procedure (Scotland) Act, 1899, and had been decided by them. With regard to the present opponents to the bill, the Commissioners had refused them a locus at the local inquiry, but an appeal to the House of Commons had resulted in the bill being sent before the present Joint Committee to determine whether the Edinburgh District Tramways Co. should or should not have a locus (see *The Electrician*, June 17, p. 361), but he should ask the Committee to say that the petitioners had no locus against this bill, inasmuch as it did not concern the Edinburgh tramways undertaking, which they had undertaken by the lease to work. The point of view was whether the petitioners could force upon the Leith Corporation the 'bus service which they had undertaken to work as part of the Edinburgh tramways system.

Mr. BALFOUR BROWNE, K.C., for the Edinburgh District Tramways Co., said that the omnibus routes which they wished to abandon in consequence of the construction of the electric tramways in Leith had been put upon this company in substitution for tramways. If they had been able to make tramways instead of running omnibuses the Leith Burgh Commissioners would have been bound to buy the whole of the tramways, whereas at present they were not bound to buy the omnibuses. Under the Corporation bill tramways were going to be built along streets which the omnibuses now served, and, of course, with electric traction this would mean the taking away of all the traffic from the omnibuses. He therefore failed to see why he should not have the right to appear against the bill. He asked the Committee to give him a locus and also to place upon the Leith Burgh Commissioners the obligation of running the omnibuses.

The CHAIRMAN decided to allow a locus to the tramways company, and pointed out that the question before the Committee now was as to whether Leith ought to take over the 'bus routes.

Mr. FORBES LANKESTER, for the tramway company, suggested that the following clause should be inserted in the bill:—"Provided always that the obligations with regard to the service of omnibuses under sec. 04 of the Edinburgh Street Tramways Act, 1874, in so far as still subsisting in respect to the running between Goldenacre, Trinity and Newhaven shall be transferred to and implemented by the Leith Corporation."

After consideration, the CHAIRMAN said the Committee could not accept this clause.

The bill was then ordered to be reported to the House for third reading without amendment.

SCOTTISH PROVISIONAL ORDERS.

AYR TRAMWAYS.

The Ayr Corporation Tramways Order was considered by the following Commissioners, appointed under the Private Legislation Procedure (Scotland) Act, on Saturday at Glasgow:—Lord Kintore (chairman), the Earl of Mansfield, Mr. Hobhouse and Mr. Alexander Wylie. Mr. William Hunter appeared for the promoters, Mr. John Wilson, K.C., for the Glasgow & South-Western Railway Co., Mr. A. C. M'Clure for the frontagers, and Mr. John Stewart for the Corporation of Prestwick.

Mr. HUNTER said that the bill merely asked for further powers in respect of the tramway service already given in Ayr. The first was for the doubling of the line between the Grammar School and Chapel Park-road on the Monkland route, where at present a single line existed which had the effect of seriously curtailing the service which could be run. The bill also asked for powers to run omnibuses beyond the tramway limits to Whitletts in one direction and from Prestwick to Monksland in another direction. The financial position of the undertaking was so good that a great deal more money had had to be spent upon it than the Corporation was authorised under its acts to do. The amount of excess expenditure was £7,000, which had not been got by borrowing, however, it having been paid from the depreciation and reserve fund of the Corporation. They now asked for authority to borrow the £7,000 and also an additional £25,000, to cover the expenditure contemplated under this bill. A further £10,000 was also asked for for working capital.

Provost ALLAN gave evidence as to the need for extensions of the tramway system as asked for in the bill.

Mr. F. COUTTES, general manager of the Ayr Corporation tramways, said it was quite impossible to provide an adequate service under the present conditions. A service of five minutes was absolutely necessary, and on busy days a 2½ or three minutes' service was required.

After hearing evidence against the proposal,

The CHAIRMAN said that the Commissioners found the preamble of the bill proved, but instead of doubling the line from the Grammar School to Chapel Park-road, a passing place 60yds. in length between the two points would be authorised. The authority to run 'buses would be refused, and the financial clauses would be modified accordingly.

LONDON COUNTY COUNCIL (TRAMWAYS AND IMPROVEMENTS) BILL.

Lord Hampden's Committee of the House of Lords considered the clauses of this bill on Friday last week.

The only important one was to give effect to the agreement between the Council and the London, Camberwell & Dulwich Tramway Co. for the acquisition of the latter undertaking for a sum of £6,500. The purchase is to be made immediately on the passing of the bill.

The bill was ordered to be reported for third reading.

"BERMONDSEY" CLAUSE REFUSED.

ELECTRIC LIGHTING PROVISIONAL ORDER (CONFIRMATION BILL No. 8.)

This bill came before a House of Commons Committee, of which the chairman is Mr. Agg Gardner, on Monday. Its object is to confirm a number of electric lighting provisional orders granted by the Board of Trade. The only opposed one was that relating to Caerphilly, in respect of

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which the local gas company sought the insertion of the "Bermondsey" clause.

Mr. RAM, K.C., for the Caerphilly Urban District Council, said that the proposal was, if the order was confirmed, to take electric current from the South Wales Electrical Power Distribution Co., with whom an agreement had been entered into. An application made to the Board of Trade last year for a provisional order for the district had been refused on account of a large amount of local opposition to the Council erecting its own generating station. Under the present proposal all this opposition had disappeared, the ratepayers being quite satisfied that the element of risk would now be a minimum. The cost of the installation would be £5,500. The only opponent to the order was the local gas company which was seeking the insertion of the "Bermondsey" clause. He ought to point out that the gas company's contribution to the rates was £480 per year out of a total rateable value of £64,000. The price of gas in the district was 4s. 6d. per 1,000 cubic ft. for public lamps and 5s. to private consumers. In a large part of the area which the electric lighting provisional order would cover, no gas supply was given, however, the streets being lighted with oil lamps. With regard to the "Bermondsey" clause, he contended that this scheme was altogether different from any in which the clause had hitherto been inserted. If it were inserted, the clause would be a weapon in the hands of the gas company to squeeze the electrical undertaking out of existence, for they could talk to consumers and argue the risks they would run by using electric light, which, they would say, was certain to be increased in price in a year or two, owing to the existence of the clause. The agreement between the Council and the power company stipulated that a certain minimum quantity of electricity should be taken per annum, and if the "Bermondsey" clause were inserted in the order it might have the effect of leaving a surplus upon the hands of the Council, and which would have to be paid for out of the rates.

Mr. A. H. PREECE, consulting engineer to the Council, said that the agreement with the South Wales Power Co. was for a minimum of 50,000 units per annum at 1½d. per unit. The power company had agreed to bring the current to three distributing centres, so that the cost of distribution to the Council would only be within about a mile radius of these stations. Promises had already been made to take 3,800 8 c.p. lamps. This quantity, together with the public lamps, of which there would be 100, would consume 55,000 units per annum. Selling the current at 5½d. per unit upon this output there would be a small surplus. Bridgend, another small town in South Wales, was also taking current from the South Wales Power Co., and in the first year just completed, a profit of over £200 was made.

Evidence having been given as to the need for the electric light in the district,

Mr. J. SHAW addressed the Committee on behalf of the gas company, and asked for a clause on the lines of that given a few weeks ago by the Duke of Northumberland's Committee of the House of Lords (see *The Electrician*, June 24 and July 1).

Mr. PELHAM, for the Board of Trade, objected to the insertion of the clause for the reasons he gave before the House of Lords Committee above referred to. In this case he considered the undertaking would be less speculative than usual.

The Committee refused to grant the clause, and found the preamble of the order proved.

POWER COMPANY'S APPLICATION FOR PROVISIONAL ORDERS.

ELECTRIC LIGHTING PROVISIONAL ORDERS (CONFIRMATION BILL), NOS. 7.

A Committee of the House of Commons, of which the chairman is Mr. Agg Gardner, commenced consideration of Electric Lighting Provisional Order (Confirmation Bill) No. 7 on Thursday last week.

The bill contains a number of provisional orders granted by the Board of Trade to the Clyde Valley Electrical Power Co. for a number of districts in the area given to the company under their Act of 1901. There was a large amount of opposition, wholely for protective clauses, to most of the orders, but as all the questions raised in the Shettlestone order were raised in all the others, it was decided to treat this order as the test case. Mr. H. Lloyd, K.C., appeared for the Clyde Valley Power Co., Mr. Balfour Browne, K.C., for the Glasgow Corporation, and other opponents were represented by the Hon. J. B. Fitzgerald, K.C., Mr. Baggallay, K.C., Mr. Page, K.C., and Mr. Ram, K.C.

Mr. H. LLOYD briefly explained the objects of the bill given above.

Mr. ROBERT ROBERTSON, of Messrs. Strain & Robertson, consulting engineers to the Clyde Valley Electric Power Co., said there were eight orders in the bill relating to the following places:—Barrhead, Johnstone, Renfrew, Shettlestone, Bothwell, Eastwood and Cathcart, Kilpatrick and Lanark. Of these the orders relating to Bothwell, Lanark, and Johnstone were unopposed, but the Glasgow Corporation opposed the Barrhead, Eastwood and Cathcart, Kilpatrick, Renfrew and the Shettlestone orders. Under the company's Act of 1901 Glasgow was excluded from the area of supply, and simply because the Glasgow Corporation had certain property in Shettlestone in the shape of gas and water pipes and telephones, they asked practically to have the same protection as they were granted under the Act of 1901. One point raised in the petition of the Glasgow Corporation was that the districts in question might at some future date be incorporated in the City of Glasgow. In addition, special protection was asked for, in the event of the order being passed, against electrolytic action upon the gas and water pipes of the Corporation, and also for the right to claim compensation against the company should any such damage be caused. He contended, however, that there was no such thing as electrolysis under such circumstances as would arise owing to a supply of electricity for lighting purposes. For instance, if a supply of current was being given for power purposes, the branches from the high-tension mains would be at such long intervals, that it would be quite possible to so place the mains that it would be quite impossible for any damage to be caused. If a supply of current was being given for house-to-house lighting, the mains would necessarily have to be close to the gas and water mains, but the voltage on the supply mains would be so low that the question of damage did not arise. The only possibility of damage arose in connection with tramways where the rails were not properly bonded. As a matter of fact, although the Glasgow Corporation was asking that a space of 2ft. should be left between any of their pipes and his electrical mains, he knew, as a fact, that in the city of Glasgow itself the electric light mains were laid in contact with the water and gas mains, and even twisted round them, so that the precautions asked for against the company, the Corporation themselves did not take in connection with their own undertakings. A further clause asked for by the Glasgow Corporation provided that the precautions above referred to should apply to any pipes laid in the future. But his contention was that the Glasgow Corporation was merely giving a supply of water and gas as traders in the district by the authority of Parliament, and he was seeking to be made a trader in a similar sense by being made the lighting authority in these districts at the request of the local authorities. The question of electrolysis was also raised in respect of the Shettlestone order by the Coatbridge and Airdrie Water Trust.

Cross-examined by Mr. BALFOUR BROWNE, for the Glasgow Corporation, Witness said special protection in respect to electrolysis had been refused on many occasions. He disputed the statement that anything in the company's Act of 1901 would be rendered ineffective by the granting of the provisional order, in so far as the Glasgow Corporation was protected by the 1901 Act.

In reply to Mr. FITZGERALD, for the Coatbridge and Airdrie Water Trust, he suggested that if electrolytic damage was done to the water mains, the best thing to do was to investigate the tramways as the possible cause of it.

In answer to the Committee, Witness said that in his opinion, it was unreasonable to expect the same protection in respect of small distributing mains as was given for large "power" mains.

This closed the case for the promoters.

Mr. BALFOUR BROWNE, in addressing the Committee on behalf of the Glasgow Corporation, said that under their Act of 1901 the company had agreed to indemnify the Corporation against electrolytic damage, but an attempt was now being made to get away from that bargain by endeavouring to obtain a provisional order, and under it not to give any protection. If this were done how was it to be determined whether any damage that might be caused was the result of works carried out under the Act of 1901 or the provisional order of 1904? The curious fact about it all was, that the county councils were being given the very protection which was refused to the Glasgow Corporation. He therefore asked the Committee to give him the protection asked for, and at the same time to prevent the company opposing the Corporation in the event of an application being made to include the districts in question in the City of Glasgow. This was granted in the Act of 1901, but the existence of the provisional order, constituting the company the lighting authority, would override this.

Mr. FITZGERALD, for the Airdrie and Coatbridge Water Trust, argued for the same protection as to electrolytic damage.

The Hon. T. H. W. PELHAM, of the Board of Trade, said the Board was put into a very awkward position when "power" companies promoted provisional orders, because it was often agreed between the promoter and opponents to insert in them sections of the company's "power" act which the Board of Trade had never been consulted about originally and which they considered to be inconsistent with the Electric Lighting Acts. The Board of Trade opposed this special electrolysis clause for that reason.

After consultation,

The Committee decided that the opposed provisional orders should be read in conjunction with the company's act of 1901, so far as electrolysis was concerned.

Mr. BAGGALLAY, for the Lanarkshire County Council, then proposed an amendment to the orders, by which it was sought to incorporate a section of the company's act, as regards laying mains.

Mr. PAGE, for the Renfrew County Council, and Mr. RAM, for the Dumbarton County Council, supported the application.

Mr. PELHAM opposed, for the reasons given above, contending that the electric lighting acts fully dealt with this matter.

The Committee decided to allow the amendment.

On Monday the terms of the new clauses were submitted.

The protection granted to the Glasgow Corporation in respect of electrolytic damage to their mains and pipes applies to the orders relating to Barrhead, Eastwood and Cathcart, Kilpatrick, Renfrew and Shettlestone, but when the local authorities acquire these orders, the provisions of the Electric Lighting Acts will apply. In respect of the Coatbridge and Airdrie Water Trust's opposition on the same point to the Shettlestone order, it was decided that the conditions of the special protection should also apply after the sale of the undertaking.

TORQUAY TRAMWAYS BILL.

Some discussion is now taking place in Torquay with regard to the action of the Chairman of Committees of the House of Lords in persisting in striking out an agreed electrolysis clause between the promoters of the Torquay Tramways Bill (the Dolter Electric Traction Co.) and the Torquay Corporation and the Torquay Gas Co. Briefly the history is as follows:—The Torquay Corporation gave its consent to the bill on the

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condition that special protection should be given, as regards electrolytic damage, to its gas and water mains. When the bill came before a House of Commons Committee, presided over by Mr. Russell Rea, the Torquay Gas Co. petitioned for and obtained a similar clause, simply because it had already been given to the Corporation. When the bill came before the Chairman of Committees of the House of Lords, prior to reference to an Opposed Committee of that House, the clause was struck out as regards both parties. Before the Opposed Committee of the House of Lords, however, an appeal was made for its re-insertion as a matter of honour between the parties, and this was acceded to. Now, however, the Lord Chairman of Committees of the House of Lords refuses to agree to the amendment, and has again struck out the clause. It would appear that the only chance now of the clause being put into the bill is on the third reading.

BELFAST CORPORATION TRAMWAYS BILL.

In the House of Commons on Tuesday, on the motion for second reading of this bill, there were a number of notices down for its rejection. Some were withdrawn, however.

Mr. HEALY moved that the bill be read a second time that day three months.

Mr. TULLY seconded.

The SPEAKER asked those in support of the motion to rise in their places, but as only three did so the bill was read a second time.

Mr. HEALY then moved that the bill be referred to a Hybrid Committee, but this was opposed and the debate stood adjourned.

[The bill has already passed the House of Lords; see *The Electrician*, April 29, p. 68].

OTHER ELECTRICAL BILLS.

The *Lothians Electric Power Bill* came before the Unopposed Committee of the House of Commons on Friday last week. The bill has already passed the House of Lords, when several objections were taken by Lord Balfour of Burleigh, the acting chairman, to a clause agreed upon between the promoters and the county councils. The bill takes power to supply electrical energy in "bulk" over the whole of the county of Midlothian (excluding Edinburgh and Leith) and portions of the counties of East Lothian and Lanark. The share capital of the company is £600,000 in 60,000 shares of £10 each. Mr. Bell, Parliamentary agent for the promoters, pointed out that the company had agreed with the various county councils to give special protection as regards electrolysis, and upon this understanding these authorities withdrew their opposition. When the bill came before the Unopposed Committee of the House of Lords, however, the Committee refused to insert them, it being considered that sufficient protection was granted under the Electric Lighting Acts, which were incorporated in the bill. In an endeavour to keep their bargain with the county councils, however, the promoters had again inserted the clause. The point of the clause was that it made the company liable for damage by electrolysis to any gas and water mains belonging to the county councils even if no negligence were proved. After some discussion, the Committee decided to pass the preamble of the bill.

The *Leeds Corporation (Consolidation) Bill* has been before the Police and Sanitary Committee of the House of Commons during the past week. One of the objects of the bill is to consolidate certain of the tramway acts granted to the Corporation, and also to re-arrange the fares to be charged upon the Corporation tramways. Mr. Jeeves, for the Corporation, said that the Corporation had two acts authorising different scales of charges. But they did not wish for either, and asked for the same power as that given to Birmingham last session—viz., to charge 1d. per mile or 1d. per stage, the stages being arranged to be not less than 1 mile. In Leeds it would mean that the stage would vary between 1½ and 2 miles. The Committee granted the clause asked for. The power to run express through cars was also granted. Other clauses were then gone into giving the Corporation power to carry goods, &c., upon their tramways. Much opposition was given to this proposal by the North-Eastern and Great Northern Railway Companies, but eventually the Committee granted the power to carry goods only upon existing lines. Another clause gave the Corporation authority to enter into working agreements in respect of neighbouring tramways, and also to give any other body power to negotiate with the Corporation. The Chairman said there was an objection to giving the power, probably to non-existent bodies, but it would be given to the Leeds Corporation. Any other body wishing to negotiate with the Corporation must get their own powers.

In the House of Lords on Friday last week the *Belfast and North-East Ireland Electricity and Power Gas Bill* was read a third time and passed. On Tuesday the *Loch Leven Water Power Bill* was read a second time.

In the House of Commons on Monday the Postmaster-General introduced the *Wireless Telegraphy Bill*, the text of which is given in another column. The second reading has been fixed for to-day (Friday). The *Govan Corporation* and the *Electric Lighting Provisional Order (Confirmation Bill, No. 5)* were read a second time.

The *Manchester Corporation Tramways Bill* was down for consideration before an Opposed Committee of the House of Commons on Tuesday, but it was announced that all opposition had been withdrawn. The bill has, consequently, been referred to the Unopposed Committee.

The *Middlesbrough, Stockton and Thornaby Tramways Bill* came before a House of Lords Committee, presided over by Lord Brougham, on Tuesday. The objects of the bill were set out in *The Electrician* for May 13, when it was before the House of Commons. The only opposition was on clauses. Mr. Balfour Browne, K.C., in opening, said a difficulty was experienced with the Middlesbrough Corporation as to the payment that should be made to them by the company in respect of the few hundred yards of new lines proposed within their area. The other opposition had been withdrawn. After consultation between the parties an agreement was come to that the 325yds. of new line in Middlesbrough should be purchaseable by the Corporation in 1918, at the time when the remaining lines in the city can be acquired. The amount of the annual payments or otherwise to be paid to the Corporation was left for settlement between the parties. The preamble of the bill was then found proved.

The London United Tramways Bill was read a third time in the House of Lords yesterday, and passed.

LEGAL INTELLIGENCE.

Kay v. British Westinghouse Electric & Mfg. Co. (Ltd.)

This case came before the Court of Appeal (the Master of the Rolls and Lord Justice Mathew) on Saturday on an application by defendants for a stay of execution pending appeal.

Mr. ELLIS HILL said the action was tried before Mr. Justice Jelf and a special jury at Manchester (see *The Electrician*, July 15, p. 532). Plaintiff, an employé of defendants, brought the action to recover damages in respect of personal injuries caused by his falling against an electric switch, part of the electric lighting apparatus of the factory, and getting burnt by the current. Plaintiff's case was that defendants had been guilty of negligence and that they had committed a breach of duty under the Factory Acts. On the point under the Factory Acts, the learned judge came to the conclusion that the switch was not part of the machinery within the meaning of the Factory Acts. He, however, left the question of common law negligence to the jury. The point on which he asked for a stay was that defendants set up the defence of common employment, and they proved that the whole of the works of defendants, so far as the technical part of it was concerned, was handed over to the general manager and a man named Harris. There were 1,300 switches in the factory and all but five were covered. The switch in question was uncovered and therefore the accident happened. He submitted that the defence of common employment was a good defence against the claim at common law. The jury awarded plaintiff £850 damages. Defendants were willing to pay plaintiff £1 a week until the appeal was heard.

In the result their Lordships directed that there should be a stay until the hearing of the appeal, on the defendant paying plaintiffs £1 a week, to reckon from the date of the accident until the appeal was heard, and paying the plaintiff's solicitor's costs on the usual undertaking.

Montreal Street Railway Co. v. City of Montreal.

On Friday the company petitioned the Judicial Committee of the Privy Council (Lords Davey and Robertson and Sir Arthur Wilson) for special leave to appeal from a judgment of the Supreme Court of Canada.

The City of Montreal sued the Montreal Street Railway Co. to recover $21,050 under a contract by which the company were granted a concession for establishing electric railways within the city. The company also constructed connecting lines in municipalities outside Montreal city, and the question arose whether the company were bound to pay the City of Montreal a percentage upon earnings not only within, but also without the city. The action was dismissed on the first occasion, and the city appealed to the Court of King's Bench. That Court, by three judges to two, dismissed the appeal. The city then appealed to the Supreme Court of Canada, which, by a similar majority, allowed the appeal. The company now applied for special leave to appeal from that judgment.

Their Lordships granted the leave as asked.

Telephone Subscriber's Contract.

In the Lord Mayor's Court (City of London) last week, before the Common Serjeant (Mr. Bosanquet, K.C.) and a common jury, the National Telephone Co. sued a former subscriber for £8 in respect of a telephone.

Mr. GAINE, for the company, said defendant originally entered into a contract for an unlimited service, for which £20 per annum was to be paid. Subsequently, he wished to be placed on the message rate system. In October, 1902, the transfer was made, a contract being entered into by which defendant had to pay £6. 10s., and to deposit £1. 10s. against originating calls. Towards the close of the contract plaintiffs requested defendant to deposit a further £1. That sum was not paid, and plaintiffs, in May, 1903, under the contract, temporarily disconnected him from originating calls. In July, no notice having been given by defendant to discontinue the service, another year was commenced, and £6. 10s. became payable, with a further 30s. deposit. Defendant wrote, on July 1, that he had given up the tenancy of his office and contended that the agreement terminated in June. He also urged that the service in respect of which he was sued was inefficient, and that plaintiffs had shut down his service before the amount of his deposit had run off.

The Common Serjeant pointed out that the bargain was that the defendant was to be bound by the record of calls kept by plaintiffs. That showed that the deposit had run off. The only question to be decided was whether the contract ran on, and by law that was the case. He directed the jury to find for plaintiffs for £8. Judgment accordingly.

Smart v. Rushworth Bros.

At Newcastle Assizes last week, plaintiff sought to recover £500 damages for breach of contract in connection with the supply by defendants of an electrically-driven crane.

Plaintiff said he approached defendants for the manufacture of an electrically-driven crane in July, 1900. It was agreed that delivery should

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be made in a month. Time was the essence of the contract. The crane was subsequently delivered, and was fitted into position. It was not satisfactory, and plaintiff asked defendants to remove it. He was assured that the crane would be satisfactory when it was completed. After a while the crane worked satisfactorily, and then it gradually got worse and could not be depended on. As the construction of the building proceeded they had to lift greater distances, and the difficulties increased. He was put to extra expense, and suffered much damage. In 1902, he said, the crane broke down entirely. At that time the building was not then completed. Eventually he sold the crane for £80 and the motor for £15. He had paid £220 for them, and erecting the crane cost him £10. In cross-examination plaintiff admitted that he knew defendants were well-known crane makers, and were on the Admiralty list. He had bought three cranes from the firm, and the dispute was only about the motor crane. He had asked for a 3-ton electrically-driven derrick crane. Three-ton meant to lift 3 tons. The firm told him that they had never made an electrically-driven crane before. Though a 3-ton crane, it had been made to lift 5½ tons. He claimed £500 damages.

Among the witnesses for plaintiff were Percy Devereux, electrical engineer, who said he inspected the motor very often; there had been an overload; Mr. W. D. Hunter, of the Newcastle Electric Lighting Co., who said that if oil got into the motor it would cause the insulation resistance to break down; and Mr. B. S. Patterson, engineer, who said that the breakdown was in the first place due to the motor not having been constructed for special duty.

For the defence, Mr. RUSHWORTH said that to lift 5 tons with a 3-ton crane was to put the machine to a most improper and unfair test. They usually made compound-wound motors now for electric cranes and made provision for lubricating the pulleys.

Mr. GEO. RUSHWORTH, works manager for defendants, said he went with the crane when it was erected. After the completion it worked satisfactorily. When, later, he saw the crane it was very dirty, and one of the oil cups was missing. His firm did not, of course, guarantee 3-ton cranes to lift any more than 3 tons.

Mr. CHARLES HOPKINSON, C.E., said the crane was supplied with a 13 H.P. motor, which would be reasonable for a 3-ton crane. It gave ample power to do the work in an ordinary way. In lifting 5 tons they got through without an accident more by good luck than by good management. It meant that the crane was unusually strong. It was not an uncommon thing for a fracture to start and to take years to develop.

Mr. A. G. COOPER, electrical engineer, thought the marks on the shaft were caused by cutting due to want of lubrication. In his opinion the cause of the trouble was want of attention.

Eventually the jury found for plaintiff for £200.

Tramcar Ticket Conditions.

Before the Stipendiary at Sheffield on Thursday last week, Mr. Muir Wilson, solicitor and a city councillor, was charged with refusing to show his tramway ticket on demand to a servant of the Corporation, and with refusing to pay an additional 1d. fare for which he was liable. Mr. Wilson refused to accept a ticket owing to the appearance on the back thereof of a notice limiting compensation in case of accident to £25. He now contested the validity of such notice.

Mr. BAIRSTOW, for the Corporation, said a passenger must abide by the Corporation's conditions.

Mr. WILSON said the object he had in raising the question was that the Corporation were endeavouring to impose on citizens a condition which was wild, extravagant and unjust. The object of the condition in question being printed on the ticket was that when a passenger took the ticket he was presumed to assent to the condition. The condition could not, he urged, be upheld. It was not a bye-law, but merely a resolution of the Tramways committee, confirmed by the City Council. It had never been submitted to the Board of Trade.

Ald. CLEGG, chairman of the Tramways committee, called by defendant, said the condition was passed to protect the Corporation against imposition and exaggerated and unfounded claims. The committee would not make any cavil respecting the payment of compensation where claims were just and fair.

The STIPENDIARY said he would express no opinion as to the validity of the condition. He thought the requirements of the bye-law for showing the ticket had been complied with, the defendant having pointed to the ticket on the floor of the car, but as regarded delivering and producing the ticket he must convict. In view of Mr. Wilson's honesty of purpose he should not impose a penalty.

Mr. WILSON, however, asked that a nominal penalty should be inflicted in order that he might appeal.

A fine of 1s. was imposed for failing to produce and deliver a ticket, and a further penalty of 1s. for failing to re-pay the 1d. fare.

Notice of appeal was given.

Electric Tramways Construction Co. v. Pain.

On Monday an application to postpone the hearing of this case till after the Long Vacation, on the ground of the criminal proceedings now pending, was granted.

Brazilian Imports.—Somewhat belated particulars are just issued of the imports into Brazil during 1902, which show that electrical appliances to the value of £110,756 were imported in that year, the source of these supplies being America, Germany, the United Kingdom and France, but in what proportion particulars are not available.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Ready Reference Tables." Vol. I., 1st edition. By Carl Hering. (London: Chapman & Hall). 10s. 6d.

"Proceedings of the Royal Society." No. 497. Vol. LXXIV. (London: Harrison & Sons.) 2s.

"Report of the Tariff Commission." Vol. I., Iron and Steel Trades. (London: King & Son.) 2s. 6d.

"Matriculation Directory." No. XXXVII. 1904. (Cambridge: The University.) 1s.

"Magnetism and its Elementary Measurement." By W. Hibbert. (London: Longmans, Green & Co.) 1904. 2s.

"Enroulements d'induits à courant continu." By E. J. Brunswick and M. Aliamet. (Paris: Gauthier-Villars.) fr.2.50.

"Il Selenio." By Lavoro Amaduzzi. (Bologna: Nicola Zanichelli.) 3 lire.

"Die Elektrochemische Reduktion der Nitroderivate organischer Verbindungen in experimenteller und theoretischer Beziehung." By J. Möller. (Halle-a-S.: Wilhelm Knapp.) 4m.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Applications are invited for the position of assistant town treasurer in Durban, Natal. An experienced accountant is essential, and he must be thoroughly well acquainted with municipal book and account keeping. Salary £600 per annum. Applications to the agents of the Corporation (Messrs. Webster, Steel & Co.), 3, East India-avenue, Leadenhall-street, London, E.C., by Wednesday, Aug. 3. See also advertisement.

Oban Town Council require an assistant electrical engineer with experience in a three-wire continuous-current station with batteries. Salary £70. Applications by noon of 29th inst. to the town clerk (Mr. Alex. S. Black). See advertisement.

An assistant electrician is required for experimental work in Messrs. Crompton & Co.'s instrument department at Arc Works, Chelmsford. See advertisement.

The Governing Body of the Northampton Institute, St. John Street-road, London, E.C., require a chief instructor in mathematics (day and evening, part time only). Salary £150 per session. Particulars from the principal (Dr. R. Mullineux Walmsley) and applications by Aug. 31. See also an advertisement.

Heston and Isleworth District Council require a resident engineer for their electricity works. Applications by Aug. 6 to the clerk to the Council (Mr. H. J. Baker), Town Hall, Hounslow. See also advertisement.

Acton District Council require a resident electrical engineer. Salary £200. Applications to clerk, 242, High-street, Acton, London, W., by July 25.

A manager is required for an English telephone company abroad at a commencing salary of £300. See advertisement.

Crompton & Co., Arc Works, Chelmsford, advertise in another column for an electrical engineer to take charge of indoor and outdoor testing staff.

An assistant manager, about 30 years of age, and conversant with shop management and electrical and mechanical manufacturing, is required by the British Electric Transformer Co., Hayes, Middlesex. See advertisement.

An assistant for evening classes is required for session 1904-5 in the mechanical engineering department of the Crawford Municipal Institute, Cork. £100 per annum. Further particulars from the head master and organising secretary, Mr. E. A. O'Keefe, B.E., M.I.E.E., to whom applications by Aug. 10. See advertisement.

The Library and Technical Instruction committee of Belfast invite applications for the following positions in the Municipal Technical Institute:—(*a*) Head of Mechanical Engineering department, salary £500 per annum; (*b*) Head of Textile department, £350 per annum; (*c*) assistant lecturer Physics and Electrical Engineering, £160 per annum; (*d*) assistant lecturer Practical Mathematics, £160 per annum. Applications to Mr. Fras. C. Forth, Director of Technical Instruction, the Institute, Belfast, by noon July 26.

The following appointments have been made at the Northampton Institute, Clerkenwell:—

Electrical Engineering and Applied Physics Department: Mr. L. Lamb to be junior demonstrator, Mr. C. Hobson, junior lecture assistant, and Mr. A. G. Ellis, junior technical assistant.

Mechanical Engineering Department: Mr. J. S. Warner to be instructor in automobile engineering, Mr. S. J. McConnell instructor in moulding, and Mr. G. Hulls to be engineering drawing office assistant.

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Mr. H. N. Thomas, manager of the Huddersfield Corporation Tramways, has been appointed manager of the Durban (Natal) City Tramways at a salary of £800 per annum. Mr. Thomas has been manager of the Huddersfield tramways for nearly four years, and previous to that time had experience in the Isle of Man as engineer.

EDUCATIONAL NOTICES.

Durham College of Science (Newcastle-on-Tyne).—Courses are provided at this college for students proceeding to the degrees in Science or Letters or the diploma in the Theory and Practice of Teaching, and special facilities are offered for the study of agriculture, chemistry, mining, engineering and naval architecture. Matriculation and exhibition examinations begin Sept. 26, and lectures Oct. 4. Prospectuses from the secretary. An advertisement gives some additional particulars.

Northampton Institute.—Full day courses in the theory and practice of mechanical, electrical and horological engineering will commence on Monday, Oct. 3. Entrance examination, Wednesday and Thursday, Sept. 28 and 29. The courses for mechanical and electrical engineering include periods spent in commercial workshops and extend over four years. Students also prepare for the degree of B.Sc. in engineering at the University of London. Particulars as to fees, &c., can be obtained at the Institute, St. John Street-road, London, or on application to the principal (Dr. R. Mullineux Walmsley). See advertisement.

University of Birmingham.—The session 1904-5 commences on Monday, Oct. 3. The full courses in the department of engineering extend over four years, and students who enter at matriculation and who pass successfully the examinations at the end of each year will be entitled to the degree of B.Sc. in the branch of engineering to which they devote themselves. There are lectures and demonstrations in all branches of electrical engineering, and the electrical laboratory work includes testing of continuous and alternate-current machinery, electrical instruments, meters, lamps and batteries, and insulation and magnetic testing. Further particulars are given in an advertisement, and detailed syllabuses, &c., can be obtained from the secretary.

Acton.—The foundation stone of the electricity works will be laid on Aug. 3.

Argentina.—The "Review of the River Plate" says:—

The Chamber of Deputies of the province of Buenos Ayres have approved the ad referendum contract between the Government and the River Plate Electricity Co. for the purchase by the company of the Government's share in the La Plata station and also for the public lighting of the city. The Government sells the machinery for $16,646 gold and the land and buildings for $170,000. The Government's debt to the company amounts to £127,000. The price for lighting is to be for 450 watt arc lamps, $9.25 gold and $9.25 paper per month, and for 10 c.p. incandescents $1 gold and $1 paper. The rate for private consumers is to be 25 cents gold per unit, with a reduction of 50 per cent. when the average daily consumption is over 1½kw. hours. If the company does not obtain the public lighting contract it will pay the municipality 5 per cent. of its gross revenue.

"Australian Electrical Progress."—In the form of a supplement to the "Australian Mining Standard" of May 19, there is an interesting review of electrical progress in New South Wales. In this review a large number of recent installations of plant for electric lighting, power and traction are critically described, and the numerous illustrations which accompany the text include many of the chief items of plant, the power stations, views of tramway routes, tramcars, &c.

Beckenham.—The Electric Lighting and Tramway committee recommend that further expenditure on "free" wiring up to £5,000 be authorised, and a letter from the lessees of the Council's electricity powers (the British Insulated & Helsby Cables, Ltd.) offer to pay 4 per cent. upon any further expenditure on "free" wiring. The recommendation has been approved by the Council.

Bermondsey (London).—Owing to the demand for electric energy, the Council decided on Tuesday to lay another feeder cable, at an estimated cost of £3,081. 18s 2d. The Housing committee reported having invited five firms to tender for installing the electric light in the staircases and courtyards of Hulford-street dwellings.

Boston.—A report on electricity supply has been prepared by the borough engineer (Mr. G. E. Clark), in which the Council are recommended to put down municipal works at an estimated cost of £17,263.

Bournemouth.—A meeting of ratepayers recommended the adoption of electric lighting on Sundays as well as week-days. The Lighting committee, however, in view of a recent decision by the Council not to use the electric light on Sundays, have declined to consider the matter.

British Honduras.—In 1903 the Legislative Council voted funds for the construction of a trunk telephone line from Belize to Punta Gorda and for a telephone service in Belize, the capital of the colony. When these lines are completed the principal centres of British Honduras will be in telephonic communication. The population of British Honduras is about 40,000.

Burton-upon-Trent.—The exhibition organised by the Corporation electricity department last week was opened by the mayor (Councillor A. J. Roberts).

In declaring the exhibition open, the MAYOR passed in review the history of the electricity undertaking at Burton-upon-Trent, and announced that the number of 8 c.p. lamps connected at June 25 last was 26,914, an increase on the year of nearly 4,100 lamps, not including about 2,800 lamps for which applications were in hand. The increase in the supply of current to electric motors was on an even larger scale, and represented 255 per cent. over the previous year. He thought the exhibition reflected great credit on the borough electrical engineer and tramways manager, Mr. P. J. Pringle, and his assistants.

Ald. T. E. LOWE, chairman of the Electricity committee, said that in the direction of the application of electricity to power there was an almost unlimited field at Burton-upon-Trent, and they looked to this branch for a large development of the undertaking. He referred especially to the application of electric driving in breweries, where he considered that electric power would be found most adaptable and useful.

There were a large number of electrical exhibitors, and the exhibition proved a great success.

Cambridge.—The negotiations which have been proceeding between the Council and Mr. A. A. C. Swinton (on behalf of the Cambridge Electric Tramways Synd.) as to the construction of electric tramways in this district have advanced a stage and the Council have now decided to engage Messrs. Kincaid, Waller, Manville & Dawson to advise them.

Christchurch (N.Z.).—Mr. L. Birks and Mr. A. D. Dobson, electrical engineer and surveyor, respectively, to the City Council, have prepared statistics showing the progress made by the electricity department.

During the eight months ended March the revenue was £944. 17s. 2d. and the working expenses £474. 17s. 9d. After payment of interest there was a balance of £153. 8s. 3d. to apply to redemption of capital. The destructor plant consumes an average of 157 tons of refuse per week, and the refuse includes large quantities of condemned fish, rabbits and oranges. In this way the destructor has proved a great boon to the community, and 1,500yds. of good clinker have been produced for street paving. The success of the combined undertaking has, it is stated, fully realised the Council's sanguine expectations.

Claremont (Western Australia).—The Council of this residential suburb of Perth have adopted a municipal electric lighting scheme. A loan of £7,000 has been raised and an order placed with J. Barre Johnston & Co., Murray-street, Perth, for two 76 H.P. Babcock & Wilcox boilers with superheaters, two 50kw. E.C.C.-Willans steam dynamos, balancers, switchboard, pipe work, chimney, &c., to be erected within six months. The work will be carried out under the supervision of Mr. H. Rowley, M.I.E.E., the Council's consulting engineer.

Croydon.—Mr. Cramb has reported on a suggested system of charging for electric current for power, &c., during the period of light load and recommends that the charge be 1½d. per unit except between dusk and 11 p.m. when the charge would be 5d. per unit. In the case of consumers who do not require supply between dusk and 11 p.m. he suggested that the following rentals be charged for the time switches:—For motors up to 5 B.H.P. £2 per annum, up to 10 B.H.P. £2. 10s., up to 20 B.H.P. £3, and above 20 B.H.P. £4 per annum. These charges would not apply to Wednesdays or Sundays. The report has been approved by the Corporation.

Dundee.—The Tramways committee recommend the Council to oppose the scheme of Mr. G. Balfour for forming a company to supply electricity in bulk for power, &c., to factories and mills in Dundee.

East Ham.—On Wednesday the Council decided to apply for sanction to a further loan of £10,000 for electric lighting extensions.

Electric Lighting Provisional Orders.—The report of the Board of Trade respecting the applications to and proceedings of the Board (under the Electric Lighting Acts, 1882-1902) during the past year shows that 74 applications were made, of which 34 were by local authorities and 40 by companies or persons. The complete list appeared in our issue of Jan. 8 last (p. 457).

In regard to the *Acton* application, as the promoters (the Metropolitan Electric Supply Co.) entered into an agreement to supply electrical energy in bulk to the local authority for the purposes of the order granted to that authority in 1891, this application was not proceeded with. In the case of the application of Croydon Rural District Council for *Beddington, Coulsdon and Sanderstead*, owing to representations made by ratepayers who objected to the order being granted, the Board refused the application. In regard to the *Bothwell* order (applied for by the Clyde Valley Electrical Power Co.), the Board held a conference as to this application and that for *Uddingston* (by the Uddingston District Electric Lighting Co.), and the consent of the local authority was dispensed with and the application granted, while that for Uddingston was refused. A local inquiry was held into the *Caerphilly* Council's application for an order, and after consideration of the circumstances the Board decided to grant the order. In the case of the *Cannock and District* electric lighting order (for urban district and for two parishes in the rural distict of Cannock) the local authorities consented to the application but the Urban

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Council only consented on certain conditions as to purchase and profit sharing, and as the promoters were unable to satisfy the Board that the conditions had been modified they refused to proceed with the application. The promoters of the *Eastwood and Cathcart* Order were granted an order for a portion of the parishes of Eastwood and Cathcart, but the application in regard to the burgh of Pollokshaws was not proceeded with. The *Ely* Order was granted for a portion of the Urban District of Ely, and the *Epsom* Rural District Order in respect of the parish of Cheam. In regard to the application for *Houghton-le-Spring and District*, the Houghton-le-Spring and Easington authorities consented, but the Hetton-le-Hole authority refused consent. The promoters decided not to proceed with the application as regards Seaham Harbour, and, after consideration of the representations made, the Board decided to dispense with the consent of the Hetton-le-Hole authority, and granted the order for the three districts named. The application for the *Keynsham* (Somerset) Order was granted in respect of the parishes of Keynsham and Saltford. In the case of the *Kilpatrick* Order, the two local authorities interested withheld their consent, but the Board of Trade decided to dispense with he consent and granted the order. The *Kingswood* Order was similarly treated. In the case of the *Lichfield* Order (1901) Amendment and Extension Order, it appeared to the Board that the promoters (the Corporation) had not a sufficient margin of available borrowing powers to enable them to undertake a scheme for the extended area and the application was refused. The Twickenham and Teddington Electric Supply Co., who applied for an order for the *Maldens and Coombe and Ham*, abandoned the application for the first two districts, and an order was granted for Ham. The Urban District Council of *Melksham* were unsuccessful in their application for an order, having failed to satisfy the Board that they were in a position financially to give effect to the order if granted. In the case of the *Mid Shropshire* Electric Lighting Order, the promoters (the Shropshire and Worcestershire Electric Power Co.) failed to produce the consent of the local authorities or to show that it ought to be dispensed with, and the Board refused the order. The Urban Electric Supply Co. were granted an order for a portion of the urban district of *Newton Abbot*, but were refused in respect of the remainder of the area. Northampton Electric Light and Power Co. were successful in their application for *Northampton and District*, the Board dispensing with the consent of the Northampton Rural Council. The North Worcestershire application was granted in respect of the urban district of *Bromsgrove*, the promoters (the Shropshire and Worcestershire Electric Power Co.) not proceeding with the application for *Stourbridge*, and the rural district of Bromsgrove was excluded from the order by the Board. The Clyde Valley Electrical Power Co. obtained an order for a portion of the parish of *Renfrew*, the company not proceeding for the burgh of Renfrew and the parish of Govan. This company also obtained an order for *Shettleston*, notwithstanding that the local authority refused consent. Tamworth Corporation order was granted in respect of a part of *Tamworth*, the rural district being excluded, as the notice required by sec. 4 (1) of the Electric Lighting Act, 1882, was not given. In regard to the *Thornbury* Rural District Council Electric Powers Order, as the application (made by the District Council) related to a large and thinly-populated area, consisting of 23 parishes, in only one of which it was prepared to provide a compulsory area, and as there appeared to be no probability of a supply of electric energy being provided in many of the parishes, the Board considered it inequitable that property in those portions should be liable to contribute towards the cost of the undertaking and refused the order. The Clyde Valley Electrical Power Co.'s application for the *Vale of Leven* was refused owing to the consent of the local authority not being produced. *Watford* Urban District Council were successful in regard to an extension of the area of the urban district, but as the Rural District Council had refused consent the Board excised from the order the portion of the rural district which it was proposed to include. In all other cases the applications were granted.

Since the date of the last report the Failsworth Electric Lighting Order, 1899, has been transferred to Manchester Corporation, and no application for an electric lighting licence has been entertained by the Board. Prior to the present year 1,097 applications for orders have been dealt with, 860 orders have been made and 852 of these have been confirmed by Parliament; 139 have since been revoked or repealed. Of the 33 licences issued by the Board in the early days of electric lighting not one now remains in force.

Electricity in Mines.—The "Diario Oficial" of Mexico, in the issue of June 23, announces that a new contract has been executed between the Government and the Peñoles Mining Co. revising the company's former contract and extending these privileges to Dec. 17, 1906, on condition that, within 1½ years, a new foundry is erected for the treatment of the sulphurous minerals produced at the mines, together with all necessary crushing machinery, the whole installation to be worked by electric power. The contract requires the approval of Congress.

Frome.—Sanction to a further loan of £5,000 for electric lighting has been applied for.

Goole.—An inquiry was held on Wednesday into the application of the Council to borrow £1,000 for a site for electricity works.

Hammersmith (London).—The report of the borough electrical engineer (Mr. G. G. Bell) on the past year's working of the electricity undertaking states that no new loans have been taken up during the year, but that the cash balance of £5,981 has been converted into an overdrawn balance of £4,623. 18s. 7d., and application had been made for a loan to cover the excess.

The accounts are made up to March 31, and there is, consequently, 53 weeks' expenditure shown by the accounts against 52 weeks' revenue. 487,084 more units have been sold than in the previous year with a smaller consumption of fuel, and the increase in revenue is £5,546. The income for the year was £32,725. 5s. 5d. (against £27,185), and the working expenses £19,276. 2s. 2d. (including generation and distribution costs, £17,204, compared with £16,254), so that the gross profit was £13,449. 3s. 3d. After payment of interest and sinking fund charges, the net profit was £1,855. 4s. 7d. (against £1,063. 5s. 11d.). This result has been achieved in spite of certain permanent works, costing £2,071. 18s., having been charged to revenue. A reserve of £2,500 has been formed, and the accumulated balance now stands at £3,169. 7s. 3d.

Hamilton.—Sanction to a further loan of £40,000 for electric lighting has been obtained by the Council.

Hampstead (London).—The Borough Council have decided to fix six thermal storage drums, each of 9ft. diameter by 28ft. long, for the six Davey-Paxman boilers at an estimated cost of £5,060.

Hereford.—Sanction to borrow £1,100 for the completion of the electric lighting at Burghill Asylum has been received by the Council.

Honolulu.—The Rapid Transit & Land Co. are operating over 16 miles of electric tramway, and considerable extensions are being made.

Hornsey (Middlesex).—It has been decided to increase the salary of the borough electrical engineer (Mr. Norman Staniland) from £300 to £340 a year as from July 1, with two further annual increments of £30 in July, 1905, and July, 1906.

Huddersfield.—The annual report of the Corporation tramways department contains an extract from a report of a committee of investigation appointed to inquire into the tramway finances.

This report calls attention to the absolute necessity of putting to a depreciation fund at least 3 per cent. on capital outlay, regardless of receipts, "as it is certain that portions of the track and plant will require renewal long before they are paid for." It is urged that future Tramway committees should materially increase this rate of provision for depreciation before voting any sum from future profits in relief of rates. The general manager reports that there has been no breakdown during the year. There are 70 cars in use. During the year 12 bogie cars have been converted to truck cars which has effected a saving of over 30 per cent. in current, all the rolling stock has been fitted with the Hudson-Bowring lifeguard, and the Westinghouse-Newell magnetic track brake has been adopted in place of the hand-slipper brake. Parcel depots have been established throughout the borough. The staff of the department numbers 262. Capital expenditure during the year was £10,872, the total capital outlay standing at £411,722, out of which £40,537. 18s. 4d. has been paid off. The year's receipts were £65,674. 10s. 7d. (9·66d. per car mile, against 10·28d. in the previous year), and the working expenses were £34,456. 11s. Working expenses were 5·06d. per mile run (against 5·75d.). Interest on loans absorbed £13,631. 15s. 9d. and redemption £10,638. 5s. 3d., and, after placing £11,687. 5s. 1d. to depreciation, there was a deficiency of £4,739. 6s. 6d. 2,565,643 units were generated, 1,632,000 car miles run and 11,899,287 passengers carried. 1·57 units of energy were consumed per car-mile. There are 28 miles of routes (seven of double track and 21 of single).

Hull.—An inquiry was held on Tuesday into the application of the Corporation for permission to borrow £15,800 for electric lighting and other purposes.

Industrial Applications of Electricity.—Mr. P. J. Pringle, borough electrical engineer and tramways manager at Burton-upon-Trent, has prepared an interesting pamphlet dealing with the various commercial applications of electricity, with special reference to its uses for power. The subjects dealt with include electric lighting, electrical cooking and heating, electric welding and electric energy for motor driving. The information is specially prepared for users of motors for small power, and will be found very serviceable for this purpose. There is a list of estimated horse-powers taken by various classes of machinery, a tabular statement showing the progress made in the principal towns of the country in the application of electricity to power work, and a list of local users of electric power in Burton-upon-Trent.

King's Lynn.—The accounts of the electricity department for the year ended March show total capital expenditure £45,833. 14s. 5d., an increase of £752. 4s. 5d. for the year.

The receipts from sale of current to private consumers for lighting (at 4·93d. and 2·65d. per unit) were £2,782. 13s. 9d. and for power (at 3d. and 1½d. per unit) £512. 2s. 4d. and for public lighting (at 3·32d.) £1,764. 6s. 6d. The profit on fittings was £243. 12s. 3d., the total receipts being £6,497. 1s. 10d. Working expenses were £3,141. 12s. 3d. Out of the gross profit of £3,355. 9s. 7d. interest absorbed £1,285. 16s. 7d. and sinking fund charges £1,580, leaving a net profit of £486. 7s. 4d. (compared with a deficit of £47. 1s. 2d. on the previous year). 435,064 units were generated (against 360,225), 134,276 supplied to private consumers by meter and 2,200 by contract for lighting, 69,669 for motive power and 182,327 for public lighting, a total of 388,472 sold (against 323,175). The total costs per unit sold were 3·21d. (against 3·78d.). The average prices obtained for current were for private lighting by meter 4·93d. (against 4·89d.) and by contract 2·65d. (against 2·62d.), for motive power 1·76d. (against 2·45d.) and to public lamps 2·32d. (against 2·35d.). There are 459 private consumers (compared with 401) with the equivalent of 18,816 8 c.p. lamps (against 15,212 lamps), and 37 motors (= 174½ H.P.) connected, against 25 (109 H.P.). The total maximum supply demanded was 290kw. (against 250kw.).

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Labour Lost.—According to the "Daily Despatch" of Manchester some thieves recently had a trying experience at Trafford Park. A quantity of electric cable manufactured by Messrs. W. T. Glover & Co. was stolen and put on a large fire to burn so that the insulating material over the copper might be burned away, and the metal itself made more readily available. It so happened, however, that the cable was Messrs. Glover & Co.'s fireproof type, and the labour entailed in this attempt at destruction was consequently thrown away. All that happened was that the stolen cable was discovered in a sooty condition but otherwise uninjured.

Leicester.—Certain electric tramway routes were opened for traffic last week.

Leyton (Essex).—For the year ended March the total receipts of the electricity department were £17,594. 17s. 6d., and the works costs £8,086. 15s. 8d., leaving a gross profit of £9,508. 1s. 10d. In addition £760 had been received on account of the gas plant which had been sold, bringing the profit up to £10,268. 1s. 10d.

Interest absorbed £3,838. 0s. 9d., instalment of principal repaid £5,042. 8s. 8d., leaving net profit £1,387. 12s. 5d., which was employed in reduction of amount advanced to undertaking by the Council in past times, leaving £8,431. 14s. 6d. now at debit of the undertaking. Cost of generation was 1·017d. per unit, rents, rates, taxes and establishment charges bringing this up to just under 1½d. The average price obtained for electricity was just under 2½d. for public arc lamps, 1¾d. for incandescent lamps, and 3¾d. for current taken by private consumers.

Littleborough.—An extension of time for the construction of the authorised electric tramways has been applied for by the Council.

London County Council.—At Tuesday's meeting loans of £15,636 were granted to Islington and £25,000 to Poplar for electricity supply purposes.

Tramways.—It was agreed to accept the offer of the British Insulated & Helsby Cables (Ltd.), to supply, deliver and lay additional electric cables required for the working of the Tooting tramways from the Loughborough Junction temporary generating station at 7½ per cent. above the price specified in the contract entered into with the company in May, 1902.

The Highways committee recommended the expenditure on capital account of £18,500 for the erection of a sub-station in connection with the Greenwich generating station, and £15,000 for the provision of plant, machinery, equipment, &c., of the sub-station. Consideration of the recommendation was postponed.

Maidstone.—The official inauguration of the electric tramway service took place on 14th inst.

Marylebone (London).—At the meeting of the Borough Council last evening the report of the Finance committee contained particulars of the costs incurred by Marylebone Council in connection with the recent arbitration proceedings.

These costs are itemised and show that solicitors' costs, on being taxed (including arbitrator's and umpires' fees), totalled £33,292. 19s. 10d. Out of this sum counsels' fees amounted to £12,656. 12s., as follows: Sir Edward Clarke, K.C., £2,258 10s. 6d.; Mr. Fletcher Moulton, K.C., £7,030. 10s.; Lord Robert Cecil, K.C., £1,244. 11s. 6d.; Mr. A. B. Cane, £2,123. Witnesses' fees stand for £9,248. 19s. 10d., of which electrical witnesses received £3,921. 13s. 4d., as follows: Mr. W. M. Mordey, £496. 13s. 4d.: Mr. A. Wright, £1,110; Mr. H. F. Parshall, £1,357. 10s.; Mr. E. Manville, £957. 10s. Surveyors received £3,012. 12s. 6d., gas engineers, £853. 9s. 6d., accountants, £1,357. 5s. 6d., actuary, £72. 9s., stockbrokers, £26. 5s., Parliamentary agents, £5s. 5s. The costs of the taxation were £1,030. 3s.

Accompanying the report of the Finance committee was an estimate of the expenditure on account of electricity supply. Tenders had been received by the Council for the various works in connection with the establishment of the new generating station, and the tenders recommended for acceptance by the Electricity Supply committee totalled £270,489. 12s. 9d., made up as follows:—F. G. Minter, for buildings (including constructional steel work by Dorman, Long & Co.), £57,524; C. A. Parsons & Co., electrical machinery and equipment (including crane by C. & A. Musker and cooling towers by the Klein Engineering Co.), £79,598; St. Helens Cable Co., for cables, £78,165. 12s. 9d., and Babcock & Wilcox, steam generating plant, £55,202. For the buildings and constructional ironwork 13 tenders were received, of which Mr. Minter's was the lowest. For electrical machinery five tenders were received from the following firms:—British Westinghouse Co., British Thomson-Houston Co., Willans & Robinson, Richardsons, Westgarth & Co., and C. A. Parsons & Co. For the supply of cables following is the complete list of tenders:—

W. T. Henley's Telegraph Works Co.	£96,860	0	0
W. T. Glover & Co.	95,640	0	0
Siemens Brothers & Co.	94,220	0	0
Callender's Cable Co.	89,500	0	0
British Insulated & Helsby Cables	88,906	10	0
W. F. Dennis & Co.	79,510	0	0
Western Electric Co.	78,477	6	8
St. Helens Cable Co.	78,165	12	9

For generating plant tenders were received from B. R. Rowland & Co. and Babcock & Wilcox, and Mr. A. Wright, consulting engineer to the Council, reported that the proposals of Rowland & Co. were, in his opinion, unsuitable.

The acceptance of the tender of Mr. Minter was agreed to without discussion. On the proposal of Mr. E. R. DEBENHAM, chairman of the Electric Supply committee, that the tender of Messrs. C. A. Parsons & Co. for the electrical machinery and apparatus be accepted some opposition was displayed, on the ground that the competing figures were not presented to the Council. Mr. Debenham pointed out, however, that the various tenders had been carefully analysed by Mr. Wright and the Electric Supply committee with the result that it was found that Messrs. Parsons' tender was the lowest sent in for a given output of current; consequently, the figures of the other tendering firms were not comparable. Messrs. Parsons' tender was then accepted unanimously.

Mr. DEBENHAM then proposed the acceptance of the tender of the St. Helens Cable Co. for cables, and announced that the committee had received a telegram from one of the competing firms stating that they had misread the specification, and asking leave to reduce their offer by £8,000, bringing their tender some £6,000 below that now recommended for acceptance. The committee had considered the matter, and had come to the conclusion that it was unfair at this stage to take the fresh proposal into consideration, and they therefore recommended that the original tenders be considered the basis upon which the contract should be completed.

Ald. DENNIS moved that the tenders for cables be referred back to enable the tendering firms to reconsider their offers and send in revised tenders.

This proposal was supported by Sir Thomas Brooke-Hitching, Councillor E. White and Councillor J. Lewis, but was opposed by Councillor Cornwallis West, Councillor Straus and Dr. Fletcher Little. On being put to the meeting the amendment was rejected, and the recommendation that the tender of the St. Helens Cable Co. be accepted was carried unanimously.

With regard to the tender for steam generating plant, Mr. DEBENHAM explained that the offer of Messrs. Babcock & Wilcox was not the lowest, but was the only one sent in conforming exactly to the conditions and requirements of the specification of their consulting engineer. The committee's recommendation with regard to this tender was adopted without discussion.

Melbourne (Australia).—The accounts of the Electric Supply committee for the year ended February last show gross revenue £64,846. 14s. 6d., working expenses £35,267. 4s. 1d. leaving £29,579. 10s. 5d. to meet interest (£12,750. 3s. 4d.), sinking fund (£3,500) and depreciation and renewals (£7,000), so that there was a net profit of £6,329. 7s. 1d., against £1,140. 13s. 1d. for the previous year. The total capital expended is £345,758. 18s. 3d., compared with £324,149. 7s. 9d. in 1903.

Mexico.—Commercial men in this country are waking up to the vast resources of Mexico in the matter of water power. This water power is, moreover, available in districts adjacent to the largest centres of population. Hitherto little has been done to concentrate this power by engineering methods, but the subject is now receiving attention. Already about 250,000 H.P. is being utilised or is in course of development for industrial purposes.

Amongst the companies which have harnessed water power effectively is the Mexican Light & Power Co., a Canadian concern, which is working a powerful plant at Necaxa, in the State of Puebla. At Teziutlan, in the same State, the Teziutlan Copper Co. has a large water power plant for the generation of electricity.

The Mexican Light & Power Co. will supply electric power to Mexico City at the price of £12 ($120 to $125 Mexican currency) per horse-power per year, and is establishing works to develop about 100,000 H.P., 80,000 of which will be reserved for supply to Mexico City. The San Ildefonso Co., of Mexico City, utilises water power for the generation of electric current in the rainy season and steam power in the dry season. In Mexico City, also, the Mexican Railway Co. are about to utilise the waters of the River Atoyac for the generation of electric power for use over the lines between Orizaba and Esperanza to supplant steam power, which is very expensive owing to the steep grades of this part of the company's service. In the Orizaba district there are numerous cotton mills, mining properties, &c., worked by electricity.

A comparatively small electric power plant is also owned by the Guanajuato Electric Light & Power Co., situated on the River Duero, State of Michoacan. This company's plant has a capacity of about 8,000 H.P., and supply is being given of about half this amount by overhead cable to Guanajuato for lighting and power. Several of the mines in the district are being worked electrically by current supplied by this company.

The Mexican Government is adopting a liberal policy towards concessionaires for electric power generation and supply, due mainly to the fact that fuel is a most expensive commodity in Mexico, its practically prohibitive price tending to prevent the industrial development of the country.

Municipal Wiring of Consumers' Premises.—Westminster City Council were recommended last week by a committee to oppose the proposed bill of the London County Council seeking power to authorise borough councils to wire consumers' premises on the "free" or easy payment system. After discussion the matter was referred back for further inquiry.

Nelson.—The capital expenditure of the electricity department at March last amounted to £66,471. 2s., an increase of £6,717. 14s. 9d. for the year.

The total receipts were £6,626. 13s. 5d., working expenses were £2,725. 13s. 9d. After payment of interest (£1,922. 19s. 6d.) and sinking fund instalment (£1,577. 2s. 7d.), there was a net profit of £400. 17s. 7d. to transfer to depreciation (compared with a loss of £516. 3s. 4d. on the previous year); 614,364 units were generated (against 348,525) and 555,876 sold (against 320,463). There is the equivalent of 17,556 8 c.p. lamps in use by private consumers (against 15,500), and 168 H.P. of motors

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(against 80 H.P.). The maximum supply demanded was 593·6kw. (against 360kw.).

New Mutual Telephone Syndicate.—A deputation from this syndicate waited upon the Lord Mayor of Manchester last week.

Mr. W. Thomson, chairman of the syndicate, described the proceedings subsequent to the first effort to produce a municipal competitive telephone system in Manchester 8½ years ago, when the Corporation was asked to join Glasgow Corporation in applying to the Postmaster-General for power to provide municipal telephone exchanges. The position now (said Mr. Thomson) was somewhat altered by the recent declaration of the present Postmaster-General that he proposed to negotiate for the purchase of the undertakings of the National Telephone Co. this year. This declaration, it was understood, stopped for the moment the Manchester Telephone committee from going on with their municipal telephone scheme, and it was felt by the members of the syndicate that the Corporation should, without further delay, arrange to meet the liabilities which had been incurred by the syndicate. Otherwise a serious injustice would be done to the members of the syndicate, whose work in Manchester had (Mr. Thomson said) proved of great value to the mercantile community in compelling the National Company greatly to improve its system, and it was largely due to the syndicate that the right to provide municipal telephony became possible.

The Lord Mayor is said to have "promised to convey the views of the deputation to the proper quarter."

North-Eastern Railway Co.—It is reported that this company proposes to let a contract for the electrification of the Newcastle and South Shields branch.

North London Tramways.—As stated in our last issue, Major Pringle, R.E., and Mr. A. P. Trotter, on behalf of the Board of Trade, have made an official inspection of the tramways from Finsbury Park to Wood Green and from the Manor House to Seven Sisters Corner, Tottenham, re-constructed for electric traction on the overhead system by the Metropolitan Electric Tramways (Ltd.) These important sections will be opened for traffic immediately on receipt of the Board certificate. The lines form the first part of a system comprising a total length of about 50 miles of electric tramways and light railways in North London. We are informed that the first effect of the change from horse to electric traction will be a reduction of fare from 1½d. to 1d. all the way from Finsbury Park to Wood Green terminus.

It was reported to Islington Borough Council on Friday that a conference had been held on the previous day of the delegates of local authorities north of the Thames on the subject of the system of electric traction to be adopted on the tramways in the north of London.

The delegates had, it appears, understood that the question of system had been disposed of and that they were called together to consider details. The representatives were surprised to learn that a compromise had been made by London County Council with the North Metropolitan Tramways Co., by which only about one-third of the northern lines would be electrified on the conduit and the remaining two-thirds on the overhead system. As far as Islington was concerned, only the lines through Upper-street, from the Angel to Highbury, and from Islington Green along Essex-road to Ball's Pond-road, would have the conduit system. The lines in Holloway-road, Caledonian-road, Seven Sisters'-road, and the new line from St. Paul's-road to Balls Pond-road would all be on the trolley system. Strong objection was taken to the proposal by all the representatives of the boroughs present. They were told by the chairman of the County Council that the North Metropolitan Co. strongly objected to the introduction of the conduit system on lines leased by them, and a compromise had been effected in the manner indicated. The objection of the company was mainly one of capital cost. The conduit system would cost about £17,000 per mile, against £8,000 per mile for the overhead system, or a total difference of about half a million sterling on the initial outlay, and that additional half million would, it was stated, seriously affect the financial situation. The conference suggested that, owing to the change of front, it would be better if the conference were adjourned, that they should report the situation to the several borough councils, and that the London County Council should report in detail as to the expenditure on the conduit and trolley systems and the reasons which had induced them to vary what had been understood by every borough as a decision that only the conduit system should be adopted. It was also stated at the conference that, failing the compromise, the electrification of the tramways in Islington must be delayed until the lease of the lines to the company expired in 1910.

In the course of the discussion, the town clerk quoted sec. 23 of the County Council's Electrical Powers Act, 1900, to show that the London County Council could not instal an overhead system in any borough without that borough's consent.

The matter was ultimately referred to the Works committee.

Paisley.—The accounts of the electricity department for the past year have been published, and the adverse balance has fallen from £3,068 to £1,085.

Pontypridd.—Sir Colin Scott Moncrieff has been appointed arbitrator to determine the price to be paid for the local tramways by the Council. The British Electric Traction Co. offer to sell at £6,000 and the Council offer £5,500.

Port Dinorwic (Wales).—The Board of Trade have approved of the provisional use of overhead wires in the proposed electricity supply scheme, but reserve the right to review the situation at the end of five years.

Portsmouth.—An unopposed inquiry was held on Monday into the application of the Council to borrow £5,000 for electric lighting extensions.

Post Office London Telephone Service.—Chiswick District Council have addressed a letter to Lord Stanley, the Postmaster-General, on the subject of the London telephone service, "respectfully pointing out some of the considerable disabilities to the user of the telephone and its extension in a district such as Chiswick." After urging that the "free user" tariff of £17 per annum on a three years' agreement is practically prohibitive, the letter contains the following comments and suggestions:—

The tariff of £4 per annum rental and a charge of 1d. in the local area and 2d. to other London areas is probably as reasonable in price as can for the present be expected. But before a subscriber can become a user his payment amounts to £6. 10s., composed of rental £4, guaranteed calls £1. 10s., deposit for trunk calls £1, total £6. 10s., an amount which, payable in one sum, undoubtedly, in the opinion of this Council, acts as a severe check upon the adoption of a telephone service in a large number of cases.

It is respectfully suggested that considerable advantage would accrue, both to the user and to the system, if it were possible to make the charge payable quarterly in advance, and if quarterly credit were given for the call charges, with power to the department to claim payment before the expiration of the quarter where considered necessary or advisable. The effect would be that a telephone line could be installed for a first payment of £1.

It is also suggested that the system of charging 1d. in the local exchange area and 2d. to other areas is in many cases unsatisfactory. It leads to the result that while one call to the outskirts of Chiswick may be made for 1d, another to a position 100yds. off (say, in Hammersmith or other adjoining exchange areas) costs double the amount.

It is urged that this disadvantage might be overcome by making a uniform charge of 2d. each for the first 90 calls per quarter in the London area, and 1d. for each succeeding call during the remainder of the quarter.

Up to the time of our going to press no answer from the P.M.G. had reached the Council.

Preston.—The original tramway scheme has now been completed by the opening on Saturday of the route to Ashton-on-Ribble.

Prestwich.—Salford Corporation have fixed the price of current supplied in Prestwich for power at 2d. per unit for the first 1,000 units and 1½d after.

Provisional Order Applications.—Foote & Milne and the Lancashire Electric Power Co. notify that they will apply for provisional electric lighting orders for Norden and Whitworth (Lancs.).

The Mutual Electricity Supply Co. will apply for a provisional order for Rye (Sussex).

Ramsbottom.—The Council have applied for extensions of time to carry out their electric lighting and tramways orders.

Redditch.—Sanction to an additional loan of £7,500 for electric lighting plant has been applied for.

Rochdale.—Recently an accident occurred which necessitated the supply of electricity for lighting being cut off for a time throughout the town.

A number of men were engaged in laying lines for the electric tramways, and a workman drove an iron fencing stake between the flags on the causeway in ignorance of the fact that an electric cable was laid below at a depth of from 18in. to 30in. The stake went through the cable and caused it to fuse. Flames immediately arose, and the workmen, under the impression that there was a leakage of gas, threw buckets of water and a quantity of sand on to the mains. Mr. C. C. Atchison, the borough electrical engineer, soon had workmen on the spot, but owing to the remissness of the workman who originated the fault it was some time before it was located. In the meantime, one of Mr. Atchison's assistants (Mr. Wilkinson) opened a feeder box near a point where the fault was estimated to be located, and an explosion occurred owing to the ignition of some gas. Fortunately, Mr. Wilkinson was practically uninjured, though his hair was singed by the flames. The cables in the feeder box then caught fire, and it was found necessary to shut off the supply of current throughout the town for about 20 minutes until the fault was cleared. A short length of feeder cable was burnt out. Men were soon got to work excavating, and current was supplied early on Friday morning on one part of the circuit, and on the remaining portion later in the day. The damage caused is said to have been considerable.

St. Pancras (London).—The following reductions in the charges for electric current have been sanctioned:—

Lighting, from 6d. per unit for the first hour's maximum demand, and 3d. after to 6d. and 1½d., the present flat rate of 5d. to be reduced to 4d. For power, the present rate of 2d. is to be reduced to 1d. These charges to apply only to consumers who are supplied at 220 or 440 volts and to those who agree to change from the 110-volt system to the higher voltage when required by the Council. The charges are not to apply to energy supplied to Messrs. Price & Reeves, contractors for the Charing Cross, Euston & Hampstead Railway, until such time as they have taken the million units in accordance with the contract entered into by them. The charge for current to the public street lamps is reduced from 3d. to 1½d. per unit.

The Electricity committee have been authorised to enter into negotiations with firms who let out motors on the hire-purchase system to electricity consumers, and to report to the Council on the offers received.

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Salford.—The Council on Wednesday accepted a tender for 10 single-truck double-decked tramcars with outer deck covers for £580 each car, and 10 double-truck combination cars for £697 each, also for two rail-cleaning and watering cars at £1,032. 10s.

During the past year the number of passengers carried on the Corporation tramways was 28,150,675; the receipts were £144,486. 2s. 6d.; earnings per car-mile 10·25d.; miles run 3,380,590. The year's working to March 31 has resulted in a gross profit of £60,106. 14s. 11d. The total capital expenditure is £620,069.

Seoul (Corea).—During 1903 the electric light was installed in the Audience Hall and Library of the Imperial Palace, the plant being entirely British.

Shoreditch (London).—*Exhibition.*—It is proposed by the Lighting committee of this borough to hold an exhibition of electric lighting apparatus, accessories, machinery in motion, &c., at the Public Baths in Pitfield-street, Hoxton, from Oct. 10 to 22. The prospectus of the exhibition, which is now ready, contains some interesting particulars of the various local trades which will be invited to send machinery to be electrically operated in the exhibition buildings. The Shoreditch area is one of the principal industrial divisions of the metropolis, and the number of trades which have their location in the neighbourhood of the Pitfield-street baths is both numerous and important, and will doubtless make the show a particularly interesting one. No charge is to be made for electric current within reasonable requirements, and supply will be given on the direct-current three-wire system at 240 volts for lighting and 480 volts for motors. It is calculated that the exhibition will give a fillip to the scheme adopted by the Council for the hire-purchase of electric motors, apparatus, &c., and there are certainly many special features of the exhibition which should attract manufacturers of electric plant, apparatus, accessories and sundries. The exhibition will be easy of access, being within a few minutes' walk of all the chief traffic routes north of the Thames. Applications for space have to be made by Aug. 15 to Mr. C. Newton Russell, the borough electrical engineer, Coronet-street, Shoreditch, London, N.

Smethwick.—The British Electric Traction Co. hope to have the electric tramways in the borough open for traffic by September.

Southport.—The Corporation are applying for sanction to a further loan of £20,000 for electricity supply.

"Split Turns" on Leeds Tramways.—The Tramways committee on Monday confirmed the decision of the sub-committee to remain firm on the general principle of adhering to Mr. Hamilton's system of arranging the tramway men's duties while making concessions on certain routes.

Stoke Newington (London).—The discussion of the electric lighting scheme (particulars of which were given in our issue of the 24th ult.) has been further postponed, as negotiations are pending between the parties. The local Tradesmen's Association have asked the Council for a reduction in the charges for current, but it has been decided to reply that until the statutory reserve fund of £300 has been accumulated the Electric Light committee are unable to consider any reduction of the charges.

Stockton.—The Council have decided to withdraw their opposition to the Imperial Tramway Co.'s bill in Parliament. The company have offered to pay to the Corporation for 25 years £200 per annum in respect of every mile of tramway route in the town owned or worked by the company.

Swindon.—The electrical engineer and the town clerk have prepared a statement dealing with the proposal to borrow £6,000 for extensions of the electricity works.

The report states that the equivalent of 9,800 8 c.p. lamps are connected for lighting, and motors equal 1,650 8 c.p. lamps, and that applications are in hand for a further 1,200 8 c.p. lamps. All the generating sets will be in use next winter, hence the necessity for the extension of the plant, which will consist of one boiler with superheater, one generating set of larger capacity than the existing ones, switch gear, and additional buildings, the total estimated cost being about £6,000.

The deficiency on the working of the electricity undertaking for the year ended March was £722.

Sydney (N.S.W.)—On the subject of the electric lighting of Sydney, the "Newsletter" of May 21 has the following:—

The work of laying on the electrical supply for the lighting of Sydney has been carried along with surprising speed since the weather took up, and both public and private contractors have been somewhat surprised. The work has been closely watched owing to the methodical and thoroughly well-planned style in which it has been carried out. Last week in five days 9½ miles were laid, and the whole work of covering and restoring pathway completed. During the continuous wet weather, and owing to our narrow streets and pathways, a good deal of inconvenience was felt by business people owing to the extensive disturbance of the footways, but the situation was fairly recognised, and the City Council officers expressed themselves as thoroughly satisfied with the efforts of the company to vigorously execute their contract.

We may add that this big cable-laying contract is being carried out by W. T. Henley's Telegraph Works Co.

Telephone Facilities in the Australian Commonwealth.—The Postmaster-General of the Commonwealth at the end of last year issued regulations for the use of subscribers' telephones by the public on the ticket system, these regulations taking effect as from Jan. 14 last. The regulations affecting this service are as follows:—

Any subscriber to a telephone exchange who pays a subscription at the business rate may apply to the Deputy Postmaster-General for permission to place his telephone at the service of the public. The Deputy Postmaster-General may, if he thinks fit, grant the permission applied for, and thereupon the telephone shall be available for public use, subject to these regulations:—

The subscriber shall, if the permission is granted, exhibit a plain and legible notice in a prominent position on his premises indicating that the telephone is available for public use. A charge of 3d. for each conversation of three minutes or part of three minutes shall be made and shall be paid by ticket as herein provided. Tickets for the payment of conversation charges shall be issued by the Postmaster-General's department and sold at the price of 3d. each. Books containing 12 tickets each may be purchased on application at the General Post Office.

Any person who desires to use the telephone shall place a ticket in a locked box, to be provided and kept by the subscriber, but opened and cleared only by an officer of the Postmaster-General's department, and may then use the telephone. An additional ticket must be placed in the box for each three minutes or part of three minutes by which the conversations exceed the first three minutes.

The subscriber shall be entitled to receive 1d. from the Postmaster-General for each ticket removed from the box by the officer who opens it.

Nothing in these regulations shall affect the use of the telephone by the subscriber, his family, or employés in his business.

Telephones at Railway Stations.—The northern Chambers of Commerce have been agitating for telephonic facilities at the railway stations in the north, similar, presumably, to those with which we are familiar in the South. The North-Eastern Railway Co. have, however, notified the Newcastle Chamber that they have failed to come to an arrangement with the telephone authorities as to the placing of call boxes at their stations, the terms offered not being satisfactory.

Tiverton.—The Council have voted their surveyor (Mr. J. Siddalls) an honorarium of £100 for extra services rendered during the period when electricity supply was under consideration. Messrs. Frank Suter & Co. are to erect and maintain electricity works in the district for a period of 15 years.

Tramway Guides.—Glasgow Corporation tramways department has published a very useful guide and time-table of the city and district tramways, giving directions as to the best and most economical means of travelling to places of public interest and recreation in the city and suburbs.

Tramcar Roof Covers.—A car fitted with an experimental upper deck cover has been running on the London County Council's South London electric tramways for a week past. The construction is neat, is well lighted by electricity, and has a doorway and fixed windows at each end and movable side windows, which can be closed in inclement weather. The Commissioner of Police has approved the design, and 60 covers have been ordered.

Wandsworth.—£350 is to be spent in wiring the Council House and in erecting electric ventilating fans in the Council chamber.

Wimbledon.—The accounts of the electricity department for the past year show total receipts £18,640 and expenses £16,609, leaving a profit of £1,940, against £1,527 in the previous year.

Wireless Telegraphy.—By an ordinance (No. 13) of the Governor of British Honduras it is unlawful to establish wireless telegraphy without licence in that country.

Wolverhampton.—Application has been made by the Corporation for permission to borrow £10,000 for electric lighting extensions.

Workhouse Lighting.—The Local Government Board have declined to sanction the electric lighting scheme for the Fulham-road (London) workhouse of the St. George's (Hanover-square) Board of Guardians.

York.—The extensions of the Council's electricity works were formally opened on Monday.

Marriage.—Mr. W. H. Jay, works superintendent of the Durham electricity works, was married on July 11 to Miss Florence Peden, sister of the Mayor of Folkestone.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Brixham District Council invite offers for a transfer of the Brixham Electric Lighting Order, 1903. Further particulars from the clerk (Mr. J. L. Arlidge), Town Hall, Brixham. See also advertisement.

Fulham (London) Establishment committee invite tenders for supply and erection of two steel water-tube boilers, steel flues, &c., at their generating station. Specifications, &c., from the borough electrical and consulting engineer (Mr. Arthur J. Fuller). Tenders to the town clerk (Mr. R. M. Prescott) by noon July 27. See also advertisement.

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The City of Santos Improvements Co. (Ltd.), invite tenders for the delivery f.o.b. British port and for erection at *Santos*, Brazil, of producer gas plant and gas-driven alternators of a total capacity of 400kw., and transformers. Conditions, &c., from the consulting engineers (Messrs. Mordey & Dawbarn), 82, Victoria-street, Westminster, S.W., on and after 27th inst. Tenders by noon, Aug. 20, to the secretary of the company (Mr. J. E. Rimmer), 174, Gresham House, Old Broad-street, London, E.C. See also an advertisement.

The Commissioners of the Municipal Council of *George Town, Penang*, invite tenders for supply and delivery of tramcars, complete with motors, controllers, trolleys, &c. Copies of specification, &c., from the consulting engineers (Messrs. Preece & Cardew), 8, Queen Anne's-gate, Westminster, S.W. Tenders to Mr. R. M. Christie, 4, East India-avenue, London, E.C., by noon, Aug. 24. See also advertisement.

The Lighting Committee of *Islington* (London) Borough Council invite tenders for supply of a 25 B.H.P. single-phase 50-period 200-volt alternating-current motor with all starting gear, &c., complete, and for the supply of three sets of tail-rods and bearings for 1,000 B.H.P. engines. Tenders to the town clerk (Mr. Wm. F. Dewey), Town Hall, Upper-street, N., by noon July 27.

Hackney (London) Guardians invite tenders for fitting a system up of electric fire alarm bells at their Homerton establishments. Tenders to the clerk, Mr. Frank R. Coles, Sidney-road, Homerton, N.E., by 2 p.m., July 27.

Withington District Council require tenders by 29th inst. for one electric motor and pump and one oil engine and pump for Chorlton-cum-Hardy sewage works. Tenders to clerk, Town Hall, West Didsbury.

Tenders are wanted by noon Aug. 10 for new fire appliances, including electric fire alarm communications, for East Riding Asylum, *Beverley*. Tenders to clerk, Newbegin, Beverley.

Perth Corporation invite tenders for the construction and equipment of electric tramways on the overhead trolley system. Tenders by noon of Aug. 16.

Bromley Corporation invite tenders by 3 p.m. 26th inst. for a 15kw. electric light installation for the destructor works.

Walthamstow District Council require tenders by 5 p.m. 26th inst. for about 130 5-ampere arc lamps with accessories.

Buenos Ayres Municipality (having received no tenders for the construction and working of an electric tramway from the Plaza Mayo to the suburbs of Villa Ortuzar, Devoto, General Urquiza, &c.) have issued a fresh invitation for tenders, which will be considered on Sept. 6.

It is announced in the "Boletin Oficial" of *Buenos Ayres* for June 17 that tenders are invited up to 3 p.m Sept. 13 for the construction of a network of electric tramways connecting Buenos Ayres (at the Plaza de Mayo) and the suburbs of Ortusar, Devoto and General Urquiza. Conditions of contract, &c., can be seen at the Municipal Public Works Offices, Buenos Ayres.

The *Belgian State Railway Authorities*, La Bourse, Brussels, invite tenders until Aug. 10 for plant, &c., required for the electric lighting of the railway stations at Jemappes, Warquignies, Flenu-Central and Qaregnon-Central.

TENDERS RECEIVED AND ACCEPTED.

Stepney (London) Borough Council have received the following tenders for annual supplies :—

Meters up to 10 amperes: Reason Mfg. Co. (*accepted*) £312. 10s., Chamberlain & Hookham £3 5, Ferranti Limited £326. 5s. Above 10 amperes: Ferranti Limited (*accepted*) £518. 8s., Chamberlain & Hookham £544. 15s., Reason Mfg. Co. £550. 5s. Five tenders were rejected as not complying with specification.

Demand indicators: Reason Mfg. Co. (*accepted* for both types) magnetic £451. 7s., thermal, £583. 7s., Schattner Electricity Meter Co., magnetic, £487. 2s. 6d.

The tender of the Sloan Electrical Co. has been accepted for Conradty carbons at £331. 1s. 5d. There were six tenders varying from £317. 6s. 2d. to £403. 12s. 9d., and six tenders were rejected for not complying with the specification.

Deptford (London) Council have accepted the tender of the Phœnix Dynamo Mfg. Co. for two steam dynamos and a booster in connection with the electric lighting of the town hall and municipal offices for £777. There were 29 tenders, ranging from £614 to £920, but several were rejected as not complying with the specification. The tender of the Electric & Ordnance Accessories Co. for a switchboard and connections at £340 was also accepted. There were tenders for this work from 26 firms, ranging from the amount of the accepted tender to £775.

Burslem Town Council have accepted the following tenders :—
Babcock & Wilcox, boilers, £1,087.
Sir Hiram Maxim Elec. and Eng. Co., piping, pumps, &c., £1,009.
Dick, Kerr & Co., engines and dynamos, £1,863.
General Electric Co., balancer and booster, £337.
Crompton & Co., switchboard, £598; and arc lamps, £443.
Callender's Co., cables, £9,554. 1s. 8d.
Electrical Power Storage Co., accumulators, £780. 5s.

We are informed than an order has been placed with Messrs. R. W. Blackwell & Co., 59, City-road, London, E.C., by the Underground Railways Co. of London, for over 200 50 cubic ft. motor-driven compressors for the air brakes on the new trains which are to be operated on the Metropolitan District Railway. The electric locomotives on this line are being supplied by Messrs. Blackwell with combined vacuum pumps and air compressors, which are so operated that rolling stock equipped with either vacuum or air brakes can be controlled from the locomotive with the minimum equipment of apparatus.

Walthamstow Council have accepted the following tenders for electrical stores :—

Johnson & Phillips, lamps, Nernst lamps, shades, I.C. cutouts and switches, casing and capping, carbons, globes (part of); F. Suter & Co., switches and cut outs, distributing boards, &c., conduits, bends, &c., wa-te, carbon brushes, globes (part of), Para strip (part of); W. T. Henley's Telegraph Works Co., cables; Edison & Swan Co., holders, ceiling roses, &c.; Brush Electrical Co., Para strip (part of).

For supplying and laying three-core high-tension and other cables from Southwick electricity works to the North-road sub-station, Brighton Lighting committee recommend the acceptance of the tender of Siemens Brothers & Co. for £39,420. The lowest tender was that of W. F. Dennis & Co., which was for £38,100, and the committee's stated reason for passing over this offer was "that they understand, if the contract is given to Siemens Brothers & Co. the manufacture of the cables will be executed in this country, and that such would not be the case if the contract were placed with Messrs. Dennis & Co."

Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board have accepted the tender of W. & T. Avery for a 10-ton self-contained weighbridge, and that of Wm. Ellis & Sons for a 10-cwt. platform weighing machine on wheels.

Southport Electricity committee have accepted the following tenders :—

James Proctor (Ltd.) for stoker at £73; Dick, Kerr & Co. for a 200kw. alternator at £608. 10s.

Exeter Electric Light committee recommend the acceptance of the tender of Bruce Peebles & Co. for further electricity generating plant at £1,050.

East Ham Council have placed an order with Peirson & Co. to raise the cooling tower at the electricity works by 12ft. at £118. 7s. 6d.

Cleckheaton Council have accepted the tender of the Phœnix Dynamo Mfg. Co. for a 350kw. steam dynamo (Gowlay engine).

BUSINESS NOTICE.

Messrs. Rashleigh Phipps & Co., electrical engineers, &c., are removing, on 23rd inst., to more commodious premises at 147, Oxford-street, London, W., where they will keep an artistic selection of fittings.

Owing to the annual holidays, the works of the Langdon-Davies Motor Co., 101, Southwark-street, London, S.E., will be closed from July 30 to Aug. 6 inclusive, a small staff remaining to deal with urgent correspondence.

The works of the Robertson Electric Lamps (Ltd.), at Brook Green, Hammersmith, W., will be closed from July 30 until Aug. 8, owing to the annual holidays,

Messrs. P. J. Buddery and H. W. Van der Pant (trading as Percy J. Buddery & Co), electrical, &c., engineers, 5, Kingston-road, Wimbledon, have dissolved partnership.

Messrs. A. Rosenberg & Co., electrical and mechanical engineers, have removed to 259, High Holborn, London, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

At the meeting of creditors of James Wm. Hunter and Albert Clapham, trading as the Yorkshire Motor Car & Electrical Engineering Co., 101 and 103, Kirkstall-road, and 8, Queen Victoria-street, Leeds, on Tuesday, Mr. W. H. Platts, C.A., submitted a statement of affairs showing liabilities £3,106. 1s. 8d., assets £2,220. 9s. 10d., deficiency £885. 11s. 10d. An offer of 5s. in the £ was made on behalf of debtors, but was refused by the creditors present. With a view of fully investigating the transactions of debtors, they were requested to file their petition in bankruptcy.

John Jas. and Howard Ryan de Lacy, electrical engineers, 58, Oldhall-street, Liverpool, were examined on Thursday. Unsecured liabilities, £1,833; assets (including £484, surplus from securities but not realisable), £511. The business was commenced in 1900, Mr. Hawkins, a partner, finding £635. He retired in 1901, and received £500, which debtors borrowed. Examination adjourned to Aug. 10.

In the bankruptcy of F. W. Parkes and E. Sadlier, electrical engineers, &c., The Dingle, Colwyn Bay, the first meeting of creditors will take place on 27th inst. at Crypt-chambers, Eastgate-row, Chester, and the public examination on Aug. 4 at Bangor.

It is intended to pay a dividend to preferential creditors of the Electric Timber Seasoning & Preservation Co. (Ltd.), and proofs

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of claims are to be sent to the liquidator (Mr. H. de V. Brougham, 33, Carey-street, London, W.C.), by Aug. 4.

The first meetings of creditors and contributories of the Electro-Voelker Synd. (Ltd.), 65, George-street, Croydon, will be held at 24, Railway-approach, London Bridge, on 29th inst.

The trustee in the bankruptcy of J. P. Child, electrical engineer, has been released.

The trustee in the bankruptcy of E. Ward, electrician, &c., has been released.

Claims against Thos. Williams, electrical engineer, 54, Bridge-street, Llandaff (formerly of Despenser-street, Cardiff), by 30th inst. to Mr. Geo. David, 117, St. Mary-street, Cardiff.

The Electrical Machinery Developments Co. (Ltd.) is to be wound up voluntarily. Mr. F. W. Lowther, 151, Cannon-street, London, E.C., is liquidator.

The London Telegraph & Steam Gauge Electric Co. (Ltd.) is to be wound up voluntarily. Mr. J. R. Reedman, 2, Bradley-street, London, E., is liquidator.

A meeting to receive an account of the winding-up of Braby & Tomlinson (Ltd.) is to be held on Aug. 22 at 23, Bucklersbury, London, E C.

Water Power, &c., for Sale by Treaty.—Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., have for sale by private treaty the works, roads, lands and water power owned by the Royal Ballincollig Gunpowder Factories, which it has been decided to close. The waters of the River Lee give a reliable 400 H.P. continuously. Some further particulars will be found in an advertisement on another page.

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 30, Birley-street, Blackpool.

Two Westminster dynamos, direct coupled to two Robey engines, and two 16 N.H.P. boilers are for sale by R. H. Longbotham & Co. (Ltd.), Wakefield. See advertisement.

A complete secondhand electric lighting plant, suitable for an installation of 200 lamps (14 H.P. Crossley gas engine, 70-ampere dynamo, switchboard, &c.), is advertised in another column. Full particulars from Mr. W. P. Adams, M.I.E.E., 35, Queen Victoria-street, London, E.C.

Mr. A. Underwood, 3, Queen-street, London, E.C., has for sale a 50 B.H.P. vertical compound Belliss engine coupled to dynamo 105 volt 340 amperes, and also a vertical Belliss engine coupled to Crompton dynamo 120 volts 105 amperes.

Land to be Let or Sold.—Messrs. Walfords, 27, Bolton-street, Piccadilly, London, have some exceptionally eligible land at Stamford, Lincs., for sale or to be let. Stamford is connected with three railway systems, and is within moderate distance of the Midland coalfields.

Catalogues, &c.—Section 3 of the Edison & Swan Co.'s main catalogue is devoted to the description and illustration of Ediswan electric lighting accessories, including switches and fuseboards, switchboards and wireman's sundries. A large and varied assortment of "Simplex" conduit parts forms a conspicuous part of the catalogue, and shows the adaptability of this excellent system to all classes of interior conduit work.

The Electrical Co., 121-125, Charing Cross-road, London. W.C., have ready two new sheet lists of quick-break knife switches, single way, up to 400 amperes 500 volts, and of carbons for flame lamps. The carbons listed are for gold and for red light or for extra white light, and are for lamps with perpendicular or converging carbons. Copies of these lists can be obtained on application.

Messrs. Ernest F. Moy (Ltd.), Camden Town, London, N.W., have ready a new list of S.P. two-way knife switches.

A new list of dynamos and motors is issued by H. T. Boothroyd, Hyslop & Co., Bootle, Lancs. The list is illustrated and particulars and prices are given of ship-lighting sets, of generators specially designed for mills and works, and of electric lifts, winches, &c.

Forthcoming Book.—"The Telephone Service: Its Past, Present and Its Future" is the title of a new work about to be published by Messrs. Whittaker & Co. from the pen of Mr. Herbert Laws Webb.

Advertising Literature.—Messrs. Frank Gould & Co., advertising contractors, 54, New Oxford-street, London, W.C., have prepared a pamphlet entitled "Some Notes on Advertising and Press Publicity." Copies will be forwarded free of charge on request.

"Gas Works Directory and Statistics."—We have received from Messrs. Hazell, Watson & Viney a copy of this directory for 1904-5. To those interested in gas supply (and there are many electrical installation firms who have occasion to consult such statistics) the book should prove invaluable, as it contains a mass of carefully-compiled and up-to-date information regarding the gas undertakings of the United Kingdom. The published price is 10s. 6d.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from July 18 to 19, with the ports of destination:—

Africa—Cape Town, £658 (including £350 telegraph material); Delagoa Bay, £392; Durban, £1,900 (including £86 telegraph material); East London, £42; Port Elizabeth, £224. *Argentina*—Buenos Ayres, £90; *Australasia*—Auckland, £372; Christchurch, £20; Fremantle, £120; Melbourne, £21; Otago, £34; Perth, £140 (including £56 telegraph material); Sydney, £919 (including £662 telegraph cable); Wellington, £452. *Belgium*—Antwerp, £272; Ostend, £30. *Brazil*—Rio Janeiro, £330. *Burma*—Rangoon, £129. *Ceylon*—Colombo, £83 (telegraph material). *China*—Shanghai, £363. *Colombia*—Santos, £10. *Germany*—Hamburg, £84. *Gibraltar*, £461 (telegraph instruments). *Greece*—Piræus, £115 (telegraph material). *Holland*—Amsterdam, £24; Flushing, £45 (telegraph material). *India*—Bombay, £415; Calcutta, £2,262 (including £622 telegraph material); Madras, £25. *Italy*—Messina, £495. *Japan*—Kobe, £30; Tokyo, £765; Yokohama, £1,024. *North Atlantic*, £18,000 (telegraph cable). *Russia*—Riga, £145; St. Petersburg, £479. *Straits Settlements*—Penang, £128; Singapore, £83. Total £31,181, against £12,861 in the corresponding week last year (July 15 to 12.)

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

April 18, 1904.

8,848 C. W. CROCKER. Bristol. Securing shades on incandescent lamps.
8,861 P. A. VAILE. Telephones.
8,903 B. HYDE. Pressure-controlled switches.*
8,910 C. J. KLEIN. Push buttons.
8,912 F. WALLOCH. Line selectors of intercommunication telephone apparatus. (Date applied for, Sept. 25, 1903, date of application in Germany.)*

April 19, 1904.

8,918 H. W. SULLIVAN. Relays.
8,922 G. W. HAYWOOD and S. G. BROUNGER. Automatic switches for controlling motors and circuit-breakers.
8,950 S. THOMAS, H. JONES and S. THOMAS. Electric candle nozzle.
8,960 E. HILLER. Automatic short-circuit lever switches.
8,965 SIEMENS BROTHERS & Co., J. F. SIMPSON and H. C. WHFAT. Section insulators for overhead trolley wires.*
8,968 A. P. HANSON. Manufacture of electrical apparatus. (Date applied for Nov. 20, 1903, date of application in Denmark.)*
8,984 P. DELAFON. Manufacture of positive electrodes for galvanic batteries.
8,986 LA SOCIÉTÉ ANONYME L'ELECTRIQUE. Electric road vehicles. (Date applied for, Jan. 14, 1904, date of application in France.)*
8,989 H. P. MARTIN. Kingston-on-Thames. Service box or manhole covers. (Date applied for, April 20, 1903, date of application in U.S.)*
8,991 F. T. TALCOTT and B. F. KERR. Kingston-on-Thames. Self-winding electric clocks.
8,992 T. W. GLEESON and R. HAMILTON. Telephone and telegraph system. (Date applied for, May 1, 1903, date of application in U.S.)*
8,999 W. MCDEVITT. Protecting the live parts of switches.*
9,008 G. A. PETERS. Self-registering electrically operated sectional targets

April 20, 1904.

9,103 C. A. DAY (Fabrik Elektrischer Zünder, G.m.b.H., Germany). Electric igniting devices for miners' safety lamps and the like.
9,115 B.T.-H. Co. and S. WOODFIELD. Boosters.
9,116 B.T.-H. Co. (G.E. Co., U.S.). Reflectors.
9,117 B.T.-H. Co. (G.E. Co., U.S.). Dynamo electric machines.
9,123 C. E. FOSTER, E. R. GROTE and M. V. ELY. Arc lamps.*
9,133 G. MELLER. Monophase collector motors.

April 21, 1904.

9,165 F. A. POWELL and H. G. LONGFORD. Birmingham. Insulation of sparking plugs for motor engines.
9,167 J. WILLOCKS. Glasgow. Applying electricity to the feet for medical purposes.
9,168 C. CHESTER and T. CHESTER. Halifax. Sparking plugs for motors.
9,190 W. S. WEEDON. Arc lamp electrodes. (Date applied for, April 21, 1903, date of application in U.S.)*
9,208 C. JONES, J. PROCTOR, K. CLARK and T. WATERHOUSE. Overhead conductors for supplying electrical energy.
9,215 W. WILSON. Switches. (Date applied for, April 21, 1903, date of application in U.S.)*

April 22, 1904.

9,226 G. HOFFMANN. Germany. Continuous-burning arc lamp with amalgam electrodes.*

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9,238 E. G. WRIGHT. Guildford. Joint for coupling up telegraph and telephone wires and the like.
9,248 W. H. STOCKHAM. Handsworth. Manufacture of guards, frames or shades for electric lamps.
9,255 ROMANOFF (LONDON) SYNDICATE (Hippolyte de Romanoff, France). Electromotors for motor vehicles and fixing same.
9,303 T. C. FUTERS. Electrical control of winding engines.
9,306 BROWN, BOVERI & CIE. Automatic regulation of electric current. (Date applied for, April 23, 1903, date of application in Switzerland.)*
9,307 E. MORCK. Alternating-current meters on Ferrari's principle.*
9,310 H. BIRBECK (S. Schwarzschild, W. S. Dodd and J. F. Johnson, U.S.). Electric burglar and fire alarms.*

April 23, 1904.

9,318 J. B. SCAMMELL and E. A. MUSKETT. Insulating and water proofing compositions.
9,340 F. MORRIS. Carrying trolley wires of electric tramways.
9,372 A. F. HILLS, D. URQUHART and A. E. HONEY. Armatures for dynamo-electric machinery.
9,373 A. F. HILLS, D. URQUHART and A. E. HONEY. Brushes for dynamo-electric machinery.
9,375 E. VEDOVELLI née DEL CASTILLO. Electrical resistances (Date applied for, Oct. 19, 1903, date of application in France.)*
9,377 S. P. WOOD and MCKENZIE AND HOLLAND (LTD.) Electric treadles or contact makers for railway signalling and the like.
9,385 BROWN, BOVERI & CIE. Automatic regulation of current in electric lighting installations. (Date applied for, April 25, 1903, date of application in Switzerland.)*
9,386 O. ZERKOWITZ. Electric jacquard card cutting, electric weaving and the like.

April 25, 1904.

9,397 J. H. DALE. Manchester. "Clusters" for incandescent lamps.*
9,427 C. W. CROSBIE and A. WARD. Manchester. Automatic electro-magnetic sanding-gear operated simultaneously with the electric emergency brake from controller handle.
9,442 C. A. WRIGHT. Leytonstone. Resonators for high-frequency wireless telegraphy.
9,443 C. A. WRIGHT. Leytonstone. Vacuum electrodes for the production of X-rays with currents of high frequency.
9,453 J. W. GIBBS. Kingston-on-Thames. Electric shoes. Date applied for, July 16, 1903, date of application in U.S.)*
9,468 A. NEUBURGER. Heating the charge of electric furnaces.*

April 26, 1904.

9,517 A. RICHARDSON, J. HEAP, H. HEAP, J. BAILEY, T. BRIERLEY and R. BILLINGTON. Manchester. Insulators and hangers or cars for overhead trolley wires.
9,523 W. O. DUNTLEY. Battery cells.*
9,530 C. RIDLEY and J. RIDLEY. Coventry. Electrical ignition for internal combustion motors.
9,542 W. WILLIAMS. Southsea. Sparking plugs for electric ignition of internal combustion engines.
9,547 H. C. LEVIS (G.E. Co., U.S.). Electrodes.
9,565 J. S. RAWORTH. Electric tramway or railway vehicles.
9,581 R. MCNEILL. Electric motors.*

April 27, 1904.

9,647 P. PICHARD and E. MEUNIER. Electromagnetic igniters for explosion motors.*
9,649 A. RUDD. Electric light brackets and fittings.
9,658 B.T.-H. Co. (G.E. Co., U.S.). Machines for making incandescent lamps.
9,660 B.T.-H. Co. (G.E. Co., U.S.). Starting devices for electric motors.
9,669 SIEMENS BROTHERS & Co., G. S. GRIMSTON and F. TURNER. Telegraph apparatus.
9,683 S. CHURCHILL-OTTON. Sanitary rotating diaphragm for telephones.*

April 28, 1904.

9,711 B. N. DADOE and S. LORD. Liverpool. Apparatus for starting and controlling electromotors and in circuit-breakers for use therein.
9,718 C. O. BASTIAN. Vapour arc lamps.
9,744 GENERAL CONTRACTS Co. and W. H. FLOOD. Water-tight covers for tumbler switches.

April 29, 1904.

9,796 J. G. EVERETT. Windsor. An electrolytic resistance for electro-therapeutic use.
9,802 A. HOWSON. Nantwich. Electric ignition plug for internal explosion engines.
9,815 C. KRAFT. Charging storage batteries without special apparatus.*
9,831 R. W. JAMES (Northern Electric Co, U.S.). Regulation of electric circuits for the production of constant current.*
9,840 L. LAUFER. Electric alarm appliances.
9,841 B.T.-H. Co. (G.E. Co., U.S.). Commutators for dynamo-electric machines.
9,842 B.T.-H. Co. (G.E. Co., U.S.). Resistance units and methods of making same.
9,843 B.T.-H. Co. (G.E. Co., U.S.). Incandescent lamps.
9,844 B.T.-H. Co. (G.E. Co., U.S.). Vapour electric apparatus.
9,859 P. CENTNER. Apparatus for obtaining magnetic fields having a rectilinear reciprocating motion.
9,874 G. S. DUNN. Switches. (Date applied for, Aug. 25, 1903, date of application in U.S.)*

April 30, 1904.

9,884 A. B. SOAR and H. F. JOEL. A controller for electric motors.
9,914 C. HAUPTMANN. Germany. Magneto-electric igniting device.*
9,951 C. DE KANDÓ. Driving mechanism for electric vehicles.*
9,950 C. DE KANDÓ. Collector rings of alternating-current generators and motors.*
9,954 W. SPROWSON. Safety device for electric lifts.*
9,959 W. H. HARFIELD and W. RUTLEDGE. Electric steering gear.
9,964 P. CENTNER. Electrical percussive drill.
9,969 J. WILHELMI. Electrically driven coal hoists.
9,981 K. WALTHER. Shade carrier for glow lamps and the like.*
9,984 W. E. HITCH. Oxford. Electric cable conductors.

May 2, 1904.

10,019 B.T.-H. Co. (G.E. Co., U.S.). Dynamo-electric machines.
10,036 A. BERLIN. Liverpool. Electric cables.*
10,044 T. SUTCLIFFE. Moulding tool to be used in making caps of ceiling roses, cutouts and the like.

COMPANIES' MEETINGS AND REPORTS.

Metropolitan Electric Supply Co. (Ltd.)

An extraordinary general meeting was held on Tuesday, under the presidency of Mr. W. H. CRIPPS.

The SECRETARY (Mr. E. Cunliffe-Owen, C.M.G.), having read the notice,

The CHAIRMAN said: A few days ago I should have begun my remarks by expressing pleasure at meeting you here to-day, but I must tell you that a little difficulty has arisen in the matter we have met to discuss. There is nothing, however, in the difficulty which will prevent you from passing the resolution we are going to propose, slightly modified. We have now received from Marylebone Borough Council £1,318,000 in cash, which leaves only £10,000 owing to us, which has been set aside to cover any little differences as regards the value of leasehold properties and things of that kind we agreed to settle by mutual agreement. But now, as regards this amount of money, £1,212,000 of it represents the award of the arbitrator for our loss of Marylebone, the remainder being sums we have spent from time to time on their behalf since the date of the notice to treat, so that that money does not come into consideration. The question, therefore, is as to what the directors advise to be done with this £1,212,000. We have come here to-day asking you, subject to the little difficulty I am going to explain presently, to agree that that profit be distributed in this way—namely, that £6 per share be returned on each of the ordinary shares. That will absorb £600,000. As to the remaining £100,000, some small portion of it will have to go towards paying the costs of the arbitration, and a small portion of it towards disuniting a little bit of the system, to be paid for out of that sum; but a substantial portion of this £100,000 will remain, which we propose to carry to our reserve fund—anyhow, temporarily. As regards the £500,000 which represents the capital, we have had to consider the position of the debenture-holders, and, to a certain etxent, the position of the preference shareholders also. The result of that consideration has really brought this scheme to our minds, but, before we carry out our proposition, we should call another meeting, have it properly put before you, and then you can criticise it in every detail. But what we suggest is this—that it may not be well, from legal and and administrative difficulties, to reduce our capital by the whole of that half-million; in other words, it will not be the best thing to do to make the ordinary capital half a million instead of one million, and we propose a midway course. We propose to reduce the capital of the company from £1,000,000 to £750,000, and the simplest way of doing that, we think, would be this—that for every holder of two £10 shares (of course, you can subdivide it for yourselves if a person holds only one share)—but for every holder of two £10 shares we should give in exchange three £5 shares and £5 in cash. In that way you would reduce your capital to £750,000. That briefly is what we propose to do, but there will be considerable difficulties in carrying it out. Our legal advisers say that we cannot reduce the capital of the company—that, first of all, we should have to get the sanction of the shareholders. That, I take it, we should not have any difficulty in doing at the meeting we are going to have; but we must get also the consent of the Court of Chancery or get a special Act of Parliament. On the whole, we have been advised—though not absolutely finally—that it will be the cheapest, the most economical and the safest way to carry that out by an Act of Parliament. Parliament compelled us to sell our concern, and we believe that Parliament will give us every facility for putting us in a right position after that sale. But I must now revert to the division of this £600,000. The way we arrived at the conclusion that it was profit was this: We had our view that it was profit in the same way that if you buy a thing for £1 and sell it for £2 the difference is profit. We consulted our lawyers, however, and they said it was so important a matter that they would like to have the opinion of the very best counsel that could be obtained, and we, therefore, obtained the opinion of three of the ablest counsel at the Bar. They have had several months in which to think over the matter, and we have had several consultations with them, and they have advised us there is no possible question, from their point of view, that this £700,000 is profit and nothing else. They said that before we can divide it we must get a proper balance-sheet prepared by our auditors and certified that that was in excess of the capital; and the auditors have certified to the directors that £500,000 is capital and that the other £700,000 is profit. The board, therefore, passed a resolution that that should be divided in the form of dividend (it could have been done by way of an interim dividend), but in pursuance of my promise we come to ask you to do that. Now comes in a difficult question, however—the question of the debenture-holders. They are not satisfied that we can divide the £600,000 as we propose. Why? They say, forsooth, that it is capital and not dividend. That is the immediate

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question. It is only part of the debenture-holders who have moved in this matter—the 3½ per cent. debenture-holders who have lent us £250,000. What is the security they have got at the present time for that £250,000? They have got the security of the whole of our concern with the exception of the part we have sold. In addition to that they have got the security of the half million I have been talking of as capital which is now lying at the bank. Yet they tell us they intend to move the Court of Chancery for an interim injunction to prevent us from dividing this £6 a share. The question which arises, I think, is that the best thing that could happen would be that they should move for this injunction. The point would then come on for hearing and both parties would be represented, which is an important matter. How long it would take the Court to decide about the injunction I cannot say.* All I can say is, that if you will give your consent and pass this resolution for returning this £6 a share, the very moment this prohibition, so to say, is removed, you shall have your cheques sent to you. This matter of the injunction was sprung upon us at the last moment, but we are told by our legal advisers that our position is perfectly secure. This is the resolution I am now going to put to you—

"*That the recommendation of the Board that a bonus of £6 per share be paid to the holders of ordinary shares in the company whose names appearin the register on July*, 12, 1904, *out of the profit which has been made by the sale of the Marylebone undertaking be approved and confirmed.*"

The CHAIRMAN, in reply to questions, said, I was asked what would be the effect on the company if the debenture-holders are successful in the interim injunction. The effect of that would be that for the time we should be in the position of having £600,000 extra lying at our bankers, which no doubt we should invest at 3½ per cent. until the matter was cleared up by Act of Parliament, which could not be done until next year. As to the position of the preference shareholders. They have no preference as to capital. We gave them 4½ per cent., and explained that they would not have a preference as regards capital, but only as regards dividend. Then as to whether the debentures could be paid off. We should only be too pleased to pay them off, but the holders will not be paid off. It would be of enormous advantage to the company if we could pay them off, and I may say that we could do so in five minutes, but the period has not arrived for paying them off. One part of the debentures will be paid off in 1909 and the other portion in 1916.

The resolution was then carried unanimously.

Mr. GEORGE KITCHIN than said: Mr. Chairman, on occasions like these it is always usual, and it is a very good and wholesome custom, for shareholders to recognise the fact that the people on whom the brunt of the work has fallen should receive some adequate recognition of the work they have done for the benefit of their shareholders. It is no slight matter that the board have had to fight so much in connection with the question of the arbitration between the Marylebone Borough Council and ourselves. Constant attention, great wariness, considerable tact, and, above all, courage, have been necessary in meeting very questionable proceedings occasionally (as has appeared to the man in the street); and those who appealed to Cæsar wished, when Cæsar had given his verdict against them, to wriggle out and escape from the consequences of their appeal. In these days it is necessary for anyone who has to confront a municipal body, backed up, as it seems to be, by all the intricacies of the law, to have men of great and tried capacity to steer you clear of the difficulties which have to be encountered, and I think that everyone will agree with me that the chairman and directors of this company have done their work exceedingly well. My intention was to propose a vote including the general manager and the staff, because I know—and I am sure that a great many other shareholders also know—that an immense amount of work has been done by these gentlemen, and more especially by Mr. Conacher, in carrying this matter through. However, owing to the way in which the notice was sent out calling the meeting, it would not be in order for me to propose any definite resolution which would include Mr. Conacher and his colleagues. I may mention that my original intention was to propose that the vote of money to be distributed should be £10,000, from which you may draw your own conclusion of what I think is the proper amount which should be divided among the general manager and his colleagues. I now move the resolution which has been put in your hands—namely :—

"*That in view of the able manner in which the negotiations between the company and the Marylebone Borough Council have been carried on and the successful result attained thereby, a sum of* £7,000 *be voted to the board from the profit on capital account made by the sale of the Marylebone undertaking, of which* £3,000 *should be paid to the chairman and the balance divided between the remaining directors in such proportions as they may determine, provided that if the said sum, added to the ordinary remuneration of the directors for the current year, exceeds the total remuneration payable under the articles of association in any one year, the excess shall not be paid until January* 1 *next.*

Mr. JOHN NEWTON: I consider there should be no limit to the reward of the officials of the company, and I think that the mover has implied a limit in talking about making up a round figure of £10,000. I trust that the directors will abundantly reward every official for his work—properly and abundanty reward him, for the work has been done remarkably well. I think that the staff should be remembered in the same way that the directors are remembered.

Mr. KITCHIN then put the resolution, which was carried unanimously.

The CHAIRMAN: Allow me to thank you on my own behalf, and also on behalf of my colleagues, most cordially for this extremely generous gift. I need not say how immensely indebted I have been—although I did not mention it before—to my brother directors, who I hope will return thanks for themselves. With regard to our general manager, our secretary and the officials, I entirely endorse anything that has been said in their favour, and I think that you are indebted quite as much to them as to ourselves, or even more so.

A very cordial vote of thanks to the chairman for presiding was carried unanimously, and the proceedings then terminated.

* Soon after the termination of the proceedings at the meeting the result of the application to the Court was made known, and as the injunction asked for by the debenture-holders was refused, cheques in payment of the bonus of £6 per share were posted the same evening (Tuesday).

Chili Telephone Co. (Ltd.)

The fifteenth ordinary general meeting was held on Wednesday, Mr. GEORGE KEITH in the chair.

The SECRETARY (Mr. Edmund Petley) read the notice convening the meeting and the auditor's report.

The CHAIRMAN said: Gentlemen, the business of the Company has, for some years, been making steady progress. The shareholders have been receiving a gradually increasing dividend, and the financial position of the Company has at the same time been strengthened. The position was such that the Directors felt themselves justified in commencing to make an interim distribution, and there is every reason to expect that this can be continued in future years. The accounts I have now the pleasure of submitting to you are, I think, of a satisfactory nature. The revenue in Chili has increased during the past year about 9 per cent. Some 443 new subscribers have been added to the subscription list, and there has been a considerable increase in message and sundry receipts. A corresponding increase has of course occurred in working expenses. The expenditure in Chili has increased about 5 per cent., and works out at 46 per cent. of the revenue—rather less than it did last year. When it is considered that all the improvements and changes in the existing plant are charged up to revenue, I think the rate of working is a satisfactory feature and reflects great credit on the management in Chili. The result of the year's business in Chili is a net income of £33,687, showing an increase for the year of £4,964. You will see by the revenue account that, after adding interest, discounts and transfer fees, and deducting the London expenses and charges for debenture interest and income tax, there is a net profit for the year of £28,570; and adding £2,637 brought forward from last account, there is an available balance of £31,207. An interim dividend of 3s. per share has been paid and £14,010 transferred to the reserve. The Directors now recommend the payment of a final dividend of 4s. per share, making a total dividend for the year of 7 per cent. and carrying forward £2,502 to the next account. Turning to the balance-sheet you will find that the debenture issue stands at £35,000, as compared with £56,000 last year. On March 31, the issue falling due, £21,000 was paid off and the remaining £35,000 has been extended by arrangement with the holders, with a view to their being paid off as the finances of the Company may permit. The payment of such a large amount has drawn somewhat heavily on the cash reserve, but it means a saving in debenture interest of £1,260 per annum, which will now go to profits. The capital expenditure for the year amounts to £2,196, which has been expended on new extensions. An additional circuit has been put up between Santiago and Valparaiso to meet the growing traffic between these cities. Several provincial offices have been opened and additional inter-town lines erected. Altogether some 679 miles of new wire have been equipped and added to the property. Since the arrangement with the Argentine, the Chilian people have been able to devote more attention to industry and finance. As our business shows, there is a gradual improvement going on which is likely to continue. The nitrate and other industries are doing well and the harvest has been good. The adjustment of public expenditure to revenue is improving the financial situation of the country. I think we may look forward to more prosperous times in Chili and to the continued success of our business. I now move the adoption of the report and accounts.

The motion was carried unanimously, as were resolutions approving the dividend and re-electing the retiring director (Mr. Frank W. Jones) and the retiring auditor (Mr. T. A. Welton).

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The report of the directors for the period from Jan. 1 to June 30, 1904, states that the total receipts, including balance of £1,128. 11s. 4d. brought forward, were £165,614. 8s. 1d. Traffic receipts show a decrease of £13,280 compared with the half-year ended June 30, 1903. The total expenses of the half-year, including repair of cables, &c., were £63,578. 15s. 8d., a decrease of £2,314. 7s. 2d., compared with the corresponding period of 1903. £12,000 has been placed to renewal fund, leaving a balance of £90,035. 12s. 5d. Quarterly interim dividends of 12s. 6d. per cent. on the ordinary and of £1. 5s. per cent. on the preferred stock, have been paid, absorbing £43,750, and second quarterly interim dividends of 12s. 6d. per cent. on the ordinary and £1. 5s. per cent. on the preferred stock, requiring £43,750, will be paid on July 30, and the balance of £2,535. 12s. 5d. will be carried forward. All the main cables and land lines of the company are in good working order. A scheme of pensions for employés of the company, in lieu of the present system of endowment assurance, has been prepared by the directors, and will be submitted to the stockholders for approval.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—At a meeting of this company on Monday the agreement with the City of Buenos Ayres Tramways Co. for the purchase of the latter's undertaking was confirmed. The chairman (Lord R. Browne) said there had been a great accession of traffic on the Anglo-Argentine system since the introduction of electric traction and an amalgamation would lead to many economies. They would control and work about 104 miles of tramways, many of them passing through the best parts of the city. The proposed fusion was popular in Buenos Ayres.

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BRITISH CONTINENTAL ELECTRICITY CO. (LTD.)—The directors' report states that the receipts from sale of current show an increase of £256. 18s. 7d., while working expenses have been reduced. An agreement has been entered into with the Società Negri for an all-day supply of electrical energy from their water-power station near San Remo, whereby possible competition has been avoided and the profit-earning prospects of the company greatly improved. The directors recommend a dividend on the 5½ per cent. cumulative preference shares for the year ended April 30 (£550) and writing off the whole of special legal expenses (£204. 13s. 3d.), leaving £204. 0s. 1d. to be carried forward.

CITY & SOUTH LONDON RAILWAY CO.—The report of the directors for the half-year ended June 30 states that receipts from all sources were £80,203. 17s. 11d., and working costs £35,569. 9s. 2d., leaving a profit of £43,634. 8s. 9d. Inclusive of balance from Dec. 31, the total is £44,403. 16s. 3d. After making provision for interest and transfer to renewal fund of £1,500, a balance remains available for dividend of £31,684. 12s. 5d. Out of this the directors recommend the full 5 per cent. dividend on the preference and a dividend at the rate of 2½ per cent. per annum on the consolidated ordinary stock for the half-year, leaving £701. 9s. 11d. to be carried forward. During the half-year 9,226,987 passengers (exclusive of season ticket holders) were carried, and the receipts (including season tickets) were £76,387. 14s. 1d., against 8,711,062 passengers and £72,286. 3s. 6d. receipts in the December half-year. The directors regret the slight diminution in the dividend, but consider that with the competition of the electric tramways and the continuance of the fine weather, the general traffic of the line is showing a steady improvement. Negotiations with the railway companies and other public bodies in respect of the extension to King's Cross, St. Pancras and Euston have made considerable progress, but are not yet sufficiently advanced to allow a contract to be entered into for the construction of the line. It is, however, hoped that these negotiations will be brought to a conclusion at an early date, and authority will, therefore, be asked for the creation and issue, when required, of the capital necessary to carry out the extension, the interest on which will not be a charge on the revenue until the line is open for traffic. The works of the Baker Street & Waterloo Railway are making rapid progress, and the plans of the low level subway at the Elephant and Castle connecting the platforms of the two stations have been agreed. The Great Northern & City Railway was opened in February last, and the interchange traffic with that railway is steadily progressing.

CITY OF BUENOS AYRES TRAMWAYS CO. (LTD.)—At a special meeting on Monday a resolution authorising the proposed fusion with the Anglo-Argentine Tramways Co.'s undertaking was approved. Mr. J. Heaton, who presided, said the municipality of Buenos Ayres had declined to grant to the City of Buenos Ayres Co. a concession to electrify the city lines except upon terms which made it impossible to accept them. They proposed to limit the term to 64 years, whereas they had granted to other companies 99 years. Hence the proposals for the fusion of the company with the Anglo-Argentine Co.

DIRECT UNITED STATES CABLE CO. (LTD.)—The report of the directors for the six months to June 30 states that the half-year's revenue, after deducting out-payments, amounted to £43,121. 6s. 5d., compared with £48,886. 12s. 7d. for the corresponding period of 1903, a difference of £5,765. 6s. 2d. against the past half-year. Working and other expenses amounted to £21,185. 11s. 2d., leaving a balance of £21,935. 15s. 3d. as net profit, making, with £2,479. 8s. 10d. brought forward and £1,965. 17s. compensation for surrender of lease of premises at New York, a total of £26,381. 1s. 1d. For the corresponding period of 1903 the working expenses and other payments amounted to £21,724. 0s. 7d. Three quarterly interim dividends of 3s. each per share, amounting to £27,319. 10s., have been declared and paid, and a final dividend of 3s. per share is now proposed, making 3 per cent. for the year and a total distribution of £36,426. After transferring £6,000 to reserve, the balance of £2,168. 1s. 1d. is proposed to be carried forward. Reserve has been debited with £11,725. 0s. 7d. for cost of cable repairs, and, after being credited with interest on investments and amount transferred from revenue, amounts to £463,952. 16s. 9d., taking investments at cost price.

DUBLIN UNITED TRAMWAYS CO. (1896), LTD.—The directors' report for the half-year ended June 30 states that the amount available for division is £44,153. 9s. 2d., and dividends are recommended on the 6 per cent. preference shares and at the rate of 6 per cent. per annum, tax free, on the ordinary shares. £2,000 has been put to reserve, and £3,000 appropriated towards cost of electric welding the Dalkey line. £4,015. 19s. 2d. is carried forward.

EASTERN TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended March 31 states that the revenue amounted to £635,884. 18s. 11d., from which are deducted £175,160. 7s. 6d. for ordinary expenses and £40,759. 5s. 3d. for expenditure relating to maintenance of cables, depreciation of spare cable and income tax payable abroad, leaving a balance of £419,965. 6s. 2d., to which is added £32,867. 10s. 9d. from last half-year, making a total available balance of £452,832. 16s. 11d. After making provision for income tax payable in England, interest and for two quarterly preference dividends (absorbing £93,599. 3s. 1d.), there remains £359,233. 13s. 10d., out of which the directors have placed £8,000 to reserve for maintenance ships, £170,000 to general reserve, and have paid an interim dividend of 1¼ per cent. on the ordinary stock, amounting to £50,000, and now recommend a final dividend on the ordinary stock for the year ended March 31 of 1¼ per cent. and a bonus of 2 per cent. (absorbing £130,000), both payable on 23rd instant, tax free, making a total distribution of 7 per cent. for the year, leaving £1,233. 13s. 10d. to carry forward.

GENERAL ELECTRIC CO. (LTD.)—The report of the directors for the year to March 31 states that the net trading profits and income from investments, &c., amount to £83,864. 14s. 1d. Deducting depreciation and debenture interest (£25,607. 14s. 11d.), there remains £58,256. 19s. 2d., out of which preference dividend has been paid (£12,500), leaving £45,756. 19s. 2d. The directors now recommend payment of managing directors' and employés' bonus (£4,575. 14s.), a dividend of 7 per cent. for the year on ordinary shares (£21,126), and putting £20,055. 5s. 2d. to reserve, which will then amount to £80,265. 7s. 2d. The Witton engineering works and foundry are now in full working order. The favourable anticipations expressed in last year's report have been realised, and the number as well as the nature of the contracts in hand are encouraging for the future. The position of the carbon works is much improved. The Manchester and Birmingham factories continue to show good results. During the year further 1,342 ordinary shares have been allotted to the directors of the company at par.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

BARBER & COLMAN (LTD.)—Reg. July 1, capital £10,000 in £1 shares, to acquire, for the purposes of sale in the United Kingdom, the British Colonies, Europe and Asia, mechanical contrivances, patented articles, appliances, devices and goods manufactured, patented and supplied by four American companies (Messrs. Barber & Colman, the International Battery Co., the Krag Metallic Co. and the Woodward Governor Co.), to acquire such of the business of Messrs. Barber & Colman as is now carried on in Manchester, with the premises held in connection therewith, to adopt a certain agreement and to carry on the business of mechanical and electrical engineers, tool makers, metal workers, &c. First directors, H. D. Colman, W. A. Barber and R. C. Webster. Reg. office, 25, South Corridor, Royal Exchange, Manchester.

DEUTSCH-NIEDERLANDISCHE TELEGRAPHENGESELLSCHAFT.—A company was registered at Cologne on Tuesday with the above title and with a capital of 7,000,000 marks. The promoters are the Dresdener Bank. The head offices of the company will be in Cologne. The president of the new company is Herr W. Müller.

ELECTRIC FOG SIGNAL CO. (LTD.) (81,540.)—Reg. July 12, capital £10,000 in £1 shares, to acquire inventions relating to railway fog signalling, in particular to acquire benefit of certain existing inventions for an electric fog signalling apparatus and to turn to account any such inventions.

HARVEY & CO. (LTD.) (81,365.)—Reg. June 25, capital £240,000 in £10 shares, to acquire the business of Harvey & Co. (Ltd.), and to carry on the business of electrical, mechanical and general engineers, and makers of machinery for hydraulic, electrical, tramway, railway, agricultural and manufacturing purposes, to carry on any business relating to the winning and working of minerals, the production, smelting and working of metals, &c. First directors, F. Harvey, N. J. West, F. H. Harvey, J. Mead, J. Vivian and H. Whitford. Reg. office, Hayle, Cornwall.

LEMMON & CO. (LTD.) (81,576.)—Reg. July 14, capital £2,100 in £1 shares, to acquire business of surgical electricians carried on by R. J. Lemmon and H. Scholey at 19, Hanover-square, London, W., as Lemmon & Co., and to carry on the business of electricians, engineers, suppliers of electricity, manufacturers of anatomical, orthopædic and surgical appliances, &c.

LEWIS MOTOR CO. (LTD.) (81,425.)—Reg. June 30, capital £2,000 in £1 shares, to acquire and become licensors of patents for electric motors, dynamos and other electrical appliances, and to carry on the business of manufacturers of electric motors and dynamos and other electrical goods and appliances, electricians, electrical, mechanical and chemical engineers, suppliers of electricity, contractors for the construction and equipment of tramways and railways with electric or other mechanical power, &c. First directors, F. M. Lewis, B. P. Scattergood and A. R. Chorley. Reg. office, 4, South-parade, Leeds.

R. H. LONGBOTHAM & CO. (LTD.) (81,481.)—Reg. July 5, capital £10,000 in £1 shares, to acquire business carried on at Wakefield and Newcastle-on-Tyne as R. H. Longbotham & Co., to manufacture and deal in machinery, rolling stock, instruments, tools, &c., and to carry on the business of electrical, mechanical and general engineers, electricians, manufacturers, distributors and suppliers of electricity, &c. First directors: R. H. Longbotham, W. N. Hemingway and G. A. Longbotham. Reg. office, Ings Foundry, Ings-road, Wakefield.

MAGNETIC SEPARATOR (LTD.) (81,392.)—Reg. June 28, capital £1,250 in 5s. shares, to carry on business indicated by title and that of electrical and mechanical engineers, manufacturers of scientific, agricultural, industrial and other machinery, tool and boiler makers, metal workers, &c. First directors: J. T. Dawes, J. M. Moss, H. Higginbottom, W. de Wolf and A. R. Davis. Reg. office, 37, Tithebarn-street, Liverpool.

THERMIT LIMITED.—Reg. July 1, capital £50,000 in £10 shares, to acquire patent rights, trade marks and secret processes for the extraction and production of metals, alloys and other products from oxides and sulphides, the heating of metals to be welded, forged or otherwise dealt with, the making of moulds, &c., for operating the alumino-thermic process, in particular to acquire the trade marks Thermit and Corubin. First directors, Dr. H. Goldschmidt, Dr. K. Goldschmidt and R. Stutz.

STATUTORY RETURNS.

CALCUTTA TRAMWAYS CO. (LTD.)—In return to April 26 the capital is £525,000 in 105,000 shares of £5 each, of which 102,268 have been taken up. £5 per share has been called up on 44,088 shares, and £326,240 has been received (? including payments in advance). £185,100 is considered as paid on 58,180 shares. Mortgages and charges, £350,000.

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ROBERTSON ELECTRIC LAMPS (LTD.)—The return to May 19 gives capital as £50,000 in 5,000 shares of £10 each, of which 4,500 have been taken up. £10 per share has been called up on 4,400 shares and £44,000 has been received. £1,000 is considered as paid on 100 shares. Mortgages and charges, £10,000.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—According to return to July 5 the capital is £1,000,000 in 70,000 ordinary, 40,000 preference and 90,000 unclassified shares of £5 each, of which 68,983 ordinary and 40,000 preference shares have been taken up. £5 per share has been called up on 42,000 ordinary and 40,000 preference, and £2. 10s. per share on 10,983 ordinary shares, and £443,667. 10s. has been received. £80,000 is considered as paid on 16,000 ordinary shares. Mort. and charges, £179,947.

MORTGAGES AND CHARGES.

BATH ELECTRIC TRAMWAYS (LTD.)—A mortgage, dated July 1, 1904, to secure not more than £10,000, has been registered. Property charged, undertakings authorised by Bath and District Light Railways Order (1901) and Bath Electric Tramways (Light Railways Extensions) Order (1903) and all permanent ways, stations, power houses, sheds, rolling stock, &c., appertaining thereto, certain leasehold land in St. Michael, Bath, with buildings, fixed plant, &c., thereon, and company's general assets, present and future. Holders, Union of London and Smith's Bank

BRITISH ELECTRIC CALIBRATED FUSE CO. (LTD.)—Issue on July 11 of £100 debentures, part of series created Dec. 4, 1903, securing £3,000, charged on company's undertaking and property, present and future, including uncalled capital. Holder, J. Lang. No trustees. Previously issued of same series, £1,650.

CUTTING BROS. (LTD.)—Issue on June 20 of £2,600 debentures, part of series created same date to secure £4,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees.

ELECTRIC SUPPLY CORP. (LTD.)—In the issue of 46,600 shares of £5 each in this company recently offered for subscription allotment letters were posted on Monday.

ISLE OF THANET ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—Trust deed, dated July 6, 1904 (supplemental to two trust deeds dated Jan. 18 and Aug. 5, 1902, securing £50,000 debenture stock), has been registered. Property charged, company's undertaking and property, present and future. Trustees, City Safe Deposit & Agency Co.

OTTO ELECTRICAL MFG. CO. (LTD.)—Issue on June 23 of £1,500 debentures, part of series created June 22, 1904, to secure £5,000, charged on company's undertaking and property, present and future, including uncalled capital. Holder, J. Deakin. No trustees. No previous issue of same series.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26¾d. per oz. (July 21). Consols 88⅛—88⅜ for money, 88⅜—88½ for account; 2½ per cent. annuities 87⅞—88¼ (July 21). Consols Pay Day, Aug. 4; Stocks and Shares Continuation Days, July 26 and Aug. 10; Ticket Days, July 27 and Aug. 11; Pay Days, July 28 and Aug. 12; Mining Share Carry-over Days, July 25 and Aug. 9.

CENTRAL LONDON RAILWAY CO.—A dividend for the half-year ended June 30 of 4 per cent. on the undivided ordinary and preferred ordinary stocks has been declared, and a dividend at the same rate on the deferred ordinary stock, provided for and payable at the end of the year's working. The balance forward is £48,737, including £37,000 from previous half-year.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—Dividend warrants on account of the distribution for the year 1904 on this company's preference and ordinary shares have been posted.

DUBLIN & LUCAN ELECTRIC RAILWAY CO.—For the half-year ended June 30 a dividend of 10 per cent. on the preference shares is declared (reducing the arrears to nine months). £100 is placed to reserve and £161 carried forward.

LONDON ELECTRIC SUPPLY CORP. (LTD.)—The number of units sold for the half-year ended June 30 was 4,494,220, producing a gross revenue of £54,776, compared with 1,927,876 units in the corresponding period of 1903, producing £36,825.

METROPOLITAN RAILWAY CO.—A dividend has been declared for the past half-year on the consolidated stock at the rate of 3 per cent. per annum. A year ago the dividend was at the rate of 2½ per cent. per annum.

RIO DE JANEIRO TRAMWAYS, LIGHTING & POWER CO.—A syndicate of Canadian and American capitalists has formed this company with a capital of $50,000,000. Amongst the principal promoters is Sir William Van Horne, who participated in the establishment of a similar company in Cuba.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—During the midsummer quarter the quantity of electricity sold is returned at 1,431,553 units, estimated to produce £22,964, against 1,460,572 units, which produced £23,612 for the corresponding period of last year.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed July 27 a special settling day in 120,000 £5 fully-paid ordinary shares of the *Anglo-Argentine Tramway Co. (Ltd.)*, and have ordered the same, as well as a further issue of 1,235 £10 fully-paid ordinary shares of the *British Electric Traction Co. (Ltd)*, to be quoted.

SOUTH LONDON ELECTRIC SUPPLY CORP. (LTD.)—The accounts for the half-year ended June 30 show a net profit of £14,149, against £5,210 for the corresponding six months of last year.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	...	...	...	...	...	...
Airdrie	July 8	209	...	22	4,292	...
Ayr Corporation	,, 16	503	+ 82	9	3,208	+ 28
Barnsley	,, 8	164	- 16	27	4,482	- 802
Barrow	,, 8	233	...	22	3,585	...
Bath Electric Trams, Ltd.	,, 13	745	...	28	16,488	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	...	...	...	...	...	...
Birmingham Corporation	...	...	...	...	...	...
Birmingham Tramways Co.	,, 16	5,771	+ 592	2	11,569	+ 1,253
Blackburn Corporation	,, 15	1,067	+ 216	16	15,450	+ 1,310
Blackpool Corporation	,, 14	1,419	+ 64	15	18,970	+ 726
Blackpool and Fleetwood	,, 16	964	+ 160	2	2,101	- 344
Blackp'l, St. Anne's & Lytham	,, 14	651	+ 106	87	9,964	+ 5,878
Bolton Corporation	,, 17	2,033	+ 102	16	29,908	+ 54
Bournemouth Corporation	,, 13	1,266	+ 160	‡15	16,524	+ 954
Bradford Corporation	,, 16	5,211	+ 1,133	15	71,185	+ 12,449
Brighton Corporation	,, 17	1,213	+ 231	15	15,068	+ 697
Brisbane Tramways	May 25	2,378	+ 104	22	50,588	+ 557
	June 1	2,331	+ 269			
Bristol Trams & Carriage	July 15	5,645	+ 269	8	43,802	- 767
Buenos Ayres & Belgrano	June 19	3,188	+ 429	9	29,967	+ 1,105
Burnley Corporation	July 16	1,268	+ 328	16	16,960	+ 4,131
Burton Corporation	...	...	...	...	...	...
Calcutta Tramways Co.	,, 16	s36,182	+s4,500	3	s64,952	+ s9,891
Camborne-Redruth	,, 18	118	- 9	11	1,280	- 98
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co.	,, 16	232	+ 8	28	5,463	+ 317
Central London Railway	,, 16	6,282	- 315	2	12,646	- 875
Chatham & Dist. Lt. Rys.	,, 14	721	+ 54	28	15,954	+ 2,082
City & South London Rly.	,, 17	2,272	- 218	3	7,119	- 299
Cork Electric Trams Co.	,, 14	612	- 68	28	12,605	- 1,055
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 8	690	+ 123	27	13,854	+ 2,262
Dover Corporation	,, 16	290	+ 26	16	3,509	- 219
Dublin & Lucan Railway	,, 15	144	+ 19	2	305	+ 85
Dublin Southern District	,, 15	1,204	+ 136	2	11,585	- 21
Dublin United	,, 15	4,394	+ 134			
Dudley—Stourbridge	,, 8	975	+ 91	27	22,800	+ 778
Dundee Corporation	,, 13	814	- 20	...	...	...
East Ham Council	,, 16	804	+ 85	15	11,886	+ 1,087
Gateshead & Dist. Trams	,, 8	902	+ 40	27	24,046	+ 1,094
Glasgow Corporation	,, 16	15,109	+ 1,543	††7	96,563	+ 2,033
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 8	306	- 4	27	6,602	+ 689
Gt. Northern & City Rly.	,, 16	959	- 9	22	20,888	...
Greenock & Port Glasgow	,, 8	741	+ 101	27	14,519	+ 680
Halifax Corporation	,, 6	1,648	+ 155	15	23,006	+ 1,594
	,, 13	1,847	+ 292			
Hartlepool Tramways	,, 8	331	- 8	27	7,526	+ 692
Huddersfield	,, 16	1,428	+ 99	15	20,740	+ 860
Hull Corporation	,, 16	2,268	+ 394	15	32,868	+ 3,970
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	,, 13	161	- 46	9	2,721	+ 281
Ipswich Corporation	,, 16	621	...	15	7,778	...
Isle of Thanet Co.	,, 16	1,322	+ 43	2	2,446	- 8
Kidderminster & District	,, 8	161	+ 6	27	3,174	- 129
Kirkcaldy Corporation	,, 13	246	+ 80	28	6,101	...
Lanarkshire Trams Co.	,, 14	669	...	23	17.281	...
Leeds Corporation	,, 16	6,400	+ 690	18	94,168	+ 5,860
Leicester Corporation	,, 16	1,466	...	9	10,494	...
Liverpool Corporation	,, 9	11,199	+ 597	28	281,454	+ 6,404
Liverpool Overhead Rly.	,, 18	1,722	- 20	†3	5,083	- 49
*London County Council	,, 2	13,329	+ 1,835	§13	156,931	+ 26,152
Lowestoft	,, 16	291	...	¶51	10,157	...
Manchester Corporation	,, 16	13,486	+ 1,417	15	186,521	+ 6,126
Mersey Railway	,, 16	1,384	+ 24	2	2,818	+ 61
Merthyr	,, 8	204	- 32	27	5,404	+ 134
Middleton	,, 8	376	- 18	27	8,454	+ 67
Nelson Corporation	,, 16	128	+ 31	16	1,870	+ 783
Newcastle-on-Tyne Corp.	,, 16	4,149	+ 861	2	7,691	+ 1,165
Newport (Mon.)	,, 16	555	+ 90	15	7,888	+ 1,766
Oldham, Ashton & Hyde	,, 8	569	- 21	27	14,475	- 826
Oldham Corporation	,, 3	1,165	...	18	20,688	...
	,, 10	1,250				
Perth (W. A.) Elec. Trams.	,, 15	1,286	+ 139	28	37,413	+ 4,986
Peterborough	,, 8	316	+ 19	27	3,875	- 155
Poole and District	,, 8	350	- 7	27	7,518	- 19
Portsmouth Corporation	,, 16	2,567	+ 366	†15	31,136	+ 2,585
Potteries	,, 8	1,763	+ 296	27	45,628	+ 3,747
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rotherham	,, 8	249	- 53	27	2,586	- 104
Salford Corporation	,, 18	4,402	+ 263	16	64,676	+ 5,259
Sheerness	,, 6	89	- 2	27	1,502	- 398
Sheffield Corporation	,, 17	4,902	+ 418	§16	76,886	+ 2,511
Southampton Corporation	,, 14	1,080	- 103	...	...	...
Southend Corporation	,, 13	506	+ 59	15	5,154	+ 432
Southport Tramways	,, 8	395	+ 17	27	8,211	+ 451
S. Staffordshire Trams.	,, 8	725	- 250	27	20,857	- 1,749
Stockport Corporation	,, 15	743	+ 406	15	9,176	+ 3,987
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	,, 8	545	- 1	27	13,848	+ 796
Taunton Trams	,, 8	63	+ 5	27	1,418	- 103
Tynemouth and District	,, 8	849	- 64	27	7,214	- 429
Tyneside Trams Co.	,, 13	479	+ 75	28	10,262	+ 1,859
Wallasey District Council	,, 16	927	+ 74	§15	11,596	+ 596
Walsall	...	...	...	...	...	...
Warrington Corporation	,, 14	333	+ 28	15	4,862	+ 115
West Ham Corporation	,, 14	1,149	...	20	15,479	...
Weston-super-Mare	,, 6	215	+ 12	27	2,052	+ 6
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 8	396	- 87	27	10,181	- 240
Worcester	,, 8	363	+ 203	22	6 545	+ 2,823
Wrexham	,, 8	118	- 10	27	2 971	- 355
Yorkshire Woollen District	,, 8	651	+ 279	27	15,615	+ 6,699

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 8 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., July 20	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE.	BUSINESS, WEEK TO JULY 20. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	5 —5¼	4 15 3	April, Oct	5½	6¼
St.	6%	Do. Permanent 6% Deb. Stock	137 —141	4 5 0	..	140½	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	98 —100	5 0 0	..	99½	99
10	6%	Barcelona Tramways Ord.	8 —9	3 6 8	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	93 —98	4 13 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 —100	5 2 0	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	1 1/16—1 3/16	..	..	..	..
1	..	Do. 5% Cum. Pref.	1/16—1	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1¼—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96 —101	4 9 3	..	97	..
10	8%	Bristol Tramways and Carriage Ord.	18½—19½	4 2 1	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 15 3½	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100 —103	5 16 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	99 —102	4 18 6	..	..	..
10	5/0	† Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
40	4½%	† Do. 4½ per Cent. 1st Mort. Debs.	103%—105%	4 6 2	..	104½	..
100	4½%	† Do. Vancouver Power Debs.	97 —100	4 10 0	..	..	..
10	6/0	†British Electric Traction Ord.	8½—9½	8 8 5	..	8⅞	8⅝
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—11	5 9 1	Feb, Aug	10 15/16	10 13/16
St.	5/0	Do. 5 per Cent. Perpetual Debs	116 —119	4 5 1	..	..	..
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	95 —98	..	..	..	..
5	3/0	Buenos Ayres and Belgrano Ord.	2¾—3½	4 16 0	..	3 1/16	3
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼—5¾	5 4 4	..	5 1/16	..
5	3/0	Do. "B"	5 —5½	5 9 1	..	..	..
St.	5%	Do. 5 per Cent. Debs.	105 —108	4 12 8	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	101 —104	4 16 6	..	102½	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	94 —99	5 1 0	..	..	..
5	3/6	Calcutta Tramways	7½—7¾	3 17 6	..	7 7/8	7½
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 3 3	..	106½	105
1	1/0	†Cape Electric Tramways Shares	1¾—2	5 0 0	..	2	..
St.	4%	Central London Ordinary Stock	89 —92	4 7 3	June, Dec	91½	90⅝
St.	4%	Do. 4 per Cent. Pref. Stock	102 —105	3 17 3	..	104½	102¾
St.	4%	Do. Deferred Stock	79 —82	4 17 7	..	81½	..
100	4%	† Do. 4 per Cent. Debs.	106 —109	3 13 5	..	108	107
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2%	City and South London Rly. Con. Ord.	47 —49	4 16 11	Feb, Aug	48⅜	47½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —126	4 0 0	Feb, Aug	..	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 —109	3 13 5	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 10	..	..	..
10	6 0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8⅓	Gt. Northern & City Rly. Prf. Ord. (4%)	4 —5	..	..	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	18 —19	5 5 3	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	13¾—14¾	4 2 10	Mar, Sept	..	..
St.	4¼%	‡ Do. 4½ per Cent. Debs.	107 —109	4 2 8	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¼—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 —91	4 7 11	..	..	..
10	1½%	Liverpool Overhead Railway Ord	3¾ —4	3 8 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10⅛—11	4 10 1	..	10¾	10½
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —105	3 16 4	..	104	102¾
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	¾—¼	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	¼—1	5 0 0	..	1/16	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..
100	4¼%	Do. Sterling 4½% Debs. (1922)	105 —107	4 5 0	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 —2	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99—102	4 18 1	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	..	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	April, Oct	..	..
St.	3%	Waterloo and City Ord.	89 —92	3 7 11	Jan, July	..	..
					June, Dec	91½	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	97 —101	3 19 2	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	12/6	Anglo-American	46 —49	5 18 0	F,My,Ag,N	..	..
St.	25/0	Do. Preferred	91 —93	6 3 6	F,My,Ag,N	92⅝	91⅜
St.	2/0	Do. Deferred	6⅛—7	1 8 7	F,My Ag,N	..	..
100	£2	Commercial Cable Capital Stock	170 —180	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93 —95	4 2 6	Jn Ap,Jy,O	95	94
10	5/0	Cuba Submarine Ord.	6¼—7¼	8 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2¼—3¼	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98%—101%	4 9 2	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10½	6 4 0	Ja,Ap,Jy,O	10¼	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 —101	4 9 2	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	126 —131	5 7 0	Ja,Ap,Jy,O	131	129
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 —89	3 18 6	Ja Ap,Jy,O	88⅛	87½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 6	May, Nov	107	105½
10	2/6	†Eastern Extension	11¾—12¼	5 14 3	Ja,Ap,Jy,O	12⅛	12
St.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 15 0	Feb, Aug	107	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	99 —102	3 19 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99½—102%	3 18 9	May, Nov	101¼	100
10	5/0	Gt. Nrthn. (of Copenhagen) excoupon 61	25⅛—26⅛	5 13 2	Jan, July	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 —101	4 9 2	June, Dec	..	..
25	37/6	Indo-European	42 —45	5 11 2	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..
10	6/0	West African Telegraph Shares	6 —7	5 14 3	..	..	..
2½	..	West Coast of America	1/16—3/16	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	96	..
10	..	West India and Panama	3/8—1/2	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½—6¾	8 17 9	May, Nov	6⅞	6½
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 —102	4 18 1	Jan, July	..	..
10	3/0	Western Telegraph	12½—13	5 7 8	Mr,Jn,O,D	12 9/16	12½
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 16 3	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99 —102	3 18 5	..	100½	99½
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5½	5 14 4	..	..	..
10	5/0	Globe Telegraph and Trust	8¾—9½	5 19 0	Ja Ap Jy O	9	8 11/16
10	3/0	Do. 6 per Cent. Pref.	13¼—13¾	4 7 2	Ja Ap,Jy,O	13⅝	13 7/16
8	4/0	Reuter's	6¼—7¼	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	118 —123	4 18 9	April, Oct	..	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed., July 20.	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE	BUSINESS WEEK TO JULY 20. Highest.	Lowest.
		TELEPHONES.					
5	2/0	Chili Telephone (fully paid)	5 —5½	5 9 1	August ..	..	..
1	7½	Monte Video Telephone Ord.	1/8—9/16	..	..	..	..
St.	6%	National Co. Pref. Stock	106 —108	5 13 9	..	107¼	106
St.	5%	Do. Def. Stock	89 —92	5 11 2	..	92½	90
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 8	Feb, Aug	13 5/16	12⅝
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅛—5⅜	4 13 0	Feb, Aug	5 1/16	5 1/16
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 —99	3 10 8	June, Dec	98½	97½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 —105	3 16 2	..	104½	..
..	5/9	Dc. Do. Prov. Certs. 35% to be pd.	64 —65	..	..	..	..
1	0/8⅜	Oriental	1/8—1 3/16	6 6 3	April, Oct	..	..
1	0/7⅛	Do. 6 per Cent. Cum. Pref.	1 —1⅛	6 4 6	..	..	..
5	5/0	United River Plate	6 —6⅜	6 3 3	July.....	5 1/16	4¾
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5½	4 15 3	June, Dec	5 1/16	4⅝
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 —106	4 14 4	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord. (f.p.)	⅞—1	..	..	..	..
1	0/8⅜	Do. 7% Cum. Pref.	1⅛—1⅜	5 1 9	..	..	..
St.	..	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con. Ex Bonus of 25% Deb. Stk.	100 —105	4 7 0	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
St.	4¼%	Do. 4¼ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
5	..	Bromley (Kent) El. Lt. & Power Shares	5½—6	..	..	..	..
St.	4½%	Do. Do. 1st Debs	100 —103	4 7 5	..	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord	10¾—11¼	4 8 11	..	11	..
5	3/6	Do. 7 per Cent. Pref.	10¼—10¾	3 5 1	Mar, Sept	10⅜	..
5	4/0	Calcutta Electric Supply Ord.	7 —7½	4 13 4	..	7½	7⅜
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105 —108	3 14 1	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7⅛—8	5 0 0	Feb, Aug	7⅜	7⅛
5	2/3	Do. 4½ per Cent. Pref.	5¼—5½	4 1 10	Feb, Aug	5 1/16	5 1/16
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	..	4 13/16	..
5	2/3	Do. Do. (19 3)	4½—5	..	..	4 13/16	..
St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 0	..	103¼	103
5	3/6	Chelsea Electric Supply Ord.	6¼—6¾	4 1 6	March ..	6⅞	6¾
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 2 6	Jn, Dec ..	..	..
10	5/0	†City of London Electric Lighting Ord.	10¾—11¼	4 8 10	Feb, Aug	11	..
10	6/0	† Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	120 —125	4 0 0	Jn, Dec ..	..	..
St.	4¼%	Do. 4¼% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	102	..
10	4/0	County of London Elec. Supply Ord.	7½—8½	4 14 3	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	11⅝	11⅜
St.	4¼%	Do. 4¼% Deb. Stock (all paid) (red.)	105 —108	4 3 6	..	106⅜	06
St.	4¼%	Do. Second Deb. Stock Prov. Certs.	100 —103	4 8 0	..	..	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 —93	5 7 6	..	..	..
5	3.6	Folkestone Electricity Supply Co. Ord	5½—6	4 11 8	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 8 0	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
5	5/0	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	7⅝	..
St.	4½%	I of W. Elec Lt. & Power 4½% Db. St (red.)	101 —103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	1/32—1/32	..	..	..	..
5	7/0	Kensingtn & Knghtsbdge Ord.	12 —13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	..	..
3	..	London Electric Supply Ord.	1½—1⅝	..	..	1½	..
5	3/0	Do. 6 per Cent Pref.	4¾—5½	5 14 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	94 —97	4 2 11	Mr,Jn,S,D	..	..
10	9 6	Metropolitan Electric Sup. Ord.	21 —22	3 19 7	April, Oct	21¾	21½
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5½	4 1 10	Jan. July	5 1/16	5 1/16
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort	108 —112	4 0 4	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.	96 —99	3 10 6	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93 —16	4 13 9	..	..	..
10	6/0	Notting Hill Electric Ord.	13½—14½	4 2 9	March....	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	100 —103	3 18 3	..	..	..
5	4.0	Oxford Electric Ord.	5½—6	5 8 4	March ..	..	..
St.	4%	† Do. 4% Deb. Stock	97 —100	4 0 0	..	..	..
1	..	Rand Electric	1 —1½	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb	100 —103	4 7 9	April, Oct	..	..
5	9 6	St. James' & Pall Mall Elec. Ord.	14½—15½	4 13 7	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	8¾	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	96 —99	3 10 6	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¾—3½	6 3 1	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	3/0	South London Electric Supply Ord.	3¾—4¼	3 10 7	..	..	..
5	2/6	Urban Electric Supply Ord.	4½ 5	5 0 0	..	..	..
5	2/6	Do. 5% Cum. Pref.	4½—5	5 0 0	..	4 15/16	4¾
5	7/0	Westminster Electric Supply Ord.	12½—13½	5 0 0	Mar, Sept	13½	12 15/16
5	2/6	† Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	6⅜	..
		ELECTRIC MANUFACTURING &c.					
1	..	Aron Elec. Meter 6% Cum. Pref.	⅛—⅜	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾—6¼	6 8 0	July, Feb	5¼	..
5	3/0	Do. 6 per Cent. Pref.	5¾—6¼	4 16 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 7	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	3½—3¾	8 0 0	..	3 7/16	3⅜
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	85 —88	4 10 11	..	86¼	..
2	..	Brush Electrical Engineering	½—1	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	¾—1½	9 12 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	71 —76	5 18 4	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½—10½	5 14 3	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5½	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	101 —105	4 5 8	Nov, May	102	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	92	..
1	1/2⅔	Chadburn's (Ship) Telegraph Ord.	¾—1⅛	8 0 0	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¾—2¼	6 13 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	94 —97	5 3 6	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7½—8	..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5 —5½	5 9 1	..	5⅛	..
St.	4½%	Do. 4½% Deb. Stock	103—105	4 5 9	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅞—¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 —82	4 18 1	June, Dec	7⅛	89
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	77 —82	6 4 0	..	89	79½
5	2/6	Edmundson's Elec. Corp. Ord.	6 —6½	5 7 8	H'lf-yearly	6⅛	6⅛
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅜—6	5 0 0	..	5 1/16	5⅛
St.	4½%	† Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 4 0	..	106⅛	..
2	1/2½	Electric Construction Co.	1¼—1⅜	8 14 6	Jan, July	1 5/16	1⅜
2	2/9½	Do. 7 per Cent. Cum. Pref.	2¼—2⅜	5 2 0	July	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Deb. (red.)	96 —99	4 0 9	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 —9½	5 5 3	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	11 —12	6 5 0	Feb, Aug	11⅜	11
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	5 1/16	5
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 6	Feb, Aug	18⅝	18⅜
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	12/0	†Telegraph Construction & Mainten'ce.	36 —39	6 3 0	Mar, July	38½	37
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	99 —102	3 18 5	Jan, July	..	..
5	..	Willans and Robinson Ord.	2 —3	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3 —4	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	78 —83	4 17 0	May, Nov	..	..

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NOTES.

AN interesting report on Mines and Quarries by Mr. HENRY HALL, Inspector of Mines for the Liverpool and North Wales District, has just been issued by the Home Office. It consists mostly of statistics and details relating to accidents which occurred during the year 1903, and it is pleasing to note that none of these have been attributed to electricity. Mr. HALL says that the use of electricity is making rapid progress and headway for hauling, pumping and coal-cutting, and it is its adaptation to the last-named work which will have to be carefully watched and its dangers adequately guarded against. He calls attention to the fact that "with the ordinary motor for coal cutting a good deal of sparking takes place when the machine meets with unequal resistances, for instance, when the cutting tools come in contact with hard substances, such as iron pyrites; and these sparks would no doubt ignite fire-damp if it happened to be present." He is of the opinion that it would be exceedingly difficult to keep an enclosed motor sufficiently cool to allow of it doing its work properly, and if this be the case,—which we take leave to doubt,—it seems that there is nothing for it but to abandon the idea of using continuous-current machines in fiery mines and devote attention exclusively to induction motors.

IN spite of the great advances which are being made in coal cutting by machinery, it appears that coal so obtained still forms but a very small part of the whole production, only about half-a million tons, or 3 per cent., being got in this way. These figures refer, of course, to Mr. HALL'S district, in which there are now about 80 machines at work, out of which only five or six are driven electrically, the remainder being operated by compressed air. Each machine produces, on the average, about 7,000 tons annually, an amount equal to the output of seven or eight miners. Regarding electrical coal-cutters, it is somewhat disappointing to learn that Mr. HALL thinks that they will not result in any great economy, but in this opinion he is not supported by many colliery experts. He adds that there are several seams in Lancashire where machine cutters might pay, and where they are being tried, but faulty ground and soft friable roofs make their general use even in these seams sometimes impracticable. Their only chance is in thin hard seams, where the colliers' "getting" price is very high, or in seams where the machine can do the holing in the under-clay and thus add substantially to the percentage of round coal.

MR. HALL appears, however, to have overlooked the fact that the efficiency of a coal-cutting machine is not to be rated by merely comparing its output with that of a given number of men, as far as actual working cost is concerned. It is a fact that, under certain conditions, the output of a colliery may be at least doubled by substituting coal-cutting machinery for manual labour, and this point is of the greatest possible importance when considering standing charges, which are often exceedingly heavy. Besides, it is rather early yet to draw conclusions as to the ultimate success or failure of coal cutting by electricity, owing to its having been adopted so recently and the more or less imperfect conditions governing its present working. There has always been opposition to the introduction of labour-saving machinery, and electric coal-cutters have, unfortunately, enjoyed no exception to the rule, but this opposition is by no means insuperable, and will doubtless soon die out. When once electricity is adopted as the only means of conveying energy in collieries, then the coal-cutting machinery, if worked on a properly-organised system, will form an integral part of the whole plant, and not until then will it be possible to determine its true value.

AN important statement was made by Sir HENRY FOWLER, M.P., presiding at the ordinary general meeting of the National

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Telephone Co., which took place last Friday. It will be remembered that, by giving notice to the company not later than June 30th last, the Government would have had the power of compulsorily acquiring the company's undertaking as from December 31st, but, in spite of certain negotiations having been carried on, the notice was not given. However, the negotiations referred to by the Postmaster-General on June 16th are still proceeding, and from Sir HENRY FOWLER'S remarks it is possible that the transfer will take place by agreement, at no distant date. Naturally, no details were given, as matters have not reached a sufficiently advanced stage, but it is at least satisfactory to know that the question has not been dropped, and it may therefore be hoped that State control of telephony will soon be a *fait accompli*.

ALTHOUGH it has been known in a general way for a long time that the electrical resistance of iron increases with the amount of impurities it contains, and particularly with the percentage of manganese, yet Mr. J. A. CAPP'S article on this very timely subject is of considerable value inasmuch as his figures indicate clearly to what extent the resistance of iron depends upon the various impurities. This information cannot fail to be of considerable use, both to the steel maker and to the engineer who has to draw up specifications for third-rails. In cases where the third-rail has to be specially ordered, the rectangular cross-section of rail proposed by Mr. POTTER offers advantages as far as cheapness and convenience are concerned. At the present time, however, it is more usual for steam railways to be adapted to electrical working than for entirely new electric railways to be constructed, and considerable economy is sometimes effected by using old track rails for the conductor or third-rail. The high resistance of these old track rails is frequently of minor importance, since the deficiency in this respect is, as a rule, compensated for by large cross-section. It is only in the case of a large amount of traffic, calculable beforehand from the technical and commercial data, that it would be advisable for economical reasons to substitute specially rolled rails.

THE curious business methods of the London County Council are instanced by a joint report which has recently been issued by the Finance and General Purposes Committees. It appears that the Finance Committee has been deliberating for some time on the enormous capital expenditure for which the Council has become liable, and it has been deemed expedient that the Councillors should be kept better informed of the extent of the Council's capital commitments. Between them the two Committees have evolved a scheme under which each Committee shall, before February 1st in each year, prepare estimates of the capital expenditure during the financial year and the following six months respectively. The various reports will then be considered by the Finance Committee, who will allow a margin for contingencies, and the anticipated total will subsequently be placed before the Council. But there is also to be given an estimate of what it is anticipated will have to be loaned to various local authorities. If the estimates, on coming before the Council, are approved, they will be inserted in the Money Bill for the ensuing year. This proposal is certainly a sensible one, although it will probably prove by no means easy of execution, while the estimates are almost sure to be fairly wide of the mark. In addition to this suggestion of new procedure, however, the report recommends that in the case of contracts for works exceeding £100,000, the contracts are not to be signed by the Council until the terms of payment have been investigated and approved by the Finance Committee. Also when any Committee proposes the expenditure of more than £50,000, it must discuss matters with the Finance Committee before bringing proposals to the Council. Finally, half-yearly returns of the Council's commitments on capital account for all departments are to be prepared by the Finance Committee, who will also submit to the Council a similar statement every year. Thus it is hoped that an approximate idea of the financial position will be available before fresh ventures are attempted.

THROUGHOUT the numerous discussions which have taken place in Parliamentary Committee rooms concerning the equity of the "Bermondsey" clause, it has always been maintained by the champions of municipal trading that the object of the gas companies was, and the effect of the clause would be, to prevent the extension of an electrical undertaking by making consumers afraid to adopt electric light with the possibility of an annual increase in the price hanging over their heads. This view is held by the Ilford Urban District Council so far as to induce them to abandon an application for free wiring powers in respect of which the House of Lords Committee imposed the "Bermondsey" clause, more or less in its original form. But we venture to think that this state of affairs need only hold good for this session, because the clause inserted by the House of Lords Committee in the Ilford Bill was prior to the one drafted by the Duke of Northumberland which is much less oppressive—if, indeed, it is oppresive at all—and which is being regarded as a more valuable precedent in view of the reasons given by the Duke of Northumberland for propounding his modification of the original clause. In fact, promoters of electrical undertakings might almost concede the latter clause to the gas companies without any misgivings in order to save the expense of an opposition.

ON another page of this issue will be found a brief description of the new system of electric tramways in the North of London opened to the public last Friday. It will be seen from the map which we reproduce that the area to be served is a very large one, although the total route miles do not reach so large a figure as that of the South London tramways. Of course, the two undertakings differ in several points, the chief being that the system worked by the Metropolitan Electric Tramways Co. follows standard overhead practice. Another point is that the company do not generate their own energy, but they obtain a supply "in bulk" from the Brimsdown station of the North Metropolitan Electrical Power Supply Co. It is interesting to observe that current is generated there at 11,000 volts, which is the highest voltage used for supply to tramways in this country.

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Pacific Cable Conference.—This conference, which was to have been held in London during July, has, we learn on good authority, been postponed until November, at the request of the Government of Canada.

Personal.—According to *Nature*, the Paris Academy of Sciences has awarded the Lecomte prize of 50,000fr. for the most interesting work in physical science to Prof. Blondlot for his researches on the *n*-rays.

Opening of the Derby Corporation Tramways.—The official opening of the Derby Corporation tramways took place on Wednesday. A full illustrated description of the combined lighting and tramways undertaking at Derby appeared in our issues for June 10th and 17th.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Relssi-Issa (Yemer)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Cayenne—Paramaribo	July 13, 1904
Assab—Massowah	July 26, 1904

The Raworth Regenerative System of Tramcar Control.—A demonstration of this system was given on the Gravesend and Northfleet Electric Tramways, by permission of the directors, on Wednesday. By means of an ammeter with a middle zero scale, regenerative effects were observed in slowing down to take the points on entering passing places, &c.; the various braking and regenerative effects were also clearly and forcibly demonstrated when the car descended a gradient of 1 in 11. The car was of a pattern designed by Mr. J. S. Raworth, and known as a "one-man" car, owing to the fact that only a driver is required for its operation. Details of experiments similar to those carried out at Gravesend were described in *The Electrician*, Vol. LI., p. 526, and the "one-man" car was illustrated on p. 885 of the same volume. Mr. Raworth's patents covering his regenerative control system were dealt with on p. 46 of our issue of April 29th.

British Association.—The following programme of Papers has been arranged for reading before Section G (Engineering) at the forthcoming Cambridge meeting, but is subject to alterations and additions:—*Thursday, August 18th.*—11:30 a.m., address by the Hon. C. A. Parsons, President of the Section; 2 p.m., lecture by Mrs. Ayrton, "The Origin of Sand Ripples." *Friday, August 19th.*—Mr. C. Dugald Clerk, "The Internal Combustion Motor in Britain"; Prof. B. Hopkinson, "Some Tests on small Gas Engines." To be followed by a general discussion. *Monday, August 22nd.*—Mr. C. H. Merz, "The Use of Electricity on the North-Eastern Railway and on Tyneside"; Mr. A. A. C. Swinton, "Electricity from Water Power"; Mr. W. M. Mordey and Mr. A. G. Hansard, "Energy Losses in Magnetising Iron"; Prof. J. A. Fleming, "Large Bulb Incandescent Lamps as Secondary Standards of Light." *Tuesday, August 23rd.*—Major Sir Hanbury Brown, K.C.M.G., "The Control of the Nile"; Mr. J. H. Wicksteed, "A Universal Testing Machine of 300 tons for full-sized Members of Structures"; Mr. S. Cowper-Coles, "A New Process for applying Zinc to Metallic Surfaces"; Mr. J. W. Hayward, "The Effects of Receiver Drop in a Compound Engine."

Opening of the Northampton Corporation Tramways.—The Northampton Corporation tramways were opened to the public on Thursday last week by the Mayor. The system was authorised in 1901 by a provisional order granted by the Board of Trade under the Tramway Act of 1870. The total mileage is 9 miles of single track and 5½ miles double track of 3ft. 6in. gauge. Ordinary overhead equipment has been adopted with side arms and span wires. The rails are of the girder type weighing 90lb. per yard, and the feeders, which are laid under the footpaths in Sykes conduits, are of 0·2 sq. in. and 0·6 sq. in sections. Twenty double-deck single-truck cars have been ordered, each having a seating capacity of 45 passengers and equipped with hand, slipper and electric brakes. The Corporation have erected their own power station in conjunction with a refuse destructor, but the lighting of the town is at present carried out by the Northampton Electric Light and Power Co. The Corporation power station contains two Lancashire boilers, having a total evaporative capacity of 26,000lb. per hour, which supply steam to three Willans-International Electrical Engineering Co.'s sets, which have a total capacity of 550kw. There is also a 360-ampere battery working in conjunction with reversible boosters. Mr. A. Fidler has acted as consulting engineer and Mr. Gottschalk is the manager of the system.

City and Guilds of London Institute.—At a meeting of the Council of the City and Guilds of London Institute held on Monday afternoon, the diploma of "Associate of the City and Guilds Institute" was awarded to the following matriculated third-year students of the Central Technical College who have completed a full course of instruction as prescribed by the Council:—

Civil and Mechanical Engineering.—H. D. Creedy (Siemens medal), J. M. de Artola Soruco, W. G. Banister, A. A. Barnes, G. A. Beggs, F. S. Bond, L. J. G. Bowers, S. Bowen, A. Carmichael, E. M. Cory, O. C. Daniell, J. A. V. Dupré, S. S. Elliott, T. G. Garforth, C. W. Gibbs, G. R. Griffin, H. R. Liebstein, N. N. Maas, F. Neuhaus, H. A. Newton, R. H. Osler, R. Peters, E. F. R. Pole, R. B. Robinson, W. S. Strachan, A. H. Street, O. H. Teulon, O. W. Thomas, S. M. Udale, A. E. M. Van der Meersch, R. F. Vogel, E. G. Walker, F. E. Walker, H. J. Wheaton, H. H. Wilder, J. W. Wooding. *Electrical Engineering.*—H. W. Purle (Siemens medal and premium), A. M. Beale, A. Cunnington, C. H. Davidson, O. I. Davis, C. F. Edwin, E. Fisher, C. J. Guttmann, R. A. Harris, M. Hayashi, H. W. Kefford, W. C. C. Langdon, H. C. Lott, W. H. Lowe, C. B. R. Merton, C. J. C. Moon, A. R. Palmer, L. M. Rampal, L. I. Solomon, T. D. W. Weston, J. L. Wilson. *Chemistry.*—P. S. Arup, T. R. Lucas, Miss M. N. Reid, R. W. Tonkin.

In addition to the above, certificates have been awarded to 32 matriculated third-year students who have completed a full course of instruction at the Central Technical College and to 61 students who have completed a full course of instruction at the Technical College, Finsbury.

Society of Engineers.—A visit was made by the president (Mr. D. B. Butler) and members of the Society of Engineers on Wednesday to the shipbuilding and engineering works of Messrs. Yarrow & Co. at Poplar, where they witnessed the building and engining of light-draught high-speed craft of all kinds, notably torpedo boats, destroyers and light-draught gunboats. Electrical driving has been adopted in the works, the main motive power being supplied by three Belliss and Morcom compound-condensing engines, which drive three Parker dynamos direct, each dynamo being capable of an output of 430 amperes at 210 volts. Steam is supplied by three Lancashire boilers. Over the boiler house is a cast-iron tank, in which is a Ledward evaporative condenser. The drainage from the main roofs is collected in the tank and is used for condensing purposes, an economy in the use of the town water thus being effected. Most of the machine tools in the various shops are of the latest pattern and are placed in groups, each line of shafting being driven by its own motor. The shafting is 3in. in diameter and runs at 140 revs. per min. Larger machines, which are not continuously at work, are driven by independent motors. The shops are fitted throughout with electric travelling cranes made by Messrs. Adamson. The air-compressing machinery is also driven electrically, a very complete pneumatic system being laid down throughout the works. There are arrangements for delivering compressed air on board vessels in course of construction on the river bank. The principal tools are fitted with pneumatic hoists. There is also a complete installation of hydraulic plant which has been specially designed for the construction of the Yarrow water tube boiler. Electric lighting is partially used in the establishment, the current being produced by the same dynamos that supply power; the circuits, however, are kept separate. The shops are all heated by steam which is taken from the main boilers, and the various departments are all in telephonic communication. These new works which give employment to about 1,200 men, are of such capacity and so advantageously arranged that Messrs. Yarrow are enabled to carry out on the same premises nearly the whole of the operations connected with the building and engining of the vessels they construct. The whole of the plant and machinery is of the newest type and so laid down and arranged that they afford every facility for convenience in the execution of work and punctuality in its delivery.

Visit of the Glasgow University Engineering Society to Germany.—The members of the Glasgow University Engineering Society, accompanied by some 15 members of the

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University College (London) Engineering Society, have just returned from a 10 days' trip to Germany, in the course of which they have visited the chief engineering works and shipbuilding yards in Hamburg, Kiel, Berlin and Stettin. The party, numbering 72 in all, included the Presidents, Dr. Henderson, from Glasgow University, and Prof. J. D. Cormack, from University College, London. On arrival in Hamburg on July 15th, the party proceeded at once to visit the yard of Messrs. Blohm and Voss, where the floating docks and power station were of particular interest. A tour round the harbour followed, and in the evening the party moved on to Kiel. The following day was spent in visiting the Imperial and the Germania shipbuilding yards. The forenoon was devoted to the former, and, thanks to the courtesy of the authorities and the chief constructors, who conducted the party, the visit proved an exceptionally interesting and instructive one. A thorough inspection was made of the warships "Barbarossa" and "Roon," of which the former is undergoing repairs and the latter is in course of construction. In the afternoon the visit to the Germania yard proved not less interesting, the admirable modern equipments of the yard and the forethought of Messrs. Krupp for the welfare of their workmen presenting many striking features. In the course of the evening a number of the members paid a visit to Holtenau in the launch lent by the directors of the Imperial yard. On Sunday afternoon the party proceeded to Berlin, where the next few days were spent. On Monday, a visit was paid to the Technical High School at Charlottenburg and the experimental tank in connection with it. Geheimrath Flamm conducted the visit and afterwards joined the party at lunch in the students' restaurant. A most interesting afternoon was spent in the machine tool works of Messrs. Ludwig Loewe. On Tuesday, the majority of the party visited the Berlin establishments of the Allgemeine Elektricitäts-Gesellschaft and of the Berliner Maschinenbau-Actien-Gesellschaft, lack of time only preventing them from extending their visit to the new locomotive works of the latter firm at Wildau. The remainder of the party spent the day in Stettin, where they were entertained to lunch by the famous Vulcan Company, and afterwards shown over the yard. The forenoon of Wednesday was spent in the cable works of Messrs. Siemens and Halske, which are situated at the Nonnendamm, not far from Charlottenburg. The members were entertained to lunch by the firm at the Berlin Club, and afterwards paid a visit to the highly interesting works of Messrs. A. Borsig at Tegel. Thursday having been reserved for sight-seeing, the party spent the day visiting the palaces and parks in which the historic town of Potsdam abounds. On Friday morning a visit to the optical works of Messrs. Goerz concluded the programme, and the party started on their return journey, some via Hamburg and Leith to Glasgow, and the rest direct to London. All members of the party are highly satisfied with the result of their trip and speak in the warmest terms of the kindness and courtesy with which they were received in all the places they visited. At the farewell supper a presentation was made to Mr. Hans A. Reincke, the honorary secretary of the Glasgow University Engineering Society, who made all the arrangements, and to whom the success of the visit was largely attributed, by the members of the party.

Aluminium Conductors.—In the course of a Paper on aluminium conductors, recently read before the Canadian Electrical Association at Hamilton, Mr. Roderick J. Parke gave the following data and comparative figures with regard to commercial aluminium and commercial copper of sizes commonly used in practice, the copper being hard drawn:—

	Aluminium.	Copper.
Specific gravity	2·68	8·93
Conductivity (Matthiessen standard)	62·00	97·00
Tensile strength (per square inch)	28,000	45,000
Coefficient of linear expansion	0·0000128	0·0000093
Coefficient of temperature resistance	0·00114	0·00117
Modulus of elasticity	9,000,000	14,000,000
Cross-section for equal resistance	1·56	1
Diameter for equal resistance	1·25	1
Weight for equal resistance	0·47	1
Tensile strength for equal resistance	0·96	1
Price for equal cost	2·13	1
Rate of temperature change (resistance)	1·00	1

The cost of transportation and erection of aluminium conductors is less than that of copper; the durability of the line is greater, and the cost of maintenance less on account of the smaller strains to which poles, cross-arms, pins and insulators are subjected. On account of its peculiar nature, aluminium retains for years some of the grease used in drawing, and this grease prevents any great amount of sleet from forming upon it. This fact has been noted often enough to be well established. To balance the advantages cited there are the following disadvantages:—Difficulty in making joints, greater sag due to larger coefficient of expansion, and insufficient strength of conductors of the sizes used for telephone and telegraph wires. The difficulty of soldering aluminium is well known, and, while it can be done, the operation in the majority of cases is attended with so much difficulty that unsoldered joints are preferable. For joining aluminium wires smaller than No. 0000 B. and S. gauge, the two ends are inserted into a piece of flattened tube and the tube given 2½ twists by means of two pairs of ordinary wire connectors. This makes a perfectly satisfactory joint of low resistance and as strong as the wire joined. Larger sizes are conveniently joined by means of the ordinary dovetail cable splice; by means of terminals compressed on the ends of the cables at the factory, these terminals being threaded and thus adapted to be united in the field by a threaded stud, or by inserting the ends to be joined into a cast sleeve and compressing the sleeve between dies in a small portable press. The sag of aluminium conductors is somewhat greater than that of copper in hot weather. It is not so much greater as might be expected, however, because the lower modulus of elasticity of aluminium causes it to contract more as the strain is relieved from it and because the weight of aluminium, for equal areas, is only three-tenths that of copper, while the strength of it is two-thirds that of copper. This causes aluminium to start with a smaller minimum sag than copper. One curious result of this is that whereas aluminium will have a maximum sag of 3in. or 4in. more than copper in a 100ft. span, it will have actually a smaller maximum sag in a 1,000ft. span, for while the span moves farther or deflects more rapidly than copper for a given temperature change, it starts with so much smaller sag at low temperature that it never overhauls the copper when long spans are used. On this account and that of its small weight, it would seem to be the best material for long span work. The use of a reliable dynamometer for stringing aluminium wire is strongly recommended. The smallest size of aluminium which it would be advisable to use in pole line work is No. 4 B. and S. gauge, which has a breaking strength of about 1,000lb., which is the minimum strength that should be allowed in any conductor on a pole line. Aluminium is not readily oxidisable, and the greater number of mineral acids seem to have no chemical effect upon it, but chlorine in any of its unstable combinations is more or less detrimental to it, particularly where the conductors are exposed to sea air or where they are installed within the vicinity of certain chemical works. The writer tested some aluminium conductors for cross-section, tensile strength, torsion and resistance, and found the results given in the table below:—

Approx. gauge.	No. of strands.	Approx. gauge of strands.	Twists in 6in.	Breaking strains per sq. in.	Per cent. elongation in 6in.	Resistance per 1,000ft. at 75°F.
000	7	7 B. & S.	21	29,100lb.	2	0·106
0	7	9 B. & S.	22	33,000lb.	2¾	0·172
2	7	10 B. & S.	30	35,500lb.	3½	0·262

As aluminium is one-quarter greater in diameter than equivalent copper, it is evident that the self-induction of the line will be the same when the aluminium wires are separated 25 per cent. more than the copper wires. The static capacity of the aluminium will be approximately 5 per cent. greater than that of copper with the same spacing. The skin effect will be exactly the same with either of the two metals, since the effect of the greater diameter of the aluminium is exactly offset by its greater specific resistance in making the calculations for the per cent. increase of resistance. All practical transmission lines possess sufficient excess of self-induction over capacity to cause a slight lag in alternating currents, and the power-factor over an aluminium line would, therefore, be slightly better than that over a copper line on account of the smaller self-induction and greater capacity.

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ELECTRICAL ENGINEERING IN SOUTH AFRICA.

BY JOHN ROBERTS.
(Borough Electrical Engineer, Durban.)

A short account of the work done in South Africa, more especially relating to the municipal undertaking in Durban, Natal, may be of interest to those engaged in the same kind of work in England, including users, manufacturers and suppliers of plant.

While in England gas is a most formidable rival of electric lighting, in new countries electricity easily outdistances gas both in cost and efficiency, and the reason is that the former can be so much more easily and cheaply distributed by the use of overhead mains throughout the great areas which usually obtain in colonial towns. In addition, the cost of production of current may generally be taken at not more than twice English figures, but gas cannot be manufactured for less than three to five times English cost. Owing, also, to the fact that coal is somewhat poor and by-products cannot be disposed of at payable prices, its quality is by no means good.

Electricity is, therefore, generally much used in South African towns where central stations are in operation. Its scope would be immensely increased if heating and cooking by electricity were a commercial success. Domestic cookery in South Africa is so troublesome, on account of the hot climate and the ever-present and world-wide domestic servant difficulty, that I believe a supply of gas distributed for this only would pay were it not for the cost of distribution.

The problem before municipalities in South Africa is to supply electricity as a necessity of life, and not, as in England, as a luxury for the rich, for I think it will be admitted that in this country electricity cannot yet be said to be the poor man's light. In Durban, with a population of about 65,000, there are about 2,400 consumers. Judged by English standards, this is a good proportion; but even here it has not got down to the poorer classes. It is the writer's aim to bring it within the reach of everyone, and in this brief article are shown the means which are being tried.

At the outset it should be explained that work is not carried out strictly according to Board of Trade rules. For instance, overhead wires are used freely, an isolated consumer a long distance from the mains is not guaranteed very close pressure regulation and elaborate records are not always kept. At the same time, the anxiety to avoid expensive compensation claims for accident to life and limb causes supply authorities to take precautions which even the English Board of Trade do not enforce. For example, every electric light and tramway pole is thoroughly earthed—at any rate, in Durban. It is carried out in a cheap and simple manner, and has proved of great service in regard to reliability and safety. In fact, it is my opinion that, while a supply company should be bound by certain regulations as to the appearance of work erected in public thoroughfares, ordinary business considerations will make it avoid accident and provide regular supply.

Production of Power.—Dynamos in South Africa must be driven by engines; there is no water power available. With the exception of the Victoria Falls on the Zambesi, none can be relied on to give a reasonable amount of power throughout the year. In most towns the question of a water supply for steam is a serious one. Where a public supply is obtainable the water is generally of good quality, but its cost is always high. The lowest price I know of is in Durban, where it is sold for industrial purposes for about 2s. per 1,000 gallons. In large plants every means must be taken to economise this item, and, further, the supply often being precarious, large storage tanks must be used and provision made for at least a 24 hours' supply.

As the quality of the water is usually good, it has been the writer's experience that water-tube boilers are the best. In Johannesburg, however, where water is bad, they give trouble if not properly looked after, and the Lancashire form would, I believe, be popular if the cost and difficulties of transport did not frequently make its installation impossible. It has been the writer's experience that a water-tube boiler of good design is cheaper to maintain and less liable to cause trouble than a large cylindrical boiler, in view of the less highly skilled and less experienced labour normally available. This is more marked in electric plants, where boilers are being constantly taken in and out of service at irregular intervals. For small plants, where, for instance, each unit does not exceed 100 H.P., the water-tube boiler is not suitable, and greater efficiency can be obtained from the locomotive type. The loss of efficiency from brickwork, even at its best, puts the former type, when of small sizes, quite out of count. I could quote very respectable figures indeed of coal consumption obtained in small electric light plants using locomotive-type boilers. The Scotch marine type would be better still for these conditions if it were not for the fact that its large diameter causes trouble from straining when taken carelessly in and out of service.

To epitomise: I believe that for large plants the water-tube boiler is the best, except perhaps on the goldfields where water is bad. If, however, proper water softening and purifying plants are put down this difficulty will probably be eliminated, and the water-tube boiler will have a great and successful career before it in the Transvaal.

Few remarks are necessary with regard to steam engines. English practice in direct coupling has, perhaps, been somewhat slavishly followed down to the lowest sizes. Should oil ever be imported in bulk at low prices, the oil engine will do well. The writer is aware of a number of situations where about 100 H.P. to 200 H.P. is required, and both coal and water being difficult to obtain, a cheap oil-driven electric generator would command earnest attention.

In the larger electric generating plants in the country, the generating units are very similar to those in English works. The installation of steam turbines is being considered, but I believe that engineers will do well not to be hasty in installing machines of this class. I believe they will never be very successful in South Africa on account of the water difficulty, and that it will be too expensive to produce the very high vacuum necessary for economy. Attention will, I believe, be more profitably spent on the gas engine. The consulting engineers to the Johannesburg municipality have chosen such machines for the new electric station, and their example will be followed if the experiment is successful. Their decision was bold, but local opinion amongst engineers is growing in favour of the innovation. I believe that such a gas-electric works will prove of great convenience and utility for municipal supply. The following are the possibilities of such a combined system:—

1. Gas would be manufactured outside the town radius altogether.
2. No water is wanted except in small quantities, and the site of the works can be chosen quite independently of the proximity of river or sea.
3. Both gas and electrical energy would be distributed.
4. Current would be distributed for lighting, for small motors and for larger motors where the advantages of electric control are required, such as lifts, printing presses, &c.
5. Gas would be distributed for heating and for large engines.
6. All complication of high-tension distribution is obviated, as gas would be delivered to gas engine sub-stations where low-tension current would be generated directly.
7. Power at ¾d. a horse-power-hour and current at 2d. a unit.

If ever a gas turbine is invented to reduce the size of the sub-station plant such a system is bound to come. It may remain for South Africa to show it can be done.

Condensing Apparatus.—As will be gathered from the remarks on the water question, the type of condensing plant must be chosen after a careful study of conditions. There are some situations in which I would not recommend the use of such apparatus at all, though these are rare. In small electric plants adjoining collieries, where we have the conditions of cheap coal, scarcity of water and few daily hours of running, the expense of operating the condensing plant for the short time it is wanted is not, in my opinion, worth the saving of coal effected by its use. To make such a small electric light plant pay, the wages for repairs and skilled attendance must be cut down, and there is no other part of the entire plant likely to increase these items so much. Where water for boiler-feeding is good, but no condensing supply available, no condensing plant is so reliable as jet condensers with cooling towers. A certain amount of water must, of course, be constantly added to the system to make up for evaporation from the towers, and this should be added in the form of boiler-feed, and all complications and possible troubles due to using con-

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densed water charged with oil are eliminated. The steam from the auxiliaries should be used to heat the feed water.

Regarding cooling towers, it is not generally possible to use natural draught, except during hours of light load, when provision should be made in the casing of the towers to effect this and so avoid the loss of power entailed by running fans continuously. I believe the barometric form of condenser is good. Surface condensers are chiefly used on the goldfields, on account of the bad quality of the water there.

In this connection I would like to mention that very good results have been obtained in the old station of the Durban Corporation by using sewage for condensing purposes, and this method is quite worth consideration under certain circumstances. For the past six years sewage has been pumped through ejector condensers, and engines aggregating 700 H.P. have relied on this means for a vacuum. Solid matter gives no trouble as it is all broken up in the centrifugal pumps. The vacuum was not very high, but would have been all right if an air pump had been added. The sewage got rather hot sometimes, but this was not important as it was discharged direct into the sea. The result has been a saving of thousands of pounds, as the only other way of obtaining condensing water entailed great expense. I should mention that the old station was a combined electric lighting and sewage pumping works.

Method of Distribution.—A more serious question than that of choice of generating plant is the choice of a distribution system, and the success of the scheme greatly depends on the intelligence with which conditions are gauged. Owing to the scattered nature of the load, it is rare that a simple continuous-current supply may be adopted. In this case a three-wire 440 or 480-volt network should be used. Generally such plants are not of more than 200kw. in three generating units. I do not think balancers should be put in. It is simpler to split each generator into two of 220 or 240 volts each, and the slightly increased capital cost on dynamos is more than offset by the saving of balancers and switchboard complications; very simple operation and easy regulation of circuits is also obtained. The question of batteries must be considered in this connection and I do not recommend them for the conditions. The amount of day load obtainable in a small colonial town is so small that it is more profitable not to run the plant during the hours of daylight at all. If the attempt is made to encourage a day load the result will be loss, I am convinced. It should be explained that dull weather, fogs, &c., practically do not exist. In a station such as I have suggested operation requires no highly trained labour. Introduce batteries and it is a different matter altogether.

So much for plants of very small size. In the larger towns continuous current is unsuitable unless a mixed system is adopted—viz., direct current for the centre of the town and alternating for the suburbs. I do not think even this is satisfactory. The reason for adopting continuous current at all is on account of motor supply, but while it is comparatively easy to define the limits of the motive power area when the supply is commenced, colonial towns have a suprising and most unpleasant habit of spreading themselves out in unlikely directions and I am quite sure that in a very few years the dividing line between the continuous and alternating areas will prove to be quite in the wrong place. Moreover the manufacturing districts are apt to be a long way from the centre of the town, and it is there that continuous current is chiefly wanted.

It may be taken, therefore, that a continuous-current supply is not consistent with economy in mains and flexibility for unexpected extensions. I do not seriously entertain a three-phase high-tension scheme with rotaries to feed continuous-current networks. I wish nothing worse for anyone who tries to cover a large and quickly growing town with continuous-current by this means than that he shall run it and keep pace with the demand for five years after he instals it. A system must be adopted which is cheap in mains, easy to operate—with no moving machinery in sub-stations—simple to extend to any reasonable distance in any direction, and capable of supplying in a fairly efficient manner a motive power demand in any part of the district. Two or three-phase alternating current is, of course, without any rival for such conditions, and, if anything, I think two-phase is best. One important advantage it possesses is that it permits of single-phase circuits being run out to isolated consumers.

System of Mains.—When dealing with smaller towns, overhead mains should always be used. An occasional underground feeder may be used chiefly to lighten the pole line near the generating works and perhaps an underground distributor, when the load is heavy, to a few large shops. But, except in these cases, it is folly not to take advantage of overhead distribution.

In larger towns, where high-tension alternating current is adopted, all high-tension mains should be laid underground, both for business and residential parts. In the former, underground low-tension distributors should be used, but in the suburbs the mains should be placed overhead. In Durban the most distant consumers are 4 miles from the works in one direction, 4 miles in another and 3 miles in another. The whole of this area is covered, and every ratepayer is entitled to the supply. To cover this, over 10 miles of underground distributors and over 50 miles of overhead mains are in use. Had underground been adopted throughout, the above results would never have been attained. The street lighting question is one that has an important bearing on the matter. The mains for the street incandescent lamps as well as the lamps themselves are supported on the same poles as the private lighting wires, and street lamps can consequently be added to a private lighting overhead network at a cost of £2. 5s. per lamp. A good source of revenue is thus obtained and the thoroughfares are well lighted at a very small capital cost. In Durban there are 700 of these lamps in use. Had underground distributors been laid, the cost of installing cables, posts, &c., for these 700 incandescent lamps would have been prohibitive. The street lighting question is one which is well worth the consideration of those supplying in country districts. In Durban, the town proper is lighted with about 200 arc lamps by underground mains, but the suburbs are more extensively illuminated owing to the ease and cheapness with which incandescent lamps can be installed on overhead pole lines.

Regarding the actual method of overhead construction, this is generally cheap and simple. The high-tension mains are laid underground, as previously stated, and are led to transformer and switch boxes dotted about the districts, and usually situated at the intersection of roads. Each transformer can, therefore, feed the overhead mains in four different directions, so that heavy routes of wires are thus avoided; in fact, distributing at 200 volts, a pair of 19/16 wires is quite big enough on each phase, and in the absence of a motor-load in residential districts it is not always necessary to take both phases of the two-phase system down each thoroughfare. The small feed from the transformer to the overhead wires should be laid underground—across a road, if necessary—and the absence of a large number of overhead wires at these transformer feeding points prevents unsightliness. Overhead work should be carried out with a discreet use of occasional underground mains, and no unsightliness need exist. The system of distribution proposed is very flexible; as the load increases in density, so that the 19/16 conductor becomes too small, another transformer and switch box must be put down where necessary and the high-tension feeder run out to it.

For the overhead mains iron poles are generally best. In Durban they are from 25ft. to 30ft. overall. Wooden poles must be protected below the surface of the ground from the ravages of insects. The iron pole is more sightly and if discarded for any reason can always be sold at a good figure. The pole arms should be of pitch pine or oak, and where an end strain has to be taken should be reinforced with angle iron. Insulators are best of the Post Office pattern. The Americans are putting on the market remarkably cheap and good glass insulators for overhead work, but the objection to them is that they are not very sightly. The conductors should be of hard-drawn bare stranded copper. Where the load is fairly heavy a pole line should be planted on both sides of the road. Trees and telephone wires are the two greatest troubles an overhead lighting network has to contend with, and in the case of the former the only cure is vigorous lopping. In some instances suburban properties stand well back from

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the road and poles can then be planted on the boundary line instead of on the kerb line; this, however, must be done with caution. Regarding telephone wires, where these are numerous extra high poles should be used. The lighting wires should then be placed quite at the top and the telephone wires below them, with, say, 3ft. of clear space between the two different sets. This is the best way to get rid of mechanical interference troubles. For electrical interference, judicious "twists" of either or both sets of wires will eliminate the difficulty. Of course, the great obstacle to a nice working arrangement, similar to the above, is that the electric lighting and telephones are generally in the hands of two different authorities. Such, however, is, fortunately, not the case in Durban, and it is anticipated that the two systems may be extended side by side in a very cheap and efficient manner.

The use of overhead high-tension mains under these conditions is not advocated owing to the difficulty of keeping them clear of the other two sets, and because of the necessity of keeping such high-tension wires on separate poles. It is too difficult to provide for the complete separation of three sets of wires, especially when one set is dangerous to life, and it is therefore cheaper in the long run to put all high-tension mains underground. Underground mains should be armoured and laid in the ground direct, and not, except in exceptional cases, drawn into pipes or laid on the solid system. All three systems are in use in Durban. Before leaving the subject of overhead mains, it may be well to remark that overhead low-tension distributors should not be, in all cases, considered absolutely permanent. They might often be used in districts where the demand is at first small and to carry out street lighting cheaply, but as the district or the demand grows, the line can be taken down and planted elsewhere, underground mains being substituted. None of the overhead line material is subject to the smallest depreciation if iron poles are adopted.

Charging and Account-keeping.—The special conditions of South African towns demand that English methods of charging for current be very carefully examined before being adopted. Gas is not a serious competitor of electricity, and a supply authority must consider how to make the cost of current low enough to place it within the reach of the poorest. If electricity does become the universal means of illumination, the supply and distribution of current in South Africa is a different matter to that undertaken by English authorities, whose consumers are mostly shopkeepers and a few wealthy residents. The following are the conditions in a South African town, it being assumed that electricity is universally used for lighting:—

1. The daily hours of darkness throughout the year are uniform and long. It is dark by 5:45 in winter and by 7:30 in summer. A good evening load is therefore obtainable all the year round.
2. The largest class of consumer is the small private householder.
3. Accounts are always rendered monthly.
4. The consumers are scattered, and the work of reading meters is formidable.

From the above it follows that:—

1. The average monthly units per consumer will be small.
2. Monthly consumption will be uniform throughout the year.
3. The work of reading meters, periodically examining them, rendering accounts, collecting accounts and amount of bad debts will collectively figure out to one of the most serious items of the total cost of production.

I do not hesitate to say that under the above conditions the operations enumerated under deduction No. 3 must be greatly simplified; that such complications as are introduced by the maximum demand system of charging must not be tolerated; that the larger consumers must be charged by meter at a flat rate, with, perhaps, discounts to the largest of them, but that small householders should not pay for a meter at all. There is quite a large class in Durban who must be supplied at from 5s. to 6s. per month before they can be reached. Now, to do it at this figure, payment must be secure in the first place and the account must be collected in advance. The prepayment meter would go far to solve the difficulty, but its first cost and upkeep are against it even if there were a really satisfactory instrument on the market. But I believe that it is not worth while attempting to measure the amount of electricity supplied to the very small householder. His daily hours of consumption remain fairly constant throughout the year, and the amount of his account can be closely calculated if he is not allowed to exceed a certain maximum consumption. The objection may be raised that he will be careless with his light and waste it. Doubtless he will not be so economical as he would be if he paid by the unit; but he will not burn it deliberately all day long, and if he should occasionally leave a lamp burning all night it will make small difference to the generating station. The only item which would be increased by such a wasting of energy would be coal, and this is but a small proportion of the total costs. Moreover, the supply authority can afford to use a little more coal, since they save in the capital cost and upkeep of meters, not to mention bad debts. It is also important to note that the extra coal is not used during the times of maximum load. In Durban, a trial of the system on a small scale has been most successful and promises to solve the difficulty of supply to the small consumer. A cheap and simple instrument is installed on the premises of the small consumer. Having declared how many lamps he requires as a maximum load, the monthly charge is based on this number and collected in advance; the instrument referred to automatically dims the lights if the predetermined number is exceeded, and the proper light can only be obtained when the lamps in excess are switched off.

The above is an attempt to show briefly the local conditions of electric supply in South Africa. Hints are given which show that usual practice in England may not be successful in South Africa. In no other field may slavish following of the recognised methods of other countries prove so disastrous to commercial success.

ELECTRIC TRAMWAYS IN NORTH LONDON.

On Friday last the first section of electric tramways, being part of a most extensive system in the north of London, controlled by the Metropolitan Electric Tramways (Ltd.), was thrown open to the public. This section, of about 4 route miles in length, has been converted from the horse tram system. It takes, as will be seen from the accompanying map, the form of a ⊥, extending from Wood Green to Finsbury Park, and from thence to Stamford Hill, with a short branch from Finsbury Park southwards. This converted part is indicated in the map by the heavy crossed lines. The conversion of the remainder of the horse-worked system is progressing rapidly, and it is expected that the horses will be replaced by electricity very shortly. But the company is also constructing new lines, part of which are nearing completion. Although the network of lines will be constantly added to as occasion demands, an idea of the magnitude of the system may be obtained from the fact that at no very distant date the length of route is expected to reach from 60 to 70 miles.

In order to deal efficiently with the system, which covers a very extended area, it was decided to generate power at high voltage at one or more main power stations and to convert the high-tension alternating current, at suitably situated sub-stations, to continuous current at 550 volts. Of the two main power stations shown in the map, and belonging to the North Metropolitan Power Supply Co., who sell current in bulk to the Metropolitan Electric Tramways Co., only that at Brimsdown is at present generating power for traction purposes. Since both the frequency and the voltage of the three-phase currents generated at Brimsdown differ from those adopted at Willesden, it is not possible to inter-connect the high-tension systems of these two stations; but we understand that, when extensions are put down, arrangements will be made to that effect.

It will be noted that the Brimsdown power station is situated at one extreme point of the traction network. The reason for this, it appears, is that a suitable site more in the centre of the system was not easily obtainable; but the present site possesses the advantage of being on the banks of the Lea navigation, and also quite close to the Cambridge main line of the Great Eastern Railway. Coal at 12s. a ton is brought up to the power house in barges on the waterway referred to.

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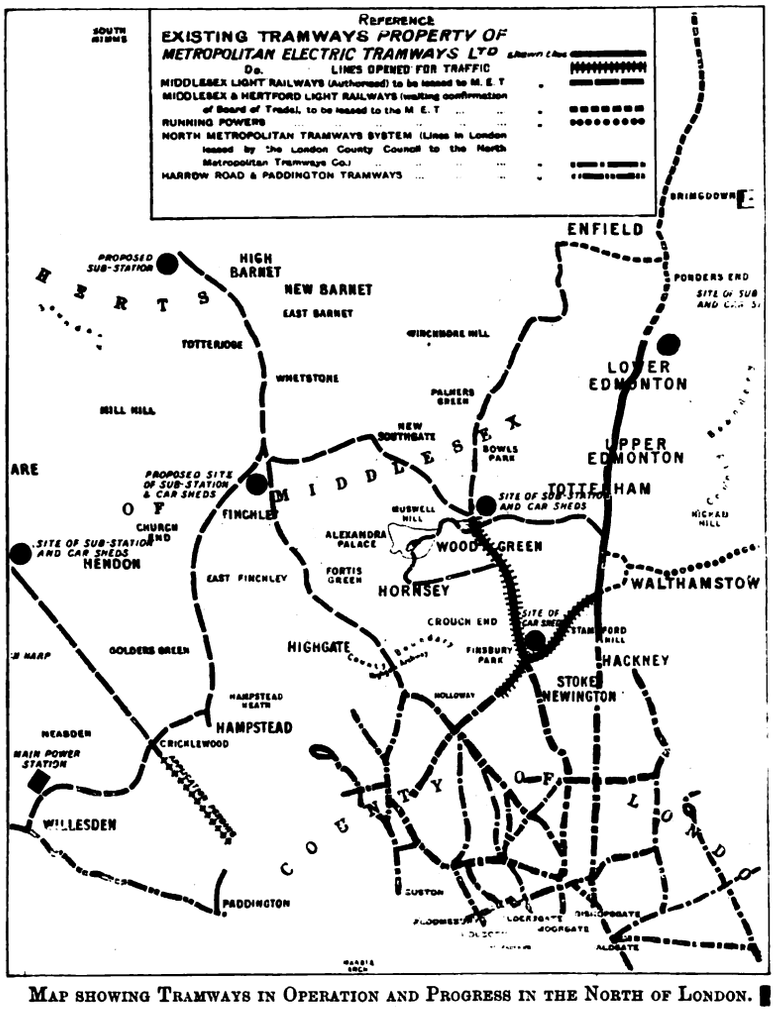
It is then hoisted by an electric crane on to a weighing machine, from whence it is distributed into the coal bunkers by an electrically-driven conveyor. From the bunkers the coal falls into the coal hoppers of the boilers, passing on its way through a transportable weighing device. There are six Babcock & Wilcox boilers, which supply steam at 160lb. pressure to three 1,000kw. turbo-generator sets, each consisting of a Parsons steam turbine driving a Brown-Boveri three-phase dynamo. Current is generated directly at about 11,000 volts, and, after passing the controlling and measuring devices on the switchboard, is conveyed to the sub-stations by three-core lead-covered and paper-insulated cables, laid in duplicate on the solid system by the British Insulated & Helsby Cables (Ltd.). Each core has a cross-section of 0·1 sq. in. These cables were tested with alternating current at a pressure of 20,000 volts.



MAP SHOWING TRAMWAYS IN OPERATION AND PROGRESS IN THE NORTH OF LONDON.

Two sub-stations, at Edmonton and Wood Green, are now in operation, and two others, at Finchley and Hendon, are in course of erection. The electrical plant at Wood Green consists of two 250kw. rotary convertors, which are started by means of a directly-coupled 10 H.P. induction motor. The transformers have a capacity of 92kw. each. Reactances are inserted into the alternating-current circuit in order to diminish hunting. There are also several negative boosters, of which, however, only one is being used at present. In addition, there are the high and low-tension switchboards, built up of white marble and equipped with the customary controlling and measuring devices. The equipment at Edmonton is identical, with the exception that each of the rotaries is of 100kw. Continuous current is supplied by the converters at a pressure of 550 volts.

The tramways are operated on the overhead trolley system, the erection having been carried out by the company's own staff. According to circumstances, either centre-poles or side-poles, or side-poles with span-wires are employed. All the poles are built up of three sections, and are 25ft. high from the ground. They were supplied by Messrs. John Spencer (Ltd.), and weigh—according to the strain they have to withstand—about 840lb., 1,050lb. and 1,200lb. respectively. The trolley wire of hard-drawn copper, 0·409in. in diameter, was supplied by Messrs. Frederick Smith & Co. Both span and guard wides are of galvanised stranded steel, composed of 7/12 and 7/17 S.W.G., respectively. Besides being effectively earthed at their ends, the guard wires are also earthed at every fifth pole by being bonded to the rail. The ears used are 15in., 24in. and 36in. long, being supplied by Messrs. Estler Bros. Messrs. Thomas Noakes & Sons supplied the frogs, which are of the mechanical and fixed trailing types. Vulcanised bitumen feeders were supplied and laid in wood troughing by Callender's Cable and Construction Co.

In 1903 Messrs. Dick, Kerr & Co. were commissioned by the tramway company to reconstruct the 8½ miles of lines, and nearly the whole has now been completed. It was necessary to lower the road under three bridges in order to obtain sufficient headroom for the electric cars. The route consists throughout of double line, and thoroughfares had to be widened in some cases. Rails, weighing 101lb. to the yard, and supplied in lengths of 45ft., are used, the grooves being 1⅛in. wide and 1⅛in. deep. The fish-plates weigh 47lb. per pair and are 2ft. long, and the tie bars have a cross-section of 1½in. by ⅜in. Simple sole plates are used, measuring 24in. by 8in. by ⅝in. Two Neptune bonds, of 0000 B.&S. gauge, are fitted, as a rule, at each joint, but for special work plastic bonds, supplied by Messrs. R. W. Blackwell & Co., have been adopted. Every 100yds. the rails are cross bonded. Most of the pavement is of wood, laid on top of a 6in. bed of concrete, but occasionally granite setts are employed. At Edmonton and Wood Green the old car sheds have been adapted to the new cars by raising the roof. They are also provided with plenty of inspection pits. About two dozen cars are at present running over the 8 miles of single line in operation, but altogether some 150 cars have been ordered from the Brush Co. They are of the double-deck type, capable of seating 68 or 74 passengers, and have an overall length over the platforms of 32ft. 6in. and 35ft. 5½in. respectively. Maximum trucks are employed, and the motors are of G.E. 58 type. Hand brakes and an electric rheostatic brake are provided. Lifeguards of the Tidswell and Wilson and Bennett types are used. The destination signs are of the illuminated roller blind design. A number of cars have cushions, some have rattan and others bentwood. The stairways are partly of the ordinary and partly of the London United Tramway Co's. pattern.

Mr. A. H. Pott is engineer to the Metropolitan Electric Tramways Co., and all work has been carried out to his specification and under his direction.

We propose to give a full and detailed description of the Brimsdown power station and the various sub-stations in an early issue.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Loci in Mechanical Drawing." By Alex. MacLay. Part 3. (Manchester: The Technical Publishing Co.) 2s. 6d.

"Transactions of the American Electrochemical Society." Vol. V. 1904. (Philadelphia: The Society.) $3.

"Physikalische Technik." By Dr. Otto Lehmann. In two volumes. Vol. I., 1st part. (Braunschweig: Friedrich Vieweg und Sohn.) 1904. 16m.

"Die vagabundierenden Ströme elektrischer Bahnen." By Dr. Carl Michalke. (Braunschweig: Friedrich Vieweg und Sohn.) 1904. 3m.

"Corso di Elettrotecnica." Vol. I. By Guido Grassi. (Rome: Editrice Nazionale.) 14 lire.

"Il Radio." By Augusto Righi. (Bologna: Nicola Zanichelli.) 3 lire.

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THE NORTH-EASTERN RAILWAY AND CARVILLE POWER HOUSE.

(Continued from page 552.)

Although the general arrangement of the switch gear at the sub-stations, in general principle, follows that installed at the Carville power house, yet there are necessarily a few details in which the two schemes are not exactly alike. Perhaps the cardinal point in which they differ is with regard to the 'bus bars. At Carville, it will be remembered, there was absolutely nothing between the main oil switches and the 'bus bars in the shape of instruments and apparatus, the contention being that, as the continuity of supply depended upon the immunity of the 'bus bars from breakdown, they should, therefore, be free from anything likely to cause such an occurrence. But matters can hardly be placed on the same footing with regard to sub-stations, because continuity of supply does not depend on one sub-station only, and it is extremely unlikely that more than one sub-station will come to grief at the same time. From this it is not to be inferred that precautionary measures have been neglected, but that, simply by relaxing certain conditions which have not been thought absolutely essential, the work has been greatly simplified. As may be seen by Fig. 15, which is a diagram of connections at Pandon Dene sub-station, each set of 'bus bars is divided into two separate portions by selector switches; one of these portions is fed by the incoming feeders and the other supplies the transformers, &c. Between the two portions are inserted instrument transformers so that the total energy passing through the sub-station can be measured by one wattmeter. This is, of course, a great simplification and almost a necessity. Tracing out a feeder entering the station as three separate cables laid solid in earthenware pipes and not as a three-core cable, it is seen that connections are taken through the concrete board to the potential transformers and spark-gaps, and that a 300-ampere selector switch is then inserted before coming to the current transformers. From this point to the duplicate 'bus bars the connections are exactly the same as those at Carville. It may be pointed out that the arrangement of selector switches for cutting off the feeder, or isolating the spark-gaps and potential transformer from it, is not the same as that at Carville. In the sub-station the spark-gaps are on one side of the board and the potential transformers on the other, and the selector switches are one above the other instead of side by side. Each spark-gap, together with the selector switch controlling it is fixed on a marble slab, behind which the cable is brought up and a connection tapped off through the board to the potential transformer. The part of Fig. 16, showing the back of a rotary converter panel, is self-explanatory if studied in conjunction with Fig. 11 on p. 137 of *The Electrician* for May 13th. Briefly, connections are taken from the 'bus bars through isolating switches, oil switches, current transformers for instruments, and each cable is then split into two and taken under the floor to the main transformers. In this case, of course, no spark-gaps are required.

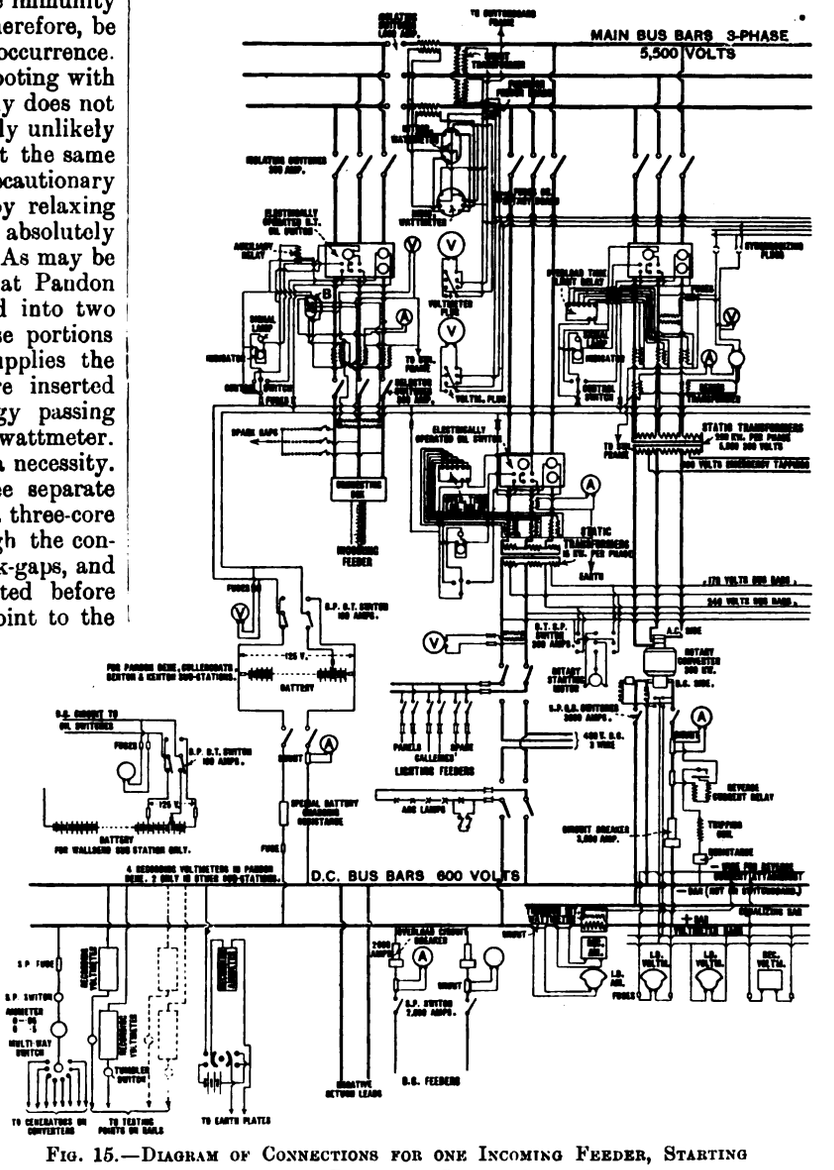

FIG. 15.—DIAGRAM OF CONNECTIONS FOR ONE INCOMING FEEDER, STARTING TRANSFORMERS AND ONE ROTARY AT PANDON DENE SUB-STATION.

The connections from the 'bus bars to the small transformers which supply the starting induction motors can be clearly seen on the diagram of connections. As a matter of fact, these transformers are also used for lighting the sub-station, but in the event of their breaking down the lighting current may either be obtained from auxiliary tappings on the main transformers or, by means of a change-over switch, from the company's continuous-current network. There are two tappings on the transformers for starting, the induction motors being run up on the first at 178 volts, and then, by means of a two-way switch, thrown over to the second tapping at 240 volts.

The main oil switches employed in the sub-stations are of the Westinghouse type (Fig. 17). The mechanism consists of an iron cross-piece, from which hang three wooden rods carrying the moving contacts of the switch. The cross-piece is guided by means of a parallel link motion, and this is controlled by means of a pair of large solenoids, the armatures of which, on the controlling switch being closed, pull up the whole of the linkwork and cross-pieces against their own weight. Part of the linkwork consists of a toggle joint, which locks itself when the switch is in the closed position, and opposite this is a hammer, which is caused to strike the toggle and knock it out of its locked position by means of a small solenoid energised through the controlling switch. As soon as the toggle is released the linkwork and cross-pieces fall by their own weight, assisted at the commencement of their travel by springs. The fixed contacts of the switch are at the top of the oil pots, and the wooden rods each carry a cross-piece with copper contacts, which bridge across the fixed contacts when the rod is drawn up. The break occurs on a renewable tip. Each feeder switch is fitted with a reverse current cut-out, which automatically opens the switch so soon as power to the extent of 100kw. or more is passing from the sub-station through the switch into the feeder instead of entering the sub-station, and each converter switch is fitted with a time limit overload cut-out. Current for operating or tripping the high-tension switches and for lighting the pilot lamps is supplied from a small Tudor battery.

With regard to the low-tension switch gear there is not a great deal to be said. The board itself is of polished white marble,

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and there is a circuit-breaker on each machine and feeder panel. The negative poles of the machines and feeders are connected permanently to the negative 'bus bars, and the equalising switches for the compound windings are fixed on pedestals near the machines. Feeders having a sectional area of 1 sq. in. connect the 'bus bars with the third rail.

At one end of the sub-station there is a three-phase Berry transformer with a Siemens-Schuckert induction regulator, which reduces the voltage from 6,000 to 2,000 for lighting

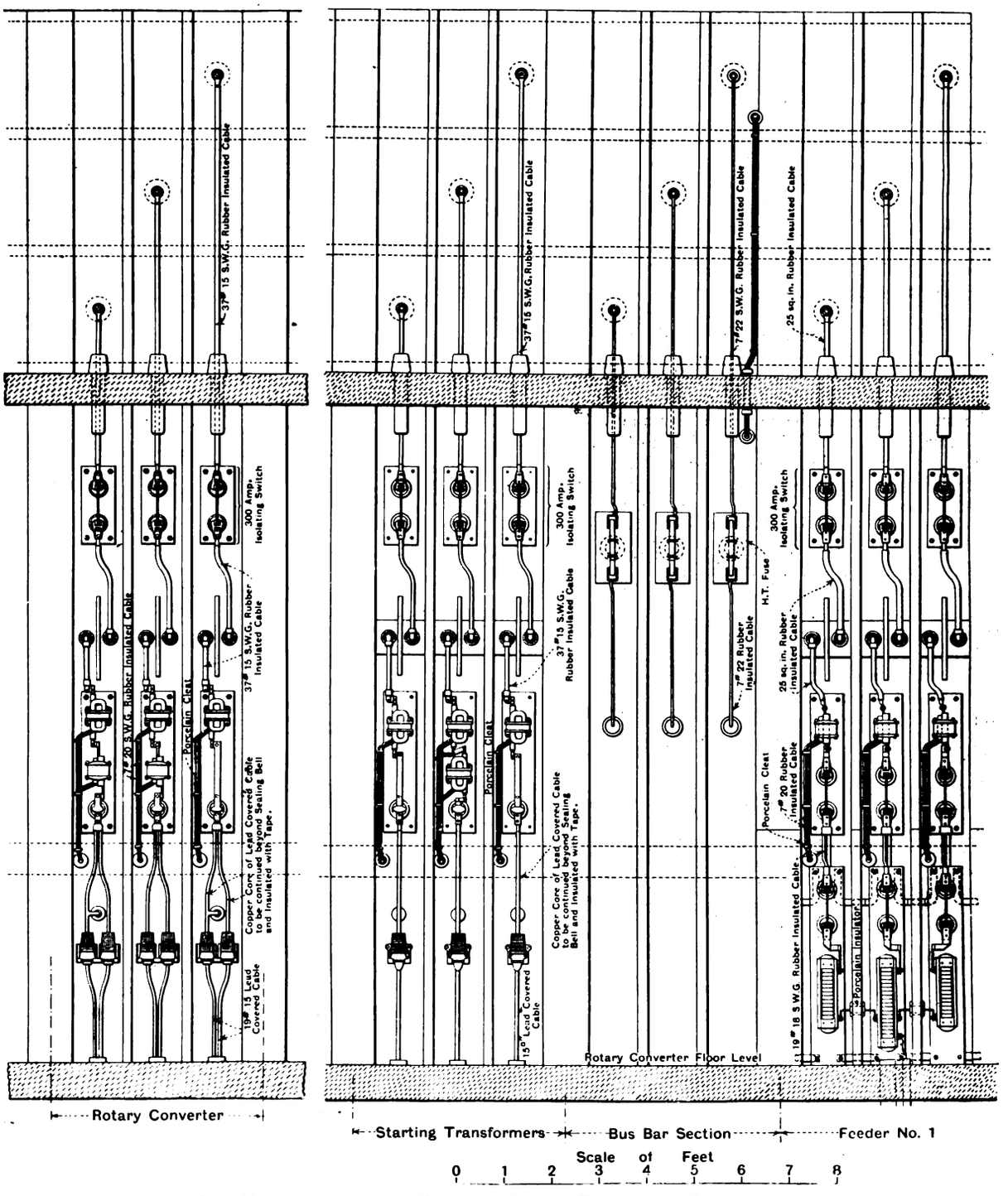

FIG. 16.—ARRANGEMENT OF CABLES AT BACK OF HIGH-TENSION SWITCHBOARD.

certain of the railway company's stations. In this regulator, the chief point consists in altering the relative position of a coil to a stationary alternating field so that the number of lines of force passing through the coil vary in accordance with its position. In this particular case, the primary voltage of a three-phase current high-tension line is 2,200 and it is necessary to vary this from 2,000 to 2,400 volts. The regulating transformer adapted to obtain this variation consists of a machine similar to a three-phase motor. The stator of this motor is star wound, and the coils are connected by way of three fuses direct to the 2,200-volt circuit. The adjustable coils are fixed on the rotor, the shaft of which carries six slip rings. The rotor winding forms three distinct sections, the beginnings of which are connected to the 2,200-volt circuit through the slip rings, whereas the ends are carried to slip rings and thence to the circuit the pressure of which is to be varied. The stator coils induce the alternating field mentioned above, so that the pressure set up in the rotor coils depends on the position of the rotor. This pressure will be 0 when the coils in the rotor are between two fields and will add to or subtract from the primary pressure when the rotor is turned a few degrees either in one or the other direction. The maximum variation obtainable in this manner is 200 volts, as the rotation is limited to a definite angle by means of two end switches operated from the rotor shaft by

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levers. Adjustment of the position of the rotor can be affected either by hand or automatically. For the latter purpose additional gear is required consisting of a controlling apparatus, a throw-over relay, and a motor with worm gearing and a transformer. The latter is a three-phase Berry transformer of 6kw. capacity and transforms from 2,000 to 110 volts. The low-tension pressure is required for the controlling apparatus, the relay and the motor. Two pilot wires are run from the end of the line to the point where the regulating transformer is fixed and are connected to two terminals of the controlling apparatus. According to the pressure in the pilot wires a lever in this apparatus makes contact to either of two terminals or remains in a central position. These terminals

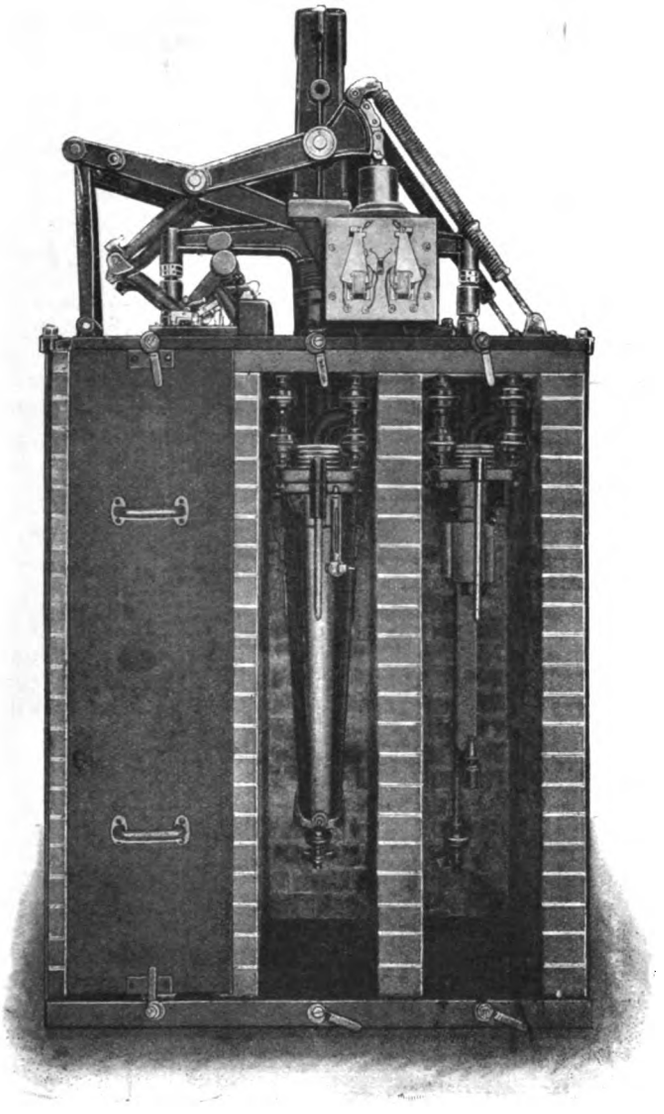
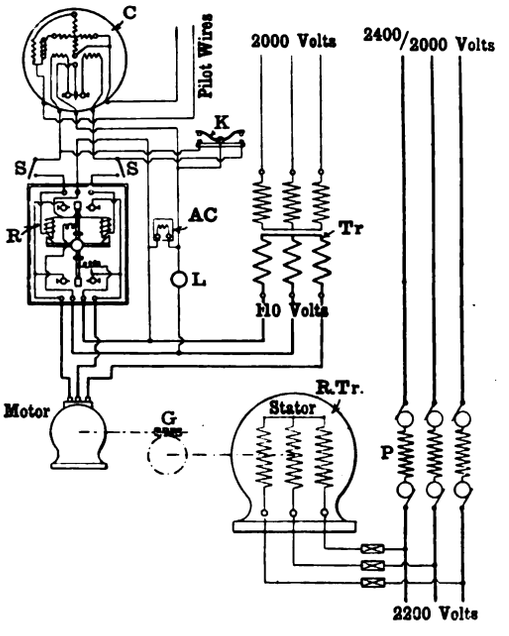


Fig. 17.—Westinghouse Oil Switch.

are connected by way of the end switches referred to above to two electromagnets operating the throw-over switch. One phase on the secondary side of the transformer is connected directly to one motor terminal, and the other two phases are connected to the throw-over switch which reverses the motor. When the pressure is reduced below a certain amount, for which the controlling apparatus can be adjusted, the contact lever swings to one side, makes contact with one terminal, and thus excites one electromagnet; this causes the throw-over relay to start the motor in a certain direction. If the pressure increases above a certain amount a similar action takes place only in the opposite direction. The motor is of the induction type with a short-circuited rotor, and will develop about ½ B.H.P. at about 1,400 revs. per min. This speed is reduced in two steps by gearing running in an oil bath, so that the ultimate speed is about 2 revs. per min. The slow speed shaft is coupled to the rotor shaft of the regulating transformer by a crank shaft and crank. As the rotor of the motor has a considerable momentum on account of the high speed an electromagnetic clutch coupling is provided between the two gears in order to bring the rotor of the regulating transformer to an immediate standstill as soon as the contact lever in the controlling apparatus opens the circuit of an electromagnet in the throw-over relay. A handwheel and spindle are provided for shifting the rotor of the regulating transformer by hand. The throw-over relay can also be operated by hand by a two-way key instead of the automatic controlling apparatus. From this transformer there are two three-core cables, so arranged that if the transformer should break down they may be joined together and fed through from other sub-stations or either of them fed from the transformer separately. They are controlled by B.T.-H. oil switches. The sub-station is provided with an air-blast device for cleaning high-tension gear, and it may be mentioned that provision is made for drawing off the oil from the transformers by means of a pipe fitted with two cocks, one inside the station and the other outside. The former is always left open, so that if a fire occurred the attendant would not have to approach the transformer, but would simply have to turn on the cock outside the building.

Altogether, the capacity of the transforming plant for the North-Eastern Railway, inclusive of lighting, is no less than 13,960kw. But after leaving this transforming plant the current for lighting is still at 2,000 volts and for transforming it down, there are 22 transformer chambers at the railway



AC=Auxiliary Coil. R=Throw-over Relay. Tr=Transformer.
L=Lamp. C=Controlling Apparatus. RTr=Regulating Transformer.
K=Two-way Key. S=End Switches. G=Gearing.
P=Rotor with 6 Slip Rings.

Fig. 18.—Diagram of Connections of Regulating Transformer.

stations, most of which contain 15kw. transformers, but a few have 50kw. transformers. The high-tension switch gear in the sub-stations, as well as the transforming and converting machinery, was supplied by the British Westinghouse Co.; the high-tension cables were supplied by Messrs. Siemens Brothers.

(To be continued.)

Traffic Commission.—The Royal Commission on London Traffic has appointed Mr. Stephen Sellon to make a report upon the tramway undertakings of the principal cities and towns of the United Kingdom, and to investigate the traffic and operative results obtained in connection therewith, and the conditions in regard to tramway transportation existing in such cities and towns, as compared with London.

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ELECTRICITY AT THE "GRAPHIC" OFFICES.

It is assuredly a sign of the times that the most modern methods should be employed for the production of one of the oldest established newspapers. The proprietors of the *Graphic*, when they moved into their new offices this year, wisely decided to avail themselves of the services of electricity, not only for lighting and for electrotyping, as they have done hitherto, but also for driving all the printing machines and other auxiliary apparatus. The result has been an interesting and well-designed example of this useful application of electrical energy.

The new offices are in a fine four-floor building in Tallis-street, near the Victoria Embankment, London. About 450 16 c.p. lamps are required to light the building. Almost all the wiring is surface work, twin lead-covered cable being employed in the offices, and steel tubing in the machine rooms, foundry, composing room, and other places where workmen are employed. The twin lead-covered cable is fastened to the walls by brass clips. Two kinds of steel tubing are used for the other circuits, most of it being of the split type, the plain end of one length of tubing being simply thrust into the socket of the next, and in some cases screwed tubing is employed. For supplying the larger motors driving printing machines in the basement the tubing if it is not screwed is bonded. A

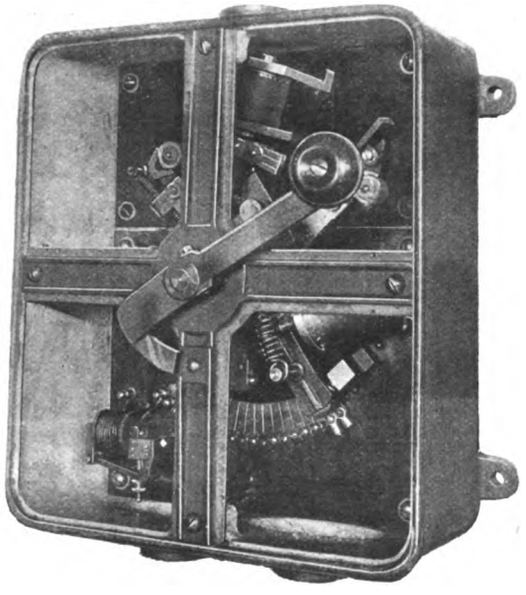

FIG. 1.—GENERAL VIEW OF MOTOR-STARTING SWITCH.

brass clip is screwed firmly to either side of the joint, and the two clips are then joined by 7/20 copper wire, or brass or copper strips. On these circuits, moreover, the tubes are not run on the surface, but are placed in trenches cut in the recesses to the basement which extend underneath the street. A distribution board system is employed throughout, there being about three lamps on each of the lighting circuits. These circuits and the smaller motors are supplied at 205 volts on the three-wire system, but there are separate circuits for light and power throughout. The eight 15 H.P. motors driving the printing machines are supplied at 410 volts.

These last-mentioned motors run at 800 revs. per min. each driving a Dawson's "Perceler" two-feeder machine capable of printing up to 3,200 impressions per hour. The range of speed varies from 1,500 to 3,200 per hour, the economical range (*i.e.*, when resistances are in the field circuit of the motor only) being from 2,400 to 3,200. There are six speeds between the two latter limits, and also six armature resistance contacts. This regulating switch is entirely independent of the starting switch, and can be locked up. The starting switch is of the Holmes-Page automatic pattern, and is illustrated in Figs. 1, 2 and 3. It has been particularly designed for those cases in which a motor is started and stopped frequently (a condition which arises with printing machinery during the process of "making ready"), or where it is desirable that the operator should not be able to use the starting apparatus for any other purpose than that of starting and stopping the motor.

The starter comprises a double-pole main switch with no-volt and overload release, working in conjunction with a

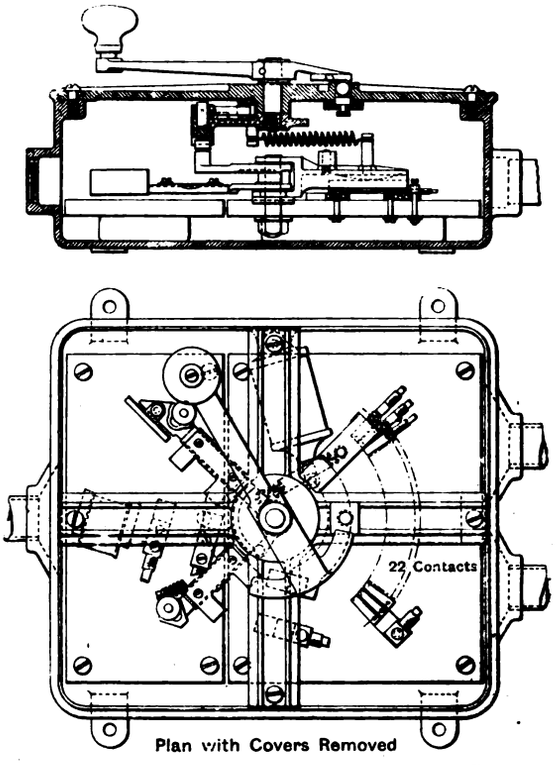

FIG. 2.—PLAN AND SECTION OF MOTOR-STARTING SWITCH.

slow-motion rheostat with dash-pot control, so that the resistances cannot be switched out too rapidly however quickly the attendant may turn the lever. When the operating handle is moved from the "off" to the "on" position,

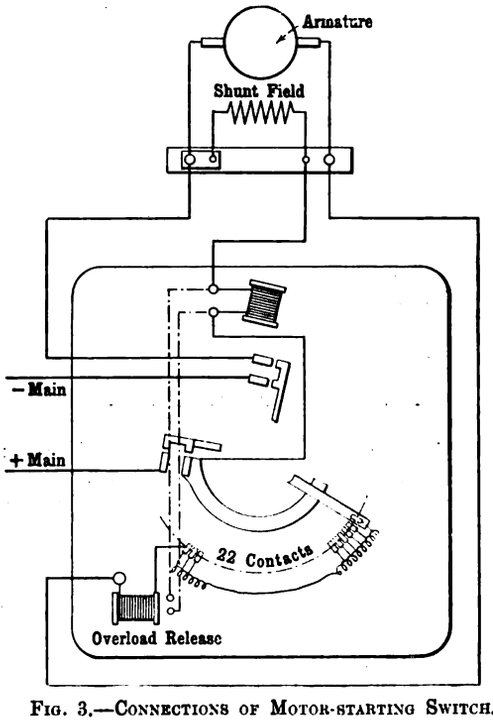

FIG. 3.—CONNECTIONS OF MOTOR-STARTING SWITCH.

a double cam which it carries engages with a projection on the double-pole switch arm and closes the switch, an iron armature carried by the switch arm being brought up against the faces of the hold-on bobbin at the same time. When the operating lever is moved on a little further, the double cam is

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released, but the double-pole switch is left closed by the action of the hold-on bobbin. When this slight further movement is given to the operating lever, the rheostat arm is set in motion in the direction to cut out resistance, but the rate at which it does this is controlled by the dash-pot already referred to, and may be adjusted to suit any particular conditions. When it is desired to stop the motor, the handle is moved to the "off" position, which first opens the double pole switch and then rapidly inserts all the starting resistance ready for starting up again. Should the double-pole switch open, in consequence of the failure of the supply or through the action of the overload device, it is impossible to close the double-pole switch again without first inserting all the resistance.

All the resistances, both for the starting switch and regulating switch, are placed in the pit below the machine.

In addition to the regulating and starting switches, some special devices have been added in connection with these machines. One of these is a short-circuiting push switch, worked from the brake lever in such a manner that, when the brake is put on, the hold-on bobbin of the starting switch is short-circuited and allows the switch lever to fall back, breaking the main circuit of the motor. Another arrangement, fitted to each machine, enables the business manager to know, while sitting in his office, which machines are running, and, if he desires it, to count the speed of any one of the machines. A supplementary contact is provided on the armature terminal of the starting lever of each machine motor, and this closes the circuit of a lamp upon the indicator shown in Fig. 4, and lights up the number corresponding to the particular machine. To enable the speed to be counted, a link motion on the "flyer" of

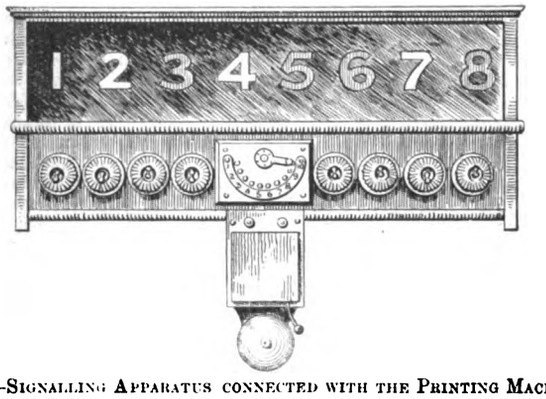

FIG. 4.—SIGNALLING APPARATUS CONNECTED WITH THE PRINTING MACHINES.

the machine opens and closes the circuit of a single-stroke bell, placed on the same indicator board in the business manager's room. By means of the switch arm on this board, any one of the eight machines may be connected to the bell.

Besides the eight large printing machines in the basement, there are two "Cropper" machines driven through shafting by a 1 H.P. motor running at 1,010 revs. per min. On the second floor three 4 H.P. motors are in use for driving cutting machines, two of the motors running at 875 revs. per min. and the third at 1,100. Six stitching machines are driven by a 4 H.P. motor running at 875 revs. on the third floor, and there are also two 7 H.P. motors running at 710 and 750 revs. respectively on this floor, driving four large and four small folding machines and four "guillotines" through shafting.

The foundry and composing rooms are on the top floor of the building, the latter being exceptionally well lighted, good light in a composing room being an absolute necessity. The actual making of the half-tone blocks is not done at the *Graphic* offices, but the blocks received from the engravers are re-touched by the *Graphic's* own engravers before replicas of them are cast for printing. These artists have the original drawings before them, and their work is to remove the artificiality of the half-tone block by restoring the dead whites, intensifying the blacks, adding texture to clothing, &c., to put in the delicate shading, and generally to introduce those original features of the drawing which have been unduly toned down by the "screen" employed in the half-tone process. The block then proceeds to the foundry, where a plaster-of-paris mould of it is taken under hydraulic pressure, and a cast of this mould is then made. A hard coating of nickel is then deposited electrolytically upon the casting, to enable its surface to withstand the printing process, the casting being first placed for a few moments in an electrotyping bath to cover it with the copper film necessary to make the nickel adhere to it. A small motor-generator furnishes the low voltage current for this purpose; an average current of 50 amperes at from 5 to 7 volts is utilised.

The main switchboard is in the basement. Current is taken from the City of London Electric Lighting Co., and continuity of supply is ensured by two sets of mains run from different distributing sub-stations, a throw-over switch being provided. There are separate meters and separate 'bus bars for the light and power circuits. The meters are two-rate Aron meters, one period of 12 hours (including the company's "peak") being assessed as day and the other 12 hours as night. In addition to the usual instruments, a Weston ammeter is provided in conjunction with a multiple ammeter switch and a shunt on each motor circuit. By this means the ammeter can be connected on to any one of the motor circuits that it may be needful to watch.

The whole installation has been carried out by Messrs. J. H. Holmes & Co., to whom we are indebted for much of the information contained in this article, and our thanks are also due to the editor of the *Graphic*, who was kind enough to arrange for our inspection of the offices.

POLYPHASE SUB-STATIONS.

BY S. L. PEARCE.
(Chief Electrical Engineer, Manchester.)

The following is an abstract of the discussion on the above Paper which took place before the Incorporated Municipal Electrical Association, June 30th. The Paper itself was published in *The Electrician* for July 15th, p. 521, and July 22nd, p. 552.

DISCUSSION.

Mr. E. T. RUTHVEN-MURRAY (Willesden) expressed surprise that the opinion that rotary converters were unsatisfactory was still existent. He had used such machines for 12 months, during which time he had turned out half a million units, but had never experienced any trouble whatever, and he regarded the rotary converter, even for lighting purposes, as an almost perfect machine. He thought the author had hardly given the two-phase system as good a showing as it should have, for he had omitted to mention in dealing with the question of power rating of machines that a two-phase rotary converter had a larger output for its weight than a three-phase machine, the ratio being 1·32 for three-phase and 1·6 for two-phase, as compared with the output as a continuous-current generator. With a six-phase machine an advantage of 30 per cent. was obtained over the three-phase rotary. The great advantage of rotaries, as the author had pointed out, was their low prime cost and high efficiency, but the want of stability referred to, he (Mr. Murray) had never experienced. If used with proper auxiliaries a rotary was quite as flexible a machine for lighting as a motor-generator. The practice at Willesden was to have the primary of the step-down transformers mesh-connected and the secondary star-connected. The primaries of two of the transformers had dial regulators, by which a regulation of 50 per cent. could be obtained on the continuous-current side by cutting out or adding windings on the primaries. He thought that this was probably the best method of regulation that could be applied to rotary converters, and, even with a 10,000-volt system, a method of using dial switches in connection with transformers would be eminently sound and safe if the high-pressure transformers were star-connected and the dial switches placed adjacent to the earthed neutral. At present he had only 3,000 volts, but the whole thing was safely encased, the casing being earthed so that no real danger resulted. The low-pressure transformers were star-connected, and the middle wire of the continuous-current system was connected to the centre of the star connection so that the rotaries themselves balanced the three-wire continuous-current system. This was an exceedingly interesting and useful feature. The Paper stated that transformers might be connected either star or mesh, but it did not mention the fact that it was sometimes useful to have the primaries connected in one way and the secondaries in another. It was not absolutely necessary to operate rotary converters at the low frequency of 25 or 30 cycles. There had been some 50-cycle rotaries at work in this country for many years in connection with the Isle of Thanet tramways, and in the course of a very few weeks the large system of the Metropolitan electric tramways would be operated from 50-cycle rotary converters. With synchronous motor-generators it was stated that the line pressure was taken straight on to the terminals of the stator of the motor. He would like to know if the author thought this was advisable with the comparatively small machines used in Manchester. He (the speaker) was installing some motor-generators for 10,000-volt working, and the makers of the machines, even with such large sizes as the author referred to, refused to build them to take the 10,000 volts directly on to the stator. If rumour was accurate, there had been a great many burn-outs at Manchester, probably due to the small size of the

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machines and the failure of the windings on the stators. The stability of synchronous motors was rather a myth. If they were worked at unity power-factor they were just as unstable as a rotary converter. With regard to the use of induction motors, he was very impressed with the remarks of Mr. C. F. Scott on the occasion when he (Mr. Murray) read his Paper on double-current generators two Conventions ago. Mr. Scott said that the lower power-factor of an induction motor was not such a terrible thing after all. Very often the slight extra investment owing to the larger amount of copper necessary was a very good thing, and there was no doubt about it that an induction motor was a machine that would run with variations of pressure and so on that no synchronous machine would stand. The author stated that "in every sub-station means must be provided for starting up from the alternating-current side in the event of the low-tension direct-current not being available. For this purpose the motor generator with an induction motor is specially useful owing to the rapidity with which it can be started to enable a supply of direct current to be obtained for starting up the synchronous sets," and later on in the Paper said "batteries are very seldom provided in sub-stations." He did not know why that should be. He had a battery in his sub-station, and the starting up of the rotaries was simplicity itself. He started up on the direct-current side through an ordinary starting resistance, speeded up and then synchronised with the incoming high-tension supply. But he was astonished that no mention was made in the Paper of the latest method of starting up synchronous motors and rotary converters. He regarded it as a very important one to keep in mind. There was a distinct objection to the use of synchronous machines under certain circumstances because of the time taken to synchronise, but with this method, in which the machine was started practically as an asynchronous machine, one of the great objections to synchronous machines was done away with. He had given a great deal of attention lately to the question of a direct supply by means of polyphase current, but thought that its advantages had been overstated up to the present time. The great problem to be faced in this connection was that of regulation. They might commence at 10,000 and transmit 10 or 11 miles and there transform down to 2,000. That was all very well. But when transformation down to 200 volts had to take place there must be some method of regulating the pressure, and he was inclined to think that in the power schemes there would be no reduced labour costs in running. Moreover, where there was a multiplicity of small transformers, the capital cost of the whole would be greater than if all the plant was contained in one sub-station and distribution carried on in the ordinary manner as at present. He could not speak from experience as to the use of three-phase transformers, but he should prefer to use single transformers for the reason stated in the Paper—viz., that, if one transformer failed, the system could be maintained by means of the other two. He thought the most important detail in a sub-station was to arrange the wiring to the switch gear so that it was absolutely safe—encase it, if possible, in an incombustible tubing. In the operation of machines, the Paper remarked upon the tendency to snychronise on the full-load voltage. He should prefer to say that the tendency directly would be to do away with synchronising altogether. Returning to the question of balancing, he had successfully dealt with a difference of balance of 25 per cent. for short periods on a 200kw. rotary converter with about 3 per cent. variation in pressure. The machine was, of course, not running at full load at the time. Hunting of rotaries almost entirely arose from the engines, but the increasing use of steam turbines would probably avoid this altogether, as these had an admirably even angular velocity. There was no need why rotaries operating at 50 cycles and driven from steam turbines should not be as absolutely reliable and free from hunting as were rotaries at 25 cycles driven by reciprocating engines. Personally, he had not had the slightest trouble from hunting under any conditions.

Mr. S. Z. DE FERRANTI said that what the Paper principally brought to his mind was the exceedingly complicated nature of a distribution such as was described in the Paper. The present tendency in electrical engineering was towards far too great complication. Exceedingly cheap gas lighting could be obtained by means of the mantle, and exceedingly cheap power with gas engines from an ordinary town supply. Therefore simplicity in electrical engineering was becoming more and more a necessity. He had consistently advocated the plain alternating-current system of the single-phase type. At the Huddersfield meeting of the Association he had spoken of the development likely to take place in connection with alternating-current motors. We were still without all that was needed in this direction, but since the time of the Huddersfield meeting there had been a very great advance and many excellent alternating-current motors had been developed. In fact, so great had been the development that even main line railway work was being carried on experimentally. With further development in this direction they would be able to go to a simple system of single-phase electric supply, which, after all, was the best in simplicity so far as was known to-day. If this was to be adopted, then, for special applications, some system of transformation into continuous current would be required, such as had been shown to be possible—although not yet commercially practicable—by the mercury vapour lamp.

Mr. C. H. WORDINGHAM said that one of the chief points brought out by the Paper was that the prejudice in this country against rotary converters seemed to be at last breaking down, and Mr. Murray's experience would go far towards helping this breakdown. The figures in the Paper went to show that unless the drawbacks were very great they should be adopted. 2 per cent. gain in efficiency, as compared with motor generators, represented an enormous number of units sold during the course of a year, when the enormous output upon which it was gained was taken into account. The saving in respect of capital expenditure was even more striking. A good deal of doubt existed as to what was the lowest periodicity suitable for lighting. It had been argued strongly before the Engineering Standards Committee, and a good deal of difference of opinion existed. With incandescent lamps it was largely a question of the pressure on the lamp. The lower the pressure the lower the minimum periodicity. When they were considering an entirely new system, instead of choosing the frequency first they ought to settle what the equipment was to be, and then choose the most suitable frequency. It was impossible to exaggerate the importance of standardising frequency at the earliest possible moment. Although the Engineering Standards Committee might be as influential as possible and have the best intentions, it was no use standards being suggested if they did not recommend themselves to the users. He would be glad to hear what Mr. Pearce's experience had been in actual practice with regard to balancing by means of connecting the neutral wire of the direct current to the middle point of the star-winding of the transformer feeding the rotaries, an arrangement adopted at some of the earlier sub-stations at Manchester. In the table of comparative cost of three-phase transformers and three single transformers, he was surprised to see such an enormous difference. It certainly seemed that there must be an enormous saving in spare plant to compensate for the extra cost of the three single transformers. He was in favour of the latter method, but was surprised that it cost so much to use them.

Mr. J. S. HIGHFIELD (Metropolitan Electric Supply Co.) thought it was a great pity that the Engineering Standards Committee had not got to work many years ago. So many periodicities were now used all over the country that it was almost impossible to see how any one could now be standardised. The periodicity suggested was 25 periods, but the Newcastle people had come to the conclusion that 40 was the best, and the Metropolitan Company had adopted 60 many years ago. Naturally, his company thought it would be much better to standardise 60. The Metropolitan Electric Supply Co. subscribed to the funds of the Standards Committee, but it seemed that they were paying to have their plant made obsolete. A good deal had been said as to the reliability of sub-station plant, but reliability was a much more important thing to a company which had a competitor in its district than to a municipality supplying where there was no competition. Moreover, many consumers were firmly convinced that direct current was far better than alternating current, and were prepared to pay ½d. per unit more for it. Nevertheless, he quite agreed with Mr. Ferranti as to the enormous cost of the complications in sub-stations, especially when they reached such large sizes as they did nowadays. The Westinghouse Company were now putting down one for 12,000kw. Certainly a more simple class of supply was needed.

Mr. A. E. HADLEY (The Electrical Co.) thought that for an all-round money-making concern a 50 periodicity was the best, with sub-station machinery that required the least amount of attention. With a sub-station having motor-generators there was a very serious amount of complication. Having adopted 50 periodicity the question as to rotaries dropped out, because, although there were stations of 2,500kw. running with rotaries, experience showed that, although they could be run, they were not the best form to use. Of course, in supplying a railway company or any large power consumer they would not adopt 50 periodicity, but from the money-making point of view 50 cycles per second with asynchronous motor-generators gave them the best chance. The simplicity was very much greater with the asynchronous type. There were no separate exciting sets that had to be watched. Up to the present the only disadvantage was that they had been a great deal more noisy, and in a crowded area the question of noise was of great importance. In this respect synchronous sets had been more satisfactory, but the trouble could be overcome with asynchronous sets if they were run at a slightly lower speed. With regard to single-phase traction this had been adopted in Belgium and elsewhere.

Mr. J. H. RIDER (London County Council) thought the statement that the machinery for 25 cycles was heavier than for 50 cycles was a mistake. Perhaps the author was referring merely to the static transformers. With regard to simplicity, he would like to preach that doctrine as far as it would go. Reliability of supply took the first place, and anything that was done to put in more efficient plant, so-called, which detracted from the reliability of the supply was a mistake. With induction motors there was no trouble at all in starting up or synchronising, and the main supply from the generating station did not affect the running of the motor generator so much as it did in the case of a synchronous machine, whether it were a motor-generator or a rotary. If there was a bad parallel in the main station or any little hitch for half a second, with synchronous machinery in the sub-station it all shut down. Similarly, if the circuit breaker went in the main station through a temporary overload in the sub-station, they dare not put that in again until the sub-station attendants had opened their machine switches; if they did it would be the switching in of the running current, which would be out of phase with the running machinery owing to the latter having slightly slowed down. Although the London County Council had as good plant and as smart men as were in any other sub-station, 10 minutes was a common time to get the cars running again. This meant a line of cars 2 or 3 miles long. Mr. Chamen had given him permission to repeat a tale of what happened at Glasgow. The lighting department took a supply from the tramways department through induction motors, but all the tramway sub-stations used rotaries. There was a slight hitch, which had the effect of shutting down the whole of the tramway sub-stations. Mr. Chamen's machines, however, simply jibbed and went on again, and his customers did not know it. This was worth 25 per cent. in efficiency in his opinion. With regard to whether fuses or circuit breakers should be used, he thought the best practice was to do away with fuses and use only oil switches, and have automatic devices, both overload and reverse current, to break the circuit. He did not agree that the tendency in synchronising was to do it at the line voltage. It was just the other way. They should synchronise and operate all their instruments from the low-pressure board, having a set

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of synchronising bars for this purpose. The modern type of synchroscope made paralleling almost child's play when one was accustomed to his instruments. The remarks in the Paper on cable-charging gear he agreed with. He did not think this was necessary at all. It was put in in some cases because of the idea of some engineers that in switching on a lighting feeder there was an abnormal rise in pressure. But it did not exceed twice the normal pressure, and was only for a fraction of a second. As a high-pressure cable was tested to twice its working pressure, he did not see what harm would come if it were allowed to take twice the normal pressure for a short time.

Mr. V. A. H. McCowen (Belfast) asked for figures as to the all-day efficiency of the sub-stations.

Mr. PEARCE (Manchester), in reply to Mr. Murray, pointed out that experience in this country with rotaries for lighting was very limited. The frequency of a system had a most important bearing upon its design. Nobody would adopt 25 cycles unless it was for traction purposes pure and simple. He thought 50 periodicity was much more likely to be adopted for general considerations, and with this frequency, he contended that the tendency towards instability with rotaries was very much greater than if a lower frequency were adopted. With regard to the full pressure being brought straight on to the stator, there had been no trouble in Manchester, where it was invariably done. The burn-outs referred to by Mr. Murray were as the result of something totally different. He saw no reason at all why 10,000-volt synchronous motors should not be built. He agreed with Mr. Ferranti that simplification of three-phase systems was the right course to adopt. Mr. Wordingham and other speakers had raised the question of frequency, and it appeared to him that it was highly advisable that a standard should be fixed. If 25 were fixed as the standard for traction work, then multiples of it would be advantageous for other purposes. But this question had such an important bearing upon the cost of transformers, generators and other portions of the apparatus that it would have to be very carefully considered. Therefore, he maintained the opinion expressed in the Paper that the frequency must, to a large extent, predetermine the type of the equipment for sub-stations. The balancing at Manchester from the neutral to the central point of the star was eminently successful. In reply to a point raised by Mr. Wordingham, he repeated that he found no advantage in keeping the traction and lighting high-tension 'bus bars separate; and with regard to placing circuit-breakers in the sub-station ends of the feeders, he thought these could be dispensed with if a very careful periodical test were made of the high-tension feeders to ascertain their condition. He agreed with Mr. Hadley that the noise of induction motors was a difficulty, and 50 per cent. of them in Manchester could not be run for that reason, owing to complaints from neighbours. Mr. Rider raised the question of the weight of generators, but if he compared the weights of sub-station machinery he would see that the tendency was to increase the weight of the two-phase as against three-phase. He did not agree with Mr. Rider that synchronous machines were invariably shut down if there was trouble at the generating station. He had had numerous cases in which machines had been put out of synchronism at the generating station without anything happening at the sub-stations. He had had a good deal of success with the use of synchronous machinery without any trouble at all. The usual time taken in Manchester to get running again after a breakdown was three minutes at the generating station and seven or eight minutes at the sub-station. He agreed that synchronism was far better done at low tension, but in some installations during the last few years it had been done at high-pressure. With regard to Mr. McCowen's inquiry, the all-day efficiency at the sub-stations worked out to about 75 to 76 per cent., which was not very low when the small capacity of the sets was taken into account.

SOME NOTES ON THE BRISTOL ELECTRICITY WORKS FIRE.*

BY H. FARADAY PROCTOR.
(City Electrical Engineer, Bristol.)

Having been asked by your Council to introduce to this meeting the question of the Bristol fire, the author does so with the view of affording an opening for considering the possibilities of electricity works fires in general and the Bristol fire in particular. Since so much has been published in the technical press and elsewhere, there is little or no scope for originality in the following notes, which at best must be looked upon as a bald statement of facts, but which a few months ago in the hands of an artistic story-teller would have been converted into interesting and sensational matter.

A fire occurred at the Temple Back electricity works belonging to the Corporation of Bristol at 5.15 on Wednesday evening, December 28, 1903, resulting in the destruction of the 2,000-volt high-tension Ferranti switch gear, and damage to portions of the roof and windows of the engine room. The machine switchboard, wattmeter switchboard, trunk feeders from the Avonbank electricity works, and the whole of the 44 feeder panels were destroyed, as well as all the cables leading up to them from underground. It may be well to remind you that at Bristol there are two generating stations—viz., Temple Back (the old), and Avonbank (the new). The Temple Back station, occupying the more central position, is at present used as the distributing centre for the whole of the H.T. energy, the current from Avonbank being delivered to Temple Back through six 0·80 sq. in. two-conductor concentric paper insulated lead and steel-tape armoured cables, and from Temple Back the energy is delivered by similar feeder cables (of varying sections, 0·1 sq. in. to 0·05 sq. in.) through 44 feeder panels to about 60 transformer sub-stations in different localities.

The only generators that need be considered in connection with this matter are the four 750kw. to 1,000kw. steam alternators at Avonbank, all of which were running at about two-thirds of normal full load, and two 400kw. steam alternators which were running (at two-thirds of full load) at Temple Back in parallel with the foregoing, the total alternating-current load being 2,700kw. The remaining plant, whether alternating or direct current, does not affect the subject under consideration. The voltage at the generating station at the time was 2,300 and the periodicity 93 ~ per second. There were present at the Temple Back works at the time of the outbreak, Mr. H. H. Couzens (deputy city electrical engineer), the stations superintendent, mains superintendent and others, and on the switchboard gallery two charge engineers, an improver and a switchboard boy.

The seat of the trouble was evidently in the panels of the two alternators running at Temple Back (Nos. 8 and 10); a considerable arc started on these, and it is reported that some seconds elapsed before the fuse pots burst and scattered oil, which immediately caught fire, and in turn caused all the other fuse pots to crack and let their oil run out. The handles of the machine and trunk main switches were burnt so rapidly that they could not have been operated even could they have been approached. The flames from the burning oil shot up to the roof 20ft. above the switchboard floor, and the matchboarding on which the slates rested was soon ablaze. Curiously, the amperes output only increased by about 200 for the first two or three minutes, hence the plant at Avonbank was kept running until after the lapse of about eight (?) minutes, when the load, having increaseed by about 800 amperes, some of the trunk main fuses at Avonbank gave way, and the station was then shut down.

The damage done by fire may be said to have been limited to the high-tension Ferranti switchboards, one of the arc lighting boards, the connecting cables from the switchboards to the machines, and from the switchboards to the mains in the streets; and also, as far as the building is concerned, to damage to the roof, teak window frames and a portion of the switchboard gallery. A slight amount of damage was also done to the stone window sills and glazed brickwork. The total amount of the claim paid by the insurance company was £8,225.

The remains of the old board were very carefully examined, and several consultations have been held to endeavour to ascertain the source of the breakdown, but there is not sufficient evidence to point conclusively to special features constituting the primary cause. It is most improbable that a fault on the external system is to blame since all the trunk mains and feeders were protected by fuses, and some minutes after the arc was formed the ammeters registering the entire output from the Temple Back works were examined and showed a normal current. After the fire it was found that one of the trunk mains, that remained loaded to the last, had fused for a length of about 3ft. to 4ft. in the ground outside the Temple Back works, but as the arc had apparently sufficient resistance to keep the current within the limits of the fuses at the Avonbank end these did not operate. The fuses at the Temple Back end of this trunk main were not situated where the arcing commenced, and could not, therefore, have been the cause of the same. This cable is 0·3 sq. in. section two-wire concentric paper insulated lead sheathed and steel tape armoured, and was provided with fuses at each end, and probably carried nearly 1,000 amperes before Avonbank was shut down.

It would appear that the origin of the trouble is to be found from amongst the following:—Firstly, by leakage from the metal work of the board "charged at high pressure" over the surface of the insulators and slate to "earth," or, in other words, to the other pole of the board, in which case it is further possible that this may have been in a measure caused by the presence of moisture or by a crack in one of the insulators due to the jar of operating the switch. Secondly, by the breakdown of one of the cable receivers, in which the cables from the machines to the switchboard are jointed up. In the event of such a fault occurring, however, it is most probable that, owing to the proximity of the two conductors, a "dead short" would have resulted, causing the engine to pull up, the mass of metal being too great to allow of the fault clearing itself, and the machine fuse would have operated, due to the current from other generators. Since the machine in question (No. 8 alternator) did not pull up, and since the fault was not a dead short as evidenced by the fact that the load on the Avonbank station did not run up to more than about 1,374 amperes—viz., say, 200 amperes above the normal load for the time in question—it appears that the fault did not originate at the cable receiver. Thirdly, by the abnormal action of one of the machine fuses, the blowing of the fuse causing an arc and breaking the porcelain pot filled with oil in which the fuse is placed.

* Paper read before the Incorporated Municipal Electrical Association.

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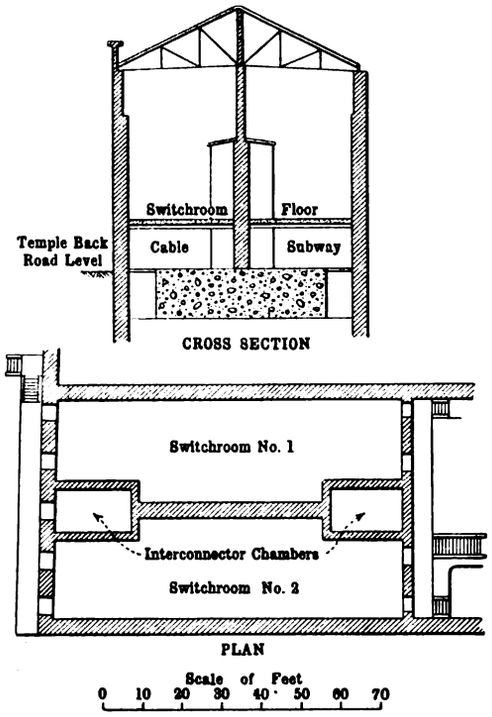
Although some engineers who have examined the board since the accident seem to favour the opinion that the improper action of the fuse was the first cause of the trouble, none of the members of the staff hold that view. The fuses were examined by the engineer in charge just a few minutes before the accident, and their temperature was normal. There was not even a full load on the machines corresponding to the switch panels wherein the trouble commenced and no switching operation was being carried out. Whilst the fault was still "on" and the Avonbank works was still delivering energy to Temple Back, the stop valves of the two running machines at Temple Back were closed and their fields shut off although the machine switches were closed and could not be approached. These machines would thus have formed two dead shorts across the system unless their fuses acted, and since the machines on examination showed no signs of having passed excessive currents, the inference is that these fuses acted in a proper manner and were not the source of trouble.

It is very certain, however, that when once the fault commenced the whole of the cause of the spreading of the trouble was attributable to the oil used in the fuse holders and switches, of which there would be about 22 gallons. The fault was very much augmented by the fact that it was impossible to get the Avonbank supply cut off till after the lapse of a few minutes, as all private telephones were rendered useless by induction on the wires, and, owing to the great number of calls from consumers, it was impossible to immediately get into telephonic communication over the National Telephone Co.'s system. It was, therefore, not until the load at Avonbank became very excessive that those in charge shut down the supply at that station.



NEW SWITCH-ROOMS AT BRISTOL.

It was also impossible to get at the switches on the trunk mains from Avonbank owing to the conflagration, though what would have happened at Avonbank had the full load been suddenly and totally removed without explanation or warning is perhaps a matter for speculation; the alternators would probably have run out of phase and the boilers would certainly have blown off steam. Whether the plant would all have remained in thorough order ready to take up the load as soon as the mains were joined across is difficult to say. Apart from the oil, there was a small amount of wood on the oldest portion of the switchboard floor, which contributed somewhat to the fire. All portions of the flooring, excepting that first installed, were formed of iron chequer plating covered with linoleum, and this withstood the test perfectly, the linoleum within a few feet of the place where the most extreme heat occurred remaining intact.

The window frames are of teak, and they were much charred, but these in themselves did not add to the trouble. In the roof the slates were laid upon matchboarding, and this formed one of the most serious features, as the fire reaching this spread rapidly along a considerable length of the engine room and necessitated the use of a great amount of water, this water doing a considerable amount of temporary damage to the electrical machinery. The cables contributed largely to the flames, although they were all encased in lead and further protected with steel armouring. The steel armouring, however, was served over with impregnated jute, and this getting soaked with oil was, of course, very inflammable.

In reconstruction: (1) The use of oil in porcelain holders is to be avoided. (2) The use of wood anywhere about the structure of the switchboard floors will be avoided, unless it is in such form as to be proof against fire. Hardwood blocks set upon a concrete foundation probably form the best and safest description of switchboard flooring, as, whilst it is practicably unburnable, it affords a good insulation from an electrical point of view, and does not appear to be open to the objections that have been found to exist in the case of glass. (3) Cables, although armoured with lead or steel armouring, must be further protected by being either buried or run in metal casings; and (4) the roof must have in its construction no wood, unless it be thoroughly protected, as in the construction of fireproof doors.

Ferranti switchboards of the type whereon the accident occurred have been very generally accepted as being of the most suitable form for use under the particular conditions of the Bristol system, but it seems imperative that boards constructed on this principle should not be built into any external wall of a building, for, although the walls of the generating stations at Bristol are formed of most excellent bricks set in cement and are 2ft. thick, there is no doubt that, with continuous wet weather and strong winds, damp has found its way through, and the back slates supplied with the board afford no protection.

A drawing of the proposed fireproof switch-rooms is appended hereto.

DISCUSSION.

Mr. HAMILTON KILGOUR (Cheltenham) said that in response to an invitation by Mr. Proctor he went down to Bristol before anything was cleared away, and was amongst those who thought that the improper action of the fuse was the cause of the trouble. The locus of the trouble was undoubtedly at one or other of the two fuse positions on the machine panels. It was perfectly well known that copper fuse wires did go at times without any apparent cause. At Bristol a slight arc was maintained through the springs and flexibles of the fuse having become stiff. He had examined a great many of these in his own station, and the flexibles undoubtedly ceased to be flexible and the springs became quite stiff so that the ends of the fuse wires were not drawn right under the oil. A small arc was therefore started at Temple Back, and as Avonbank continued sending current an explosion took place in the fuse box and started the conflagration. He knew from experience that when fuses went they went with explosive violence, but he had got over this by allowing a certain amount of clearance. Otherwise, when the fuse went it upset some oil, and the arc which followed, playing on this oil, caused a fire. He thought the Ferranti board was a most excellent one, but he would like to have it modified, as suggested in Mr. Proctor's Paper, in the way of getting rid of the fuses and substituting switches with over-load and no-voltage or reverse current automatic releases.

Mr. G. H. COTTAM (Hampstead, London) asked Mr. Proctor if he had any authentic data that the oil pots were full of oil, and whether the temperature of the pots was taken by merely feeling them on the outside. He had had experience that when oil leaked out of a box and a fuse had gone the arc was sufficient to travel back and carbonise the whole box. He was of the opinion that the cause of the fire was the fact that the oil in the pots was not sufficiently high to put out the arc.

Mr. L. ANDREWS (Key Mfg. Co.) said that Mr. Proctor apparently favoured the view that the fire was started with leakage over the surface of or through one of the insulators. He (Mr. Andrews) did not think this likely, because it could be assumed that even if direct contact with the glazed brick wall behind the switchboard were made the resistance of this wall would be sufficient, even if saturated with moisture, to prevent sufficient current passing through it to start a serious arc. It was stated that after the fire a trunk main was found fused asunder for 2ft. or 3ft. feet, but that the Avonbank feeder fuses had not been blown. The Paper also stated that the sectional area of the feeder was 0·3 sq. in., with apparently a maximum current of about 1,000 amperes—*i.e.*, it was working for three minutes with a current density of 3,000 amperes per square inch. Such a current would not burn a feeder suddenly, and the current was no doubt very much heavier than Mr. Proctor estimated. He was of the opinion that something must have occurred at that point to break down the insulation; but was that failure of the insulation the cause of the trouble or the effect of the trouble? It was more likely that the fault really occurred outside the station, but Mr. Proctor said he did not think this was so, because the arc did not start at the fuse at the Temple Back station. He supposed it could be assumed that the fuse was of the same capacity as the one at Avonbank. Assuming this, they then had to consider that there was a fault being supplied from the two generating stations, one station 2 yds. away and the other 2 miles away. This would mean that the majority of the short-circuit current would come on the Temple Back station, where there were only two generators running at about two-thirds full load. If the load were suddenly thrown on two generators, one would get away quicker than the other, and that was what happened here and blew its fuse. Then the whole load would go on the remaining machine and blow that fuse as well. He did not agree with Mr. Kilgour that it was necessarily a fault in the fuse itself, because there was absolutely no fuse obtainable which could be entirely relied

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upon on high-tension circuits. About two years ago he brought back from the States a fuse that had an excellent record there and which had been used frequently on 5,000 volts. It acted well enough at Hastings on 1,000 volts, but after a time it blew all to pieces. It was all a question of the point at which the current had to be broken. If it occurred on the crest of the curve and an arc was started, there was absolutely no method known that could be relied upon. One thing that was necessary was that the gear should not be too cramped. The gear should be so removed from the high-tension parts that if anything abnormal did occur the attendant was not unnerved and time was not wasted. He was interested in a remark made by Dr. Thompson upon his (Mr. Andrews) Paper before the Institution of Electrical Engineers a few years ago. Dr. Thompson said that fuses were very good things to do without. Circuit-breakers were the best things to use because with these the circuit was actually broken inside the oil. It was not broken outside and then drawn under the oil.

Mr. C. H. WORDINGHAM said that the experiences at Bristol had brought out the vital necessity of having absolute incombustible construction for generating stations. He would like to know whether Mr. Proctor did not consider that a tiled platform with rubber mats was better than wood blocks, and also whether it was to be understood from the Paper that the whole of the trunk feeders were burned out.

Mr. PROCTOR said the whole of the mains underneath the switchboard were burned, but not those between the two generating stations.

Mr. WORDINGHAM, continuing, said that the burning of the cables in this way might be explained by the fire working back up the cables, and thus it would not be electrical at all. He was not familar with the latest construction of the Ferranti switchboard, and was not aware whether sulphur cement was used, but if it were used it was a very dangerous material. If Mr. Ferranti would forgive him referring to ancient history he might say that a fire occurred in the Grosvenor Gallery where the stream of sulphur cement that ran down was something to remember. He would like to know what fraction of the total loss to the station the insurance represented. Incidentally Mr. Proctor had speculated as to what would happen if the whole load were thrown off the Avonbank station instantaneously. This was a very serious matter, and he had actually provided a valve in a big station by which the steam pipes blew off automatically to the atmosphere if such an occurrence took place. With regard to connections to the switchboard, he thought that anything in the nature of a yarn covering to cables should be avoided. It was not necessary within a building, and certainly was a possible source of fire. If the lengths of cable were not too great, could not a copper covering be put round the cable? This would avoid melting. He had samples made of paper cables with copper covering, and it certainly was quite feasible although very costly. But it made a very safe job at the back of a switchboard.

Mr. H. W. CLOTHIER said that one thing had not been mentioned in the Paper, viz., the length of time during which consumers were in darkness. He understood that the first consumers were put on about eight hours after the accident, and that some of the load was not taken up until 27 hours after the accident. Some few weeks after the accident, in response to many inquiries which he personally received, he issued a report, and the opinion he expressed in that report he still held. The question of burning oil, however, he did not lay so much stress upon as did the author. The oil used in oil-break switches and fuses was one which had a very high flash point and it was as good an insulator as could be procured. These were two essentials of the oil. Another one was that it should not be too thin or too thick. The proper viscosity ought to be obtained. He did not suggest that this was the case at Bristol, but only mentioned it as a point in the discussion. The switchboard had not been used in the way it had been originally intended. The intention had been to instal two 2,000 kw. machines at the Temple Back station. Afterwards it was found expedient to build the new station at Avonbank and to connect up the machines there by trunk mains to the switchboard in Temple Back. Practically no alteration was made to the board. He contended that if a fuse had failed upon the board as it was originally intended to have been used, the machines would have been quickly shut down on the stop valve and the fire would have been but a trifling thing to get over. The flames could have been put out by sand or a coat or a sack, and the station would only have had to be shut down for about half-an-hour. He thought Mr. Proctor's suggestion that the insulation of the board had failed impossible. The surface insulation consisted of 2½in. of porcelain, asbestos and slate. He thought Mr. Andrews had thrown some light on the occurrence. The Paper stated that one of the trunk mains which carried 1,000 amperes up to the very last was found to have been burned down 2ft. or 3ft. This could not have been carrying current unless there was an arc, and it forced the conviction upon him that the fault on the trunk mains must have been one of the earliest incidents of the whole occurrence. But he did not think it was a good point to say that the burning of the machine fuse was due to the fault on the trunk main because the machine fuse would take more current than the main trunk fuse. He advocated the elimination of fuses from machine panels. He believed that sulphur compound was still used on the Ferranti switchboards, but when it melted it only smouldered away and did not burn fiercely.

Councillor IRWIN (Dublin) asked what kind of holders for the oil Mr. Proctor proposed to use in reconstructing the station. In the Dublin scheme they had a Ferranti switchboard, with porcelain holders, working at 5,000 volts. The switchboard floor was tiled. The switchboards were built into the walls and he would like to know the effect of damp under these conditions. It appeared from the discussion that no form of fuse at present known was absolutely reliable. This was a serious matter, but he thought there ought to be sufficient talent in the country to invent something which would be absolutely safe and reliable under all conditions.

Mr. G. WILKINSON (Harrogate) thought there was no doubt that the cause of the fire was the failure of the fuse pot, and it showed the necessity for careful and periodical inspection as well as ample ventilation. The author made the following rather startling confession in the Paper: "Some minutes after the arc was formed the ammeters registering the entire output from the Temple Back works were examined and showed a normal current." It seemed to him that as this was two or three minutes before the fuse pots burst that was the time for the switchboard attendant, by prompt action, to have put out the arc. What struck him when he examined the board was the very narrow platform which was in front of the board. But there was nothing at Bristol to disturb the well-founded confidence in the Ferranti board for certain purposes, and they need not indulge in any mild panic with regard to the working of these boards, provided there was systematic examination and especially of the fuses. At present he was putting up an addition to the Harrogate board for machines up to 1,000 amperes.

Mr. S. Z. DE FERRANTI said that he was the perpetrator of the trouble at Bristol, and he desired to acknowledge the exceedingly kindly and honourable way in which Mr. Proctor and all those who had spoken in the discussion had dealt with the matter. They might have said very much harder things than they had. He had not visited the scene of the fire, but from the reports he had had furnished him, he had come to the conclusion that it was simply that the fuse broke and then the trouble started. It was a very easy thing to make an invention, but an exceedingly difficult thing to improve it. The pattern of fuse on the Bristol board was supposed to be an improvement over a previous pattern; but, unfortunately, it was just the reverse. It was the worst pattern fuse he had ever manufactured. What occurred was that the springs, failing to operate completely, left the terminals of the fuse standing out above the oil, and it was easy to see how the trouble followed. With regard to what happened afterwards, he did not agree with Mr. Wordingham's idea about the fire running along. The cellular system demonstrated its advantage as much there as anywhere else and absolutely kept the trouble within limits. The burning oil was thrown out in small quantities and ignited the combustible material on the switchboard. The advantages of a cellular switchboard were absolutely thrown away if there was anything in the neighbourhood which could be ignited by a spark, and he would recommend the elimination of everything combustible from the neighbourhood of that and all other types of switchboard. There was no reason why the platforms should not be entirely incombustible. Mr. Okell, of Plymouth, had been speaking to him about compressed glass blocks, which would be very much better than the wooden flooring which was used. Rubber mats were about as bad a thing as possible. Lids were supplied for the fuse boxes in order to prevent dirt and dust getting into the oil. He realised the difficulty of them, but found it hard to convince other people that, although the lid was supplied by the makers, it should not be used. The Grosvenor Gallery fire happened 16 years ago. There had been a good many fires there, but the one Mr. Wordingham referred to was the principal one. Cellular switchgear was developed very largely as the result of the fire. About 14 or 15 years ago he designed a cellular switchgear for the London Electric Supply Corp. sub-stations working at 10,000 volts at a time when there was very little experience, but there had been no failure on the switchboards of the London Electric Supply Corp. sub-stations since. They were working to-day, and the large number of transformers working with them appeared to be just as serviceable now as they were then. There was a tendency to put up a great deal too many instruments on a switchboard and to do a good many things that ought to be left undone. It was very easy to make an electrical measurement, and the tendency was to put an instrument in every conceivable position in order to get a lot of information. This information was very interesting, but it was not of much good. If these instruments were dispensed with large financial savings would be made, and at the same time the security of the switch gear against breakdown would be improved. The chief fault of fuses was that they had been too good, and their employment had consequently been continued beyond their sphere of usefulness.

Mr. FARADAY PROCTOR (Bristol) in reply to Mr. Cottam, reminded that gentleman that the fire took place two days before Christmas, and it was a night when the maximum load was expected. Therefore, it was only natural to expect that the station engineer had thoroughly inspected his fuses. He felt quite sure that the pots were full of oil and that the fuses were new material. Mr. Andrews had referred to the existence of a glazed brick wall at the back of the switchboard. As a matter of fact, it was a red brick wall, and the glazed appearance was given by a coating of white enamel over the bricks. Mr. Andrews also advocated the use of circuit-breakers with time limits. He was going to use circuit-breakers in the future, and he hoped also time limits, but no one seemed to know anything very satisfactory about the latter. He did not like tiles or glass for the flooring because, if a screw, or anything of that sort, were dropped on it it might be dangerous for persons walking about. Wood was practically unburnable if it was put in in the proper form, so that there was no admission of air, in case of fire, behind it. Possibly, as Mr. Wordingham pointed out, the existence of the sulphur cement might have been one cause of the fire. The best of joints got hot sometimes. This cement might have softened the terminals, which got a little out of line, and by exercising rather too much strength in putting in the fuse or switch through it not going home easily the insulator might have got cracked. With regard to the insurance money, the company paid £8,000, but they did not get every penny he claimed for. He thought Mr. Clothier had drawn many erroneous conclusions. He saw the scene of the fire, and he (Mr. Proctor) should have thought he would have realised that a sack would not have put out such an arc as took place. There was a considerable quantity of sand on the platform, but it was of no avail. Mr. Clothier's remark that the machine fuses would take more current than the trunk main fuses was not correct. In reply to Mr. Irwin, iron holders for the oil were now being adopted at Bristol.

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COAL-HANDLING PLANT AT CHATHAM.

Messrs. Graham, Morton & Co. send us the following particulars of an Admiralty contract which they have carried out. It is in connection with the electricity supply at the Royal Dockyard at Chatham, and included the supply, delivery and erection of a complete coal-handling plant. The coal bunkers are 200ft. long. They are divided into 15 compartments, and are 17ft. wide, having a total depth of 19ft. Each division has a conical bottom, with wrought-steel outlets and flanges for the attachment of the coal-measuring apparatus. To the wrought-steel flange at the bottom of each coal bunker is attached a valve and a measure chamber to measure 5 cwt. of small coal at a time. The operation is from the stoke-hole floor. Arrangements are made so that the measurer can be moved bodily from the valve, to permit the fixing of the weighers, which are supplied in addition to the coal measurers. These are provided with complete recording apparatus, to continuously record the weight of coal weighed, and with dials capable of being read from the floor level. As it is not intended that the weighers shall be permanently in position, they are provided with eye-bolts or shackles, by means of which they can be hoisted up. Outside the boiler house, on a lattice-work structure, is fixed a steel ash hopper, 10ft. square by 9ft. total depth and of about 10 tons capacity.

There are three batteries of boilers of three, four and six respectively. The first two have one uptake each and the latter two, leading into the main flue at a higher level and supported on plate girders of 22ft. 6in. span. The uptakes are rectangular in section, 10ft. long by 4ft wide. The whole of the exterior is lagged with asbestos covering to a depth of about 1½in., and then covered with steel sheets of $\frac{3}{16}$in. in thickness and secured at the corners by means of bolts. Each uptake is provided with one expansion joint, and stiffened at intervals with angle irons. The main flue is also rectangular in section and is 11ft. high by 2ft. wide being lagged and covered in exactly the same way as the uptakes.

Fixed on the roof of the boiler house are seven single-ton electrically-driven coaling cranes. The radius of the jibs is 8ft. 9in. and height of the lift is 40ft.; the lifting rate is 200ft. per minute and the slewing rate 150ft. per minute at the jib head. The centre post is of forged steel and machined all over. A hole is bored through its length large enough to take the connecting cables. Suitable rings and collecting gear are provided and fitted at the top of the post. The jib is built of wrought-steel plates and angles of the lattice-girder type steel riveted and rigidly connected to its base. Automatic lubrication is fitted to all bearings. There are two totally enclosed series motors on each crane. One is a non-reversing motor for hoisting and the other a reversing motor for slewing. The speed of the 460 to 500-volt motors is specified not to exceed 600 revs. per min. The commutator segments are of sufficient depth to allow of a radial wear of at least ½in. on the slewing motor and ¾in on the hoisting motor. The controllers are contained in a metal case and actuated by one handle. Both controllers are connected by pinions and quadrants to the lever, and the latter is so arranged that when moved in a vertical plane it actuates the lifting and when moved in a horizontal plane the slewing controller. A spring causes the controller to return to the "off" position as soon as the handle is released. The ash-hoisting crane is fixed on the outside wall at one end of the boiler house, and is capable of lifting a total load of 10 cwt. at the rate of 200ft. per minute, the radius of the jib being 8ft. The slewing motion is operated by hand by means of a wrought-steel lever and appropriate gear, the slewing bearings of the jib being provided with antifriction rollers to facilitate operations.

A SECRET SERVICE TELEPHONE SYSTEM.

For some considerable time the General Electric Co. have been carrying out experiments in connection with a new system, whereby absolute secrecy could be maintained during the time that any two persons were in telephonic communication, and, further, to dispose entirely of all chances of "tapping" the line and the possibilities of leakage. The company have now introduced an instrument which, it is said, enables this to be carried out most successfully, and they have given the name of "SS" (secret service) to the system. In construction the instrument is somewhat of a departure from the usual form, and embodies the latest developments made in telephone work generally. Every detail has been most carefully thought out, and the whole instrument substantially made and highly finished. Two stations cannot be accidentally rung up at one time by careless placing of the switch, and all chances of cross-talking are disposed of. Moreover, each pair has a complete metallic circuit, the conversation is loud and clear, and the instrument cannot be left out of call.

The method of operation is extremely simple, an operator being able to put himself into direct communication with his correspondent at any other station on the system simply by inserting a plug and pressing a ringing key. It is impossible for a third person to overhear the conversation, or to interrupt in any way whatsoever; the inductive effects which exist on ordinary systems are entirely eliminated with this particular type of instrument by the use of twisted wire, and all chances of leakage disposed of by adopting a metallic circuit throughout. A distinct signal is given by the falling of an indicator shutter to point out which station is making a call, attention being audibly attracted by a bell; or, if the plug happens to be left in the "jack" or socket, a "buzzer" is brought into operation. On reference to Fig. 1 it will be observed that there are a number of drop indicators corresponding with the number of lines, and immediately below these are the "jacks" or plug sockets. A connecting plug with a length of flexible cord is also provided which is inserted into any "jack" according to the number of the line it is desired to communicate with. When a call is made the indicator corresponding with that particular line falls, denoting at once who is calling. Should the telephone be without an attendant when the call is made, this indicator clearly shows that a call has been made and from whom the call originated. The "SS" telephone can also be used as a central station instrument for intercommunication between outlying stations, in which case it is provided with a pair of plugs enabling the calling station to be connected through to any other station on the system.

FIG. 1.—WALL SET.

FIG. 2.—TABLE SET.

The Recent Thunderstorms.—Last Monday heavy thunderstorms broke over nearly all parts of the United Kingdom, and resulted in a number of fatalities and considerable damage to property. A lad of 17, while crossing Stamford-street, Blackfriars, was struck by lightning and killed, his body and clothing showing signs of burns. A farmer was killed by lightning at Holtfleet, near Worcester, while in the act of ploughing, his horses sharing the same fate, but a boy who was with him escaped injury. A man was also killed while walking on the top of a hill near Barmouth, and his wife, who was with him at the time, was very seriously shaken. Throughout the week numerous storms have taken place in various parts of the country, further lightning fatalities occurring on Wednesday. It is anticipated that more thunderstorms will visit this country before the weather once more becomes settled.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

The Ponderable Emission.—R. Blondlot has tried whether the polish of a metallic surface has any effect upon the ponderable emission obtained from it. He finds that if a silver coin is polished it absolutely ceases to emit the finely divided matter which affects the phosphorescent screen. If it is then heated to 100deg. in the open air for a few minutes and allowed to cool it again gives off the emission indefinitely. The same phenomena are presented by pure silver, by copper, mercury, iron, zinc and bronze coins. In the case of lead, however, the behaviour is reversed, for a polished or freshly-cut piece of lead gives off the emission, whereas a tarnished piece of lead does not. The platinum metals, gold, dry glass, fused sulphur, plaster and chalk are inactive; but a large number of liquids are active, such as tap water, salt water, pure sulphuric acid, glycerine, vaseline oil, alcohol and, generally, all odorous liquids. The author agrees with Berthelot that the emission may be due to very feeble chemical reactions produced at the surface of metallic bodies or to the volatilisation of certain constituents.

[R. BLONDLOT, *Comptes Rendus*, July 4, 1904.]

Effect of Radium Rays on Metallic Conduction —J. Trowbridge and W. Rollins point out that, owing to the peculiar properties of radium rays, we are at last in a position to decide the question as to whether radiant energy exhibiting light and passing through a metal can affect the passage of a current of electricity, as it already does in a gas by ionisation. They made the following experiment:—A metre of aluminium wire was wound in five turns round a thick sheet of lead, which was 8cm. in length and 1cm. in width. The wire was wound round the longest dimension of this shuttle-like piece of metal, and was insulated from it by thin sheets of vulcanite. The electric current, therefore, passed in one direction along the upper layer of the wire, and in the opposite direction along the lower layer. The lead intervening between the upper and lower layer could serve to confine the radiations from suitably placed radium either to the upper or the lower layer of wire. The lead shuttle, with its layer of wire, was enclosed in a lead cylinder, and a specimen of pure radium bromide was enclosed at one end of the layers of wire, so that its emanations could sweep along the upper or the lower layer of this wire. A lead diaphragm could be used to shut off the entire effects of the radium from the wires. As a result, no instantaneous effect was observed; a very slight creeping deviation of the galvanometer mirror came after a considerable interval of time, which might have been due to change of temperature. It could not be ascribed with reason to the presence of radium. The light from the radium could be seen through a slab of iron 1in. thick, yet this manifestation of energy passed through the aluminium without any apparent effect upon the mechanism of the electric current. The authors suggest that this negative result goes to support the theory that the mass of the electron is altogether apparent.

[TROWBRIDGE and ROLLINS, *American Journal of Science*, July, 1904.]

The Electron Theory.—W. Wien shows that the assumption that the electrons are not spheres, but Heaviside ellipsoids, not only satisfactorily explains Michelson and Morley's other experiment, but also supplements his own theory of radiation by electrons. According to Heaviside, the surface of an electric charge which is a sphere while at rest becomes in motion an ellipsoid whose axes are in the ratio $1-\frac{v^2}{c^2}\cdot 1:1$, where c is the velocity of light and v is the velocity of the electric charge. An electron will, therefore, only be a sphere when it is at rest. After being set in motion with respect to the ether it will assume a shape whose flatness increases with the velocity, and which becomes a circular disc when its velocity is that of light. This conception at once eliminates all the well-known difficulties of an electron moving with the velocity of light or a greater velocity, for the velocity of light is the greatest possible speed of the electron, since its shape becomes unstable as soon as that speed is exceeded. Another point of view newly introduced by this conception lies in a possible hysteresis between the velocity acquired by the electron and its corresponding change of shape. Such an hysteresis or retardation might have to be considered in an accurate theory of Röntgen rays. In any case, the new theory will bring us considerably nearer the reduction of mechanics to electromagnetic principles.

[W. WIEN, *Physikalische Zeitschrift*, July 15, 1904.]

A New Method of Observing N-Rays.—R. Blondlot describes a method in which, instead of observing the sulphide on a black ground, it is only necessary to watch the appearance or disappearance of a coloured line on a background of the complementary colour. A thin line of the sulphide is traced on a piece of white cardboard, and this is then exposed to the light of a gas flame shining through orange-coloured glass. When the flame is turned high, the only thing seen is the uniform yellow surface of the cardboard. When it is turned very low, the blue colour of the phosphorescence comes out clearly on the orange ground. The flame can be so regulated that the blue line only just disappears. If in this "sensitive" state the screen is exposed to N-rays, the blue line reappears, disappearing again when the N-rays are stopped. All fatigue and strain of the eye, giving rise to the illusions specified by Lummer and Le Roux, are thus avoided. The same method may be used for the observation of the N′-rays. The flame is then regulated that the blue line is just visible, and the N′-rays then make it disappear. The author points out that these observations require a certain training of the eye, just as the ear requires training, according to Helmholtz, for the discovery of harmonics.

[R. BLONDLOT, *Comptes Rendus*, July 11, 1904.]

Intensity of Radium Rays.—W. Seitz has made some absolute measurements of the intensity of the β-rays given out by radium preparations. The method used was not that of measuring the positive charge acquired by the radiating preparation, but that of measuring the negative charge acquired by an insulated plate exposed to the rays in a vacuum. Since in this case the preparation need not be itself enclosed in the vacuum, the method is well adapted to the measurement of absorption. The plate exposed was of brass and was connected to the electrometer through the intermediary of a platinum brush attached to a piece of iron suspended by a spring, which enabled the observer to interrupt the communication with the electrometer by means of a magnet. The author found that the preparation, consisting of 7 milligrammes of radium bromide, gave off permanently $3{\cdot}57\times10^{-12}$ amperes in the form of β-rays. This value accords well with the $3{\cdot}018\times10^{-12}$ amperes obtained by Wien from 4 milligrammes of radium bromide. As regards the absorption, the author found that Lenard's rule, according to which the absorption is simply proportional to the mass traversed, is approximately fulfilled, but that the heavier metals have a rather higher proportionate absorption. He found that a plate of lead 3mm. thick allows of the passage of a third or a fourth of the total radiation.

[W. SEITZ, *Physikalische Zeitschrift*, July 15, 1904.]

Lightning Rods.—K. von Wesendonck reiterates his contention that the chief use of lightning rods is not that they dissipate the atmospheric electricity and thus prevent lightning discharges, or rather convert them largely into a silent and gradual discharge. Such a silent discharge, he points out, would be accompanied by the luminous phenomena known as St. Elmo's fire, which, however, is much rarer than thunderstorms in Europe. He experimented with two large plates, to the lower one of which a point was attached. He found that the silent discharge commenced as soon as the distance of the point above the lower plate reached a certain value, but that as soon as it did commence, it was accompanied by luminous effects plainly visible in the dark. He doubts the efficiency of hot gases from chimneys in dispersing accumulations of atmospheric electricity.

[K. VON WESENDONCK, *Physikalische Zeitschrift*, July 15, 1904.]

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POLYPHASE SUB-STATIONS.

Recent improvements in single-phase motors may have brought us a step nearer to Mr. FERRANTI'S Utopia—a state in which electrical energy will be utilised in the form of single-phase current only—but nevertheless the methods required for the conversion of alternating into continuous current must still occupy an important position in every electrical engineer's mind. Consequently the opportunity afforded for a discussion on this subject in connection with Mr. S. L. PEARCE'S recent Paper was a valuable one, and although the general principles of sub-station design are now well known and properly appreciated, an exchange of opinions arrived at by men with experience in the working of sub-station plant could not fail to be useful. Mr. PEARCE in his Paper followed the example set by Mr. EBORALL in his Institution Paper three years ago, and divided the converting machinery into three classes—induction motor-generators, synchronous motor-generators and rotary converters—and put forward the advantages and disadvantages of each. Each class of equipment has its partisans, but there must be a general agreement on the main point that rotary converters are the cheapest and most efficient, while induction motor-generators are more expensive and waste more energy but are undoubtedly the most reliable. Synchronous motor-generators occupy an intermediate position, combining some of the advantages with most of the disadvantages of both of the other two classes of plant. Mr. PEARCE'S Paper, however, differs from the majority of other Papers written on the same subject by the fact that he gives actual figures relating to the three different types of machine. As no fault was found with these figures by the representatives of manufacturers who were present at the meeting, we may assume that they indicate more or less average practice, and at a glance the superiority of the rotary converter is evident if its reliability can be considered as firmly established. A gain of from 40 to 50 per cent. in first cost in a machine, say, of 250kw. capacity and an increase of 2 or 3 per cent. in efficiency cannot be overlooked merely because some of the early machines have given trouble, and therefore it is expedient to examine carefully the nature of the

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vagaries in early youth which have given the "rotary" a bad name. First and foremost of these was "hunting," a propensity which has been entirely overcome by the proper use of damping coils and the maintenance of constant angular velocity of the generator. At a frequency of 60 and even 50 ∿ per second, the latter condition must be rigidly adhered to, but it is safe to say that at 25 ∿ per second no trouble need be anticipated from this source if the generating plant be properly selected. As Mr. RUTHVEN-MURRAY stated in the discussion, 50 ∿ rotaries have been running for years without giving any trouble; but there is absolutely no reason why the lower frequency should not be adopted, not only for traction, but also for lighting. An alternating current, with a frequency of 25 ∿ per second, is, of course, too low for lamps; but this question does not arise when considering converting plant, for the lamps are, of course, connected to the continuous-current side. It is, in fact, only in the case when the whole or part of the low-pressure distributing system is to be alternating that we should recommend the higher frequencies, and then, it may be mentioned, there is much to say in favour of the frequency of 40 ∿ per second (adopted by chance in Derby and one or two other towns). Arc lamps as well as incandescents can be run with alternating current at this frequency, and it is far preferable to 50 ∿ for rotary converters and for motors, but, on the other hand, there is a danger of too much diversity of plant if certain standard frequencies are not adhered to.

The instability of rotary converters under certain conditions is, to some extent, a characteristic of synchronous motor-generators, although it is possessed by the latter class of machines to a lesser degree, and there is the same trouble with regard to starting up anew when there is no battery in the sub-station if the continuous-current supply has been interrupted. Thus Mr. RIDER stated in the discussion that, in the event of a main cut-out isolating the sub-station for a moment, it took the staff of one of his synchronous motor-generator sub-stations 10 minutes to restore the supply, and "this meant a line of cars 2 or 3 miles long." But it will be remembered that the starting arrangements in the London County Council tramways sub-stations are by no means as simple as they might be, and, in fact, there is no doubt that the use of rotary converters with the simple starting arrangements adopted, for instance, on the Liverpool–Southport railway, or the half-voltage arrangement described in the Paper, would have been far preferable. On the whole, however, the importance of avoiding stoppages, and the many other points at which interruptions may occur on a system such as the London County Council tramways, certainly justify Mr. RIDER'S decision to adopt induction motor-generators for his next sub-stations (in spite of lower efficiency, higher first cost, and bad power-factor), as being the type of plant in which there is the least liability to failure. Another objection frequently raised to rotary converters is that there is a difficulty in regulating the secondary voltage. This need not be the case at all. Regulation can be effected by over-exciting or by induction regulators, but we agree with Mr. MURRAY that the simplest and best method, probably, is to regulate by switching in and out additional turns of the transformer winding, as this makes it possible to run the converter continuously at its most favourable load-factor. Experience at Manchester and Willesden also shows that it is quite feasible to save a balancer by employing star-connection for the step-down transformers and connecting the centre of the star to the middle wire of the three-wire network. Many other interesting points were touched on in the discussion, which, as well as the Paper itself, will repay careful perusal.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

Electric Lighting Accounts. By GEORGE JOHNSON. (London: Gee & Co.) 5s. net.

"Electric Lighting Accounts" is to be welcomed as coming within the category of books which everybody wants, but no one thinks of writing. Although primarily intended for accountants—indeed, it forms Vol. XXI. of the Accountants' Library series, issued by Messrs. Gee & Co.—central station engineers will find it invaluable, especially those of them who are weak on the commercial side. In a handy book of 128 pages, Mr. Geo. Johnson has set out and clearly explained the use of all the forms and records necessary to complete transactions right from the requisitioning and purchase of materials to the final compilation of the annual return to the Board of Trade. The forms appear to be similar to those used by the electric supply companies associated with the British Electric Traction Co. As such, they may be regarded as the outcome of the knowledge and experience of the officers responsible for the organisation and management of that huge concern, and may, therefore, be safely adopted as representing latter-day practice. It is unnecessary for us to discuss the forms in detail, but we would call special attention to those outlined in Chapter III., which deal with the purchase, storage and recording of stores and materials. It has been our experience that the stores department is the weakest spot in many otherwise admirably managed undertakings. Through lack of system it is often found that materials are out of stock just when they are badly wanted for a breakdown, necessitating the sending of urgent telegrams and the despatch of goods by passenger train, with its concomitant charges. Moreover, the want of proper organisation in the stores department renders the weekly, monthly and quarterly statistics furnished by the manager to his committee or board practically valueless, and it is not until the year's accounts are made up that the result of the working can be definitely ascertained. In far too many cases, also, serious deficiencies of stock are revealed at stock-taking periods and have to be written off as unexplainable. Obviously this should not be so. And yet some managers are apparently content to let things remain in this condition year in and year out, forgetting that this is as serious a "fault" in their organisation as a "short" on their mains, and demands the same care and expedition in its removal. To those who experience this trouble and are unable to locate and remove it owing to lack of knowledge, Mr. Johnson's book will act as a strong beacon light in their commercial darkness. And to that large army of assistants whose ambition it is to become "chiefs" we confidently recommend a close study of the volume. Without a thorough knowledge of accounts they will assuredly find themselves sooner or later left behind in the race for promotion. For the plums of the profession nowadays fall, not to the engineer pure and simple, but to the engineer with wide commercial knowledge. It only remains for us to add that the publishers have done their work well. The author would, however, have better indicated the scope of his work had he called it "Electric *Supply* Accounts."

Starters and Regulators for Electric Motors and Generators. By RUDOLF KRAUSE. Translated by C. Kinzbrunner and N. West. (London: Harper Bros.) 1904. 4s. 6d. net.

In reviewing a technical work some consideration should be given to the class of readers the authors intend to reach. The translators, in their preface to the work before us, hope the book will prove of use to those engineers engaged in the manufacture of starters and regulators and to students. Unfortunately, as regards the former class of readers the book will be found wanting. Practically no data of practical value is contained in the book at all, with the exception of a little in the first chapter.

Even then the information would be of more value in the laboratory than in the drawing office, owing to the units used and the manner in which the data is presented. This is much to be regretted, as the need of practical data for designing starters and regulators is very great. To students the work

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may prove useful, and parts will be found to be well treated. For both classes of readers, however, a few scaled or dimensioned drawings of representative types of apparatus would have been of value. There is no work devoted exclusively to starters and regulators in English, and a book on the lines of Prof. Arnold's "Armature Construction" would be much appreciated both in the factory and in the class room.

The Law relating to the Telegraph, the Telephone and the Submarine Cable. By E. G. M. CARMICHAEL. (London: Knight & Co.) 1904.

This book contains in a convenient and handy form copies of the various Acts of Parliament which have been passed relating to telegraphy and telephony. Notes added by the author help to explain clauses in which the reader might otherwise find some obscurity or ambiguity, and references are also given to important cases. In addition to the acts the volume contains useful appendices, giving the text of the agreement between the Government and the National Telephone Co. on the occasion of the acquisition of the trunk lines, the agreement of 1901 relating to the London telephone service, the model forms of wayleave and underground wires, agreements between the National Telephone Co. and local authorities, and the Board of Trade regulations as to guard wires. It is to be regretted that the text of the original licence granted to the telephone companies is not included, as the whole legal position of the National Telephone Co., the competing municipalities and the Post Office are dependent on this; and in subsequent editions we would advise also that a copy of the model form of municipal telephone licence be added.

Elektrotechnisches Auskunftsbuch. By S. HERZOG. (Munich and Berlin: R. Oldenbourg.) 1904. 10m.

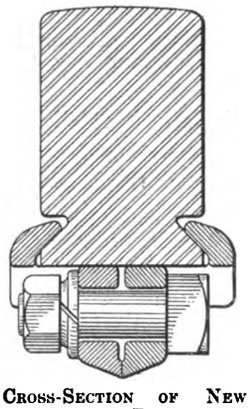
This handbook contains, in alphabetical order, the explanation of a large number of technical terms, pertaining chiefly to electrical and steam engineering. It also includes a vast amount of technical data with regard to engineering materials. Abstracts are given of patent laws, specifications, rules and regulations drawn up by various bodies for different purposes. A few mathematical tables are appended and a list of makers of a number of the articles described, together with prices, have been given by the compiler, but the list of makers given is most incomplete and not even representative. Some of the information offered is most vague, not to say misleading. A "compound steam dynamo," for instance, is defined simply as a steam engine directly coupled to a dynamo. Still, there is some good and useful information in the book.

TESTS OF STEEL FOR ELECTRIC CONDUCTIVITY, WITH SPECIAL REFERENCE TO CONDUCTOR RAILS.*

BY J. A. CAPP.

For certain classes of electric railways a steel conductor is preferable to the older and more commonly used overhead trolley wire. The third-rail presents a rather better appearance, because of the absence of an overhead structure; it is easily installed, cheaply maintained, presents a large area for conducting and collecting the current, and is particularly well adapted for high-speed and heavy service. With costs calculated on the basis of equal conductivity in rail and trolley wire, the third-rail construction is cheaper than the overhead trolley. But the average inter-urban road will use a trolley wire of considerably less conductivity than would be obtained with the smallest size steel rail (about 60lb. per yard) that would ordinarily be used, and here the first cost of trolley construction would generally be less than that of the third-rail. While no third-rail installation has yet been in operation long enough to give figures of value, it would appear that the cost of maintenance of the third-rail construction should be less than that of the overhead trolley. This consideration, together with that of sightliness and adaptability (particularly in the case of terminals, yards and very heavy or high-speed service), will frequently offset the higher cost of the third-rail construction and make it the preferable means of conducting the current from the generator to the car motor. For the first third-rail installations, old track rails were used when obtainable, and these old rails were supplemented with new rails of standard T-section and composition. With the coming of the very heavy high-speed service during the last few years, the resistance of these old and new standard T-rails was found to be so high that they would not carry the high currents necessary without too great a drop in the line potential. The rails would, therefore, have to be supplemented with additional copper feeders, but as this would be an expensive way to overcome the trouble, rails of higher specific electric conductivity were sought.

Because of the lack of specific data on the relation between conductivity and composition of mild steels, specifications for conductor rails have usually been based on the fact that the conductivity of a metal is generally more or less directly in proportion to its purity. In most cases the purity of the iron specified for such rails has been so high that not only was it difficult to obtain, but the iron was also corresponding costly. One of the factors governing the choice between a third rail and a trolley wire is the relative price of steel and copper, allowance being made for the difference in conductivity. Hence, a balance must be struck between high conductivity (which is equivalent to saying a high degree of purity or freedom from the usual metalloids associated with iron) and the cost of producing the steel of the composition necessary for the conductivity required. With the object of drafting a rational specification for such third-rail steels, a series of tests was started some time ago in the testing laboratory of the General Electric Co. on steels of as wide a range of composition as could be obtained from the steel makers, the results of these tests forming the basis of this Paper. When entering the market with an order for rails of special composition, difficulty was encountered in interesting rail makers, and the reason became apparent. The mills which make the standard T-rails, or standard rails of other sections (such as the girder and grooved rails), have generally been designed with the object of making such rails only, and practice throughout has been standardised to the greatest possible extent, both in the manipulation of the steel and in its manufacture in the furnace or converter. Hence, an order, even of considerable extent, for rails of special composition, has so upset the routine work that it was considered a nuisance to be endured, rather than a desirable business to be sought for. Obviously, then, recourse must be had to mills where such special compositions can be handled economically.



CROSS-SECTION OF NEW CONDUCTOR RAIL—2·5IN. WIDE, 4IN. HIGH AND 98LB. PER YARD.

The T-section of rail was the outcome of designs intended to present the greatest life and strength of the section, with the least weight of the metal, conditions necessarily to be met in a running rail. But the conditions for the third or conductor rail are different; here there must be provided sufficient surface for the collection of the current, and cross section ample to carry the current without an undue drop in the line potential. The strength of the section is of little moment, and any section which is easily installed in an insulator is satisfactory. This permits the use of sections rectangular, or nearly so, which may be rolled easily in any mill equipped for the rolling of merchant-bar shapes of reasonably heavy weight without any change in equipment or practice beyond the provision of grooved rails of the necessary shape. Mills rolling merchant-bar or structural steel to-day are generally equipped to make steel in the open-hearth furnace, which readily lends itself to the making of steel of the special composition demanded by the electrical engineers for the third or conductor rail. Having these facts in mind, a section of a conductor rail has been designed by W. B. Potter, chief engineer of the railway department of the General Electric Co., which, when 2·5in. wide by 4in. high, will weigh about 98lb. to the yard. This shape may be easily rolled in any merchant-bar mill heavy enough to attempt sections of this weight. A dove-tail at the bottom provides an easy means of securing the rails by fish-plates of special forms, and any of the common forms of bond may easily be applied. Ordered in lots of 1,000 tons or more, such a rail should cost no more than a plain rectangle of equal weight.

To provide steels of sufficient range to give some indication of the relation between conductivity and composition, we obtained from as many of the steel makers as we could interest samples representing all of their common products. Some of the makers kindly provided us also with samples of special steels made in crucible charges. The samples were mainly forged or rolled bars of from 1in. to 2·5in. in diameter, and from them were turned bars of 0·75in. in diameter, or 1in. in diameter by 24in. in length, on which resistivity was determined. The chips from the finishing cuts were collected, and these furnished the samples for analysis. Also, we cut similar bars from the heads of T-rails which were to be found in the yard tracks. Table I. states the electrical resistance and the chemical composition of some of the samples of steel, wrought or refined iron. Samples

* Abstract of a Paper read before the American Institute of Mining Engineers.

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Table I.—*Resistance and Composition of Steel.*

Serial number.	Resistance.	Percentage composition						
	Cu = 1.	C.	Mn.	P.	S.	Si.	Total. Not Fe.	P. + S. + Si.
1	13·20	0·33	1·27	0·09	0·05	0·05	1·79	0·19
2	12·12	0·17	1·09	0·09	0·05	0·004	1·404	0·144
3	11·55	0·20	0·95	0·10	0·08	0·05	1 38	0·23
4	11·51	0·22	1·08	0·10	0·05	0·06	1·510	0·210
5	10·04	0·36	0·87	0·08	0·09	0·04	1·44	0·21
6	9·94	0·37	0·73	0·09	0·04	0·06	1·29	0·19
7	9·48	0·23	0·89	0·058	0·01	0·005	1·193	0·073
8	9·36	0·16	0·66	0·074	0·030	0·014	0·938	0·118
9	8·42	0·144	0·46	0·09	0·08	tr.	0·774	0·17
10	8·36	0·188	0·48	0·09	0 08	tr.	0·83	0·17
11	8·06	0·16	0·48	0·091	0·04	0·01	0·781	0·144
12	8·04	0·10	0·55	0·08	0 05	0·024	0·804	0·154
13	7·92	0·10	0·25	0·04	0·02	0·05	0·46	0·11
14	7·70	0·27	0·41	0·024	0·01	0·001	0·715	0·035
15	7·66	0·28	0·28	0·027	0·034	0·04	0·661	0·111
16	7·40	0·15	0·45	0·011	0·033	tr.	0·644	0·044
17	7·38	0·19	0·21	0·025	0·04	0·034	0·499	0·099
18	7·28	0·215	0·22	0·051	0·113	..	0·599	0·164
19	6·40	0·05	0·19	0·054	0·059	0·03	0·383	0·143
20	7·82	0·15	0·068	0·13	0·02	0·15	0·518	0·30
21	7·48	0·15	0·064	0·036	0·02	0·13	0·400	0·186
22	7·41	0·16	0·074	0·12	0·027	0·10	0 481	0·247
23	7·11	0·08	nil	0·13	0·008	0·024	0·242	0·162
24	6·76	0·17	0·027	0 074	0·022	0·077	0·370	0·173
25	6·17	0·058	0·10	0 014	tr.	0·012	0·184	0·026
26	6·12	0·16	0·018	0·049	0·011	0·015	0·252	0·075

Nos. 1, 2, 3, 4, 5 and 6, are standard T-rails from several well-known makers, while Nos. 9 and 10 are cut from the 100lb. T-rail used for the conductor on the Aurora, Elgin and Chicago Railroad. No. 19 is a T-rail used by the Underground Electric Railways Co. of London, and ordered from a steel maker in Westphalia. Samples Nos. 20, 21 and 22 are ordinary refined bar iron, while Nos. 23 and 24 are special brands of refined bar-iron sold for use in stay-bolts and similar work. Nos. 25 and 26 are Swedish and Norway irons respectively. The second column gives the resistance of the samples compared with Matthiessen's copper as unity, the temperature at which the measurements were made being near 20°C. in all cases. The second half of the table gives the percentages of the usual elements to be found in steel or iron, the total percentage of these elements and the sum of the percentages of phosphorus, sulphur and silicon.

A study of the table shows that manganese preponderates in influencing the resistance of steels, and that for lowest resistivity this element must be present in very small quantity, much smaller than is usual in merchant or structural steels. While all the other elements must be present only in very small percentages, so great is the prepoderance of the influence of manganese that they may be tolerated in quantities which the steel makers would consider reasonable, without unduly increasing the resistance. For a satisfactory third-rail the lowest possible resistance (from six times to 6·5 times that of copper) is not necessary; and the great cost of making such extremely pure steel is not warranted: in fact, such extremely pure steels would probably be so soft that the frictional wear of the collecting shoe would be excessive and the life of the rail in service unduly short. Assuming, then, that a rail made from steel having a resistance not greater than eight times that of copper (13·8 microhms at 20°C.) would be desirable for conductor rails, the figures tabulated would seem to indicate that the following extreme composition would be permissible:—Carbon up to 0·2 per cent., manganese up to 0·4 per cent., phosphorus up to 0·06 per cent., sulphur up to 0·06 per cent., silicon up to 0·05 per cent.

This composition, however, would be extreme, and any overstepping of bounds might result in too great a resistance; therefore, for resistance up to eight times that of copper, the specified analysis should be:—Carbon not to exceed 0·15 per cent., manganese not to exceed 0 30 per cent., phosphorous not to exceed 0·06 per cent., sulphur not to exceed 0·06 per cent., silicon not to exceed 0·05 per cent.

This latter composition is one which could be made easily in any open-hearth furnace, and it should present no difficulty in rolling to a shape suitable for conductor rails. In fact, steel of this composition has been successfully rolled into sheets as thin as 0·014in., a size which was for a long time a standard product of a large sheet mill.

Electric Traction on the Lackawanna Railway.—The *Electrical World* of New York announces that the Lackawanna Railway, is contemplating the experimental operation of two cars equipped with Edison batteries which will be run a distance of 5 or 6 miles when traffic is light.

CORRESPONDENCE.

ELECTRICAL ENGINEERING IN CANADA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of last week, and on p. 546 of "Notes," I would call attention to some remarks of your Canadian correspondent, on which you make comments, with reference to the number of English electrical engineers in Canada. I am sure that your correspondent is making a mistake in the instance he quotes of "a large electric lighting company in Montreal." There has been for the last year only one electric lighting company in that city—viz., the Montreal Light, Heat and Power Co.—and, no doubt, this must be the company to which your correspondent refers.

As a matter of fact, however, the managing engineer is a Canadian, and the heads of the three technical departments are British. The head of the line department, which corresponds roughly to the mains department in an English system, is an Englishman and an old student of the Central Technical College. The superintendent of stations and the superintendent of the repair shop and testing departments are both of them Canadians, and it is by these three men that the technical work of the company is directed.

It is possible that your correspondent has in mind a large electric power distribution company whose headquarters are in Montreal; but, in that case, the description is misleading, and I am therefore taking the liberty of correcting same.—Yours, &c.

Rugby, July 22nd. J. M. DONALDSON.

P.S.(1)—By the way, I hope that your correspondent has not fallen into the unforgivable error of describing a Canadian as an American!

P.S.(2)—As far as Montreal is concerned, I think that an Englishman would stand as much chance as a Canadian, and a greater chance than an American (*cæteris paribus*) to secure an electrical post.

GLASGOW CORPORATION TELEPHONE ACCOUNTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am glad to see from your article on these accounts that some light is being thrown in your pages on the fallacies which have been propagated in connection with the cost of the Glasgow Corporation Telephone system. I take a special interest in this matter for the reason that, at the Glasgow Telephone Inquiry of 1897, I pointed out the inherent fallacies of the estimate then presented for a Glasgow municipal exchange. The bearing of my evidence was that, apart altogether from the prices set against the work proposed, the amount of plant provided would not give the number of working subscribers' lines which the estimate counted upon. I further pointed out that the application of a low flat rate to such a large area would result in the appearance of many subscribers in the outlying parts, who would require a large average amount of plant. My evidence was scoffed at, but the results show that it was worth serious consideration. At the present time, with less than 80 per cent. more subscribers' lines than the number on which the original estimate was based, the total capital expenditure is 3·4 times as much as was estimated—that is, the ratio of actual to estimated expenditure, in proportion to the number of subscribers served, is nearly 2 to 1. According to the original estimate, 9,000 subscribers' lines (the present number) would have cost £170,000. The present total capital expenditure is over £331,000. It is true that the present system includes some 2,400 telephones of a kind not provided for in the estimates – *i.e.*, extension and private line instruments. But the inside extension instrument represents a cost of about £3. 10s., and the average outside extension a cost of about double this figure; so that while the extension instruments are 20 per cent. of the total stations they do not represent more than about 4 per cent. of the total capital.

By counting each telephone as a complete subscriber's line, and by deducting from the capital account the estimated value of the spare plant, a figure for average capital cost per telephone is arrived at which compares fairly well with the estimated cost per line, and this figure is accepted by the

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uninitiated. The fact remains that, to produce the number of working lines which, by the estimate, should have cost about £170,000, the total capital expenditure has been over £331,000.

—Yours, &c., HERBERT LAWS WEBB.

Westminster, S.W., July 27.

PARLIAMENTARY INTELLIGENCE.

LEYTON URBAN DISTRICT COUNCIL BILL.

GAS COMPANY OPPOSITION RENEWED.

This bill came before a Committee of the House of Lords, of which Lord Newton is the chairman, on Tuesday.

Mr. BAGGALLAY, K.C., who appeared for the promoters, with Mr. Gerald Fitzgerald and Mr. C. C. Hutchinson, said one of the principal objects of the bill was to authorise the Urban District Council to construct and work tramways by electricity. Another object was to take further powers in regard to the existing electrical undertaking. With regard to the tramways portion of the bill, the local authority already had powers under an act of 1898 to work certain existing tramways when these fell into their possession. As a matter of fact, this time had already arrived, and notice had been given to the tramway companies concerned. Therefore, at the present time they were the owners of all the tramways in the district, practically speaking, with the exception of a small portion which would not fall into their hands until 1909, although it was possible that an arrangement would be come to whereby all the lines would come into the hands of the local authority at the same time. The tramways already existing, which were worked by horses, belonged to the Lea Bridge, Walthamstow and Leyton Tramway Co. and also the North Metropolitan Tramways Co. The undertakings were quite distinct, and besides converting the horse lines to electric traction, the bill proposed to link up the two systems by the construction of several new lines. The existing lines it was proposed to double. With regard to the electrical portion of the bill, he said that in 1894 the Urban District Council were granted a provisional order for carrying on an electrical undertaking. The undertaking progressed rapidly, and in 1899 the station had to be enlarged, whilst in 1901 further extensions took place. The present capacity was 45,000 8 c.p. lamps, which, in as much as only about 60 per cent. of the lamps were ever running at the same time, gave a capacity for supplying about 75,000 lamps. At present there were nearly 50,000 consumers' lamps and over 3,000 public lamps. The capital spent on the undertaking to March 31 last was £141,000, and of this £71,000 had been expended on mains and distribution plant outside the station. The actual amount raised by loans by the District Council for the purpose of carrying on their electrical undertaking was £135,500. Of this £126,500 was still outstanding as a debt. A further power had been granted to the District Council to borrow £10,000, but this had not been exercised. The last instalment for interest was £3,838 and for repayment of principal £5,042, of which £760 was produced by the sale of some old gas plant which had been used in connection with the works at an earlier date. The business had been steadily improving and last year after meeting all charges for interest and repayment of loans there was a surplus of £1,387. It was proposed, under clause 57 of the bill, to authorise the District Council to supply "in bulk" to any adjoining district councils. As a matter of fact Walthamstow and West Ham both had this power to supply, and the idea was that all these three District Councils should be able to help each other in case of breakdown. That was the sole object of the clause. Clause 58 gave power to the local authority to purchase and let on hire motors, electrical apparatus, &c. Clause 63 gave power to allow discounts not exceeding 5 per cent. to consumers for the prompt payment of their electric light accounts. The only opponent to the bill was the Lea Bridge Gas Co., who supplied something under one-third of Leyton with gas, but he was afraid he was unable from the petition of the gas company to ascertain what it was they asked for.

Mr. PADDON, for the Lea Bridge Gas Co., said he asked for the Duke of Northumberland's modification of the "Bermondsey" clause; also that the provisions of the Tramways Act of 1870 should apply to all the lines in the district which would be reconstructed, and not only to new lines. Another point was with regard to free wiring, which, although the promoters stated they did not intend to go in for, was not made clear in the bill. He had also proposed to ask for special protection as regards electrolysis, but in view of the recent decision of the House of Lords in the Torquay Bill and the evident tendency of Parliament in this matter this had been dropped. On the question of free wiring, he asked for the following words, taken from the Swindon Bill of this year: "Provided also that nothing in this section shall authorise the Corporation by their own servants or workmen to fix upon any consumer's premises electrical fittings or electrical wiring other than may be required for the service line between the Corporation's supply mains and the meter on such consumer's premises." With regard to the question of the reconstruction of the horse tramways, he asked for the following protection, which was given in the Hove and Worthing Tramways Act of last year: "For the purpose of sec. 70 of the Tramways Act of 1870, the adaptation of the existing tramways for working by electric traction shall be deemed to be the laying down of tramways."

Mr. BAGGALLAY said he could not meet Mr. Paddon on the question of the reconstruction of tramways. He would consider the point of free wiring and, if possible, agree. Dealing with Mr. Paddon's request for the "Bermondsey" clause, he said the House of Commons Committee, which had already passed the bill, had refused to put it in because, as a matter of fact, the Leyton District Council already did that which the clause provided for.

Mr. J. E. WALLER, consulting engineer to the promoters, was then called on the question of the tramways. He said that parts 2 and 3 of the Tramways Act of 1870 had been incorporated in the bill, so far as the old lines were concerned. This, he contended, gave sufficient protection to the Gas Company. He did not wish to give the Gas Company power to make him break up all the concrete foundations of the existing tramways and alter the position of their mains at his expense. The capital asked for the tramways was £128,000.

Cross-examined by Mr. PADDON, Witness said he objected to the protection asked for by the Gas Company because the tramways were practically laid in the same way as for electric traction, and only new rails would have to be laid. As a matter of fact, the District Council already had power to reconstruct the old horse tramways quite apart from this Act, and in the Act giving the Corporation these powers, the Lea Bridge Gas Co. had no protection such as they now asked for.

Mr. PADDON having briefly addressed the Committee,

The CHAIRMAN said: "We will give the Gas Company the clause from the Hove and Worthing Act which they ask for."

On Wednesday the question of the "Bermondsey" clause was gone into.

Councillor MUSGRAVE, chairman of the Electric Lighting committee, confirmed Mr. Baggallay's opening statement with regard to the electrical undertaking, and also testified to its general prosperity. He strongly objected to any clause such as the "Bermondsey" clause because he could not bring himself to believe that it would be to the benefit of the ratepayers. Another reason for his objection was that every year the Finance committee prepared an estimate much in the same way as was provided for by the proposed clause.

Cross-examined by Mr. PADDON, he admitted that the total loss over the eight years' working upon the electrical undertaking had been £8,431, but for the last two years a profit had been made.

Re-examined: The loss above referred to was arrived at by taking into account the repayment of capital and the interest on it. It was therefore unfair to say that the undertaking had been a commercial failure.

Mr. PADDON then addressed the Committee, arguing that if the success of the undertaking was as assured as the promoters stated, the clause would never come into operation.

After consultation,

The CHAIRMAN said the Committee would give the Gas Company the protection asked for, but in the mildest form, as laid down by the Duke of Northumberland.

It was then announced that the parties had agreed on the question of free wiring, and the preamble of the bill was found proved.

TORQUAY TRAMWAYS BILL.

ELECTROLYSIS DISCUSSED IN THE HOUSE OF LORDS.

In the House of Lords on Monday, upon the motion for the third reading of the Torquay Tramways Bill,

Lord CLIFFORD OF CHUDLEIGH moved the insertion of the following electrolysis clause, which, it will be remembered, was agreed upon between the promoters of the bill (the Dolter Electric Traction Co.) and the Torquay Corporation and the Torquay Gas Co., but which was struck out on two occasions by the chairman of Committees in the House of Lords:—"If at any time it be proved that any injury or damage to any mains, pipes or apparatus of the Corporation, or the Torquay Gas Co., shall have resulted from the use of electric current on any of the tramways authorised by this act, nothing in this act shall relieve the company from liability to make compensation for such injury or damage." Lord Clifford said that there were special circumstances in this case which had induced the Committee of their Lordships' House, before which the bill had come, to insert the clause. Both in the House of Lords and in the House of Commons it had been expressly stated that the insertion of the clause in the bill should not create a precedent owing to the special circumstances which existed. Lord Balfour of Burleigh, as chairman of Committees, however, had on two occasions struck out the clause for the reason that it was against public policy, and that it might hamper invention and the promotion of electric tramway undertakings by imposing more stringent liabilities than those contained in the Board of Trade regulations. But the system which it was proposed to adopt at Torquay had never before been tried in this country, and its possible effect upon gas and water mains was an unknown quantity. He, therefore, was of the opinion that it was only reasonable that the Corporation and the Gas Company were justified in asking for a guarantee against damage which might be beyond that provided for by the Board of Trade regulations. He was quite agreed that precedents were very dangerous, but in view of the fact that Committees of both Houses after consideration had agreed to insert the clause, he hoped the House would do likewise.

LORD HAWKESBURY, chairman of the Committee of the House of Lords which considered the Bill, supported the application, and said that the Committee regarded the case as one standing quite by itself.

LORD BALFOUR OF BURLEIGH opposed the application because it would be disastrous to the precedents which had governed these questions for the last 11 years. He had only followed the policy which had been regularly adopted in the past in refusing to allow the Bill to be read a third time with the clause in it. The Board of Trade regulations obliged the company to be responsible for certain defined damage, and to consent to the clause now asked for would put the Corporation and the Gas Company in a specially favoured position. There was no evidence that the Board of Trade regulations were inadequate, and even if they were the Board of Trade had power to bring them up to date without the necessity for an act of Parliament. Last year a clause similar to this

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was rejected by their Lordships' House, and he would have taken a wrong view of his duty had he acted contrary to that decision.

Lord WOLVERTON, on behalf of the Board of Trade, opposed the amendment.

Lord CROSS also associated himself with the opposition to the amendment.

Lord NEWTON said there was nothing more common when electrical undertakings were being considered than for gas companies to appear before the Committees with tears in their eyes asking for protection against electrolysis. Personally, he always resisted these pathetic appeals, because it was extremely desirable that uniformity of procedure should exist in connection with private bill Committees.

The clause was negatived without a division and the bill read a third time and passed.

TYNESIDE TRAMWAYS AND TRAMROADS BILL.

Sir Edward Strachey's Committee of the House of Commons finally disposed of this bill on Friday last week.

Mr. BALFOUR BROWNE, K.C., for the company, said that at last a settlement had been come to. The heads of agreement [given in our last issue] had been transformed into a legal document, with some slight modifications, and the clause relating to the non-enhancement of the value of the undertaking in the event of sale had been agreed as follows:—"In determining the fair market value of the tramways of the company under the provisions of sec. 83 of the Act of 1901 or sec. 37 of the Act of 1902 (these being the two acts under which the tramways could be purchased) the arbitrator therein mentioned shall not have regard to any increase of value in his opinion directly due to the use by the company of the tramways of the Newcastle Corporation under the agreement scheduled to this act, and not in his opinion due to any natural or other cause affecting the volume of the traffic on such tramways."

The CHAIRMAN: What is the object of the alteration to the printed clause that I have?

Mr. BALFOUR BROWNE replied that it was merely to save the face of the Newcastle Corporation, because they could not bring themselves to recognise that the company had been granted running powers. The object of the Corporation was to show that they had been given by them under agreement.

Mr. TALBOT, for the Newcastle Corporation, said that they had taken no part in the wording of the clause. It had been a matter between the company and the purchasing authorities.

Mr. BALFOUR BROWNE said, if that were so, he would ask the Committee to accept the printed clause as follows:—"In determining the fair market value of the tramways of the company under the provisions of sec. 83 of the Act of 1901 or sec. 37 of the Act of 1902, the arbitrator therein mentioned shall not have regard to any increase of value in his opinion directly produced by the exercise of the powers of this act conferred upon the company of running over and using the tramways of the Corporation under the agreement scheduled to this act, and not in his opinion due to any natural or other cause affecting the volume of the traffic on such tramways."

The CHAIRMAN agreed to this, and the bill, with the agreement scheduled to it, will again be reported to the House.

A report from the Chairman of the above Committee has been made to the House to the effect that an agreement had been come to between the promoters and the Newcastle Corporation for the exercise of mutual running powers over certain portions of their respective tramways, and the Committee had inserted a provision in the bill for giving effect to such agreement, and had also made provision that no increase in the value of the company's undertaking should accrue by reason of the exercise of such running powers over the tramways of the Corporation in the event of its sale to the local authorities.

EFFECT OF THE "BERMONDSEY" CLAUSE.

Ilford Urban District Council Bill.

The Police and Sanitary Committee of the House of Commons (Section A), considered the Ilford Urban District Council Bill on Monday. It has already been passed by the House of Lords (see *The Electrician*, April 29 and May 8).

Mr. VESEY KNOX, for the Ilford Urban District Council, said that when the bill was originally proposed it contained a number of sections which did not now appear. It was proposed to construct a number of new tramways which necessitated a very expensive widening, but this had been strongly opposed, and was eventually rejected at a meeting of the ratepayers. Then when the bill was before the Upper House it was proposed to borrow money for the purpose of supplying electrical fittings upon the hire-purchase systems. The Committee of the House of Lords, however, at the instance of the local gas company, put upon the promoters what was known as the "Bermondsey" clause, and the Council, in view of the fact that, in extending their system into new districts they considered the clause would have a harmful effect, had also abandoned the electrical fittings portion of the bill.

The remainder of the bill is not of electrical interest.

OTHER ELECTRICAL BILLS.

The *Manchester Corporation Tramways Bill* was before the Unopposed Committee of the House of Commons on Friday last week. It confers various powers upon the Corporation in respect of the tramways undertaking in Manchester, and also sanctions a few miles of additional lines. The preamble was found proved. The bill has already been passed by the House of Lords (see *The Electrician*, June 10 and 17).

In the House of Lords on Friday last week the *Saddleworth and Springhead Tramways (Abandonment) Bill* was read a second time.

In the House of Commons on Thursday last week the *Bournemouth Corporation Tramways* and the *Holywood Tramways Bills* were read a third time and passed. On Monday the *Lothians Electric Power Bill* and the *Leeds Corporation (Consolidation) Bill* were read a third time. The *Electric Lighting (London) Bill* was read a third time and passed, and *Electric Lighting Provisional Order (Confirmation Bills Nos. 2, 3, 4 and 6)* were read a second time. On Tuesday the *Belfast and North-East Ireland Electricity and Power Gas Bill* was read a second time, and the *Portmadoc, Beddgelert and South Snowdon Railway Bill* was read a third time.

UNDERGROUND TELEGRAPH CABLES TO THE NORTH.

The following reply was issued yesterday (Thursday) to a question by Sir THOMAS DEWAR, who asked the Postmaster-General whether he would state to what point the present system of underground telegraphic cables to the North had been advanced, and whether the area which had suffered specially through the storms in former years had now been passed.

Lord STANLEY: The pipes in the underground system to the North had been laid as far as Carlisle, and also over the Beattock Incline. Wires in the pipes had been provided as far as Liverpool, Manchester and Leeds, and are now being provided in the Warrington-Carlisle section. The original section—viz., that between London and Birmingham—traversed the area which had suffered especially through storms in former years.

ROYAL ASSENT.

The following were among a number of bills to which Royal assent was given on Friday last week:—

Electric Lighting Order Confirmation (No. 5) Act.
Paisley District Tramways Order Confirmation Act.
Leith Corporation Tramways Order Confirmation Act.
Govan Corporation Order Confirmation Act.
Glasgow and South-Western Railway Order Confirmation Act.
South-Western and Isle of Wight Junction Railway (Extension of Time) Act.
Harrow-road and Paddington Tramways Act.
Leicestershire and Warwickshire Electric Power Act.
Shipley Urban District Council Act.
Derbyshire and Nottinghamshire Electric Power Act.
Baker-street and Waterloo Railway Act.
Clyde Valley Electrical Power Act.
Birkdale Improvement Act.
Southport and Lytham Tramroad Act.
London County Council (Money) Act.
Plymouth Corportion Act.
Wolverhampton Corporation Act.
Barrow-in-Furness Corporation Act.
Doncaster Corporation Act.
Soothill Nether Urban District Council Tramways Act.
North-Western Electricity and Power Gas Act.
Charing Cross, Euston and Hampstead Railway Act.

GUILDFORD LIGHT RAILWAY ORDER.

At the Board of Trade, London, on Wednesday, Sir Herbert Jekyll heard objections to the confirmation of this order by Surrey County Council (Full particulars of the proposed line of light railway have appeared in *The Electrician*).

Mr. G. HUMPHREYS (who appeared for Surrey County Council) said the sole substantial point of objection was as to whether Wood Bridge and its approaches should be widened, as proposed by the promoters of the line, to 24ft. 6in., or to 30ft., as desired by the County Council, at the expense of the promoters. The Light Railway Commissioners insisted upon a width of 24ft. 6in. The Council maintained that the bridge was sufficiently wide at present, and for some time to come, for the ordinary traffic, and that the widening they proposed was rendered necessary solely by the light railway. In every other case in Surrey in which light railways had been authorised this proposal of the Council has been adopted.

Sir HERBERT JEKYLL said the Light Railway Commissioners had reported to the Board of Trade that "they do not consider it equitable that the Council should succeed in transferring to the company the whole burden of the work of widening the said bridge, which will inevitably fall upon the Council soon, whether a railway is made or not."

Mr. HARRAP, engineer to the promoters, said the cost of widening to 24ft. 6in. would be £2,153, and to 30ft. £6,225. Reconstruction of the bridge would be necessary in the latter case.

There was some dispute as to whether these were light railways or tramways, and it was agreed that Sir Herbert Jekyll should be communicated with on that point. A purchase clause which had been agreed to with the Guildford Corporation was put in, to have effect if the undertaking was acquired within a certain time.

Sir HERBERT JEKYLL said, with regard to the bridge, the Board of Trade were slow to reverse any decision of the Light Railway Commissioners, but the point would be reported to the Board and their decision communicated to the parties in writing.

Transvaal Imports.—The imports of electric cables, wires and fittings into the Transvaal for the four months ended April, 1904, were of the value of £22,000, compared with £20,000 for the corresponding period of 1903.

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REFUSE DESTRUCTION BY BURNING AND THE UTILISATION OF HEAT GENERATED.*

BY C. NEWTON RUSSELL.

In this Paper the author deals only with domestic or house refuse, which consists of house and shop sweepings, kitchen refuse, market sweepings and offal, and with what is known as trade refuse; he does not refer to the disposal of sweepings from macadamised or wood-paved roads, except when the sweepings are in a dry condition. The plant to be described is owned by the Metropolitan Borough of Shoreditch, London, and was opened in June, 1897. The works were about the largest of their kind and contained many new features.

The Shoreditch area, which adjoins the City of London, contains 640 acres, and had in 1897 a resident population of 124,000. A suitable place was purchased near the centre of the area, upon which was erected an electric generating station, refuse destructor, baths and wash-houses and a free library. The area allotted to the destructor works was 13,450 sq. ft., costing about 13s. per square foot.

The destructor house contains two batteries of three Babcock-Wilcox water-tube boilers, each having two refuse furnaces (one placed on either side of the boiler), while the ordinary coal firegrate immediately under the boiler tubes is provided as an auxiliary for use if required. The hot gases from the refuse furnaces pass through short side flues and immediately come in contact with the boiler tubes. The gases, after passing round the boiler tubes, find their way into one of the main flues, then to the economiser and thence to the shaft. The grate area of each boiler furnace is 27 sq. ft., the heating surface being 1,300 sq. ft.

The average amount of refuse received per day is about 85 tons, and this is delivered between 9 a.m. and 5 p.m., but the amount varies considerably; in summer it may be as low as 60 tons and in winter as high as 140 tons. As it is found impossible to get the supply at a regular rate, it is advisable to provide storage space to cope with extra large deliveries. This is done at Shoreditch, where a large rectangular iron storage bin, holding about 60 tons of refuse, is fixed under the tipping platforms.

The lifts and tip trucks are worked entirely by electricity, and are found to act well. The average amount of electric energy consumed by the lifts and trucks, taken upon a total of 25,000 tons of refuse (over a year's working) is 0·52 kw.-hour per ton, the greater portion of which is expended on the lifting operation. The record time taken to deal with a load of refuse shot into the lifts, raised to the top platform and tipped and the empty truck returned to the starting point is seven minutes, the average time being about nine minutes. The cost of repairs to the lift and tipping truck part of the equipment is very small. Each furnace is provided with both steam jet and forced air blast. In the author's experience the latter has been found preferable. The forced air blast is provided by three Sturtevant fans, each designed to give 8,000 cubic ft. of air per minute, and driven direct by a shunt-wound electric motor at a speed of 650 revs. per min. The three fans are not used continuously, the full number being only put to work during the time of heaviest load. The inlets to the fans are connected with air ducts that draw the hot air from the top platform of the destructor; the three fans are connected to a common discharge duct which is led underground to the ashpits, the draught to each being controlled by a separate air valve. The air pressure in the discharge duct at the fans is 3in. head of water, while that in the ashpits is slightly less than 1in. Even with the latter comparatively low pressure the temperature obtained in the furnaces often exceeds 2,000°F. It is interesting to note the comparatively great amount of energy (4 units per ton) absorbed by the electrically-driven fans, a matter which is open to improvement. The works are run on the eight-hour-shift system, seven days per week, so that some of the fans are always at work; in fact, they run for weeks without a stop. A direct-coupled electrically-driven fan is an ideal arrangement from a mechanical point of view, and one which experience shows to require very little attention. The furnaces have now been in daily use for six years, and it is interesting to find that the fire-bars are even now in good condition and show very little sign of deterioration. A somewhat novel system of storing hot feed water is in use (sometimes called thermal storage). The reason that led to its adoption was that, at the inception of the combined scheme, it was not thought that for some time at least the demand for electric current would be very great, and that during the hours of daylight, when refuse was of necessity being burned, it was feared that some of the heat would be lost owing to the small demand for steam.

It was therefore decided to instal Halpin's thermal storage system, with a view of storing up heat in the form of water at a high temperature. The storage vessel was originally connected to the main line of steam pipes, with a view to its being gradually filled by pumping in cold feed-water, which would be heated by means of spare heat generated in the refuse furnaces during the daytime. The intention was that a portion of the steam raised in the boilers of the destructor plant would be used for the engine driving the electric generators, and the balance passed over to the thermal storage vessel, where it would part with its heat to the feed water. The engines were designed to have adjustable cut-offs so as to drive their full load with pressure varying from 200lb. to 120lb. per square inch. The object aimed at was to fill up the thermal storage vessel at times of low load with water at a temperature corresponding to a pressure of 200lb. per square inch, and at the time of greatest demand for current not only feed the boiler from the storage tank, but by the evaporation of the hot water as the pressure fell steam would be given off to augment that supplied by the ordinary boilers. The process would proceed until the pressure reached the lowest point—*i.e.*, 120lbs.—by which time it was thought that the time of maximum demand would have passed, and that the ordinary boilers would be able to cope with the load. In practice things worked out very differently. First, it was found that pumping cold water into the vessel into which horse-power steam was being admitted caused such a water-hammering that the practice had to be discontinued forthwith, and it was found necessary to partially heat the feed water by passing it through a Green's economiser before putting it into the thermal storage vessel; this, however, effectively got over the difficulty. Secondly, by the autumn of 1897 the demand for steam during the daytime had reached nearly the limit of heat it was possible to get from the refuse furnaces; so, having nothing to spare from that source, no additional thermal storage vessels were necessary.

The boiler feed is now furnished by a Weir pump, which forces the cold water through a Green's economiser, where it is heated to a temperature varying with the load, although at light loads a maximum temperature of 250°F. has been reached. The feed then passes into the thermal storage vessel, fixed at a level of about 20ft. above the boilers. This vessel is simply a cylindrical shell 30ft. by 8ft., which is used for storing, during the hours of light load, hot water, with which the boilers are fed directly by gravity.

Most of the lime in feed water comes down in the feed-storage vessel; the amount taken out of the vessel after a run of seven months was little short of 1 ton after being dried. The deposit in the economiser tubes was less than $\frac{1}{16}$in. in thickness; it was of a harder nature than that in the feed-storage vessel, and could be removed by a scraper. The boiler tubes were frequently examined and were found fairly clean, the deposit in the tubes amounting to an average of $\frac{3}{32}$in.

This system of feed storage has undoubtedly contributed considerably to the success of the plant generally; it enables the engineer in charge of the steam-raising plant to store hot feed water during about 18 hours out of the 24, so that at the time of maximum load the vessel is about two-thirds full of feed water at a pressure and temperature equal to that of the boilers. Tests have been made on several occasions, when the demand for electricity has been within the range of the refuse furnace to supply the necessary heat, and when, of course, no coal was used. The results showed 0·95lb. of water evaporated at a steam pressure averaging 130lbs. for 1lb. of refuse burnt. A considerable reduction must, however, be made in these figures when taken over, say, 12 months. Damp weather (which affects the quality of the refuse), low barometric pressure, choked flues, warped doors, the starting up of furnaces, &c., may easily bring down the average results over a lengthy period to 0·5lb. of water for 1lb. of refuse burned. The existing vessel has, however, proved most serviceable for the storage of hot feed water, and as a means of removing the impurities from the feed water before it reaches the boiler. The economiser was not erected until some time after the works were opened, as it was not anticipated that the temperature of flue gases would warrant its insertion. However, after the plant had been running steadily for some time, and careful tests had been taken, it was found that the flue gases at the base of the chimney had a maximum temperature of 700°F.

The exhaust steam after leaving the engines (non-condensing) in the generating station is carried by a 16in. pipe to the baths, where it is put through heaters which supply all the hot water necessary for the whole of this large institution. Live steam is also supplied direct from boilers for clothes boiling, &c.

This scheme for heating the whole of the baths and wash-houses has proved eminently successful, and has excited a great amount of interest among municipal authorities. No charge whatever is made to the baths for any exhaust steam. A charge, however, of not quite £250 per annum is made for the live steam. The free library, situated close by, is heated by exhaust steam from the feed pumps.

The amount of refuse destroyed is between 25,000 and 26,000 tons per annum. The residue (or clinker) amounts to from 33 to 35 per cent. of the weight. The cost for labour for burning the refuse is

* Abstract of a Paper read at the Chicago Meeting of the Institution of Mechanical Engineers.

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very high compared with that at other destructor plants, and is one of the most serious factors for consideration.

	Per ton. s.	d.
Cost for handling and burning refuse, including yard men (average)	2	6
Clerks and establishment charges	0	4½
Repairs and maintenance of cells and plant and cost of engineering stores	0	10
Total	3	8½

The above figures are for the fifth year's working, when considerable repairs were necessary to the furnace, linings, doors, &c.

The works are run on the eight-hours-shift system, seven days per week.

The amount of electric energy consumed in the burning and handling of 25,000 tons of refuse is as follows:—

	Units per ton.
Electric fans	4·0
,, lifts and trucks	0·5
,, lighting	0·48
Total	4·98

The residue from London refuse consists of approximately—

Common clinker	30·0	per cent. of refuse.
Fine ash	3·0	,,
Flue dust	0·5	,,
Old tins and iron	0 5	,,
Total	34·0	,,

It is unnecessary for the destructor to adjoin an electric generating station. It should, indeed, be far enough away or otherwise so placed that dust from works and clinker yard cannot reach the engine room of the generating station.

LEGAL INTELLIGENCE.

Damper and Another v. National Telephone Co.

At Tonbridge County Court last week, before Judge Emden, Mrs. S. R. Damper and Miss A. Gibbons sued defendant company for £10 damage to property due to erection of telephone poles thereon. It appeared that the first-named plaintiff owned an estate between Fordcombe and Penshurst, and the co-plaintiff was tenant of the land on which the poles were erected. Tunbridge Wells Corporation had, without plaintiffs' consent, erected 28 telephone poles between Fordcombe and Penshurst, and the National Telephone Co. had continued the trespass after the transfer to them of the Corporation system. In lieu of bringing an action for damages, and for an injunction, plaintiffs negotiated with the company with the result that the poles were removed, but as plaintiff (Damper) considered she had not been fairly treated, the present action was brought to recover "nominal" damages of £10. The trespass was admitted by the company.

Mr. JAMES KING MURRAY, local manager of the National Telephone Co., said he received a letter from Mrs. Damper complaining about the poles on Jan. 18 last, and had received other letters since. As a result of inquiries, he found that Tunbridge Wells Corporation had erected the poles on land over which Sevenoaks District Council had authority.

Mr. EDGAR LAWS BLAKE, wayleaves inspector of the National Telephone Co., said he had an interview with Mrs. Damper in January. She pointed out which poles she thought were on her property, and on behalf of the company he offered her 1s. per pole, the usual rental in the country. Mr. Bolt, surveyor to Sevenoaks District Council, had advised him that the poles were not on Mrs. Damper's property. There was practically no damage, and there was now no evidence of the poles having been there. There were 17 subscribers at Penshurst (including two peers) who were isolated by the action of the plaintiff Damper. The other plaintiff had given him every assistance, and had raised no objection to the erection of the poles.

Mr. S. J. SMITH, district manager of the National Telephone Co., said he had never until that day heard of Miss Gibbons.

After hearing lengthy arguments, his Honour said plaintiffs had shown that some damage had been caused. Tunbridge Wells Corporation seemed to have put up those poles without permission from the owner of the land. He thought the amount claimed for damage was very small indeed, and there must be judgment against the company for £10 and costs.

Tramway Rating Appeals.

At the Quarter Sessions, Brentford, last week, Sir Ralph Littler, K.C., C.B., presiding, the London United Tramways (Ltd.) appealed against the assessment of its property in the Brentford Union.

At the previous hearings the Court decided that the assessment should be based on the car-miles run in each parish, and not on traffic returns. The Court also reduced the assessment for the whole undertaking from £18,552 to £11,245. After this last decision the Court adjourned sine die, it being agreed that the company and the committee should meet and apportion the reduced assessment between the various parishes.

Mr. BALFOUR BROWNE, K.C., now said they had been unable to agree as to how the reduced assessment should be apportioned.

Mr. RYDE, assessor to the company, said that he would distribute the rateable value equally amongst the different parishes, but the effect of that would be, in the case of some parishes, to increase the amount appealed against on the last occasion.

Sir EDWARD CLARKE, K.C., said the Assessment committee was anxious to have the assessment made on the traffic receipts earned in each parish.

The CHAIRMAN: But that must depend upon the number of car-miles run.

After discussion, the CHAIRMAN said the decision of the Court on that point was that the assessment must be based on the car-miles run in each parish.

Sir E. CLARKE asked that a case should be stated, and this the Chairman agreed to.

Mr. COOK, the Assessment committee's assessor, said that, in accordance with the decision of the Court reducing the 1903 assessment from £18,552 to £11,245, he had made a proportionate reduction in the case of the 1902 assessment, reducing it from £16,961 to £10,280.

The CHAIRMAN: Inasmuch as the lines were not in full operation in 1902, we must take that into consideration. Something must be taken off, and the question is how much?

The Court then retired, and on returning the CHAIRMAN said the April, 1902, rate would be reduced to £7,800, and the September, 1902, rate to £8,900 for the whole undertaking. In both these cases, therefore, the appeal would be allowed, with costs.

The CHAIRMAN said the appeal to the High Court would be on the question of the car-mile principle. The decision with regard to the 1902 rates was a finding on the question of fact, and there could, therefore, be no appeal against it.

Edison & Swan United Electric Light Co. (Ltd.)

In the Chancery Division on Tuesday Mr. Justice Joyce granted the prayer of a petition by this company for the reduction of its capital by writing off £58,910, and directed its advertisement for three months.

Chepstow Gas Co. v. Chepstow Electric Lighting Co.

An application was made to Mr. Justice Bigham and Mr. Justice Phillimore on Friday last asking that the date of the hearing of this action should be advanced. The Court declined to grant the application, which will, therefore, come on for hearing in the ordinary course.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Governing Body of the Northampton Institute, St. John Street-road, London, E.C., require a chief instructor in mathematics (day and evening, part time only). Salary £150 per session. Particulars from the principal (Dr. R. Mullineux Walmsley) and applications by Aug. 31. See also an advertisement.

The Electricity committee of the Borough of Weymouth and Melcombe Regis require a chief assistant electrical engineer, salary £120 per annum. Applications to the town clerk (Sir R. N. Howard) by Aug. 10. See an advertisement.

An assistant for evening classes is required for session 1904-5 in the mechanical engineering department of the Crawford Municipal Institute, Cork. £100 per annum. Further particulars from the head master and organising secretary, Mr. E. A. O'Keefe, B.E., M.I.E.E., to whom applications by Aug. 10. See advertisement.

The governing body of the South-Western Polytechnic, Manresa-road, Chelsea, London, S.W., invite applications for the appointment of head of the Department of Electrical Engineering. Salary £250. Applications (on forms to be obtained from the secretary) by Aug. 11. See also advertisement.

Crompton & Co., Arc Works, Chelmsford, advertise in another column for an electrical engineer to take charge of indoor and outdoor testing staff.

A good wireman is wanted for East Sussex County Asylum, Hellingly. Applications to the resident engineer. See advertisement.

An assistant for the meter department of a tramway and lighting company is required. See advertisement.

Applications are invited for the position of assistant town treasurer in Durban, Natal. An experienced accountant is essential, thoroughly acquainted with municipal book and account keeping. Salary £600 per annum. Applications to the agents of the Corporation (Messrs. Webster, Steel & Co.), 3, East India-avenue, Leadenhall-street, London, E.C., by Wednesday, Aug. 3.

Oban Town Council require an assistant electrical engineer with experience in a three-wire continuous-current station with batteries. Salary £70. Applications by noon 29th inst. to the town clerk (Mr. Alex. S. Black).

A lecturer in physics is required at the Municipal Technical School, Birmingham, in September. Commencing salary £140 per annum. Particulars from the secretary (Mr. Geo. Mellor), Suffolk-street, Birmingham. Applications by Aug. 27. See advertisement.

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Heston and Isleworth District Council require a resident engineer for their electricity works. Applications by Aug. 6 to the clerk to the Council (Mr. H. J. Baker), Town Hall, Hounslow.

Huddersfield Corporation require a general manager and engineer of their electric tramways undertaking. Salary £350 per annum. Applications by noon Aug. 8.

The Governors of the East London Technical College require a lecturer in engineering. Salary £200 per annum. Particulars from the director of studies.

A lecturer in engineering (to specialise in the subject of heat engines) is required at the University of Liverpool; also a demonstrator in applied mechanics and engineering design and drawing. Applications in the first case by Sept. 15, and in the second by Sept. 1.

A junior demonstrator in physics is required at Leeds University. Salary £100. Applications by Aug. 31.

Mr. J. Bowden, of the London United Tramways (Ltd.), has been appointed rolling stock superintendent of the London County Council tramways at £400 per annum. Two of the three candidates from whom the final selection was made were Mr. A. A. Blackburn, car superintendent, Manchester, and Mr. J. H. Bale, rolling stock superintendent for the British Westinghouse Co. on the Mersey Railway.

Mr. L. J. Wolf, of Bradford, has been appointed assistant electrical engineer at Faversham.

Mr. W. Marsh has been appointed assistant engineer and manager of Brighton Corporation tramways department.

EDUCATIONAL NOTICES.

Durham College of Science (Newcastle-on-Tyne).—Courses are provided at this college for students proceeding to the degrees in Science or Letters or the diploma in the Theory and Practice of Teaching, and special facilities are offered for the study of agriculture, chemistry, mining, engineering and naval architecture. Matriculation and exhibition examinations begin Sept. 26, and lectures Oct. 4. Prospectuses from the secretary. An advertisement gives some additional particulars.

Heriot Watt College, Edinburgh.—The entrance examination for students who wish to study for the college diploma in engineering or chemistry will begin on Sept. 26. There is a three years' course in mechanical and electrical engineering and a four years' course in technical chemistry. Arrangements have been made with leading engineering firms whereby students may combine their apprenticeship with their studies at the college. The day college calendar, which contains full particulars of courses, fees, &c., may be obtained from the principal (Mr. A. P. Laurie, M.A., D.Sc.).

Aberavon.—The Council have decided to support the scheme for the construction of an electric tramway from Briton Ferry to the beach at Aberavon. Messrs. Lewis & Fletcher, of Cardiff, are electrical engineers for the scheme.

Acton.—The report of the Electricity committee, which was submitted to the Council on Wednesday by the chairman (Mr. Godrich), recommended that the Council should delegate to the committee executive powers for the working, management and control of the electricity undertaking, the committee reporting thereon to the Council. After discussion the report was adopted.

Battersea (London).—On Wednesday the Council decided that distributing mains be extended to and throughout the Shaftesbury and Beaufoy estates, and that 170 ½-ampere Nernst lamps be provided and fixed at an estimated cost of £3,653.

Bo'ness.—At a special meeting on Wednesday, the Council decided to sign the agreement with the National Electric Construction Co. for the establishment of electricity works. The equipment of the works is to be completed within nine months, the sum payable to the contractors being £24,689.

Brighton.—The electric tramway from the railway station to the front was opened for traffic on Wednesday.

The running of the tramcars on the cross route from the Seven Dials to Elm Cross has been discontinued.

Burslem.—An inquiry was held on Tuesday into the application of the Council to borrow £21,000 for electric lighting and £10,000 for refuse destructor works. Technical details were given by the borough electrical engineer (Mr. Ashton Bremner).

Cardiff.—An informal discussion took place at the meeting of the Tramways committee on Friday as to traffic receipts, revision of fares, &c.

Ald. Carey raised the question whether it paid to run tramcars on Sundays.

Mr. Arthur Ellis (the borough electrical engineer and tramways manager) said he proposed dealing with the subject in his annual report, and added that the time had arrived when the question of fares should be taken into consideration, as the present fares were not producing the revenue he had expected them to do. Their total increase over last year only worked out at about £700 to £800. Each route should be placed on a fair comparative basis with every other route. They had the same loan charges with respect to the different routes, and it was not right that a passenger should have to pay 2d. for travelling a distance for which another passenger had to pay only 1d. by another route.

Cheltenham.—The General Purposes committee has issued its report on the condition of the electricity undertaking, as follows:—

"As at present advised, the committee see no reason to abate their confidence in the Electric Light committee, nor in their selection of a chairman nor in the electrical engineer."

Croydon.—In future the charge for current supplied to places of public worship will be 4d. instead of 4¾d. per unit. Last week the estimate of the capital expenditure of the electricity department required during 1904-5 was submitted as follows:—

For works, one direct-current generator, £7,000; foundations, &c., for same, £400; switch-gear, £250; contingencies 10 per cent., £765; motor alternator, £1,100; switch gear, £250; total £9,765. The Electric Light committee recommended that additional plant, consisting of motor alternator, with switch-gear and cables as suggested by the borough electrical engineer (A. C. Cramb), be provided at £1,350. The committee also recommended that application be made for sanction to borrow £8,415, a further instalment of the estimate of £70,950 recently adopted by the Council.

The minutes were agreed to.

Dublin.—Last week an inquiry was held into the application of the Corporation to borrow (among other sums) £21,000 for extensions to the electricity undertaking.

Objection was raised that the Corporation had not formally applied for sanction to the loan, and the inspector (Mr. Cowan, C.E.), having heard the town clerk (Mr. H. Campbell), came to the conclusion that there was no application from the Corporation before him for a loan in the matter.

Mr. P. White (for the Corporation) argued that there was an application from the Corporation. There was on the minute book of the Electric Light committee an order that all steps necessary be taken to obtain the required loan.

Mr. Cowan asked was there a definite resolution of the Corporation directing the application for a loan?

Mr. White said the objection was a purely technical one, and he would ask that the matter be adjourned to have this requirement complied with.

Mr. Cowan said the matter would have to be re-advertised, and they could proceed no further at present.

Dundee.—At a meeting of the Tramway committee of the council last week, a proposal submitted by Mr. G. Balfour, acting as promoter of a local company, was discussed.

This proposal contemplated the formation of a company to erect and equip an electric power station for supplying electrical energy to large consumers for industrial purposes. Mr Balfour's proposal was to supply such power at rates varying from ¾d. to 1½d. per unit.

Mr. Brownlee, convener of the committee, opposed the scheme, which was also reported against by Mr. Robertson, engineer to the corporation, and ultimately the committee unanimously agreed to oppose any application for a provisional order in Dundee by any company on the ground that "were a private company to obtain a footing in the town there would be a cutting of rates, which would result disastrously either to the company or to the corporation, or both, while there would be danger from the double set of wires throughout the city."

The capital of the proposed company would be £250,000.

Edinburgh.—On Tuesday, Treasurer Brown moved that £14,175 out of the past year's profits on the electricity undertaking be placed to credit of reserve, and that the balance (£9,800) be placed to credit of the rates.

He said no new principle was involved, for they had already adopted the principle of contributing from the rates to the extent of £10,000. The percentage of reserve, sinking fund, &c., to capital expenditure was in Edinbugh 23·66, Glasgow 12·81, Manchester 11·02, Liverpool 16·34, Birmingham 10·89.

Mr. Stevenson (convener of the Electric Lighting committee) moved the previous question. He asked the Council to look at the matter from the point of view of the ratepayers' security. That was in building up the reserve so that it would not only bear the strain of renewals and depreciation, but also, in the event of a bad year, to put even the probability of a call on the rates out of the question. To charge the users of a commodity of which the Corporation had a monopoly more than was necessary in order to subsidise the rates was unsound finance. Mr. Menzies, who seconded the amendment, pointed out that in the course of the next few years they might have to cable the greater part of the city, and it was for such purposes that a large reserve was necessary.

Eventually the motion was carried by 28 votes to 17.

Edmonton (London).—The Council, on Tuesday, considered the offer of the North Metropolitan Electric Power Supply Co. to lease the Council's provisional order for 26 years.

The company offered to recoup the Council for all out-of-pocket expenses and find the capital necessary to give a supply of current at a sliding scale of 7d. for the first 100 hours per quarter and 1½d. afterwards.

The consulting engineer (Mr. R. Hammond) regarded the terms as most favourable and deserving of careful consideration.

It was agreed to invite, by advertisement, offers from other companies either to supply in bulk, the Council laying the mains and being the distributors, or to work the undertaking, provided the Council installed plant, &c., at a rent equivalent to interest and sinking fund charges, the Council to have the option of purchasing at the end of seven years at a premium of 12 per cent., at 10 years at a premium of 7½ per cent., or at 15 years without premium.

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Electric Lighting Notices.—Notices of intention to apply for provisional electric lighting orders have been given by the following in respect of the districts preceding their names:—

Andover.—Southern District Electricity Corp.
Beverley.—Empire Electric Light & Power Co.
Bideford.—Mutual Elec. Supply Corp. and Southern District Elec. Corp.
Bishops Stortford.—Bishops Stortford & Stansted Electric Lighting Co. and Mutual Electricity Supply Corp.
Bodmin.—Southern District Electricity Corp.
Bognor.—V. Collinson. [Supply Corp.
Brentwood.—Empire Electric Light & Power Co. and Mutual Electricity
Bromsgrove (Rural).—Stourbridge District Council.
Camberley.—Bournemouth & Poole Electricity Supply Co.
Clacton.—Mutual Electricity Supply Corp.
Cleethorpes.—District Council. (Extension of one year.)
Clewer.—Windsor Electrical Installation Co.
Congleton.—Southern District Electricity Corp.
Cuckfield (Rural).—Haywards Heath Electric Supply Co.
Dover.—Dover Corporation. (Powers to supply outside borough.)
East Barnet.—Empire Elec. Light & Power Co. and G. Vaughan Fowler.
Egham.—Urban Electric Supply Co. [and Foote & Milne.
Farnham.—Farnham & District Electric Supply Co., Farnham Gas Co.
Farnborough.—G. Vaughan Fowler.
Fenton.—G. Vaughan Fowler.
Frimley.—Bournemouth & Poole Electricity Supply Co.
Golborne.—Lancashire Electric Power Co.
Harpenden.—Mutual Electricity Supply Corp.
Haywards Heath.—District Council.
Herne Bay.—Electric Supply Corp.
Hessle and Anlaby.—Hessle District Council.
Hollingbourne.—Kent Electric Power Co.
Ince.—District Council. (For extension of area.) [trict Electricity Corp.
Kingsbridge.—Kingsbridge & Salcombe Electrical Co. and Southern Dis-
Little Hulton.—Lancashire Electric Power Co.
Littlehampton.—Mr. Aylwin.
Malling (Rural).—Kent Electric Power Co.
Margate.—Margate Electric Supply Co.
Marlborough.—Marlborough Corporation.
Matlock Bath.—Foote & Milne.
Newhaven.—G. Vaughan Fowler and Southern District Electricity Corp.
Northfleet.—Gravesend Corporation.
Poole (Rural).—Bournemouth & Poole Electricity Supply Co. [Corp.
Portslade-by-Sea.—Hove Elec. Lighting Co. and Mutual Electricity Supply
Preston (Rural).—Hove Electric Lighting Co. [Power Co.
Rosherville.—Foote & Milne, Gravesend Corporation and Kent Electric
Rye.—Mutual Electricity Supply Corp.
St. Thomas (Devon).—Exmouth Electric Supply Co.
Seaford.—Foote & Milne. [Gas Co.
Shepton Mallet.—Shepton Mallet Electric Supply Co. and Shepton Mallet
Stansted (Rural).—Bishops Stortford & Stansted Electric Lighting Co.
Sunbury.—Metropolitan Elec. Supply Co. and Mutual Elec. Supply Corp.
Swanage.—Southern Dist. Elec. Corp. and Swanage & Dist. Elec. Supply Co.
Tamworth.—Tamworth Corporation (for part of rural district, including
Thrapston.—Geo. Smith. [Wigginton, Bolehall and Glascote).
Topsham.—Exmouth Electric Supply Co.
Tunstall.—Burslem Corporation.
Turton.—Lancashire Electric Power Co.
Whitworth.—Foote & Milne and Lancashire Electric Power Co.

Electric Power in Emergencies.—An Oldham firm recently called upon Mr. S. Willmott Newington, the borough electrical engineer, at 5:30 p.m., for a supply of electricity for power in consequence of a breakdown of steam plant. A 7½ H.P. motor was put down, the cable laid and the supply of current commenced the next morning by the usual time of starting work.

Electric Traction on the Scandinavian Railways.—It is reported that the Scandinavian State Railway authorities intend to invite at an early date tenders for the electrification of some 200 miles of railway, including not only generating plant and general equipment, but motors and rolling stock for both passenger and goods service.

Electric Tramways in Durham.—An interesting report on "improved methods of transit" was presented to Durham County Council on Wednesday by the Electric Supply committee.

The report stated that the county had increased by 94,000 in population during the last decade, and there seemed to be need of some more popular means of transit to disperse the people over a larger area and so avoid congestion. Therefore, the committee asked for authority to engage an expert to report upon the practicability of a county scheme of electric traction founded upon the returns received from local authorities, and to furnish an approximate estimate of the cost of such a scheme, showing capital outlay, upkeep and maintenance cost per annum, and approximate estimate of cost to the County; and to further authorise the committee, on receipt of this report, to invite the local authorities to attend a conference to ascertain their views as to the working of a county scheme.

The matter was adjourned to a future meeting, the chairman stating that the Council had no power to spend money in engaging an expert.

Electricity in Mining.—A correspondent of the "Financial News" describes the introduction of electric power for the first time recently at the Greenwood smelter, British Columbia, power being transmitted from Cascade, 25 miles distant, and generated at the water power works of the Kettle River Power Co. The smelter will require something like 800 H.P. when the furnaces are in full operation, and there is no doubt that electrical power will be found vastly more economical than steam. The new copper converters are now in place, and the matte, which heretofore has been sent to Tacoma and other outside points, will henceforward be locally converted into blister copper. Recently there was installed in the converter building a Nordberg blowing engine, arranged for either steam or electricity, capacity 5,000 cubic ft. of air per minute at 12lb. pressure; a 300 H.P. Canadian General Electric variable speed induction motor, with switchboards, &c.; two banks of transformers, to reduce voltage from 20,000 to 2,000, and others to reduce from 2,000 to 550; a 75kw. generating set for driving electric crane and trolley locomotives, and a hydraulic "accumulator" and pump for tilting converters, run by 25 H.P. electric motor. A 30 ton four-motor electric travelling crane to handle the matte in 5-ton ladles completes the electrical equipment.

Embezzlement—At Barnstaple on Friday, Edward Eyes, engineer, was sentenced to four months' hard labour for embezzling the moneys of his employers, H. A. Willey & Co., electrical engineers, Exeter.

Fire.—Reuter's Agency states that the St. Petersburg electric cable and wire factory of Felten and Guilleaume were destroyed by fire on Tuesday, the loss being estimated at 2,500,000 roubles.

Fulham (London).—On Wednesday the Finance Committee reported to the Council that they had passed an estimate of £45,042 (in addition to £7,000 already sanctioned) as a first instalment for the electric lighting extensions. Owing to the steady increase in the number of customers, it appeared quite clear that a case had been made out for an extension of the plant. The report was adopted.

Grimsby.—The report of the borough electrical engineer (Mr. W. A. Vignoles) on the working of the electricity undertaking for the year ended March (the third year) states that on Jan. 1 a new system was started of charging 1d. per unit for current for power supply, cut off entirely from dusk to about 9:30 p.m.

The improvement in the demand for current for power (continues the report) is not fully indicated by the figures, as many of the motors now supplied were only connected during the last month of the year. It is estimated that the power demand during the current year will amount to 70,000 units, and will form a fourth of the total supply to private consumers. There are applications in hand of the equivalent of 2,308 8 c.p. lamps (compared with 2,210 last year). An underground sub-balancing station has been constructed and equipped with an automatic balancer during the year, effecting a marked improvement in the steadiness of the light, feeders 1 mile 660yds. and distributor cable 1 mile 1,154yds. in length have been laid, and 93 services run to consumers' premises by the employés of the department, and automatic stokers have been fitted to the Lancashire boilers. Total capital expenditure is £78,286. 19s. 3d., increase of £7,033. 4s. 5d. for the year. Receipts (£9,086) included sale of current by meter £4,308. 18s., for public lighting £1,639. 15s. 1d., and for traction £2,723. 2s. 1d. Working expenses were £4,548. 13s. 5d. Interest, &c., absorbed £3,491. 17s. 1d., and £1,573. 7s. 10d. was put to sinking fund, the result being a deficit of £581. 10s. 11d. on the year's working. There are 361 private consumers, with lamps, motors, &c., equivalent to 30,555 8 c.p. lamps (compared with 287 and 21,334 respectively at March, 1903). There are 41 motors aggregating 167 H.P. (against 16 motors 45 H.P. last year). 897,328 units were generated. 442,628 were supplied for traction (against 372,114), 102,139 for public lighting (against 95,702), and 254,835 to private consumers (against 185,622). 16,519 units were supplied for power (against 4,770). Generation costs per unit sold were 0·84d. (against 0·96d.), and total costs 1·24d. (against 1·40d.)

Mr. Vignoles has prepared an interesting pamphlet describing the advantages which electricity offers over other prime movers for power work, and this, together with the liberal terms offered at Grimsby for current supply for power, should have the effect of largely increasing the demand for current. The testimonials from present users of electric power for a large variety of purposes show that in Grimsby, as elsewhere, electricity has only to be introduced to be immediately appreciated.

Heckmondwike.—The Yorkshire (Woollen District) Tramways Co. notify that, "owing to the impossibility of coming to a satisfactory agreement with Heckmondwike Council for the supply of power, the company find it impossible to maintain the present service running through the Heckmondwike district." The Heckmondwike Council supply electricity for use within the township, and the difference with the company is as to the price to be paid for extra supply caused by the public demand for the cars.

Infirmary Lighting—Chelsea (London) Guardians have instructed their Building committee to obtain prices for wiring the workhouse infirmary.

Japanese Imports.—The imports into Yokohama during 1903 showed a decrease in the value of electric motors of £18,683 compared with 1902, and a decrease of no less than £23,120 in the value of imported electric light apparatus and accessories. It is stated that much of this decrease is due to Japan's increasing home manufacture of plant and machinery. In this connection it may be stated that so far as the Japanese Government supplies are concerned, tenders are usually only advertised locally, in the Japanese language, in the "Official Gazette," with little more than a fortnight given for sending in the tenders, and as a deposit has to be provided or bonds lodged by the tenderer, outside contractors

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find their opportunities for executing Japanese contracts much curtailed. It is urged that an agent on the spot is best equipped for trading on a large scale in Japan.

According to latest returns, telephones were imported into Japan at Yokohama, in 1902, to the value of £13,234 against nil in 1903. Electric light wire and cables were imported into the same port in 1903 to the value of £31,651, an increase of about £3,600 over 1902, while imports of telephone wire for 1903 were nil compared with £34,260 in 1902.

Keighley.—An inquiry was held here on Wednesday into the application of the Council for permission to borrow £11,500 for extension of the electricity undertaking. Already sanction to a loan of £39,321 has been obtained, and satisfactory progress has been made since the works were opened in March, 1901.

Leith.—The gross profit on the electricity undertaking during the past year was £7,687. After paying interest and sinking fund instalment the net profit was £2,997, out of which £1,894 had been carried to police account in repayment of sums advanced in former years, and the balance (£1,103) added to £661 from previous year gives a surplus of £1,764 for reserve.

Light Railways.—An inquiry was held on Monday for an order to extend the time for constructing the Blackpool and Garstang Light Railway. Owing to financial disturbance the promoters did not obtain sufficient applications for share capital to justify going to allotment, £180,000 being required. Sufficient capital would now be forthcoming. It was also asked that the name should be changed to the Blackpool and Fylde Light Railway, to distinguish it from the Garstang and Knott End Railway. The Commissioners decided to extend the time for 18 months.

At their last meeting the Herts County Council passed the following resolution :—

That, subject to Middlesex County Council extending the light railway proposed to be constructed by them to the county boundary at Barnet, the necessary steps be taken to construct the Barnet light railway, and that the Highways committee be empowered to employ an engineer to prepare plans, working drawings and specifications. That the Highways committee be empowered to take the necessary steps to acquire the lands required for widening the main road at Barnet along which the light railway will pass.

At Liverpool, on Wednesday, a Local Government Board inquiry was held into the application for an order for the construction of a light railway from Tarporley to Cuddington (Cheshire) 5 miles, 3 furlongs in length. Mr. E. O. Ferguson, C.E., is engineer to the scheme, which was supported by a number of farmers and tradesmen in the district, and by the Dean and Chapter of Chester, but was opposed by the Cheshire Lines committee and by a number of landowners and tenants.

London County Council.—At Tuesday's meeting the Finance committee reported upon the proposed loan to Marylebone for the purchase of the electric light undertaking of the Metropolitan Electric Supply Co., and recommended that they be authorised to invite and accept tenders for London County bills for £1,500,000 to provide funds for the advance of £1,415,000 to Marylebone. This was agreed to. It was also decided to give Marylebone Council permission to borrow £433,800 to defray part of the cost of installation of the electric light within the borough and for the purchase of meters.

Shoreditch applied for a loan of £9,958 for similar purposes and Woolwich for £10,000 (part of £22,767), and these loans were agreed to.

An agreement was approved with Battersea Council for the supply of electric current (at 4½d. per unit) to the iron building being erected at St. John's-hill, for a visitors' education centre.

The Highways committee recommended that the estimate of £18,500 be approved and expenditure of that amount be sanctioned in connection with the erection of a sub-station to be established as part of the Greenwich electricity generating station for the electrical working of portions of the Council's tramways, and that the estimate of £15,000 be approved and expenditure of that amount be authorised in connection with the provision of plant, machinery, equipment, &c., for such electricity sub-station. The recommendations were agreed to, and it was decided to accept the offer of H. Lovatt (Ltd.) for the erection of the superstructure of the first portion of the Greenwich generating station.

The Highways committee reported that they had received an invitation from the President of the Board of Rapid Transit Railroad Commissioners of New York to appoint a representative from the Council to take part in the official opening of the subway for traffic next September. It was decided to appoint Mr. J. Allen Baker, chairman of the Highways committee.

The same committee recommended the purchase of the London, Camberwell and Dulwich Tramways Co.'s undertaking for £6,600, and this was agreed to.

Malaga.—In the Chorro, two hours' journey by rail from Malaga, an extensive electrical plant has been erected for the purpose of supplying Malaga and the intervening districts with electric energy for manufacturing and industrial purposes. The company owning the tramways at Malaga have hitherto used horses, but have at present under consideration a proposal to adopt electric traction in the outlying suburbs, and hope to obtain permission to electrify their system in the city at a later date.

Manchester.—The Improvement committee have asked the city surveyor to prepare a return showing the money expended by the committee for the purposes of the tramways. It was stated by members of the committee that the Tramways committee were indebted to the Improvement committee for the widening of various streets, and that it was only right the ratepayers and Council should be shown to what extent the tramways had been aided in this way.

Mandalay.—The Lieut.-Governor of Burma recently formally opened the electric tramway system.

Marylebone (London).—At the meeting of the Council last evening a report of the Electric Supply committee was presented dealing with the purchase of various properties in the borough for the purpose of clearing a site for the electricity generating station and offices.

On the subject of the replies to the committee's recent advertisement inviting applications for the post of electrical engineer, the report stated that six candidates had been selected from the number, and their qualifications duly considered. The committee had come to the conclusion that none of the candidates were quite suitable for the post, and they asked the Council to authorise them to again advertise for a resident electrical engineer to the Council at a salary of £600 per annum. This was agreed to.

With regard to the appointment of an electrical accountant, the committee reported having selected Mr. E. J. Jennings, at present accountant and bookkeeper to the electricity department of St. Pancras Council, and they recommended his appointment at a salary of £250 per annum. This was agreed to.

The applications received for the positions of mains superintendent, meter department superintendent, and installation inspector are still under consideration by the committee.

Councillor J. A. Michell, J.P., was elected a member of the Electric Supply committee in the place of Councillor W. Bailey, resigned.

Meshed (Persia).—According to reports, the introduction of electric lighting into Meshed has resulted in a riot. It appears that the tomb of the Imam Risa and some adjoining buildings were lighted electrically, and this seems to have disturbed one of the numerous fanatical groups of the country, who caused a riot, with the result that the ringleader was arrested—and 500 persons were thrown out of employment.

Morecambe.—Negotiations are still proceeding between the Tramways committee and the local tramways company on the proposed electrification of the tramways.

Municipal Telephony.—Scarborough Telephone sub-committee recommend that the further consideration of the proposal to establish a municipal telephone exchange be deferred.

Portsmouth Telephone committee recommend the Council to increase the salary of the engineer and manager of the municipal telephone department (Mr. C. M. Gardner) by £25 per annum, in recognition of the successful work he has accomplished since the inauguration of municipal telephony. It is further recommended that an additional increase of £25 be given when 2,000 instruments are connected with the exchange and working. The number now fixed is over 1,800.

Obituary.—Gen. Sir Michael Anthony Shrapnel Biddulph, R.A., G.C.B., Gentleman Usher of the Black Rod, died on Saturday in his 81st year. Deceased, who had a distinguished military career, served throughout the Crimean campaign and was an assistant engineer in the trenches and Director-General of Submarine Telegraphs in the Black Sea during the period of hostilities.

The death is also announced, in his 56th year, of Mr. J. G. B. Elliott, secretary of the Tramways Institute of Great Britain and Ireland. Mr. Elliott had been over 20 years associated as secretary with various undertakings, including the London, Deptford and Greenwich, the North Staffordshire, the Croydon, the West Metropolitan, the Potteries and the Stockton and Darlington tramway undertakings.

Oldham.—The accounts of the electricity department for the year ended March show a total capital expenditure of £242,974. 1s. 10d., an increase of £26,092. 1s. 10d. for the year.

Receipts were £11,641. 18s. 3d. for current for private consumers, £180. 17s. for public lighting, and £13,608. 3s. 8d. for tramways, the total from all sources being £26,324. 7s. 8d. Working expenses were £13,321. 12s. 4d., leaving £13,002. 15s. 4d. gross profit. Adding to this £6,160. 19s. 4d., balance from previous year, there was £19,163. 14s. 8d. to dispose of. £1,000 was placed to the borough fund and £4,000 to reserve. Interest required £7,683. 14s. 8d., and sinking fund instalment £5,905. 19s. 4d. There was now a balance forward of £389. 15s. 10d. 3,330,291 units were generated (compared with 3,189,849 in the previous year), 17,362 were supplied to public lamps, 848,095 to private consumers and 2,177,309 for traction, a total of 3,042,766 sold (against 2,869,312). The total maximum supply demanded was 790kw. for lighting and 975kw. for traction.

Portsmouth.—The receipts of the Corporation tramway department during the past year were £92,916. 18s. 5d., the working expenses £43,426. 14s. 4d. and the interest and sinking fund charges £33,461. 12s. 8d. The balance (£16,028. 11s. 5d.) has been transferred to reserve.

Price of Gas in South London.—The South Metropolitan Gas Co. have reduced their charge for 1,000 cubic ft. of gas to 2s. This

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is the lowest price per 1,000 for gas ever made in the Metropolitan area, and, as a standard figure (not considering discounts), is probably the lowest charge in the kingdom. No mention is made as to whether the competition of electric light has brought about this latest reduction.

Ravensthorpe (Yorks.)—The District Council have resolved to apply for a provisional electric lighting order.

Redditch.—The District Council decided, on Friday, to abandon gas-driven plant at the generating station and to borrow £7,500 for putting down steam engines.

Rio Grande do Sul (Brazil).—A report recently published upon the trade of Rio Grande do Sul intimates that at Rio Grande (the chief port of this State), at Pelotas, at Bagé, at Jaguaro and at Santa Maria the telephone is well established, although the populations at all those places are comparatively small. The electric light is in full working order in the three last-mentioned towns. Tramways are also running, but these are worked by mules.

St. Pancras (London).—It was reported on Wednesday that the taxed costs of the plaintiffs in the recent action, "Colwell and others *v.* Borough Council" (for vibration, &c., at the King's-road station), and which would be charged to the electricity account, amounted to £1,060. Interests had been acquired from Mr. Colwell and other tenants at £2,675, and negotiations were pending as to the purchase of other interests. It was decided to ask the London County Council for sanction to a loan of £10,000 for electricity supply.

Shoreditch (London).—The Council have approved a recommendation of the borough electrical engineer (Mr. C. Newton Russell) to grant large consumers of electrical energy for power a sliding scale of discounts as follows:—

Not less than 50,000 units per annum 25 per cent. off rate of 2d. per unit, 35,000 20 per cent., 25,000 15 per cent., 15,000 10 per cent., 10,000 5 per cent. and 5,000 2½ per cent. These discounts, which are to come in force in the December quarter, are only to be allowed if accounts are paid within 21 days. In addition, consumers using 50,000 units per annum for power are to be charged a uniform 3½d. per unit for current for lighting.

Southwark (London).—The recent accounts of the Council's electricity department for the year ended March show capital expenditure of £2,328. 11s. 11d. during the year. The total amount borrowed is £78,555, of which £3,796 has been repaid, and there are now overdrafts of £3,891. 1s. 6d. on revenue and £3,344. 8s. 11d. on capital account.

The receipts from current supplied to private consumers were £8,694. 13s. 5d., from public lighting £3,287. 8s. 8d., the total being £13,231. 4s. 8d. Working expenses were £7,279. 7s. 6d. (£267. 13s. 2d. less than in the previous year), leaving £4,951. 17s. 2d. Interest absorbed £2,530. 11s. 1d., and repayments of loans £2,197, the surplus for the year being £224. 6s. 1d. The deficiency at March 31, 1903, was £729. 15s. 11d.; 833,208 units were generated (compared with 749,159 in previous year), 254,586 were supplied to public lamps (against 213,268), and 538,832 to private consumers (against 464,113). Total maximum supply demanded was 570kw. (against 525kw.).

"Split Turns" on Leeds Tramways.—A poll of the Corporation tramcar motormen and conductors has resulted in 130 votes in favour of and 489 against the automatic rotation of duties, so that each man would take his turn on each route and on both long and short days. On the question whether the principle should be adopted of appointing the older servants to work the shorter days, 277 voted in the affirmative and 332 in the negative.

Stourbridge.—The Board of Trade have deferred the revocation of the Council's Provisional Electric Lighting Order, 1899, for 12 months.

A draft agreement with the Midland Electric Corp. for Power Distribution for the supply of electricity in bulk was submitted to the Council on Monday. Nine tenders were submitted for laying electric lighting mains, and one of these was accepted subject to the sanction of the Local Government Board to a loan. The Board have intimated to the Council that they should be prepared to show at the adjourned inquiry that there was such a demand for the electric light as would justify them in carrying out the work.

Suez Canal.—Under the supervision and with the full permission of the Egyptian Government, Lloyd's are establishing the Marconi system of wireless telegraphy along the Suez Canal. The lighthouse at Port Said is, we learn, to be used as a signal station, and at Port Tewfik a 180ft. pole has been erected. It is anticipated that the service will be in working order by the first week in August.

The duration of the passage through the Suez Canal was again reduced in 1903 to 17 hours 48 min., compared with 18 hours 41 min. in 1901 and 18 hours 2 min. in 1902. The mail steamers have completed the journey at an average of 15 hours 30 min. The percentage of ships using the electric light for transit by night has risen from 94 to 96 per cent. Indeed, except for some of the very large battleships and some Turkish ships, the use of the electric light at night has become universal. The tonnage through the Canal in 1903 reached 11,907,288 tons, an increase of 658,000 tons over 1902.

Sweden.—The electric light is being introduced in connection with public works in Sweden to a large extent. At Uddevalla harbour accommodation has been considerably extended, and the electric light will be introduced as soon as these extensions are completed.

At Helsingborg the electric tramway system has been recently completed, and has proved, as usual, a great boon to the public.

The Government, as previously reported, have entrusted the Royal Railway Board with the task of making certain experiments with electric motive power on the State railways, and have made the Board a grant of 425,000 kroner (nearly £24,000). Experiments will be commenced upon the Tomteboda–Vartan and the Stockholm-Jarfva lines of railway, of a total length of nearly 14 kilos. (about 8⅝ miles). Single-phase alternating-current will be employed, and the experiments are to commence at the beginning of 1905.

Tonbridge.—The result of the past year's working of the electricity department was a deficit of £1,280. 9s. 2d.

Tramways in Germany.—The employment of horses in tramway work has now almost entirely ceased in Germany. So far back as October last the length of tramways worked by horse traction had diminished to 32 miles, compared with 3,410 miles of electric lines. This mileage is distributed over 134 towns, and is, except for a few short sections of conduit traction in Berlin, Dresden and Dusseldorf, entirely worked on the overhead system. The two short lines of accumulator cars which are running in Germany are, we are informed, likely to be discontinued shortly.

Trieste.—The Società Romana, an Italian enterprise, has established large carbide of lime works on the river Kerka, about 7 miles from Sebenico (Dalmatia), the company utilising the immense water power available at this place. The plant installed includes two 7,000 H.P. Ganz generating machines, and power is transmitted to Sebenico. The output of carbide of lime represents about 74 tons per day. At present about 15,000 H.P. is obtained from the falls, but it is estimated that at least 60,000 H.P. could be obtained if required, as there is a 132ft. fall of water. Besides these large works, the town of Sebenico is lighted throughout by electricity generated at the same source, the Municipality owning the electricity works. Further up the river, the Società Romano are erecting large works at the Manojlovac waterfall, where a large plant is being installed. The capital invested in these undertakings by the Società is already over £350,000.

Electric tramways have been inaugurated in the cities of Pola and Rovigno.

Concessions have been granted for a local electric railway from Laurana-Abbazia-Volosca-Mattuglie, for a similar railway between Abbazia-Mattuglie-Volosca-Ika-Laurana, and for a similar railway between Spalato-Grabovaz-Vergoraz-Metcovich-Immoschi. Other lines of electric railways are in contemplation.

Ware (Herts.)—An agreement has been entered into by the Council with the North Metropolitan Electrical Power Distribution Co. for the supply of electric energy into the district.

West Ham.—The accounts of the electrical undertaking for the year ended March 31 show that the capital expenditure for the year was £83,342, bringing the total to £268,511.

The gross income was £30,363, of which £25,000 came from private lighting, £3,096 from public lighting, £1,514 from power and £210 from traction. Expenditure, including interest and instalments of loans, exceeded income by £3,788. There was a credit balance of £1,689 from the previous year, and it was recommended that the deficiency (£2,099) be made good from the general district fund. The borough accountant, in his report, said that "for two years the Electric Lighting committee had set aside annually £1,000 for reserve. In view, however, of the state of the accounts for the past year he was unable to advise that this course be followed on the present occasion, but was of opinion that, when the finances of the undertaking permit of it, £1,000 per annum should be regarded as an absolute minimum, especially in view of the fact that the capital expenditure in equipment, which will probably become inoperative before the expiration of the loan, amounts to nearly £150,000." The additional expenditure, as compared with the cost, and the interest and sinking fund payments on unremunerative capital have been heavy. It is expected that a considerable increase in supply will take place during this next financial year, but as the capital charges will also be much heavier, the increased revenue will, it is anticipated, be little more than sufficient to meet the additional charges.

The report was adopted, and its recommendations agreed to.

Westhoughton (Co. Durham).—The Council have received offers from the Hulton Colliery Co., Musgrave & Sons, and the Lancashire Electric Power Co. to supply electricity, and further information is to be obtained from the first-mentioned before coming to a decision.

Wimbledon.—The capital expended on the electricity undertaking during the year ended March 31 was £15,544. 9s. 10d., bringing the total to £115,746. 2s. 10d.

The income was £18,640. 4s. 3d., including £12,111 from the sale of current by meter and £5,984. 7s. from public lighting. Annual expenses were £9,346. 18s. 4d. Interest absorbed £3,155. 10s. 7d. and sinking fund instalment £2,992. 1s. 11d.; £205. 8s. 1d. was voted to meeting expenses of obtaining the 1903 extension order and £1,000 was placed to reserve, the balance (£1,940. 5s. 4d.) being carried forward. 1,283,060 units were generated. 539,673 were supplied to public lamps and 653,305 to private consumers. The total maximum supply demanded was 772kw.

Wiring Consumers' Premises.—Last week Wandsworth (London) Council were recommended not to approve the proposal of the London County Council to include in their bill provisions to enable local authorities in London to obtain powers to wire and fit up con-

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sumers' premises for electric lighting or to obtain loans for that purpose; but the matter was referred back for further consideration.

Hampstead and Stoke Newington Borough Councils have decided to support the proposed legislation.

Yeovil.—The Council have declined the offer of Mr. G. V. Fowler to take a transfer of their electric lighting order.

Outing.—The staff of the Electrical Co. held their annual outing on Saturday last, the party making a trip by rail from Waterloo to Staines and by launch to Bray Lock and back, luncheon being served on board. On the return to Staines, dinner was served at the Bridge House Hotel, 75 sitting down. Mr. J. Stottner, the general manager, presided, supported by Mr. Loewi, the secretary. The usual loyal and friendly toasts were given. A very enjoyable day was spent.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Brixham District Council invite offers for a transfer of the Brixham Electric Lighting Order, 1903. Further particulars from the clerk (Mr. J. L. Arlidge), Town Hall, Brixham.

The City of Santos Improvements Co. (Ltd.), invite tenders for the delivery f.o.b. British port and for erection at *Santos*, Brazil, of producer gas plant and gas-driven alternators of a total capacity of 400kw., and transformers. Conditions, &c., from the consulting engineers (Messrs. Mordey & Dawbarn), 82, Victoria-street, Westminster, S.W. Tenders by noon Aug. 20, to the secretary (Mr. J. E. Rimmer), 174, Gresham House, Old Broad-street, London, E.C.

The Commissioners of the Municipal Council of *George Town, Penang*, invite tenders for supply and delivery of tramcars, complete with motors, controllers, trolleys, &c. Specification, &c., from Messrs. Preece & Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders to Mr. R. M. Christie, 4, East India-avenue, London, E.C., by noon Aug. 24.

Tenders are wanted by noon Aug. 10 for new fire appliances, including electric fire alarm communications, for East Riding Asylum, *Beverley*. Tenders to clerk, Newbegin, Beverley.

Perth Corporation invite tenders for the construction and equipment of electric tramways on the overhead trolley system. Tenders by noon Aug. 16.

Leeds Corporation invite tenders for supply of two 1,000kw. turbo-alternators, with condensers, exciters, &c. Tenders by 10 a.m. Aug. 15.

Crewe Corporation require tenders by Aug. 8 for supply of 1,500 tons of slack for their electricity works.

Glasgow Corporation invite tenders for wiring Govanhill District Library. Tenders by Aug. 8.

Tenders are invited until August 10 by the *French* Post and Telegraph Authorities, 103, rue de Grenelle, Paris, for cast metal heads for joining cables, nine lots of porcelain insulators, tin solder, bronze wire, copper wire and tinned copper collars, bimetallic wire, sundry iron and steel goods, rods, &c.; also until August 11 for 203,080 poles (injected) in 40 lots.

TENDERS RECEIVED AND ACCEPTED.

The Metropolitan Asylums Board have accepted the following tenders:—

For installing fire alarms at Darenth Asylum, P. Dewhirst £320. 5s. (12 tenders were received, ranging from that of accepted to £1,650. Engineer-in-chief's estimate £380.)

For installing telephones at Eastern and Western Hospitals, P. Dewhirst £359. 10s. (18 tenders received, ranging from the accepted to £1,200. Engineer-in-chief's estimate £580.

For annual supplies of electrical accessories: ArmorJuct Mfg. Co., Baxter & Caunter, Berliner Telephone Mfg. Co., Craigpark Electric Cable Co., Dewhurst's Engineering Co., Edison & Swan Co., Electrical Co., General Electric Co., E. Goossens, Pope & Co., H. Greene & Sons, India Rubber, Gutta Percha and Telegraph Works Co., Lawrence's Limited, London Electrical Fittings Co., A. P. Lundberg, Pryke & Palmer, Siemens Brothers & Co., Siemens Electric Appliances, Sun Electrical Co., J. H. Tucker & Co. and Veritys Limited.

St. Pancras (London) Council have received the following tenders for a low tension switchboard at King's-road station:—

British Westinghouse Co., Ltd. ..... (*accepted*)	£1.035	7	Westminster Eng. Co. ..	1,230	0
Crompton & Co.	1,955	0	Consolidated Electrical Co.	1,220	0
John Fowler & Co.	1,665	0	Nalder Bros. & Thompson	1,215	0
Dorman & Smith	1,658	0	Kelvin & James White ..	1,170	10
Elec. & Ord. Accessories Co.	1,560	0	Bertram Thomas	1,153	0
Aberdeen Elec. Eng. Co.	1,490	0	B.T.-H. Co.	1,122	0
Electric Construction Co.	1,357	0	Cowans Limited	1,109	0
Edison & Swan Co.	1,332	0	Electrical Co.	1,095	0
Elliott Bros.	1,296	0	Northcote, Heaver & Co.	1,083	0
Siemens Brothers & Co.	1,270	0	Johnson & Phillips	1,059	0
Ernest F. Moy (Ltd.)....	1,260	0	J. G. Statter & Co.	1,026	0
Veritys Limited	1,249	0	Ferranti Limited	900	0
			T. W. Broadbent	728	0

Hammersmith (London) Council have accepted the tender of Davey, Paxman & Co. for "Economic" boilers, with superheaters, at £4,889. There were 31 tenders, varying from £3,800 to £9,100. The Council have also placed an order with the Barry Transporter Co. for overhead apparatus for the removal of ashes from the boiler house at £190.

Salford Corporation have accepted the following tenders for the tramways:—

Russell & Sons, sectional B poles, £5. 15s. each, and sectional C poles, £7. 12s. 6d. each; Hall & Pickles, iron and steel work; Giddings & Dacre, glass, wire, solder, lead and tin; J. Bentley & Co., paints, oils, &c.; Brilliant Shining Metal Polish Co., metal polish; W. T. Glover & Co., lead piping; R. W. Blackwell & Co., pull-offs, strains and car accessories; Docker Bros., special paints and varnishes; L. Andrew & Co., Commercial Electric Co., Liverpool Electric Cable Co. and Estler Bros., car accessories (electric); Miller & Co., 30in. diameter chilled cast-iron wheels; J. J. Rigby (Ltd.), oil for Wells' lights; Brecknell, Munro & Rogers and National Rail & Tramway Appliances Co., car accessories (mechanical); Geo. Hill & Co., switches, section boxes, &c.; Johnson & Phillips, rubber-covered cable.

Stepney (London) Council have received the following tenders for supply of cable for the period ending Dec. 31, 1906:—

W. T. Henley's Telegraph Works Co. (*accepted*)	£11,007	10
Callender's Co.	11,225	10
Siemens Brothers & Co.	11,293	0
British Insulated & Helsby Cables (Ltd.)	11,302	0
W. T. Glover & Co.	11,339	0

The tender of the Western Electric Co. was informal.

Stepney Council have also accepted the tender of Jessop & Appleby Bros. for an electric crane at £508, and that of Bruce Peebles & Co. for motor boosters at £526.

The Paterson Engineering Co. have recently received orders for boiler feed purifiers as under:—

Through Babcock & Wilcox, for H.M. dockyards, Pembroke; through Edwin Danks & Co., for H.M. dockyards, Chatham; through Bellis & Morcom (Ltd.), for their Ledsam-street works; for Ealing electricity works, combined exhaust steam heater, softener and condensation water purifier.

At the meeting of Brighton Corporation last week the recommendation of the Lighting committee (set out in our last issue) to accept the tender of Siemens Brothers & Co. for supplying and laying three-core high tension and other cables from Southwick electricity works to North-road sub-station at £39,420 was adopted.

Fulham (London) Council have accepted the tender of the British Thomson-Houston Co. for 100 3-ampere, 100 5-ampere, 75 10-ampere, 10 50-ampere and 5 100-ampere induction wattmeters at £491.

Fulham (London) Council have also accepted the tender of Aiton & Co. for steam exhaust condenser pipes at £624, and that of Windsor & Co. for excavation and concrete work for a 750kw. turbine alternator at £133. 2s. 6d.

Chester Town Council have placed an order with the Sunbeam Lamp Co. for 4,000 incandescent electric lamps at £141. 13s. 4d., and with the Lancashire Dynamo & Motor Co. for a 4 H.P. electric motor at £48. 9s.

On the recommendation of the Education committee, the London County Council have accepted the tender of the Electric Supply Co. for a 15 H.P. electric motor at the Culloden-street School, Poplar, at £112. 15s.

London County Council have also accepted the tender of C. & A. Musker for electric tip cranes and locomotives for the Greenwich generating station at £4,108, and overhead travelling cranes at £1,192.

Loughborough Town Council have accepted the tender of E. Green & Son for an economiser at £402. 10s., and that of T. Sugden (Ltd.) for two superheaters at £283.

Hampstead (London) Borough Council have accepted the tender of the St. Helens Cable Co. for 12 months' supply of cable. There were seven tenders, and the lowest was accepted.

Edwards & Armstrong have obtained the contract for the supply and erection of the generating plant, mains, &c., for Topsham electricity scheme.

D. Firth & Son have obtained the contract for the electric lighting installation at Macclesfield Asylum.

Wigan Electric Light and Tramways committee have accepted the tender of Johnson and Phillips for cables.

City of Birmingham Tramways Co. have placed with the Diesel Engine Co. a repeat order for two Diesel engines each of 160 B.H.P.

Buxton Council have accepted the tender of Callender's Co. for electric lighting cable.

Heckmondwike Council have placed an order for cable with W. T. Henley's Telegraph Works Co.

Radcliffe Council have accepted the tender of Etheridge and Clark for the construction of the permanent way of the tramways.

BUSINESS NOTICES.

Messrs. Harris, Lee & Co., electrical engineers, Johannesburg, have removed their London offices from 14, Upper Thames-street, to 165, Queen Victoria-street. We are informed that during Mr. Harris's recent visit home, the firm secured the sole agency for the whole of British South Africa for Messrs. Crompton & Co. A well-

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selected stock of plant and material is held by the firm in South Africa on behalf of the manufacturers they represent. These agencies include (among others) the St. Helens Cable Co., the Electric & Ordnance Accessories Co., Evershed & Vignoles, Zurich Incandescence Lamp Co., the A.P.B. Accumulator Co., &c., &c.

Messrs. J. H. Coleman & Thos. Groves, electrical and general engineers, 9, Tavistock-street, Leamington Spa, have dissolved partnership.

The works of the Electric Construction Co. at Wolverhampton will be closed from July 30 to Aug. 6 inclusive, a small staff being retained to deal with urgent correspondence.

The Zurich Incandescence Lamp Co.'s works, including the dispatch department, will be closed from noon July 30 until Aug. 8.

BANKRUPTCIES, LIQUIDATIONS, &c.

A receiving order has been made against Harold Powell, electrical engineer, formerly of Strand-arcade, Derby. The first meeting of creditors will take place on Aug. 3, at 47, Full street, Derby, and the public examination on Aug. 9, at the Court House, St. Peter's-churchyard, Derby.

A meeting of the Doe Portable Electric Light and Power Syndicate, Ltd., will be held on Aug. 30, at 122, Cannon-street, London, E.C., to receive an account of the winding-up.

The estates of H. J. Robertson and J. M. Carr (trading as J. Pearce & Co.), electrical engineers, Glasgow, have been sequestrated.

A meeting will be held at Hamilton House, Bishopsgate-street Without, London, E.C., on Aug. 26, at 11 o'clock, to receive an account of the winding-up of the Electric Magnetic Traction Co. (Ltd.)

A winding-up order has been made against Shippey Bros. (Ltd.). 13-14, King-street, Cheapside, London, E.C.

Water Power, &c., for Sale by Treaty.—Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., have for sale by private treaty the works, roads, lands and water power owned by the Royal Ballincollig Gunpowder Factories, which it has been decided to close. The waters of the River Lee give a reliable 400 H.P. continuously. Some further particulars will be found in an advertisement on another page.

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 30, Birley-street, Blackpool.

Two Westminster dynamos, direct coupled to two Robey engines, and two 16 N.H.P. boilers are for sale by R. H. Longbotham & Co. (Ltd.), Wakefield. See advertisement.

A complete secondhand electric lighting plant, suitable for an installation of 200 lamps (14 H.P. Crossley gas engine, 70-ampere dynamo, switchboard, &c.), is advertised in another column. Full particulars from Mr. W. P. Adams, M.I.E.E., 35, Queen Victoria-street, London, E.C.

An 800kw. direct-current dynamo (new and by first-class maker) is offered for sale in another column. A similar machine can be inspected in operation.

Business Premises for Sale.—Some freehold business premises, close to Finsbury Park station, London, N., and suitable for factory, &c., are advertised in another column. Particulars from Messrs. Emmet & Co., solicitors, 14, Bloomsbury-square, London, W.C.

Catalogues, &c.—Messrs. W. T. Glover & Co., of Trafford Park, Manchester, have ready a revised catalogue of electric wires and cables, which, in addition to a complete description of the well-known vulcanised rubber cables supplied by the firm, introduces several new features, notably the classification of the various types of "Diatrine" paper lead covered cables for lighting and power mains for either low or high voltages. We have recently described in these columns the hydraulic pressure method of testing patented by Messrs. W. T. Glover & Co., and which, as our readers are aware, the company claims to be obviously more effective than the usual 24-hour water-immersion test. Descriptions are given in the catalogue also of the following special types of cables: "Diatrine paper leadless" cables for underground mains and mining work, "Bitumen insulated" cables for solid systems, "Leather-sheathed" cables for rough usage and "Fire-resisting" cables for switchboard connections for train, theatre and ship lighting, &c. A comprehensive foredge index is provided, enabling those consulting the catalogue to speedily turn to any special subject matter required. The tabulated particulars are full, and the illustrations of the various types of special cables, printed in colours, show at a glance the materials of which they are composed.

We referred last week to the new catalogue (section 3) of electric lighting accessories, switches and fuse boards, switchboards and wiremen's sundries issued by the Edison and Swan Co. This section of the main catalogue comprises 68 large 4to pages crowded with illustrations and particulars of the varied electric lighting accessories manufactured and supplied by the company. Numerous designs of H.V. lampholders (both bayonet and screw patterns) are shown. Some of these are specially designed for high candle-power lamps and for watertight fittings. Counterweights, ceiling roses, wall sockets are listed in variety, and the well-known Ediswan flush stage-floor socket now in general use is illustrated. Various designs of "Tumler" switches and a large assortment of cutouts, fuse boards, distribution boards, casings, &c., find a conspicuous place in the list. There are some good examples shown of Ediswan switchboards, including the board supplied to Wyndham's theatre and a board designed for country house lighting, built of red marble. The list is well arranged, and justice has been done to the illustrations by the printer.

Particulars are given in the "Progress Sheet" issued by the General Electric Co. for July of a new pattern switch and cutout board. The fuse terminals are each mounted on separate china slabs. The boards are intended for circuits up to 250 volts. Some easily adjusted brackets and shelf clips for electric light fittings are also illustrated, as is a new form of protected wall plug. A new insulating varnish called "Voltalac" is listed. This material is said to be specially suitable for use on armature coils of railway motors.

Messrs. Ferranti Limited have ready catalogue sheets Nos. 1, 2 and 3, giving prices and descriptions respectively of reverse-current relays for continuous-current circuits, moving-coil instruments and shunts for moving-coil ammeters.

"Mechanical Draught for Boilers" is the subject of a Paper read by Mr. W. Yates at the recent summer meeting at Liverpool of the Institution of Heating and Ventilating Engineers. We have to acknowledge receipt of a copy of the Paper.

Particulars of the cable equipment in connection with the North-Eastern Railway electrification scheme are issued in pamphlet form by Messrs. Siemens Brothers & Co.

"One Million Horse-Power" is the title of a pamphlet just issued by the British Westinghouse Co., containing a partial list of Westinghouse power installations in the British Empire.

Mordey's patent fuses are illustrated in a sheet sent out by Messrs. Ernest F. Moy (Ltd.), Camden Town, London, N.W.

A new list of "Perfecta" resistance apparatus is issued by Messrs. Monté Callow & Co., 6, Ludgate-broadway, London, E.C.

Messrs. W. H. Bailey & Co., Salford, Manchester, have a new catalogue ready of "Full Bore" Reducing Valves, &c.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from July 20 to 26, with the ports of destination:—

***Africa*—Alexandria, £199; Cape Town, £152; Durban, £414; East London, £14; Port Elizabeth, £210. *Argentina*—Buenos Ayres, £3,095. *Australasia*—Auckland, £390; Lyttelton, £479 (including £180 telegraph cable); Melbourne, £64; Perth, £111; Sydney, £1,634 (including £40 telegraph material). *Belgium*—Ghent, £10. *Brazil*—Rio Grande, £277 (telegraph material); Rio Janeiro, £91 (including £57 telegraph apparatus). *Burma*—Rangoon, £17. *Canada*—Montreal, £40; Toronto, £1,083; Vancouver, £6,100 (submarine cable). *Ceylon*—Colombo, £98 (telegraph material). *Channel Islands*, £78. *China*—Shanghai, £115 (including £25 telegraph cable). *Denmark*—Copenhagen, £86. *Germany*—Hamburg, £528. *Holland*—Amsterdam, £25. *Hong Kong*, £75. *India*—Bombay, £190; Calcutta, £2,565 (including £240 telegraph material); Madras, £1,446 (including £43 telegraph material). *Japan*—Tokyo, £2,090; Yokohama, £222. *Mauritius*, £93. *Russia*—St. Petersburg, £752 (including £200 telegraph cables). *Spain*—San Sebastian, £13). *Straits Settlements*—Penang, £468; Singapore, £25. Total £23,249, against £6,827 in the corresponding week last year (July 22 to 28).**

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

May 2, 1904.

10,055 CALLENDER'S CABLE AND CONSTRUCTION CO. and J. C. A. WARD. Supports for electric conductors especially suitable for use in mines.

10,058 GENERAL CONTRACTS CO., E. S. COOK and W. H. CHIPPERFIELD. Switches*.

10,070 L. F. BOGIA, jun. Regulating sockets for electric lighting, heating or power purposes.

10,073 S. G. BROWN. Telegraphy.

10,079 W. D. KILROY. Electrical system of training searchlights.

10,080 A. E. TANNER. Distribution of electrical energy over large subdivided area.

10,081 R. F. VENNER. Electricity meters.

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May 3, 1904.

10,119 C. C. Regnart. Adapting electric candles to sconces.
10,133 C. J. Mayhew. Southsea. Sparking plugs for internal combustion engines.
10,142 P. A. McGeorge. Electrical conductors.*
10,147 J. Sayers. Derbyshire. Automatic electric brake on electric cars operated from an outside source.
10,171 R. A. Müller. Liverpool. Regulating the secondary current produced by direct-current converters.*
10,172 B. Imray (Bullock Electric Mfg. Co., U.S.). Dynamo electric machines.*
10,173 W. H. Warren and C. E. Hunter. A combined switch and plug connector.*
10,182 C. H. Merz and A. H. Marshall. Conveying current to electric vehicles on railways.
10,183 C. H. Merz and A. H. Marshall. Current collecting apparatus and overhead frogs for use with electric tramway and railway vehicles.
10,189 E. R. Waterman. Heating liquids by electrical current.*

May 4, 1904.

10,200 A. J. Beaumont. York. Switch lamp holders.
10,210 S. G. Bennett. Wolverhampton. Electric traction on a shallow conduit system.
10,229 J. S. Bailey. Derby. Life-guard or saving car for electric locomotive.
10,242 B.T.-H. Co. (G.E. Co., U.S.). High-tension switches.
10,243, 10,244, 10,245, 10,246, 10,247, 10,248, 10,249, 10,250 and 10,341 E. A. Carolan (G.E. Co., U.S.). Vapour electric apparatus.
10,276 T. Silvene. Electric block signal systems.*

May 5, 1904.

10,308 J. Haydock and T. S. Jones. Halifax. Supporting and connecting trolley wires of overhead electric systems.
10,345 S. Z. de Ferranti. Balancing devices for high-speed motors.
10,356 E. B. Phillips and T. C. Parkin. Construction of mounting of trolley-arms for collecting energy from overhead cables.
10,370 A. J. Boult (C. Potter, U.S.). Storage battery plates.*
10,391 F. Neugebauer. Electrical time cutouts for controlling railway barriers and the like.*
10,393 H. J. W. Schwedler. Electro-medical apparatus.*

May 6, 1904.

10,429 W. McAuslane. Liverpool. Incandescent lamps.
10,430 A. Whalley and E. A. Bayles. Chester. Cables.*
10,448 S. H. Halford, E. Shouls and S. Bridgwater. Electric ignition coils and the like.
10,455 J. Struthers. Elevated structures for communication by railway, tram, or other means in cities; for the distribution therein of electricity, power, heating, lighting, cooling and the like, the transport of goods, and for communicating by wire.
10,456 and 10,460 B.T.-H. Co. (G.E. Co., U.S.). Switches.
10,457 and 10,458 B.T.-H. Co. (G.E. Co.,U.S.). Alternating-current motors.
10,459 B.T.-H. Co. (G.E. Co., U.S.). Electric control systems.
10,461 B.T.-H. Co. (G.E. Co., U.S.). Multiple switch rheostats.
10,463 and 10,493 H. H. Lake (Submarine Signal Co., U.S.). Producing sound vibrations in water.*
10,477 H. H. Lake Submarine Signal Co., U.S.). Apparatus for receiving submarine signals.*
10,488 I. B. Birnbaum and F. G. Bell. Earthing devices applicable to lightning arresters and the like.
10,492 D. K. M. K. Edgcumbe and E. I. Everett. Electrical measuring instruments.
10,495 H. H. Lake (Submarine Signal Co.. U.S.). Method of finding the direction of sound.*

May 7, 1904.

10,502 R. C. Griesbach. Birmingham. Prepayment electricity meters.
10,503 W. A. Entwistle. Yorks. Trolley wheel spindles for electric cars.
10,511 W. Heap and W. A. Barnes. Manchester. Commutator brush holders.
10,525 J. Maclean. Glasgow. Driving gear for electric rotary brushes.
10,551 F. Krizik. Arrangement of motors on electric vehicles.
10,559 Siemens Brothers & Co. (Ltd.) and W. F. Eichenaner. Galvanic batteries.
10,560 R. H. Davis. Lamps for use in submarine operations.
10,575 E. J. Steljes. Type-printing telegraphs.

May 9, 1904.

10,598 E. E. Kelsey. Lingfield. Conductors and rails of electric railways.
10,608 R. Kennedy. Leeds. Dynamo-electric machinery.
10,623 H. W. Nichols. Automatic trolley controlling device.*
10,646 A. J. Boult (J. B. Entz, U.S.). Controlling or regulating means for electric apparatus.*
10,647 C. de Kandó. Bearings for motors of electric vehicles.*
10,648 C. de Kandó. Electric motor systems.*
10,656 W. Fellenberg. Enclosed fuses for electric installations.
10,662 C. H. Merz and A. H. Marshall. Supply of current to electric vehicles on railways.
10,667 P. M. Justice (S. J. Morse, U.S.). Actuating mechanism for secondary electric clocks and other intermittently electrically impelled apparatus.
10,672 F. W. Le Tall (Cooper-Hewitt Electric Co., U.S.). Gas or vapour electric apparatus.
10,688 J. Bohm. Device for grinding commutators.*
10,691 W. J. Roussell and A. King. Electrically operated typewriters.*

May 10, 1904.

4,556A S. Z. de Ferranti. Balancing devices for high-speed motors. (Date applied for, Feb. 24, 1904.)
10,709 W. B. Stockigt. Germany. Dry cells.*
10,722 L. Andrews. Manchester. Reverse current electric circuit breakers.
10,723 L. Andrews. Manchester. Reverse current relays for electric circuit breakers.
10,727 G. Kirk. Glasgow. Electrically-operated travelling perforating machine.
10,748 C. A. Vandevell and W. H. W. Proctor. Coventry. Dynamos or the like.
10,755 A. R. Bankart. Portsmouth. Electrical bacteriological incubator.
10,770 G. A. Nussbaum. Microphones.
10,794 H. S. Blackmore and E. A. Byrnes. Electrolytic apparatus.*
10,800 A. F. Berry. Transformers.
10,811 W. P. Thompson (A. C. Stewart, U.S.) Liverpool. Sparking or igniting devices for combustion engines.*
10,812 T. Blaney. Liverpool. Overhead trolleys for electric vehicles.
10,818 G. D. Barilf. Winding clocks automatically by an electric motor.*

May 11, 1904.

10,836 J. H. Henderson and C. N. Higgin. Manchester. Registering apparatus for electricity meters.
10,837 F. Render. Manchester. Fuse leads for electric blasting.
10,839 S. E. Fedden and W. J. Howard. Sheffield. Protecting electric circuits and apparatus.
10,840 F. Wagstaffe and S. R. Cameron. Manchester. Life-guard for electric vehicles.
10,858 L. Cerebotani and A. Silbermann. Receiving apparatus for wireless telegraphy.*
10,873 A. Voelker. Manufacture of electric incandescent bodies.
10,878 B.T.-H. Co. (G.E. Co., U.S.). Protecting alternating current apparatus.
10,879 B.T.-H. Co. (G.E. Co., U.S.). Oil switches.
10,881 E. A. Carolan (G.E. Co., U.S.). Conducting chemical reactions.
10,882 B.T.-H. Co. and T. Holden. Electricity meters.
10,896 J. Y. Johnson (A.E.G. vorm. W. Lahmeyer & Co., Germany). Electric installations.*
10,906 B. Lichtenfels, sen. Electrically stopping railway trains.*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

4,681 Hanson. Cables and jointing same.
4,682 Hanson. Telephonic exchange apparatus.
9,231 Brown. Telegraphy.
9,531 A. Round and W. Round (Exors. of the late B. J. Round and Round). Electro-depositing metals on parabolic reflectors, &c.
11,525 Mamy. Extra-highly vibrating electric contact breaker.
11,529 Lake (General Incandescent Arc Light Co.). Rheostats.
11,515 Timm. Telegraphic punching and perforating machines.
11,739 Lake (Sem). Coin-freed telephone apparatus.
11,765 Bill. Fusible electric cut-outs.
12,091 Harrington. Enabling shades on bayonet-pointed lampholders to be easily removed.
12,174 Lake (Cantono). Trolleys for overhead systems.
12,218 Parshall and Parry. Electric signalling for railways.
12,301 Ewart. Arc lamps.
12,312 Carolan (G.E. Co., U.S.). Materials for insulating purposes.
12,314 Carolan (G.E. Co., U.S.). Electric motor-control system and switches therefor.
12,315 Carolan (G.E. Co., U.S.). Electric motor control systems.
12,379 Hawthorn. Electric fire alarms and thermo-indicators.
12,408 Parsons and Stoney. Dynamo electric machines.
12,618 Hewer. Collecting current from slotted conduit for working tramcars.
12,651 Stanley. Grooving and cutting apparatus for use in manufacture of earthenware cable conduits.
12,706 Bowley. Flexible metallic tubing.
12,745 Morrison and Maclachlan. Switch for electric hoists.
12,838 Carolan (G.E. Co., U.S.). Electric heaters.
12,839 Carolan (G.E. Co., U.S.). Controllers for electric motors.
12,956 Carolan (G.E. Co., U.S.). Switches for arc lamp circuits.
13,182 Croucher. Electro-deposition of metals upon aluminium, alloys of aluminium and other metals.
13,278 Werner and Olsen. Electric alarm and controlling apparatus.
14,167 Le Tall (Cooper Hewitt Electric Co.). Systems of electrical distribution.
14,476 Davies. Arc lamps.
14,597 Carolan (G.E. Co., U.S.). Machines for making bases for electric lamps.
14,958 Hosking (Hosking). Combined tellurion and lunarium or seleutrope
15,592 Carolan (G.E. Co., U.S.). Synchronising dynamo electric machines.
15,700 Imray (Farbwerk vorm. Meister Lucius & Brüning). Reducing organic substances in electrolytic bath.
15,811 Lancashire Dynamo & Motor Co. and McLeod. Dynamo electric machines for regulating charge and discharge of storage batteries used in combination with main generators.
16,159 Cooper. Electric measuring.
16,454 Reinach Preece and Scott. Electrical mechanism for indicating approaching failure of weft in looms for weaving.
16,511 Scott. Electric hoist controllers.
16,740 Carolan (G.E. Co., U.S.). Time limit devices.
16,741 Carolan (G.E. Co., U.S.). Arc lamps.
16,742 Carolan (G.E. Co., U.S.). Switches.
16,744 Carolan (G.E. Co., U.S.). Controlling switches and cutouts.
17,001 Mills (Pocheron & Cellery). Automatic stopping apparatus for lace and net machines.

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17,246 CAROLAN (G.E. Co., U.S.). End play devices for rotary shafts.
17,630 BULLERS LIMITED and CHAMBERS. Socket joints of metallic telegraph and like poles.
18,550 MACLEAN. Commutator for dynamos and electric motors.
18,593 SPAGNOLETTI. Automatic electro-mechanical cutout.
19,200 LAMBELLE. Lifeguard for electric tramcars.
20,907 JONES. Telegraph systems.
21,194 BATTAGLIA-GUERRIERI. Transmitting printing telegraph messages over long lines and apparatus therefor.
23,664 SIEMENS BROTHERS & Co. (Siemens & Halske A.G.). Starting and braking electromotors.
23,851 STOTHERT & PITT and PITT. Electric cranes.
23,862 VON KÖHLER. Electric log recording and like apparatus.
26,775 ABEL (Siemens & Halske A.G.). Manufacture of homogeneous masses of tantalum and like difficultly fusible metals.
26,776 ABEL (Siemens & Halske A.G.). Manufacture of incandescent bodies for glow lamps.
27,044A HARDINGHAM (Electric Boat Co.). Storage batteries. (Date applied for, Dec. 10, 1903.)
27,921 OTIS ELEVATOR Co. (Otis Elevator Co.). Automatic control of electric motors.

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833 REDMON HALL CONWAY and SMITH. Telephone systems.
1,676 BLONDEL. Processes for manufacturing electrodes for arc lamps. (Date applied for, Feb 5, 1903.)
2,035 ROYCE & CLAREMONT. Safety device for preventing reversal of boosters or generators.
2,457 WRIGHT and ACLY. Switches. (Date applied for, Jan. 31, 1903.)

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Ltd.)

The sixty-fourth half-yearly meeting took place on Friday last under the presidency of Sir JOHN WOLFE BARRY, K.C.B.

The SECRETARY (Mr. A. R. Hardie) read the notice convening the meeting, and the report of the auditors.

The CHAIRMAN then said: Gentlemen, the gross revenue for the half-year under review amounted to £635,884, as against, for the corresponding period (March 31, 1903), £626,750, or an increase of £9,134. The revenue for the current half-year, however, includes an amount of £15,440 for interest on investments in respect of reserve funds which was credited to the reserve fund at March, 1903. The reason for this alteration was explained at the last general meeting, and was fully approved by the stockholders. I, this is deducted the gross revenue for the present half-year shows a decrease of £6,306 compared with that of the half-year ended March 31, 1903. The receipts from the traffic with South Africa show a considerable decrease as well as those from traffic with China, Japan and the Philippines. The diminution of the receipts from the latter source is mainly due to the important reduction of rates which came into force in July last year, and also to the fact that the new American Pacific Cable Co. is carrying the bulk of the American traffic with these places. The European traffic continues to pass exclusively by the Associated Companies' routes. The Indian traffic shows an increase, and the traffic with Egypt also shows a considerable improvement, but the latter will probably be of a temporary nature, as up to the date of these accounts the increase was to a large extent due to the prolonged cotton crisis. The total expenses for the half-year, exclusive of income tax payable in England, show an increase of £17,763 when compared with the corresponding period of 1903. There was an increase of 68 in the number of the staff at our stations in England and abroad, and during the period to March 31, 1904, our staff had to deal with about 1,000,000 more words than in 1903.] This increase in the volume of traffic has been due to a general development of business, the exceptional conditions caused by warlike expeditions, and the cotton crisis, &c., and also to the important reductions in the rates which have been brought into force from time to time during recent years. The result of these reductions so far has been that we have had more work to do, while the gross revenue from messages during the year under review has been rather less than it was a year ago. The item maintenance of instruments shows the substantial decrease of £2,627. The increase under the heading of "Maintenance of Cables" is the result of this account only having received a credit of £16,293 from other companies and accounts for repairs to, and renewals of, cables during the current half-year, as against £60,364 credited for the half-year to March, 1903, or a reduction on this account of £14,071. As a set-off against this, however, the value of cable used and sundry expenses at stations on account of maintenance of cables show a decrease of £8,401.

The result of the half-year's working is that, after providing the usual amounts for interest on debenture and preference stocks, we are able to recommend the usual final dividend of 1½ per cent. and a bonus of 2 per cent., making, with the interim dividends already paid, a total distribution of 7 per cent. for the year ended March 31, 1904, and carry the sum of £170,000 to the general reserve fund, against £180,000 in the corresponding period of 1903. We have also, in pursuance of an arrangement which has been fully explained at former meetings, repaid £100,000 to the Eastern & South African Co. on account of the loan made to us by that company in order to enable us to meet certain extraordinary expenditure in connection with the cables forming the new route to South Africa and Australia. We have also applied a similar sum from the general reserve fund in reduction of the cost of these cables, &c., the balance of the suspense account being £563,078. We have also applied from reserve fund the sum of £135,859 on account of the partial renewal of the original Aden-Bombay cable laid in 1870, and £23,206 on account of the partial renewal of the Suakim-Perim No. 2 cable, &c., laid in 1876. You will find, however, that, notwithstanding the credit of £170,000 received from the revenue account during the present half-year, the balance of this fund has been reduced to the extent of over £90,000. As the renewal of our older cables will probably become more frequent in future, it is very necessary to make as large appropriations to the general reserve fund as possible.

Our old steamship "Chiltern" has been sold out of the service and, we believe, has since been broken up. She was built in 1866 and acquired by the British Indian Telegraph Co. in 1870 and taken over from that company at the amalgamation in 1872. During these 34 years she has carried out a very great number of repairs and has proved a most valuable ship for the work she had to do. We were sorry to be obliged at last to come to the conclusion that it was necessary to put her out of commission. You will see that we have reduced the maintenance ships' fund by a sum of £31,800, being the difference between the cost and the amount realised by the sale. It has been our custom to build up the maintenance ships' reserve fund against the depreciation of our vessels as we retain the vessels on our books at cost, so that in case of a sale it is necessary to write down that fund in this way. Included in the capital expenditure this half-year is the cost of a small cable-repairing vessel suitable for work in comparatively shallow water. It is anticipated that a saving will be effected by using a vessel of this type for certain minor repairs instead of in every case employing the Company's larger and more expensive ships. The successful employment of vessels of this type, however, is only possible with an organisation such as ours, when they can be utilised in conjunction with the vessels of our cable repairing fleet, which can carry out repairs and renewals successfully in any depth of water. You will no doubt remember the question was raised at one of our meetings as to the depreciation of our reserve fund securities, and I am sorry to say that the depreciation is still further increased notwithstanding the very high class of security generally which forms our reserve fund investments. It is fortunate that, so far as we know at present, it will not be necessary to realise any of these securities, and we trust that when the time comes to do so their market value will have considerably improved. You will see that there is no subject of special importance beyond the review of the figures in the accounts. As my remarks on the accounts must necessarily more or less resemble all previous statements, I am afraid you may begin to regard them as somewhat monotonous, but so long as the statement I have to make is as satisfactory as the present one, I trust it will be regarded by the stockholders as some compensation for its similarity to all former reviews of the financial aspect of the Company, more especially as the dividend and bonus continue at the uniform rate of 7 per cent. per annum.

Although I do not propose to say anything with regard to the old question of the Government Pacific Cable competition, the grievance still remains and continues to adversely affect our revenue. I have nothing new to add to what I have said on several former occasions, both at these meetings and at the meetings of the Eastern Extension Company, which company is more seriously affected than this Company. We are, meeting this unfair Government competition by the best means available—viz., by consistently continuing our old policy of constantly endeavouring to improve the speed and accuracy of our service by the application of the latest form of apparatus and by granting additional facilities to the telegraphing public, with due regard to the interests of our stockholders. A policy of this kind must necessarily tend to increase expenses, but we are perfectly satisfied that this is a sound policy calculated to maintain our present revenues, and, I hope also, to augment them in the future. With regard to another question which is always more or less before us, viz., "Wireless Telegraphy," you will, no doubt, have seen that the De Forest system of wireless telegraphy has been successful in carrying war correspondents' messages from ship to shore during the present Russo-Japanese war. While holding the view that wireless telegraphy will not compete with long-distance submarine telegraphy, there are certain places where wireless telegraphy can be usefully employed. We have a case in point in the Azores where the cables of some of the Associated Companies touch. It is desired by Portugal that some of the outlying islands should be placed in telegraphic communication. Owing to the nature of the bottom and the landing places of these islands, it is not considered a suitable place to make the connection by cable, neither would the traffic warrant an expenditure on this account. We therefore intend to connect the points by a system of wireless telegraphy, to be worked in connection with our cable system. I have nothing further to add, but shall be pleased to answer any questions.

There being no questions asked, the Chairman then moved—

"*That the printed report and accounts of the Directors to March* 31, 1904, *submitted to this meeting be and the same are hereby received and adopted; that the dividend to be paid on the preference stock of the Company to June* 30, 1904, *at the rate of* 3½ *per cent. per annum, less income tax, be approved; and that, in accordance with the Directors' recommendation, a dividend be and is now declared of* 1½ *per cent., with a bonus of* 2 *per cent., both free of income tax, on the ordinary stock of the Company, making, with previous payments by way of dividend on account, a total payment of* 7 *per cent. on that stock for the year ended March* 31, 1904."

Sir J. DENISON-PENDER, K.C.M.G., seconded the motion, which was carried unanimously.

Mr. JOHN NEWTON moved a vote of thanks to the Chairman and Directors, and said: You do not give us a very glowing account of our position, but it is encouraging as far as it goes. I think our only trouble is really the Government competition, and I think they have had enough of that. I therefore hope our future is now ensured.

The resolution was seconded and carried unanimously, and the CHAIRMAN having briefly replied, the proceedings terminated.

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Direct United States Cable Co. (Ltd.)

The fifty-fourth ordinary general meeting was held on Tuesday, under the presidency of Mr. E. M. Underdown, K.C.

The GENERAL MANAGER and SECRETARY (Mr. T. Finnis) having read the notice calling the meeting,

The CHAIRMAN said: The revenue for the six months to June 30, after deducting outpayments, amounted to £43,121, while working and other expenses, including income tax, but exclusive of cost of cable repairs, absorbed £21,185, leaving a balance of £21,936 as net profit, making, with £2,479 brought forward from the previous half-year and £1,966 compensation received on surrender of lease of premises at New York, a total of £26,381, which has been appropriated as follows:—Interim dividend of 3s. per share to March 31, £9,106. 10s.; proposed final dividend of 3s. per share to June 30, £9,106. 10s.; transferred to reserve fund account, £6,000; and balance proposed to be carried forward, £2,168, making the before-mentioned total of £26,381. Now, gentlemen, we should have been glad to lay before you a larger figure in respect of receipts for the past half-year, but, as all business men know, business has been very slack, and continues to be somewhat slack at the present. We must, therefore, suffer—as all other companies have to do—a general diminution in earnings. The working expenses in London are the same within £50 as in 1903. The working expenses at the stations show very little change. Less has been spent on repairs and renewals to buildings, and the stations outlay, on the whole, shows a decrease of £222. In the remaining items of ordinary expenditure there are reductions of £171 in directors' remuneration and of £160 (which we regret) in income tax, making the half-year's expenditure in the aggregate £538 less than in the corresponding period of last year. The reserve fund account has, as you know, according to our usual plan, been credited with the interest on the investments, £7,583, and with £6,000 transferred from revenue. On the other hand, it has been debited with £11,725 for cable repairs, and the balance now amounts to £463,953. I should say that we have not been so fortunate as usual—as in some past years—in securing a very long period of freedom from any interruption of our cables. We have had interruptions, which, however, we have dealt with successfully and expeditiously. We have had the advantage of securing the assistance of a ship on the other side of the Atlantic upon economical terms, and the result is that, notwithstanding that we have had some rather serious repairs, the reserve has not been affected to a greater extent than about £10,700 during the year, which is so far gratifying. As you know, the income from the reserve fund in respect of interest, &c., is not carried to our general revenue account, but it remains as a guarantee and a guard against any unforeseen occurrences, although we hope that we shall not be troubled in this way, and you see that we are well able to deal with any temporary interruptions. The reserve fund account stands at an amount which is very satisfactory, and places us in a very firm position. The investments have been increased during the past half-year by £11,000, and they now stand at cost at £449,426. Their present market value, notwithstanding the continued depression in prices, is very slightly under cost. The whole results of the financial year are as follows:—Receipts £92,902, less expenses and other ordinary payments £43,002, leaving a balance of £49,900. We have paid in dividends £36,426 and placed to reserve £14,000, making together £50,426, less reduced balance in hand, as compared with June, 1903, £526, leaving, as I just said, £49,900. I have informed you that the reserve fund has been reduced on balance by £10,712, which is made up by charging the cost of the year's repairs to it £41,903, less receipts from interest, &c., £17,191, and the figure I mentioned before of £14,000 transferred from revenue, That leaves the diminution of £10,712 to which I have alluded. I am happy to inform you that our cables are in perfectly good condition and working to our entire satisfaction. There is a paragraph in the report of the Anglo-American Telegraph Co. which I will read to you. It is as follows:—"A scheme of pensions for employés of the company, in lieu of the present system of endowment assurance, has been prepared by the directors, and will be submitted to the stockholders for their approval"—that is to the meeting of that company which will be held on Friday. With respect to this, I should say that we have not lost sight of that system, which has been adopted by nearly all the cable companies; and we have studied it. There are circumstances, however, with respect to this Company which place it in a somewhat different position from the other companies; but we shall continue to study the question, and if or when any plan of the kind is resolved upon we shall place it before you for your approval. I now move the adoption of the report and accounts.

Sir JAMES PENDER, Bart., seconded the motion, which was carried unanimously, and resolutions were afterwards passed re-electing the retiring directors, the Hon. Thomas H. A. E. Cochrane, M.P., and Mr. John Varley, and the auditors, Messrs. Deloitte, Dever, Griffiths & Co. and Messrs. J. and J. Sawyer & Co.

A vote of thanks to the chairman and directors brought the proceedings to a close.

City & South London Railway Co.

The fortieth ordinary general meeting was held yesterday, Mr. Charles Grey Mott presiding.

The SECRETARY (Mr. W. F. Knight) read the notice convening the meeting.

The CHAIRMAN then said: I am sorry we have to meet you with a slightly reduced dividend, but, on the whole, we feel that the result of the half-year's working has been more favourable than at one time we feared would be the case. Considering that in the past six months we have had, during the entire period, to contend against the competition of the electric trams in the south of London, whereas in the corresponding period they were only running for four or five weeks; considering that during the latter part of the half-year the weather was exceptionally fine against unsettled weather last year; and considering also that we have to pay this half-year additional preference interest in connection with the money raised to pay off the final amount due for the site of St. Mary Woolnoth Church—considering all these things, we think that we may congratulate ourselves on being able to pay you a dividend at the rate of 2½ per cent. If you turn to the capital account you will see that we have issued during the half-year debenture stock amounting to £9,000, preference stock amounting to £4,325, and that we have received in premiums from the issue of these stocks £1,567, making a total receipt on capital account of £14,892. The expenditure, on the other side, has been £3,484, and therefore we have been able to reduce the debit balance on capital account from £33,991 to £22,584, a reduction of £11,489. Now, as to the revenue receipts. You will see that there is a decrease in the number of passengers carried, exclusive of season ticket holders, of 284,463, and a decrease in the money taken of £3,802, a decrease in the transfer fees of £43, and a decrease in the sundry receipts of £53, making a total decrease of £3,898. On the other hand, we have received from season tickets an increased sum of £1,804, from parcels an increase of £12, and from rents an increase of £515. I am happy to say that the rents keep steadily increasing, and I hope that that will continue. We are letting gradually more and more of the property which we have. The net result of these figures is a net decrease in the receipts of £1,567. Then we have a decrease in the expenditure of £1,350, made up as follows:—A decrease in the locomotive and generating department of £310, in carriage repairs of £346, in traffic expenses of £308, in general charges of £111, in passenger duty £66, in law charges £45, and in rates and taxes £254. There is an increase in maintenance of £30, which leaves a net decrease in the expenditure of £1,350. Deducting this amount from the traffic receipts, the net revenue shows a reduced balance of £217 only. Practically, therefore, we have a net revenue of the same amount as for the same period of last year. But we have, of course, to pay increased debenture stock interest of £346, and we have a decrease in the receipts from interest. This time last year we had considerable amounts on deposit in connection with capital expenditure, but this year we have not that money on deposit, and the interest shows a diminution of £237 for the half-year. Then, at the beginning of the corresponding half-year we brought forward a much larger balance from the previous six months than we did last January, and therefore we are short by that difference—a sum of £522—the result being that there is a smaller amount for dividend by £1,322. The preference stock dividend this time takes £1,140 more, so that the sum available for the ordinary dividend is less by £2,400, which is more than ¼ per cent. However, we brought a large sum forward at this time last year, which we have reduced from £1,500 to £700, and with that we are enabled to pay the 2½ per cent. which we recommend to-day. With regard to the percentages, about which you like to know, I may tell you that the working expenses have been reduced from 46·37 last year to 45·6 this year, which is very satisfactory. It is a very low rate for working expenses when you bear in mind that it includes not only the operating of the railway but the expenses of working the lifts, which are very considerable. The expenses per train-mile are 1·29d., against 1·26d. last year, and the locomotive charges 4·59d. against 4·47d. These are very much the same. The traffic expenses are 6·5d. against 6·3d. last year. The receipts per passenger have diminished from 1·88d. last year to 1·85d. this year. It is a very small diminution, but the slightest diminution, when you are carrying millions of people, makes a difference in the receipts. There is a tendency towards an increase in penny fares. I may tell you at this point that our penny fares are now, as nearly as possible, one-half of our whole traffic. The receipts per train are 16s. 8d. against 16s. 1d. last year, and per train mile 2s. 7d. against 2s. 6·48d. That is satisfactory. We have reduced the number of trains this year, by careful management, and we have also reduced the train-mileage to some extent. The train-miles have been reduced from 620,000 last year to 589,000 this year, and the number of trains run from 101,000 to 96,000 this year. The result has been that the number of passengers per train has increased from 93·8 last year to 95·9 during the period under review. The number of passengers carried, as you will see by the latest returns, exclusive of season ticket holders, is 9,226,987, against 9,511,450 in the corresponding period of last year, but I do not think there is any actual material diminution in the number carried, because we have had a large increase in the season ticket holders. If you add the additional season ticket holders to the number of passengers I have given you, I think we may conclude that the total number of people travelling by our railway this past half-year has not materially differed from the number carried in the corresponding six months of 1903. With reference to the Euston extension, as I explained before to you, the negotiations connected with that extension have been very laborious and difficult to carry out, on account of the number of railway companies and public bodies we have had to agree with, as regards the plans for a connection with those railways, and the arrangements as to easements and other matters. I am glad to say that, owing to the excellent way in which the negotiations have been conducted, chiefly by the general manager—(Hear, hear)—a very satisfactory arrangement on the whole has been made. We have been fairly met by all the companies, and we are quite satisfied with the arrangement. There is only one not finally concluded, but we hope it will be before many days are over, and that then we shall be in a position to consider the question of acquiring the necessary property and commencing the construction of the extension. The Baker-street & Waterloo Railway is now making very rapid progress, and will before many months are over be open for traffic, I hope. We have made an agreement for an underground subway connection between the platforms of the two railways at the Elephant and Castle, and we expect that will be a very great advantage to both. The Great Northern and City Railway

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was opened in February last, and its traffic is slowly progressing. I now move the adoption of the report and accounts.

Mr. C. S. GRENFELL seconded the motion, which, after a brief discussion, was carried unanimouely, as was a motion approving the dividends.

An extraordinary meeting followed, at which the proposal of the directors that £300,000 (part of the authorised capital of the company) be created into £150,000 5 per cent. perpetual preference stock and £150,000 ordinary consolidated stock, and that the directors be authorised to issue this preference and ordinary stock as they may consider necessary, was approved. A further resolution authorising the directors to exercise the borrowing powers possessed by the company in the creation and issue of £100,000 4 per cent. debenture stock as occasion might require, was also carried unanimously.

A vote of thanks to the directors and officers of the company was carried unanimously, the Chairman remarking, in replying to the vote, that a great deal of the success of the company was due to their excellent officials, and especially to the general manager.

The proceedings then terminated.

National Telephone Co. (Ltd.)

The thirty-fourth ordinary general meeting was held on Friday last at Hamilton House, Victoria Embankment, London, E.C., and was presided over by Sir HENRY FOWLER, M.P.

The SECRETARY (Mr. Albert Anns) read the notice convening the meeting and the auditors' report.

The PRESIDENT then said: So far as the past half-year is concerned, as compared with previous June half-years, I think the directors and shareholders have every reason to congratulate themselves, seeing that it is a record half-year. The report for June half-year is in the nature of an interim report, as we cannot accurately review the whole position of the company except at the end of the financial year, and I did this at some considerable length in February. The working for the half-year just expired shows an income, in respect of the business of that half-year, of £984,600, compared with £894,583 for the correspoding period of 1903, an increase of £90,016. Working expenses amounted to £567,071, compared with £509,414, an increase of £57,657. The net result, after deducting Post Office royalties (£90,702), is a profit balance of £326,825, compared with £303,156 for the corresponding period last year—that is to say, the increase in net income, after some exceptional items of expenditure have been dealt with, is £23,668. Rentals carried forward for unexpired terms of running contracts amounted to £937,296, compared with £874,383, an increase of £62,913. The available balance for dividend is, therefore, £258,285. We propose to transfer £100,000 to reserve and to carry forward £9,369. Capital expenditure during the half-year has amounted to £394,654. I wish to remark as to these figures, that our capital account, which, as you know, has been increased during the half-year by the issue of £1,000,000 of debenture stock, is now fully paid up. Our expenses have increased all round in all the principal items, which is natural. Our rates have increased, insurance has been heavier, and naturally the increase in our business means an increase in the number of operators and in all other working expenses. I think I am right in saying that we have added to our staff nearly 1,000 new operators during the half-year. The increase in the number of our stations, perhaps one of the very best indices of progress made, has been a record one during the last half-year, amounting to no less than 19,615 stations, which is represented in the increased income to which I have called your attention. We have spent an unusually large sum this last half-year in maintenance and replacements, replacements being, as you know, a charge for a portion of a certain class of capital expenditure, of which one-third is fairly chargeable to revenue, an arrangement which we are very particular to carry out strictly. The number of our shareholders remains pretty stationary: last December we had 10,250, and to-day we have 10,355. And as an illustration of the large number of bloated capitalists who own capital in this company I may say that the average holding is £531; therefore we have a large constituency of shareholders holding, on an average, but a very small sum in the concern. Our debenture-stock holders have increased in number, owing to the new issue of debenture stock. Last December there were 3,400, and now they number 4,400.

Another feature of our business is that of unexecuted orders. I explained in February that these unexecuted orders are mainly due to our want of capital to execute them. Last year we had 9,232 people waiting to be connected to our service, but whose orders remained unexecuted; and this half-year, although we have put on the great bulk of that 9,000 odd, we still have 9,700 awaiting connection. This represents a rental, if it were earned, of over £53,000 a year. The number of telephone messages over our lines during the last year was 938,000,000, and the average receipt per message 0·41d., or less than ½d. I think, therefore, that I may congratulate the shareholders on a very good half-year.

There is one subject about which I must say a few words, and as to which I am in a position of some difficulty—I refer to the negotiations which are going on with the Postmaster-General. Under the company's licence the Postmaster-General, by giving us notice on or before June 30 last, was empowered to acquire compulsorily the company's undertaking as from Dec. 31, 1904, the purchase price, in case of difference, to be determined by arbitraton. This notice has not been given, and, consequently, the Postmaster-General's compulsory rights have ceased. But the Postmaster-General has indicated his desire to come to an arrangement with the company by agreement, and negotiations with this object are now in active progress. I need hardly tell the shareholders that they involve intricate investigations, and that many difficult questions have to be considered which cannot be determined hurriedly. I believe the Postmaster-General will credit the directors of the company with a desire to meet him in a fair spirit, and all I can say now is that I hope the negotiations will result in a satisfactory arrangement being arrived at which will enable this great public service to be adequately and properly developed, and which will, at the same time, be equitable and fair to our shareholders. Having said so much, I must ask you to have confidence in your directors, and to leave the negotiations in their hands. I now move the adoption of the report and accounts, and that the dividends therein set out be paid for the six months ended June 30, 1904.

Mr. GEORGE FRANKLIN seconded the motion.

Mr. H. HUGHES asked whether the charge of £100,000 for discount and commission in connection with the issue of the £1,000,000 debenture stock was not excessive.

The PRESIDENT said the stock was issued at 95 per £100 of debentures, and, looking at the state of the money market, the directors considered that was a satisfactory issue for a 4 per cent. debenture stock. It would certainly compare favourably with similar issues, and the directors were satisfied that they had made a good bargain.

Mr. LEA SMITH thought the shareholders ought to congratulate the board upon the grand report they had presented, considering the many difficulties they had had to face and the heavy royalty they had to pay to the Post Office. The public would recognise what a splendid undertaking theirs was, and they should also learn from their case the disadvantages of licensing in this country. He thought the public did not fully appreciate what they got for their money. The public grumbled at the price they paid for the use of the telephone, and yet the president had told them that the cost came out at 0·41d. per message. With regard to the negotiations with the Post Office, he felt sure the proprietors were content to leave this matter in the hands of the directors, in whom they had perfect confidence.

The resolution was then carried unanimously.

Mr. HACKING said that, considering the amount of revenue the company had made, and also taking into account the importance of the negotiations that were going on with the Post Office, the directors would be justified in increasing the deferred dividend.

The PRESIDENT said he should have stated that they were putting the full £100,000 this half-year to reserve. He regarded their reserve fund as of vital importance to the company, whatever might be the result of the negotiations with the Post Office. A shareholder (perhaps the largest) for upwards of £25,000 had complimented the directors "upon their decision to add to the reserve in preference to making an increase in the dividend. It was most desirable that the company should become financially strong enough to enable them to hold their own against all comers." Perhaps next half-year the directors would see more clearly the position of the company than they did at present.

The retiring directors (Sir James Fergusson, Bart., M.P., Mr. Samuel Herrick Sands and Sir James Thomas Woodhouse, M.P.) were then re elected, as were also Messrs. Welton, Jones & Co., the retiring auditors.

Mr. LEA SMITH proposed a cordial vote of thanks to the chairman, directors and staff of the company, and said that a great improvement had, he thought, been noticeable in the working of the telephone lately.

The motion was carried unanimously.

The PRESIDENT thanked the proprietors for their vote. Mr. Lea Smith had, he said, referred to the improved working of the telephone. Its past defects had not been the fault of the company. The National Co. had not the same liberty, power and freedom possessed by the American Telephone Co., otherwise their system would, by this time, have been quite equal to the American system, which had been most justly praised.

The proceedings then terminated.

General Electric Co. (Ltd.)

The ordinary general meeting was held on Wednesday, Mr. G. BYNG presiding.

The SECRETARY (Mr. N. Gunz) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said the year had been a most difficult one, as the home trade had been exceedingly quiet, especially the building trade, upon which the electrical industries largely depended. The company had maintained their turnover, and in some departments had increased it, but they had had to expend more money in doing so, and, prices ruling lower, they could hardly expect to do better than in previous years; therefore the result shown in the balance-sheet must be considered satisfactory. Their investments had increased by £12,000, due mainly to the foundation of the company's own houses in South Africa. The board believed that all the investments were sound. Sundry creditors showed an increase of about £20,000, but a great deal of this was due to contracts which had since been liquidated. The reserve had been raised to £80,000, and the board hoped that next year it would cover the items of "goodwill and patents" standing at £92,000. There remained a surplus which would enable the directors to pay a dividend of 7 per cent. on the ordinary shares, an improvement on the distribution of last year. It could, however, hardly be considered a grand return upon the ordinary capital invested in a large manufacturing concern. It rather showed that this dividend could be earned by the company in bad times, and the shareholders must look forward to a more adequate return in the good times which they hoped would soon come back. Their works were full of orders and the board had decided to add an auxiliary factory to their Manchester works. One of the most satisfactory orders for the year had been the contract for 340 motors for the lifts for the underground electric railways of London. The fact that the company had been the pioneer of polyphase work in this country had assisted them considerably in their mining work, and it was only fair to state that they had not found any difficulty in getting in this country both the intellectual as well as the manual labour required for such intricate work. With regard to their carbon works the directors were satisfied they had quashed the mistaken idea that this article could not be produced in this country, but the present

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unfair competition prevented them making both ends meet in that branch, and they had been again obliged to write off a considerable sum for running these works. The board, however, believed they would eventually make this branch successful. With the exception of the carbon works every one of the various departments had contributed, in a smaller or larger degree, to the total profits. The company had invested £1,000,000 in factories, stocks and trading accounts, and employed over 5,000 hands. He moved the adoption of the report and accounts.

Mr. H. HIRST seconded the motion, which was adopted.

The retiring director (Mr. M. Railing) was re-elected and the auditors re-appointed, and the meeting terminated.

BAKER STREET & WATERLOO RAILWAY CO.—During the June half-year the capital expenditure was £140,384. The company's bill for further capital, &c., powers awaits Royal assent. At the meeting on Wednesday, the chairman (Mr. T, J. Hare) stated rapid progress was being made with the various sections of the line, and the railway was likely to be opened some time next year.

CENTRAL LONDON RAILWAY CO.—The report of the directors for the half-year ended June 30 states that the capital expenditure during the half-year was £24,956. 3s. 4d., receipts from all sources amounted to £184,961. 15s. 6d., and working expenses to £95,125. 12s. 11d., leaving £89,836. 2s. 7d. The number of passengers (including workmen) carried since the opening of the railway has been 169,333,806, of which the half-year under notice contributed 22,969,397, being a decrease of 209,741 compared with June, 1903. The average receipt per passenger was 1·86d. After providing for interest, &c., the net revenue account shows a balance of £108,737. 6s. 3d., including £36,078. 7s. 1d. from last half-year. The directors recommend dividends at the rate of 4 per cent. per annum for the half-year on both the undivided ordinary stock and the preferred ordinary stock. Putting aside £10,467. 18s. 5d., the proportion applicable to deferred stock, £48,737. 6s. 3d. is carried forward. Agreements have been completed for letting for building purposes the upper portion of the station buildings at Chancery-lane, Tottenham Court-road, Marble Arch and Queen's-road, and negotiations are proceeding for the British Museum station, leaving only Lancaster Gate, Notting Hill Gate and Holland Park station sites for disposal.

DUBLIN & LUCAN ELECTRIC RAILWAY CO.—The directors' report to June 30 states that the total receipts show an increase compared with corresponding period of 1903, of £296. 11s. 5d. The expenditure shows a decrease of £173. 6s. 8d. After providing for interest, £1,211. 1s. 8d. is available. The full year's dividend on the 5 per cent. preference shares (being 10 per cent. on the half-year) requires £950 and reduces the arrears to nine months. A further £100 is to be paid off electrical equipment (capital account), and £161. 1s. 8d. is carried forward.

EAST LONDON RAILWAY CO.—At the meeting on Monday the chairman (the Hon. A. E. Gathorne-Hardy) said that he regretted he was unable to announce any progress in reference to the electrification of the company's system.

EDMUNDSON'S ELECTRICITY CORP. (LTD.)—At the meeting last week the chairman (Mr. F. E. Gripper) reported that satisfactory progress had been made during the year. Since the last meeting they had completed electric lighting works at Caterham, Glossop, Berwick, Ryde, Surbiton, Frome and Dorking, and had completed and opened electric tramways at Glossop and Scarborough. At Newbury the lighting works were almost completed, and would be opened in a few weeks. Good progress had been made with the Lancashire electric power station, and it was expected that would be opened early next year. With the exception of two towns, they would then have the whole of their works opened and running. The two exceptions were Ramsgate and Inverness, for which, after many attempts, they had recently obtained the necessary powers. It was not the intention of the directors to seek for further powers, except such as might be necessary for their existing undertakings, as they would have ample scope in the development of the undertakings which they were now interested in. The rapid expansion of the various undertakings was shown by the lamp connections, which during the year increased from 335,000 to 568,000 8 c.p., and had since increased by another 65,000. The result of the year's trading was a net profit of £39,640. 16s. 8d., or about £13,000 more than last year. In addition they had received £18,914. 17s. as interest and dividends on their investments, or about £3,000 more than last year. Realisation of investments had brought in a profit of £5,058. 10s. 5d., principally derived from the completion of the sale of their Woolwich undertaking. The total profits amounted to £63,698. 10s. 7d., against £56,924 last year. Including £11,733. 6s. 4d. from last year, the total amount to be dealt with was £75,431. 16s. 11d. Interest had absorbed £11,025. 18s. 8d., preference dividends £15,544. 12s. 8d. and the interim ordinary dividend £8,750, leaving £40,111. 5s. 7d. The directors recommended that £5,000 further be written off goodwill, that £5,437. 14s. 4d. be carried to reserve, and that a final dividend, at the rate of 9 per cent., be paid for the half-year on the ordinary shares, making 7 per cent. for the year; £13,923. 11s. 3d. would be carried forward. The amount of their investments in subsidiary companies, taken at par, amounted to £957,982. 16s. 6d. The reserve against those investments had been increased by £45,000, a total of £165,384. 14s. 1d. With the £70,000 reserve, they had now a total of over £235,000, which was a 25 per cent. reserve against realisation at par of their investments.

GREAT EASTERN RAILWAY CO.—At the half-yearly meeting on Wednesday the chairman (Lord Claud Hamilton) said in January he stated that, owing to the uncertainty as regards the future of electric traction, the directors had thought it advisable not to undertake any new scheme in regard to electricity until they were fully satisfied as to its value. They were now watching the development of that portion of the Lancashire & Yorkshire Railway between Liverpool and Southport which was worked by electric traction, and they had also thought it advisable to go to France and see whether there was anything for them to learn in regard to the working of some of the French railways. Accordingly, in May, accompanied by the general manager and other principal officials, he went to Paris, but they came back thoroughly satisfied that there was nothing in what they had seen, though a great deal of it was commendable, that would prove of use to the Great Eastern Railway. They were continuing the policy of holding their hands until they found something they could recommend to the shareholders with full confidence.

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY CO.—The report for the half-year ended June states that the capital expenditure during the period amounted to £717,190. The estimate for the current half-year is £900,000. The engineers' reports state that the progress of the works during the half-year has been satisfactory. With one exception, all of the station sites are in the possession of the contractors. The rent due from the Underground Electric Railways Co. of London, under the terms of the agreement for lease, dated Jan. 13, 1903, up to June 30, 1904, permits of a dividend at the rate of 4 per cent. per annum.

LIVERPOOL OVERHEAD RAILWAY CO.—The accounts for the past half-year show an available balance of £10,370. 18s. 6d., and the directors recommend the interim dividend on the 5 per cent. preference shares and a dividend at the rate of 1¼ per cent. per annum on the ordinary shares, the same as for the corresponding period last year. The balance carried forward is £4,052. 5s. 10d., against £3,747. 5s. 10d.

METROPOLITAN RAILWAY CO.—The total receipts for the half-year to June 30 (deducting proportion of revenue of the City lines and extensions) were £443,459. 6s., and the expenses £207,842. 1s. 5d., leaving a profit of £235,617. 4s. 7d. The receipts show an increase of £18,991. 9s. 1d., and the expenses a decrease of £3,409. 13s. 6d. compared with the corresponding half-year of 1903. A dividend on the ordinary stock for the half-year at the rate of 3 per cent. per annum is recommended. The works required for the electrification of the line have proceeded rapidly, and in the course of a short time the testing of the machinery and plant under normal conditions of working will take place. Thirteen trains of new corridor cars have already been constructed and are being electrically equipped at Neasden. The remainder of the rolling stock required for the new system of working is in course of construction at Manchester and Birmingham. The Harrow and Uxbridge Railway was opened for traffic on July 4.

SOUTH-EASTERN RAILWAY.—At the half-yearly meeting of the proprietors of this railway yesterday, Mr. H. Cosmo Bonsor, who presided, said that the decrease of 139,000 passengers carried over the line in the past half-year was, in the main, attributable to the electrification of the tramways in the South Metropolitan area. At one station alone on their metropolitan system there was a decrease of 600,000 passengers during the half-year. There was also a decrease in the long-distance traffic, due chiefly to the competition of motor cars and carriages, and particularly of motor bicycles.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

ARNOLD GOODWIN & SON (LTD.) (81,633.)—Reg. July 22, capital £10,000 in £1 shares, to manufacture, construct, equip, work, administer, manage or construct railways, tramways, trolleyways, factories, warehouses, &c, in England or elsewhere, and to carry on the business of railway proprietors, manufacturers of rails, sleepers, cables and the like, electricians, electrical, mechanical and general engineers, producers and distributors of electricity, &c. A. Goodwin is permanent governing director. Reg. office, 56 and 58, Sumner-street, London, S.E.

DAVIES, KENT & STEWART (LTD.) (81,627.)—Reg. July 21, capital £3,500 in £1 shares (2,500 preference), to acquire business carried on as Davies, Kent & Stewart, and to carry on the business of manufacturers of electrical accessories, flexible wire makers, electricians, suppliers of electricity, &c. The subscribers are G. A. G. Davies, electrical engineer, H. W. Kent, electrical engineer, B. G. Stewart, electrical engineer, L. H. Lewis, electrical engineer, Gertrude M. Kerry, Mrs. M. A. E. Stewart and H. P. Parrott.

ELECTRICAL BLEACHING CO. (1904), LTD. (81,614.)—Reg. July 20, capital £75,000 in £1 shares, to adopt (five) agreements—one with the Electrical Bleaching Co., three with C. E. W. Gaddum and one with J. J. Graham—and to carry on the business of bleachers, dyers, makers of vitriol and bleaching materials, &c., electricians, electrical engineers, suppliers of electricity, &c. The subscribers (with 100 shares each) are C. E. W. Gaddum, G. Worthington, W. H. Marriott, F. H. Allen, Gerald St. John Day, electrical engineer, E. L. Thorpe, electrical engineer, and H. Wood (one share). First directors, C. E. W. Gaddum, G. Worthington, W. H. Marriott, F. H. Allen, G. St. John Day and E. L. Thorpe. Reg. office, 196, Deansgate, Manchester.

STATUTORY RETURNS.

AUCKLAND ELECTRIC TRAMWAYS CO. (LTD.)—In return to May 23 the capital is given as £300,000 in £10 shares, all of which have been taken up. £10 per share has been called up on 28,510, and £285,096 has been received, leaving £4 in arrears. £14,900 is considered as paid on 1,490 shares. Mortgages and charges, £85,100.

BOARDMAN ELECTRICAL PATENTS (LTD.)—The return to Jan. 14 gives capital as £2,000 in £1 shares, of which 1,000 have been taken up. £1,000 is considered as paid. Mortgages and charges, nil.

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CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—According to return to June 2 the capital is £500,000 in 60,000 ordinary and 40,000 preference shares of £5 each, of which 35,000 ordinary and 40,000 preference have been taken up. £5 per share has been called up on 15,000 ordinary and 40,000 preference shares, and £275,000 has been received. £100,000 is considered as paid on 20,000 shares. Mortgages and charges, £200,000.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—In return to June 29 the capital is £120,000 in 60,000 ordinary and 60,000 preference shares of £1 each, all of which have been taken up. £1 per share has been called up on 50,000 ordinary and 50,000 preference, and £100,000 has been received. £20,000 is considered as paid on 10,000 ordinary and 10,000 preference. Mortgages and charges, nil.

EVERSHED & VIGNOLES (LTD.)—According to return to June 21, the capital is £30,000 in £10 shares, of which 2,700 have been taken up. £27,000 has been received. Mortgages and charges, £14,000.

HESWALL ELECTRIC LIGHT CO. (LTD.)—The return to June 12 gives capital as £1,500 in £1 shares, of which 1,225 shares have been taken up and paid for in full. Mortgages and charges, nil.

LISBON ELECTRIC TRAMWAYS (LTD.)—According to return to June 23, the capital is £1,000,000 in 500,000 ordinary and 500,000 preference shares of £1 each, of which 500,000 ordinary and 425,553 preference have been taken up, all being considered as fully paid. Mortgages and charges, £500,000.

MACARTNEY, McELROY & CO. (LTD.)—The return to June 21 gives the capital as £60,000 in 5,000 ordinary and 1,000 preference shares of £10 each, of which 2,912 ordinary have been taken up. £10 per share has been called up on 2,892 and £28,920 has been received. £200 is considered as paid on 20 ordinary shares. Mortgages and charges, nil.

ROBERTSON ELECTRIC LAMPS (LTD.)—In return to May 19 the capital is £50,000 in 5,000 shares of £10 each, of which 4,500 have been taken up. £10 per share has been called up on 4,400; £44,000 has been received. £1,000 is considered as paid on 100 shares. Mortgages and charges, £10,000.

MORTGAGES AND CHARGES.

BARNABY & CO. (LTD.)—A debenture dated July 19, 1904, to secure £250, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. Holder, Mrs. L. Collins.

BASTIAN METER CO. (LTD.)—Issue on July 18 of £100 debentures, part of series authorised on April 22, May 23 and June 10, 1901, to secure £6,000, charged on certain land, with premises thereon, and company's other assets, present and future, including uncalled capital. Trustees, H. A. Saunders and D. J. Cowles. Previously issued of same series, £5,350.

VAN RADEN & CO. (LTD.)—A debenture dated July 18, 1904, to secure £1,500, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. Holder, Mrs. H. E. Robinson.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26⅞d. per oz. (July 28). Consols 88¼—88⅜ for money, 88⅛—88⅜ for account; 2½ per cent. annuities 87—87⅛ (July 28). Consols Pay Day, Aug. 4; Stocks and Shares Continuation Days, Aug. 10 and 29; Ticket Day, Aug. 11; Pay Day, Aug. 12; Mining Share Carry-over Days, Aug. 9 and 26.

BLACKHEATH & GREENWICH DISTRICT ELECTRIC LIGHT CO. (LTD.)—Letters of allotment for a further £30,000 4½ per cent. first mortgage debenture stock and a further 30,000 7 per cent. cumulative preference shares have been posted. We are informed that both issues were oversubscribed by the shareholders and debenture stockholders.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.) The transfer books and register of members will be closed from Aug. 5 to Aug. 13 inclusive, preparatory to payment of half-year's dividends on the first and second preference shares.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORP. (LTD.)—An interim dividend on the ordinary shares at the rate of 8 per cent. per annum for the half-year ended June 30 was declared yesterday, payable Aug. 15.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The directors have declared an interim dividend on the 6 per cent. preference shares (less tax) for half-year to June 30, and an interim dividend on the ordinary shares for the same period at the rate of 4 per cent. per annum (less tax), payable Aug. 22. The amount of electricity sold in the company's London districts during the half-year is estimated to realise £59,338, compared with £49,854 for the corresponding period of 1903. The transfer books and register of members will be closed from Aug. 8 to 20 inclusive, preparatory to payment of interim dividends on the preference and ordinary shares for the half-year ended June 30.

ELECTRICAL BLEACHING CO. (1904), LTD.—During the week this company, which has a share capital of £75,000 in £1 shares, has invited applications for 42,500 shares.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The directors have declared an interim dividend of 9s. per share on the ordinary shares, being at the rate of 9 per cent. per annum, payable Aug. 9.

NEWCASTLE & DISTRICT ELECTRIC LIGHTING CO. (LTD.)—An interim dividend of 7 per cent. per annum has been declared.

NORTH METROPOLITAN TRAMWAYS CO. (LTD.)—The directors recommend a dividend at the rate of 3½ per cent. per annum for the past half-year, leaving about £260 to be carried forward.

WESTMINSTER ELECTRIC SUPPLY CORP. (LTD.)—An interim dividend at the rate of 13 per cent. per annum, for the half-year ended June 30, has been declared.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	July 23	1,877	+ 279	8	12,705	+ 2,392
Airdrie	,, 16	226	...	23	4,518	...
Ayr Corporation	,, 23	864	− 7	10	4,078	+ 26
Barnsley	,, 16	174	− 21	28	4,656	− 324
Barrow	,, 15	276	...	23	3,860	...
Bath Electric Trams, Ltd.	,, 20	742	...	29	17,229	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 17	1,138	+ 21	...	...	...
Birmingham Corporation	,, 23	338	...	§16	4,806	...
Birmingham Tramways Co.	,, 23	5,494	+ 253	8	17,068	+ 1,506
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 21	1,950	+ 137	16	15,920	+ 1,070
Blackpool and Fleetwood	,, 23	1,470	+ 79	4	3,571	− 265
Blackp'l, St. Anne's & Lytham	,, 21	795	+ 4	88	10,749	+ 5,877
Bolton Corporation	,, 24	2,014	− 34	17	31,922	+ 21
Bournemouth Corporation	,, 20	1,166	+ 144	‡16	17,694	+ 1,099
Bradford Corporation	...	...	...	...	...	...
Brighton Corporation	,, 24	1,168	+ 208	16	16,223	+ 905
Brisbane Tramways	June 8	2,270	+ 82	23	52,858	+ 589
Bristol Trams & Carriage	July 22	5,480	− 151	9	48,782	− 616
Buenos Ayres & Belgrano	June 26	3,803	+ 443	10	33,370	+ 1,553
Burnley Corporation	July 23	1,103	+ 214	17	18,053	+ 4,345
Burton Corporation	,, 21	393	...	¶16	5,818	...
Calcutta Tramways Co.	,, 23	a86,270	+ a3,846	4	a101,222	+ a13,237
Camborne-Redruth	,, 25	110	− 26	12	1,390	− 67
Cardiff Corporation	,, 23	2,162	+ 28	16	34,006	+ 813
Carlisle Tramways Co.	,, 23	258	+ 2	29	5,722	+ 320
Central London Railway	,, 23	6,087	− 315	3	19,783	− 1,141
Chatham & Dist. Lt. Rys.	...	...	...	...	...	...
City & South London Rly.	,, 24	2,316	− 229	4	9,435	− 528
Cork Electric Trams Co.	,, 21	556	− 89	29	13,161	− 1,144
Darwen Corporation	,, 22	255	− 4	16	3,817	− 107
Devonport & Dist. Trams	,, 15	655	+ 140	28	14,510	+ 2,402
Dover Corporation	,, 23	275	+ 4	16	3,765	− 215
Dublin & Lucan Railway	,, 22	153	+ 27	3	458	+ 118
Dublin Southern District	,, 22	1,325	− 1,219	3	17,937	− 2,959
Dublin United	,, 22	4,487	− 3,044			
Dudley—Stourbridge	,, 15	1,005	+ 80	28	23,305	+ 807
Dundee Corporation	...	...	...	...	...	...
East Ham Council	,, 23	812	+ 112	16	12,648	+ 1,199
Gateshead & Dist. Trams	,, 15	1,008	+ 117	28	25,054	+ 1,211
Glasgow Corporation	,, 23	11,993	+ 522	†8	110,556	+ 2,555
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 15	348	+ 67	28	6,951	+ 756
Gt. Northern & City Rly.	,, 23	955	...	23	21,853	...
Greenock & Port Glasgow	,, 15	709	+ 115	28	15,749	+ 796
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 15	418	+ 122	28	7,944	+ 814
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 23	2,170	+ 259	16	35,638	+ 4,229
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	,, 20	154	− 37	10	2,375	+ 244
Ipswich Corporation	,, 23	580	...	16	8,278	...
Isle of Thanet Co.	,, 23	1,410	+ 112	¶42	19,238	− 420
Kidderminster & District	,, 15	2 8	+ 19	28	3,388	− 111
Kirkcaldy Corporation	...	...	...	...	...	...
Lanarkshire Trams Co.	,, 21	960	...	29	18,241	...
Leeds Corporation	,, 21	5,971	+ 13	18	100,140	+ 5,908
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	,, 16	11,795	+ 1,095	29	293,249	+ 7,499
Liverpool Overhead Rly.	,, 21	1,894	+ 184	14	6,979	+ 135
*London County Council	,, 9	14,117	+ 2 920	§14	171,047	+ 29,081
Lowestoft	,, 23	316	...	¶52	10,478	...
Manchester Corporation	,, 23	13,152	+ 735	16	199,673	+ 6,861
Mersey Railway	,, 23	1,594	+ 230	3	4,407	+ 841
Merthyr	,, 15	215	+ 5	28	5,619	+ 140
Middleton	,, 15	446	+ 51	28	8,900	+ 122
Nelson Corporation	...	...	...	...	...	...
Newcastle-on-Tyne Corp.	,, 23	3,660	+ 145	3	11,851	+ 1,310
Newport (Mon.)	,, 23	589	+ 69	16	8,427	+ 1,835
Oldham, Ashton & Hyde	,, 15	698	+ 35	28	15,113	− 790
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams	,, 23	1,269	+ 162	29	38,682	+ 5,148
Peterborough	,, 15	189	+ 10	28	4,064	− 145
Poole and District	,, 15	378	+ 10	28	7,891	− 9
Portsmouth Corporation	,, 23	2,492	+ 466	†16	33,629	+ 3,051
Potteries	,, 15	1,789	+ 214	28	47,417	+ 3,990
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 15	294	+ 33	24	2,880	− 71
Salford Corporation	,, 25	4,3.7	+ 271	17	69,003	+ 5,590
Sheerness	,, 13	89	− 10	28	1,591	− 408
Sheffield Corporation	,, 24	4,861	+ 93	§17	81,217	+ 2,604
Southampton Corporation	,, 21	1,068	− 46	3	3,040	− 378
Southend Corporation	,, 21	512	+ 91	16	5,666	+ 534
Southport Tramways	,, 15	401	+ 21	28	8,611	+ 472
S. Staffordshire Trams.	,, 15	748	− 253	28	21,605	− 2,007
Stockport Corporation	,, 22	680	+ 320	16	9,856	+ 4,307
Sunderland Corporation	,, 24	1,564	+ 138	16	21,521	+ 890
Swansea Trams	,, 15	622	− 207	28	14,470	+ 589
Taunton Trams	,, 15	65	...	28	1,482	− 103
Tynemouth and District	,, 15	428	+ 11	28	7,643	− 418
Tyneside Trams Co.	,, 20	479	+ 132	29	10,841	+ 1,991
Wallasey District Council	,, 23	1,041	+ 196	§16	12,638	+ 793
Walsall	,, 23	503	...	28	13,963	...
Warrington Corporation	,, 21	337	+ 16	16	5,129	+ 181
West Ham Corporation	,, 21	1,127	...	21	16,606	...
Weston-super-Mare	,, 13	313	+ 23	28	2,364	+ 29
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 15	464	+ 44	28	10,645	− 196
Worcester	,, 15	885	+ 219	23	6 929	+ 3,042
Wrexham	,, 15	114	− 20	28	3,085	− 375
Yorkshire Woollen District	,, 15	717	+ 310	28	16,332	+ 7,039

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 8 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., July 27.	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE.	BUSINESS, WEEK TO JULY 27. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to280,007)5%Cm.Pf.	£¼–5⅛	4 7 0	April, Oct	5¼	5⅛
St.	6%	Do. Permanent 6% Deb. Stock	137 –141	4 5 0	..	138⅝	138⅜
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	98 –100	5 0 0	..	99½	..
10	6%	Barcelona Tramways Ord.	£⅛–9⅛	3 3 1	..	£⅛	9
10	5/0	Do. 5% Cum. Pref.	9 –10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	93 –98	4 13 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 –100	5 2 0	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	⅛–⅛	..	..	..	..
1	..	Do. 5% Cum. Pref.	1–1	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½–2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅝–4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96 –101	4 9 3	..	98	..
10	8%	Bristol Tramways and Carriage Ord.	19½–20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 –10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 –108	3 15 3½	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100 –103	5 16 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	99 –102	4 18 6	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10½	4 15 3	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝–105⅝	4 6 2	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 –100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	8½–9	8 17 9	..	8⅛	8⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅞–11½	5 6 7	Feb, Aug	10⅛	10⅛
St.	5/0	Do. 5 per Cent. Perpetual Debs	116 –119	4 5 1	..	115½	118½
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	95 –98	..	..	96	95½
5	3/0	Buenos Ayres and Belgrano Ord.	2¾–3½	4 16 0	..	3⅛	2⅞
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5½–5⅝	5 4 4	..	5½	5⅛
5	3/0	Do. "B"	5 –5½	5 9 1	..	5⅜	..
St.	5%	Do. 5 per Cent. Debs.	105 –108	4 12 8	..	107	106½
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	101 –104	4 16 6	..	..	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	94 –99	5 1 0	..	..	..
5	3/6	Calcutta Tramways	7½–7⅞	3 17 6	..	7⅞	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 –108	4 3 3	..	..	..
1	1/0	Cape Electric Tramways Shares	1⅜–2	5 0 0	..	1⅜	..
St.	4%	Central London Ordinary Stock	89 –91	4 8 0	June, Dec	90⅜	89
St.	4%	Do. 4 per Cent. Pref. Stock	102 –104	3 18 5	..	103½	..
St.	4%	Do. Deferred Stock	79 –81	4 18 9	..	..	..
100	4%	Do. 4 per Cent. Debs.	106 –109	3 13 5	..	108½	108
5	2/6	City of Birmingham Trams.5% Cm. Pref.	4½–5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 –101	3 19 2	..	..	..
St.	2%	City and South London Rly. Con. Ord.	47 –49	4 16 11	Feb, Aug	48½	47½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 –126	4 0 0	Feb, Aug	123½	..
St.	5%	Do. (1896)	120 –123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 –122	4 2 10	..	121½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 –109	3 13 5	May, Nov	107½	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 –103	4 17 10	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½–13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	..	..
10	1/8½	Gt. Northern & City Rly. Prf. Ord. (4%)	4 –4½	..	..	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 –10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	18 –19	5 5 3	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	13⅜–14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	107 –109	4 2 8	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89 –91	4 7 11	..	..	..
10	1½%	Liverpool Overhead Railway Ord	3⅜–4	3 8 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 –10½	4 15 3	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	99 –101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10⅛–10⅜	4 13 0	..	10⅛	10⅜
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 –105	3 16 4	..	104¼	103
St.	..	Mersey Con. Ord. Stock	6 –9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 –15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅛–⅛	..	..	¼	..
1	0/6	Do. 5% Cum. Pref.	⅛–⅛	5 0 0	..	..	..
St.	18/7	Do. 4½ Deb. Stock	97 –100	..	..	99	97½
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 –105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs.(1922)	105 –107	4 5 0	..	..	..
5	..	New Gen. Trac. 6 per Cent.Cum. Pref.	1 –2	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1st Mt.Db.Stk.	99 –102	4 18 1	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 –9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 –10	5 0 0	Feb, Aug	9⅜	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 –104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	89 –92	3 7 11	June, Dec	..	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	⅜–⅝	8 0 0	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	⅛–⅜	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾–6¼	6 8 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¾–6⅜	4 16 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 –104	4 6 7	..	..	..
St.	4½%	British Thomson-Houston 4½% 1st Mt. Db.	101 –103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	3⅛–3⅝	8 0 0	..	3⅞	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	85 –88	4 10 11	..	86⅜	..
2	..	Brush Electrical Engineering	½–1	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	¾–1½	9 12 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 –99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	71 –76	5 18 4	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½–10½	5 14 3	Jan, July	10⅜	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 10 11	Jan, July	5½	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	101 –105	4 5 8	Nov, May	102½	101½
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	⅝–¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 –93	4 14 9	..	..	..
1	1/2	Chadburn's (Ship) Telegraph Ord.	¾–1⅛	8 0 0	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½–2	7 9 3	Jan, July	1⅞	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	94 –97	5 3 6	Jan, July	94	..
5	..	Dick, Kerr & Co. Ord.	7½–8	..	..	8	..
5	3/0	Do. 6% Cum. Pref.	5¼–5⅝	5 4 4	..	5⅜	..
St.	4½%	Do. 4½% Deb. Stock	102–105	4 6 0	..	..	..
5	..	Edison & Swan United("A"Sh.)(£3 pd.)	½–¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 –2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb.Stock(rd.)	77 –82	4 18 1	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	78 –82	6 4 0	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	6 –6¼	5 12 0	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅝–6	5 0 0	..	6⅛	5⅞
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 –107	4 4 0	..	..	..
2	1/2½	Electric Construction Co.	1 –1⅛	9 11 0	Jan, July	1⅛	1⅛
2	2/9½	Do. 7 per Cent. Cum. Pref.	2½–2⅝	5 2 0	July	2⅝	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	96 –99	4 0 9	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 –9½	5 5 3	..	9⅜	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 –98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	11 –12	6 5 0	Feb, Aug	11⅜	11
5	2/8	Do. 4½ per Cent. Pref.	5 –5⅛	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort.Deb.Stock(rd.	107 –111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½–19½	5 2 6	Feb, Aug	..	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.	100 –103	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½–11	4 10 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Maintenance	86 –89	6 3 0	Mar, July	86½	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	99 –102	3 18 5	Jan, July	..	..
5	..	Willans and Robinson Ord.	2 –3	..	Apr, Oct	..	..
5		Do. 6 per Cent. Cum. Pref.	3 –4	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	78 –82	4 17 0	May Nov	..	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed., July 27.	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE.	BUSINESS, WEEK TO JULY 27. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅛–⅜	..	..	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅛–1⅜	5 1 9	..	..	..
St.	..	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.)	..	..	..	..	..
		Extra Bonus of 25% Deb. Stk.	100 –105	4 7 0	..	..	102½
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½–12½	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	9½–10½	4 5 9	..	9½	..
10	6/0	Do. 6% Cum. Second Pref.	10½–11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 –104	4 6 7	..	108	102½
5	..	Bromley (Kent) El. Lt. & Power Shares	5½–6	..	..	..	..
St.	4½%	Do. Do. 1st Debs	100 –103	4 7 5	..	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	10½–11½	4 8 11	..	11⅜	..
5	3/6	Do. 7 per Cent. Pref.	10½–10⅝	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7⅜–7⅝	4 10 5	..	7⅝	7⅞
St.	4%	Central Elec. Sup.Co.4% Guar.Db.Stock	105 –108	3 14 1	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7½–8	5 0 0	Feb, Aug	7⅝	7⅝
5	2/3	Do. 4½ per Cent. Pref.	5½–5⅝	4 1 10	Feb, Aug	5⅝	5⅝
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½–5	4 10 0	..	..	4½
5	2/3	Do. Do. (19.3)	4⅜–5	..	..	..	4½
St.	4%	Do. 4% Deb. Stock (red.)	102 –104	3 17 0	..	..	102½
5	3/6	Chelsea Electric Supply Ord.	6¼–6⅝	4 1 6	March	..	..
*	4½%	Do. 4½ per Cent. Deb. Stock (red.)	106 –109	4 2 6	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	10⅜–11½	4 8 10	Feb, Aug	10½	10⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jn, July	..	..
*	5%	Do. 5 per Cent. Deb. Stock (red.)	120 –125	4 0 0	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 –105	4 5 9	..	104	103½
10	4/0	County of London Elec. Supply Ord.	7½–8½	4 14 3	..	8	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11 –12	5 0 0	Mar, Sept	11⅜	11
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	105 –108	4 3 6	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	100 –103	4 8 0	..	101	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 –93	5 7 6	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5½–6	4 11 8	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 –103	4 8 0	..	..	..
10	..	Havana Electricity Co. Shares	9½–10½	..	..	..	..
5	5/0	Hove Electric Lighting Ord.	7½–8½	5 0 0	..	..	..
St.	4½%	I of W. Elec Lt. & Power 4½% Db St (red.)	101 –103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	⅜–⅝	..	..	..	..
5	7/0	Kensington & Knghtsbdge Ord.	12 –13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Knghtsbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 –105	3 16 6	..	..	..
3	..	London Electric Supply Ord.	1½–1⅝	..	..	1⅝	..
5	3/0	Do. 6 per Cent Pref.	4⅜–5⅛	5 14 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	94 –97	4 2 11	Mr, Jn, S, D	96	94½
10	9/6	Metropolitan Electric Sup. Ord.	21½–22½	3 17 9	April, Oct	22⅜	21⅝
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½–5⅝	4 1 10	Jan, July	5⅛	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	108 –112	4 0 4	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 –99	3 10 6	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93 –96	4 13 9	..	..	..
10	6/0	Notting Hill Electric Ord.	13½–14½	4 2 9	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	100 –103	3 18 3	..	..	..
5	4/0	Oxford Electric Ord.	5½–6	5 8 4	March	..	..
St.	4%	Do. 4% Deb. Stock	97 –100	4 0 0	..	..	..
1		Rand Electric	1 –1⅛	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 –103	4 7 9	April, Oct	..	..
5	9/6	St. James' & Pall Mall Elec. Ord.	14½–15½	4 13 7	Feb, Aug	14⅜	..
5	3/6	Do. 7 per Cent. Pref.	8 –9	3 17 9	Feb, Aug	8⅝	..
St.	3¼%	Do. 3¼ per Cent. Deb. Stock (red.)	97 –100	3 10 2	..	98⅛	97⅝
5	4/0	Smithfield Markets Electric Sup. Ord.	2⅜–3⅛	6 8 1	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 –90	4 9 6	..	..	..
5	3/0	South London Electric Supply Ord.	3⅜–4⅛	3 10 7	..	4⅛	4⅛
5	2/6	Urban Electric Supply Ord.	4½–5	5 0 0	..	..	..
5	2/6	Do. 5% Cum. Pref.	4½–5	5 0 0	..	4⅝	..
5	7/0	Westminster Electric Supply Ord.	12½–13½	5 0 0	Mar, Sept	13⅛	12⅝
5	2/6	Do. 5 per Cent. Cum. Pref.	6 –6½	3 16 11	..	..	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	97 –101	3 19 2	Jan, July	..	..
10	..	Amazon Telegraph	2¼–3½	..	Jn, Dec	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	12/6	Anglo-American	46 –49	5 18 0	F, My, Ag, N	46	..
St.	25/0	Do. Preferred	91 –93	6 3 6	F, My, Ag, N	92⅜	91½
St.	2/0	Do. Deferred	6⅞–7	1 8 7	F, My, Ag, N	..	..
100	82	Commercial Cable Capital Stock	170 –180	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93 –95	4 2 6	Jn Ap, Jy, O	94½	93½
10	5/0	Cuba Submarine Ord.	7 –8	7 10 0	Feb, Aug	7⅜	..
10	10/0	Do. Preference 10 per Cent.	15 –16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½–3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 –8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅝–101⅝	4 9 2	Jan, July	..	..
20	5/0	Direct United States Cable	10 –10½	6 4 0	Ja, Ap, Jy, O	..	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 –101	4 9 2	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	127 –132	5 6 0	Ja, Ap, Jy, O	131½	129½
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 –89	3 18 6	Ja Ap, Jy, O	88½	87½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	103 –108	3 14 6	May, Nov	106½	105½
10	2/6	Eastern Extension	11⅜–12½	5 14 3	Ja, Ap, Jy, O	12½	12
St.	4%	Do. 4 per Cent. Deb. Stock	105 –108	3 15 0	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	99 –102	3 19 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅝–102⅞	3 18 9	May, Nov	..	..
10	5/0	Gt. N'thn. (of Copenhagen) ex coupon 61	25 –26⅜	5 13 2	Jan, July	25⅞	25⅛
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 –101	4 9 2	June, Dec	..	..
25	37/6	Indo-European	42 –45	5 11 2	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 –100	4 0 0	June, Dec	..	..
10	6/0	West African Telegraph Shares	6 –7	5 14 3	..	..	..
		West Coast of America	⅛–⅜	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 –98	4 1 8	Jan, July	..	..
		West India and Panama	⅜–½	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½–6⅝	8 17 9	May, Nov	..	..
		Do. 6 per Cent. 2nd Pref.	5 –6	..	May, Nov	..	..
*	5%	Do. 5 per Cent. Debs.	99 –102	4 18 1	Jan, July	..	..
10	3/6	Western Telegraph	12½–12⅝	5 10 3	Mr, Jn, O, D	12⅛	12⅜
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 –104	4 16 3	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99 –102	3 18 5	..	100½	99½
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	5 –5½	5 9 1	August	..	..
1	7½	Monte Video Telephone Ord.	⅞–1	..	..	..	..
St.	6%	National Co. Pref. Stock	106 –108	5 13 9	..	107½	106½
St.	5%	Do. Def. Stock	88 –91	5 12 4	..	90	88
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 –14	4 5 8	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 –13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅛–5⅜	4 13 0	Feb, Aug	5⅜	5⅛
St.	3¼%	* Do. Deb. Stock 3½ per Cent. (red.)	97 –99	3 10 8	June, Dec	98½	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 –105	3 16 2	..	..	..
..	5/9	Do. Do. Prov. Certs. 35 to be pd.	64 –65	..	..	65	..
1	0/6½	Oriental	⅛–1⅛	6 6 8	April, Oct	1	..
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10	3/0	Do. 6 per Cent. Pref.	12⅝–13⅜	4 7 2	Ja Ap Jy O	13⅞	13⅜
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NOTES.

THE statement made by Mr. BALFOUR in the House of Commons on Tuesday with reference to the Bills which he hoped would be carried through this session is decidedly unsatisfactory from the electrical point of view. No mention was made of the Supply of Electricity Bill, from which it may be inferred that this measure, for the second year in succession, will be dropped. There is, indeed, a genuine cause for complaint that measures relating to the electrical industry cannot be introduced earlier in the session so as to allow a fair chance of their getting well forward. Last year the Bill in question was introduced so late that it did not even reach the Committee stage, whilst this year it passed through the House of Lords, only to be abandoned in the Commons. There is only a very remote chance of the non-contentious Light Railways Bill being passed, and the Valuation Bill has been definitely abandoned. The Wireless Telegraphy Bill is to be passed at all hazards, but this, again, is another instance of an electrical measure being introduced at the very end of the session; and it may safely be assumed that had this not been of national importance it would have shared the fate accorded to the remaining measures of electrical interest.

IN our description of the North-Eastern Railway rolling stock which appears in another column, reference is made to an arrangement for lifting and holding the collector shoe off the third-rail. This device is extremely simple, and does not interfere in any way with the ordinary working of the trains. Its value in case of emergency is, of course, obvious, and it is, therefore, all the more surprising that a similar arrangement has not been adopted before in this country. But it was probably thought unnecessary until after the disaster on the Paris Metropolitain Railway, which occurred just 12 months ago. In that case wooden packing blocks had to be placed under the shoes to keep them off the third-rail, but they proved worse than useless by firing, and literally adding fuel to the flames. We pointed out at the time that if it had been possible to raise the shoes and keep them off the rail, without difficulty, the catastrophe might have been rendered less disastrous, if not avoided altogether. The example of the North-Eastern Railway is, therefore, one that should be carefully studied by other electrically-worked lines.

ENGINEERS and those connected with science in its application to industry cannot fail to be gratified at the munificent gift made by the directors of Sir W. G. Armstrong, Whitworth & Co. to the Durham College of Science, Newcastle-on-Tyne. It has been resolved to contribute to the funds of the College a sum of £1,000 a year for five years. Congratulations are due to the College, not so much because of the financial aid nor because of the fact that it has come from a manufacturer, but because it proves that the work of the College is appreciated and valued by a great firm of engineers which gives employment to many old students. The employer, after all, is the best judge of the fitness of his employés, and the gift may therefore be looked upon as a very fine testimonial.

ALTHOUGH there is every reason to be grateful to Sir W. G. Armstong, Whitworth & Co., yet it is doubtful whether too many free gifts and endowments will prove of ultimate benefit to the industry and profession. There is still a tendency to attach too little importance to the standard of general education attained by youths destined for the engineering profession. We do not wish to say that a Public School education is essential for an engineer, but the profession must not be recruited too persistently from the ranks of those who have had the advantage of little more than Board School training. An electrical engineer needs to be a man with a thoroughly

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sound elementary education—an education of a nature to encourage broadness of views and scientific method of thought—and such a man is usually in a sufficiently good position to pay for his technical training, but he naturally will not do so to find himself crowded out afterwards by others who, owing to former environment, are able to exist on much smaller salaries. The standard of the profession will not be lowered, however, by the rising of a few clever men from the ranks, and there is no reason why it should not be as good socially as the so-called learned professions and the profession of arms by land and sea.

In view of the fact that the question of extra high-tension transmission over wide areas is now being considered to such a large extent by British electrical engineers, it is interesting to observe that an important conference of the American Institute of Electrical Engineers has recently been held for the purpose of discussing the matter to the exclusion of all other subjects. Two entire days were devoted to the reading of Papers and the discussions thereon, and some exceedingly important suggestions were made. There are, of course, points of radical difference between American practice and English practice in the design of high-tension transmission lines, the former being chiefly overhead and the latter underground. Moreover, the voltages employed on the American continent as well as the distances over which transmission is effected are considerably greater than any in vogue in this country. But in this latter respect it is not to be anticipated that English practice will ever compare with American, for obvious reasons. Although there are signs of an inclination towards the erection of overhead lines up to say, 10,000 volts, in certain quarters it is doubtful whether this figure will frequently be exceeded in this country owing to the comparatively short distances over which it is necessary to convey energy.

The first Paper of interest which was read before the American conference related to the protection of cables from arcs due to the failure of adjacent cables. The author pointed out that a conduit line consisting of a large number of ducts is not a desirable thing, and that, although two independent lines may cost a great deal more than a single line of the same capacity, yet this extra expenditure may be treated as an insurance against future trouble. Now, this proposition may be true when the points of generation and distribution are some considerable distance apart, but it is doubtful whether such a system would be financially possible where only a moderate distance separates them, and where there have to be a large number of intermediate feeding points. In this connection it is interesting to notice the method which has been adopted by the Newcastle Electric Supply Co., a description of whose system is now appearing in our pages. Separate lines have not been adopted, but each high-tension cable is laid in a separate duct.

The author of one of the Papers mentions that many burn-outs on high-tension cables in Chicago have been due to electrolysis of the lead sheathing owing to the return currents from the tramway circuits; but this difficulty may be easily overcome by the provision of a layer of copper wires within the lead, to supplement the conductance of the latter; both the copper and lead must, of course, be efficiently earthed. This practice is followed in England in deference to the wishes of the Board of Trade, but here the provision is in order to ensure safety should the cable break down, for the Board of Trade regulations limiting the voltage drop on the rails is sufficient to prevent electrolysis.

An entirely different case is presented by overhead lines. Little of such work has been done in this country, and it is therefore open to English electrical engineers to profit by experience in the United States. One of the chief points of difference of opinion seems to be with regard to the relative merits of steel and wooden poles, and the question must be considered in conjunction with that of lightning arrester devices. Wooden poles, if unprotected, are shattered by lightning, whereas steel poles are practically unaffected in the same circumstances. To protect the wooden poles there must be an earth wire running the whole length of the line and connected to earth at about every fifth pole; but such a wire, it is stated, costs almost as much as an additional transmission line. Here again, however, American conditions are not the same as those in England, where it will probably be found quite sufficient if simple wooden poles, protected in a similar manner to telegraph poles, are employed in conjunction with properly-designed lightning arresters.

Cable Interruptions and Repairs.

	Date of Interruption	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Cayenne—Paramaribo	July 13, 1904 ..	—
Assab—Massowah	July 26, 1904 ..	Aug. 2, 1904

North London Tramways.—In connection with our article last week on the new system of electric tramways in the north of London, worked by the Metropolitan Electric Tramways Co., we omitted to mention the following contractors:—

The British Thomson-Houston Co., dynamos, switchboards, &c.; Messrs. Dorman, Long & Co., steelwork; Messrs. Belliss and Morcom, exciters; Messrs. Piggott & Co., chimney; Messrs. Mirrless, Watson & Co., condensers; Pollak battery; Messrs. Carrick and Ritchie, travelling crane; Mr. Clift Ford, buildings.

Extension of the Water-power Station at Schaffhausen.—It appears from a note in the *Schweizerische Elektrotechnische Zeitschrift* that the management of the water-power station at Schaffhausen intends to increase the capacity of the station by filling, during the night-time, a pond having a capacity of about 10,000,000 gallons with water from the Rhine. The pond is situated at a considerable height above the river, and the pumps are to be actuated by synchronous motors, which, during the daytime, will be run as generators driven by turbines fed with water from the pond.

Röntgen Society.—It has been decided to issue a *Journal* of the Röntgen Society, and a copy of the initial number has now reached us. A well-executed portrait of Prof. Silvanus P. Thompson, the first president of the Society (1897-8) forms a supplement to the first issue. The *Journal* is edited by Mr. J. H. Gardiner, F.C.S., with the co-operation of a number of gentlemen whose names have been closely identified with X-ray and allied phenomena in their relation to medicine, the arts and sciences. The first number of the *Journal* contains a number of interesting illustrations, and the text includes a full account of the Society's operations in the past and a forecast of its future prospects. We cordially welcome the latest addition to the ranks of scientific literature.

Wireless Telegraph Notes.—A Reuter telegram from Cettigne announces that wireless telegraphic communication

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between Bari, on the coast of Italy, and Antivari, on the coast of Montenegro, was inaugurated on Wednesday. Prince Nicholas sent telegrams to the Tsar of Russia, the Emperor of Austria-Hungary and the Kings of Italy and Servia. The inauguration was followed by speeches delivered by M. Vukovitch, Minister for Foreign Affairs, the Marquis Cusani, Italian Minister at Cettigne, and Signor Marconi.

Another Reuter telegram, from Washington, conveys the intelligence that Mr. Roosevelt has approved the report of the Evans Commission awarding the control of the Government's coastal system of wireless telegraphy to the Navy Department, on the ground that it is part of the country's defence, and of more importance to the navy than to the army, with the exception of those stations necessary for communication between the army posts. The report recommends legislation to prevent private companies from interfering with the Government's coastal system of wireless telegraphy.

Statistics of Fatalities and Damage caused by Electricity in Switzerland during 1903.—According to a communication from "L'Inspectorat des installations à courant fort de l'Association suisse des électriciens," 13 persons were killed by electricity last year, and property was damaged in eight cases. Of the 13 fatalities, five occurred to persons employed in connection with the generation and distribution of electricity, one to a fitter of an electric firm and seven to persons not connected with the electrical industry. With regard to the last-named, it is mentioned that all the accidents except one were caused by gross negligence. In the case of the five accidents to the members of the staff of electricity undertakings, it appears that the victims themselves were also mostly to blame. All the fatalities were caused by alternating currents, the voltages of which were 130 in one case, 500 in another case and from 5,000 to 10,000 in nine cases. In two instances the exact pressure could not be ascertained. The victim who was killed by 130 volts was a mason. He was standing on a bed of concrete freshly laid on the first floor of a new building and still wet. He took hold of a bare conductor carrying 130 volts, and was killed on the spot. It is stated that he was a healthy and robust man.

Fire Office Regulations.—The following "Rules for Electromotors and Dynamos used in connection therewith" have recently been issued by the Associated British Fire Offices:—

(1) Motors when not in an engine room or in a separate compartment expressly set apart for their use, and built of or lined with incombustible material, must be completely enclosed in an efficient metal case forming part of the designed construction thereof. Ventilation by direct communication with the outer air or by openings in the vertical portion of the metal case protected by two thicknesses of approved wire gauze is allowed. Induction motors may have unprotected ventilation openings in their metal cases, the superficial area of each opening not exceeding ¼in. and the openings being at least ¼in. apart. Slip rings and brushes or any other sliding contacts must be completely enclosed in metal cases. Inspection holes fitted with plate glass are allowed. (2) No unprotected woodwork or combustible material must be within 18in. of any motor, and wood flooring beneath any motor must be protected by a sheet of metal. (3) The motor pulley (or other mechanical device for transmitting power from the motor) must be external to the metal case enclosing the motor. Only the shaft and the connecting conductors may be carried through into the metal case or through the wall of the compartment. No belts, ropes or other corresponding gear may be so carried. (NOTE.—Holes in the case to admit connecting conductors must have proper bushings, and exposed terminals must have proper protecting caps fitted to prevent short-circuiting. Each connecting conductor must be provided with a proper switch and proper cut-out.) (4) Dynamos must be treated as motors. (5) Resistances and starting transformers must be similarly situated and must be enclosed as required for motors. (6) All metal cases, tubes, &c., must be efficiently connected to earth. (7) Motors must not be supplied with current from dynamos or conductors having an earth return.

Junior Institution of Engineers.—The summer meeting of this institution is to be held in Germany, Düsseldorf being the first stopping place. Here, at the Town Hall, on Saturday, August 13th, the members will be welcomed by the Burgomaster and the Society of Architects and Engineers of Düsseldorf. The exhibition will be visited, and on Monday there will be an excursion to Oberhausen for viewing the works of the Gutehoffnungshütte (blast furnaces, steel works, &c.) The Beurather crane works will also be seen. On Tuesday the Elberfeld-Barmen mono-rail suspended railway is to be inspected in the morning, and in the afternoon the members proceed to Hanover for the purpose of visiting on the following day Messrs. Körting Bros'. works, the Hanover engine works and the works of the Westinghouse Brake Co. Thursday morning will be spent at Hanover, and in the afternoon Berlin will be reached. Here, on Friday, the overhead and underground railway will be seen, including car sheds, generating station, &c., also the Charlottenburg electrical enginering works of Messrs. Siemens and Halske. Saturday, August 20th, will be spent in visiting the Mariendorf works of the Imperial Continental Gas Association and the Royal Technical High School at Charlottenburg, The members leave Berlin on the Monday for Leipsic, remaining there till Wednesday, when they go on to Frankfurt-on-Main. Here, on Thursday and Friday, they will visit the municipal works by invitation of Mr. W. H. Lindley, and then go on an excursion to Homburg. On Saturday, August 27th, the return journey to England will be made via the Rhine from Biebrich to Bonn.

Statistics of German Electric Tramways and Railways.—The *Elektrotechnische Zeitschrift* publishes in its issue of July 21st a comprehensive series of statistical tables relating to German electric tramways and railways. No private traction systems, such as are to be found in connection with industrial works, mines, &c., are included. At present there are 136 towns or districts which are served with tramways. In 1903, the increase in the length of track amounted to about 185 miles, and, since some 60 miles are at the present time under construction, the total length of route in operation may be put down at roughly 2,360 miles. The aggregate power of the generating stations is given as 133,000kw. on October 1, 1903, being an increase of 11 per cent. in the year. An even greater increase—*i.e.*, 28·6 per cent—took place with regard to the storage batteries, whose total capacity rose during the year from 30,000kw. to more than 38,000kw. The number of motor cars now in use is 8,700 as against 8,300 of the year before, and the corresponding figures for trailers are 6,200 and 6,000. The overhead trolley system is almost exclusively used, the only exceptions being found in Dresden, Berlin and Düsseldorf. In Dresden accumulator and conduit systems are used to a small extent, and in the two last-named cities parts of the route are equipped on the conduit system. The third rail is made use of on the electric railway Berlin–Gross–Lichterfelde and on the Berlin overhead and underground railways. Accumulator traction pure and simple is employed in but a few isolated instances of small importance, and it seems likely that they too, will soon disappear. Horse traction is also speedily disappearing, only 32 miles (2 per cent.) being now worked in this way. Slow progress has been made in electrifying light railways, only about 5 per cent. of the latter being so far converted. Five short routes are worked with trolley omnibuses. They are Königstein–Königsbrunn (2·5 miles), Grevenbrück–Kirchveischeide (5 miles), Monheim–Langenfeld (2·8 miles) and Haidetalbahn and Johannistal–Niederschöneweide. The maximum gradients of the different tramway systems vary from 1·6 per cent. in Wiesloch to 20 per cent. in Barmen. Great variations are also found in the plant capacity per mile of single line and per motor car. In Bremerhaven, for instance, the plant capacity per mile of single line is but 12·6kw. and 6·6kw. per car, while for Barmen the corresponding figures are 72·5kw. and 29·8kw. In Wiesloch the plant capacity is as high as 60kw. per car. The average figures are 33·2kw. per mile of single line and 15·6kw. per car.

A Simple Method for Calibrating Integrating Meters.—Mr. D. P. Morrison, in writing to the *Electrical World* of New York, is of opinion that tests with "standard meters," as heretofore performed, have involved difficulties, due to the complication of the parts of the meters and to the inability of operation by a single observer, the tests ordinarily requiring two persons for taking observations. The method (described below) is applicable to any type of meter, of any size or capacity, but in the writer's present experience has been used only with two-wire meters of the induction type. In its use neither the windings nor other electrical features of commercial meters need be altered, the only change made being in the recording mechanism, the gears being adjusted to a ratio of 10 to 1 between the disc shaft and the first indicating hand. There

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are provided two hands which record and repeat 100 revolutions of the disc. The disc being graduated to 100 parts, from the combination of disc and dial, revolutions and fractions thereof from $\frac{1}{100}$ to 100 can be observed. In the shunt circuit of the "standard meter" is introduced an ordinary ball spring switch. The method of use is as follows:—The "standard" and the "unknown" are so placed in the circuit that they measure the same load. The switch in the shunt circuit of the "standard" is then opened, and the reading of its disc and dial noted. When the disc of the "unknown" comes to the starting point, the shunt switch is closed, starting the standard, to which no further attention is paid by the observer. The requisite number of revolutions of the "unknown" is noted, and as it comes to the finish, the switch of the "standard" is opened and its disc stopped. Disc and dial are again read, the difference between initial and final observations being the "standard revolutions," which, compared with those observed on the "unknown," give the error of the latter, without reference to the actual load on the two meters. Repeated observations under test have given duplication of results to within one-tenth of 1 per cent. on full load and one-half of 1 per cent. on $\frac{1}{30}$th load. In practice, the "standard" is compared with a reference standard placed in the position of the unknown, the two operations of calibration and test being identical, and, therefore, eliminating any error due to sluggishness in the starting and stopping of the working standard. The reference standard is calibrated in the ordinary way by comparison with indicating instruments. The method has been experimented with for some time on a large system, and has given such good results that a number of instruments have been built and are in constant use.

British Science Guild.—The following memorandum is being circulated by the organising committee of the British Science Guild:—

It has been a frequent subject of comment that, although the contribution of this country to the progress of science has been second to that of no other nation, the English people do not manifest that interest in and belief in the powers of science which are noticeable among the peoples of the Continent or of America. In spite of the efforts of many years, the scientific spirit essential to all true progress is still too rare, and, indeed, is often sadly lacking in some of those who are responsible for the proper conduct of many of the nation's activities. It is with the view of attempting to remedy this evil, and to bring home to all classes the necessity of applying scientific treatment to affairs of all kinds that the proposal is made to bring together those convinced of this necessity by founding "The British Science Guild." The objects and organisation of the Guild, which will be entirely disconnected from party politics, are as follows:—(1) To bring together as members of the Guild all those throughout the Empire interested in science and scientific method in order, by joint action, to convince the people, by means of publications and meetings, of the necessity of applying the methods of science to all branches of human endeavour, and thus to further the progress and increase the welfare of the Empire. (2) To bring before the Government the scientific aspects of all matters affecting the national welfare. (3) To promote and extend the application of scientific principles to industrial and general purposes. (4) To promote scientific education by encouraging the support of universities and other institutions where the bounds of science are extended or where new applications of science are devised. *Methods of attaining these Objects.*—(*a*) By publications. (*b*) By meetings. (*c*) By conferences and lectures. (*d*) By deputations. *Organisation.*—All British subjects, both men and women, are eligible for membership of the Guild; it is expected, however, that its members will be recruited principally from the following:—The House of Lords, the House of Commons, Colonial Legislatures, county, district, borough and parish councils, municipalities, educational committees, scientific and literary societies and organisations, commercial and industrial chambers and organisations, the learned professions, universities, colleges, educational bodies and graduates of all British universities, representatives of labour. At a meeting of the promoters of the Guild held, by permission of the officers, at the rooms of the Royal Society, on April 20, 1904, it was decided that the steps preliminary to the formation of the Guild should be taken by an organising committee, of which the following were appointed members, with power to add to their number:—Lord Avebury, F.R.S., Prof. W. E. Ayrton, F.R.S., Sir G. S. Clarke, F.R.S., Captain E. W. Creak, R.N., C.B., F.R.S., Mr. Clive Cuthbertson, Dr. W. Garnett, Mr. Sidney Lee, Sir Norman Lockyer, F.R.S., Lady Lockyer, Mr. N. Macoll, Prof. Raphael Meldola, F.R.S., Prof. J. Perry, F.R.S., Sir Gilbert Parker, M.P., Sir William Ramsay, F.R.S., Dr. W. N. Shaw, F.R.S., Prof. S. P. Thompson, F.R.S., Dr. Augustus Waller, F.R.S., Sir Henry Trueman Wood. The organising committee has elected Sir Norman Lockyer president, Lord Avebury honorary treasurer, Lady Lockyer honorary assistant-treasurer and Mr. C. Cuthbertson, honorary secretary. It was resolved that life members of the Guild shall pay on admission two guineas, which includes a registration fee of 2s. 6d., and that annual subscribers shall pay on admission 5s., and in each subsequent year 2s. 6d. It was also resolved that donations may be accepted. The committee are now engaged in communicating with those corporate bodies and individuals whose support and sympathy are desired. A general committee will be appointed, which will subsequently select from among its members an executive committee for the management of the affairs of the Guild. The executive committee will meet from time to time as their chairman may direct, and will formulate such rules as experience may suggest for the approval of the general committee. The general committee will probably take power to appoint or approve local and special committees, which will act as branches of the Guild.

Steam Engine Tests.—In a Paper read last Friday week before the Institution of Mechanical Engineers, Mr. E. G. Hiller announced the results of a set of elaborate tests undertaken with a view of determining the commercial and technical efficiency of a 1,200 H.P. horizontal compound steam engine installed about 12 months ago at the mills of the Bessbrook Spinning Co., Bessbrook, Armagh, by Messrs. J. and E. Wood. The Paper is of special value as it touches upon the question of the saving effected by re-heaters. Authorities are by no means agreed upon this point, and the present contribution with regard to the commercial value of re-heaters is, therefore, all the more interesting. The engine makes 65 revs. per min. and worked during the tests with steam at 155lb. per square inch and superheated to from 441°F. to 450°F. Unjacketed cylinders are used and a re-heater is fitted to raise the temperature of the low-pressure cylinder steam. For re-heating purposes steam is taken by a separate 3in. branch from the main steam pipe. Some of the principal dimensions of the re-heater, which is built of mild steel, are: Diameter of outer shell, 3ft. 11in.; number of tubes, 101; internal diameter of tubes, 2¼in.; heating surface exposed to heating steam, 600 sq. ft. Both the cylinders and the re-heater are covered with non-conducting material. During the tests the average indicated horse-power was 980, and the mean steam consumption, as determined by measuring the water fed into the boiler, was found to be 11·3lb. per indicated horse-power-hour. Results obtained without the re-heater in use showed that the consumption of steam was 0·51lb. more than when the re-heater was employed. It is calculated therefrom, after making all due allowances, that the coal saving effected per year, assuming that the engine works with the same load as at the test, is about 67 tons. The engine was, however, designed for a load of 1,200 H.P. Calculated on this basis, the saving effected per year is about 85 tons. The price of coal at the mill is 16s. per ton, so that the annual saving will be about £70 with the load at 1,200 H.P. The cost of the re-heater over that of the usual connecting pipe between the cylinders, taking into account the extra cost of carriage and erection of the re-heater, is estimated by the makers at £226. The above savings, therefore, represent the annual return on the initial cost of 24 per cent. when the engine is working at 980 H.P., and of 30 per cent. when the engine is working at the power for which it is designed. Allowing 12½ per cent. for interest on the capital, depreciation of plant and attention, the respective annual savings are £25 and £40 per annum. It is interesting to note the alteration in the distribution of power between the two cylinders with the re-heater in use and out of use. When the engine was working with steam in the re-heater, the power in the high-pressure cylinder exceeded that in the low-pressure by about 17 H.P. On the subsequent test, with the re-heater out of use, the high-pressure cylinder developed about 103 H.P. more than the low-pressure cylinder, being about 44 H.P. increase on its previous load. Supposing the high-pressure cut off to remain the same with the re-heater as without the re-heater, then under the latter condition, owing to condensation, there is a less quantity of steam passing through the low-pressure cylinder and a lower power developed in that cylinder than with the re-heater. Thus one direct result of the use of the re-heater is a substantial increase in the available power of the engine. Assuming 2,800 working hours per year, with the engine developing 1,000 H.P., the running costs per indicated horse-power-hour are as follows:—Coal for engine and banking, 2,000 tons at 16s., 0·1370d.; stokehole labour, 0·0103d.; engine house and rope race labour, 0·0103d.; oil and stores for all plant and rope race, 0·0094d.; upkeep and minor repairs and insurance, 0·0095d. Total, 0·1765d. The capital cost of the whole power plant, including a travelling crane but excluding the buildings, is given as £9,660, and nothing is paid for water.

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THE NORTH-EASTERN RAILWAY AND CARVILLE POWER HOUSE.

(Continued from page 595.)

Permanent Way.—The lines upon which electrically-propelled trains are now running have been divided up into sections as shown by Fig. 19, the section switches being of the ordinary knife pattern, situated in the various signal cabins. Telephones connect the cabins together, and if a signalman desires to cut off current from any section he simply has to open the corresponding switch in his cabin and telephone through to the signalman in the cabin at the other end of the section to do the same. The section from Gosforth to Ponteland is new and is very nearly completed. Altogether, there are 37 miles of track, comprising single, double and four-line, equivalent to about 82 miles of single track, all of which is equipped with a single third-rail, the running rails being employed for the return. The construction is of a very substantial nature owing to the heavy traffic with which it will have to deal. Up to the present time only passenger trains are propelled electrically, but the company intend applying electric traction to goods traffic, and have already built locomotives and motor fish vans for the purpose. As may be seen from Fig. 20, the third-rail is fixed outside the running rails, and is only protected by guard planks at stations, &c.; the voltage is 600. The rail itself weighs 80lb. to the yard, is of Vignoles section high-conductivity steel, and is supported by reconstructed granite insulators carried on cast-iron pillars. On double track the live rails are fixed between the two pairs of running rails, but at certain places where this arrangement has not

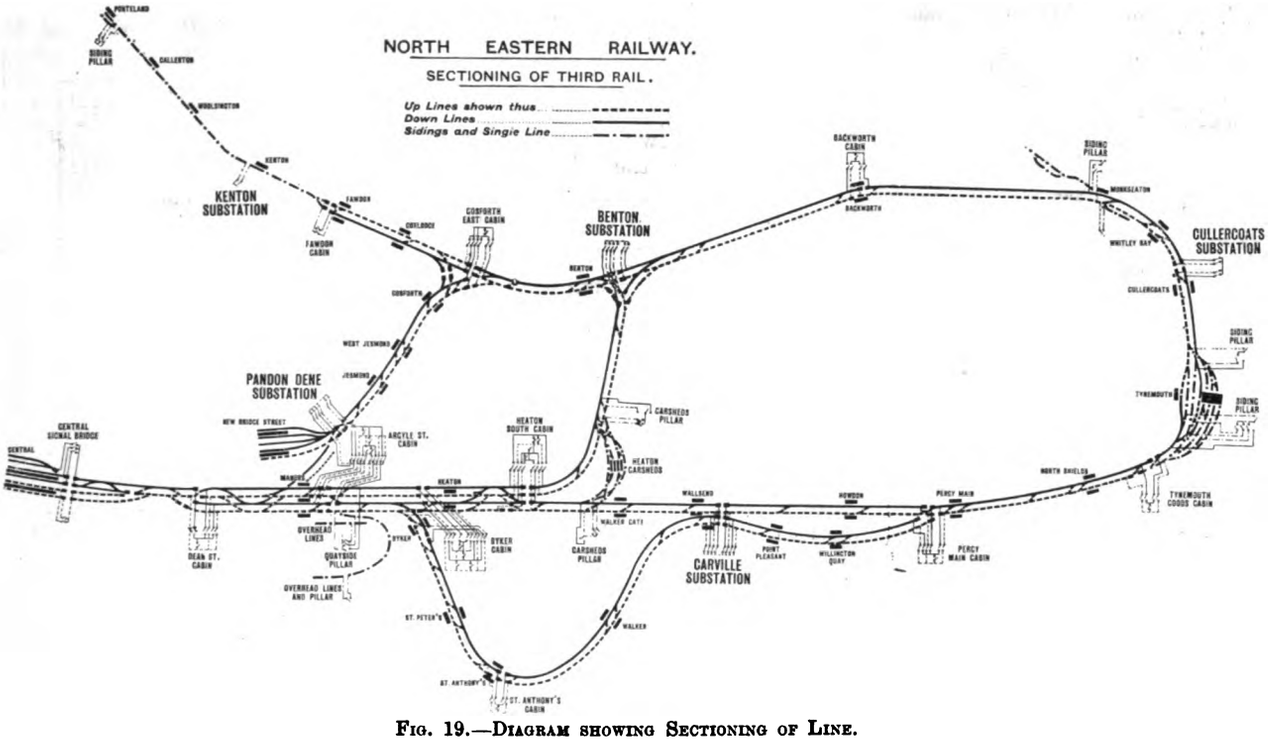

FIG. 19.—DIAGRAM SHOWING SECTIONING OF LINE.

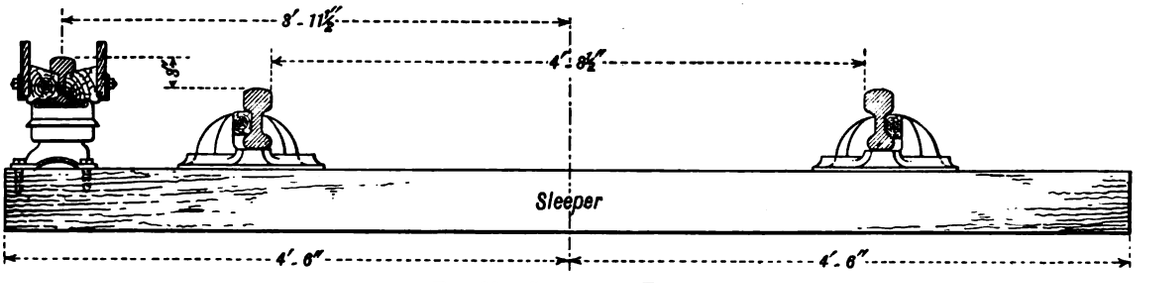

FIG. 20.—SECTION OF TRACK.

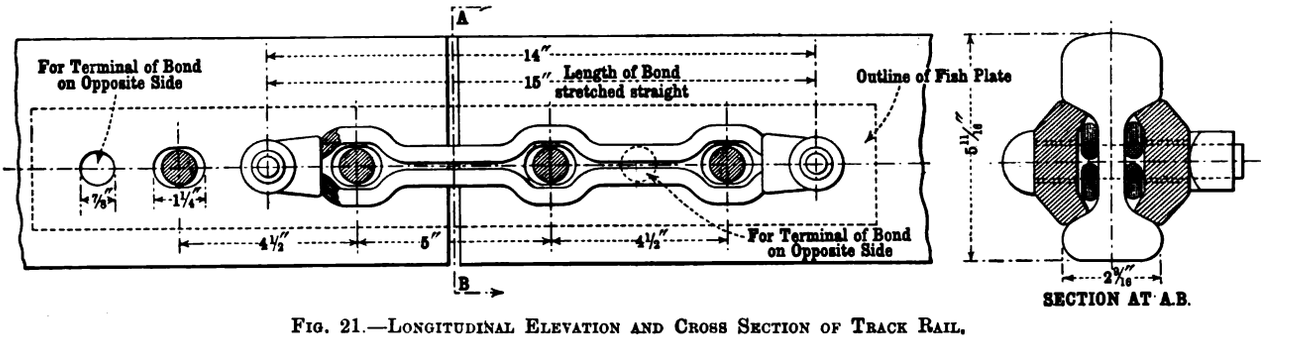

FIG. 21.—LONGITUDINAL ELEVATION AND CROSS SECTION OF TRACK RAIL.

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been found convenient, they have been fixed on the outside. Owing to the fact that the third-rail has been fixed in the six-foot way it will, of course, be a matter of comparative ease to provide an insulated return should circumstances demand it. Bonding of the third-rail has been carried out with a modified form of the B.T.-H. crown rail bond, which is fixed by means of a steel core, shaped like a double-headed rivet, cast in the terminal. The ends of the core project about $\frac{1}{8}$in. beyond the copper and it is slightly expanded at the middle, otherwise being of a cylindrical form before fixing. Hydraulic pressure to the extent of about 20 tons per square inch is applied to the ends of the core until they are flush with the copper. The

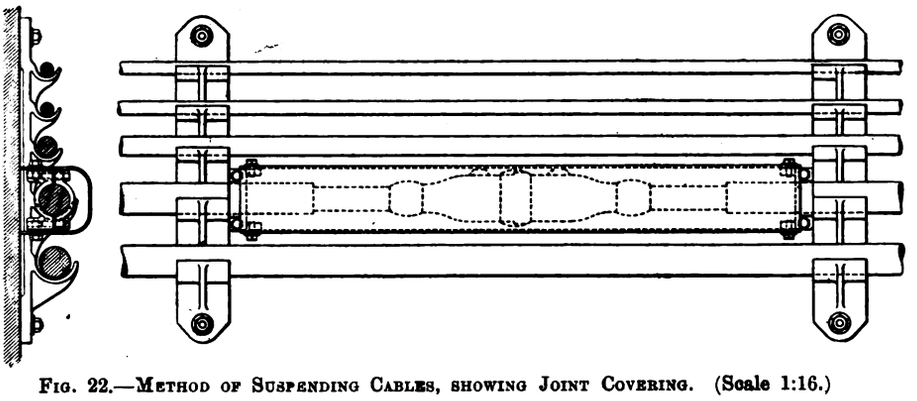

FIG. 22.—METHOD OF SUSPENDING CABLES, SHOWING JOINT COVERING. (Scale 1:16.)

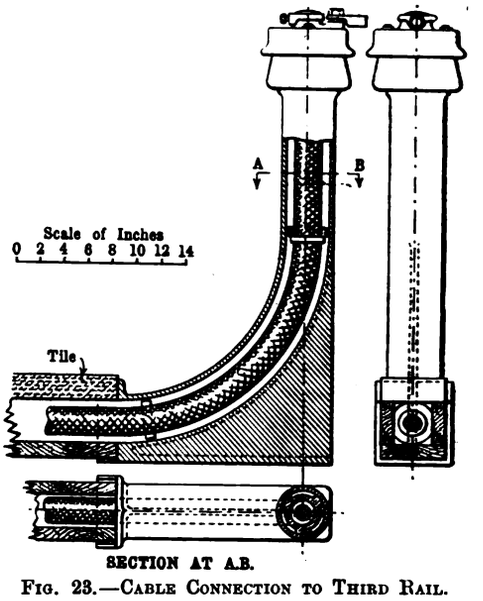

FIG. 23.—CABLE CONNECTION TO THIRD RAIL.

ends of the core being of hard steel and its middle part of softer metal it is obvious that when pressure is applied, considerable expansion takes place within the hole in the rail. Thus, a very tight and satisfactory job results. Fig. 21 shows the method of bonding the running rails, and with the exception of actual dimensions this illustration also shows the appearance of the third-rail bonding. When considering the subject of bonds for the running rails it was found that the existing fish-plates were unsuitable, as there was not sufficient space for the bonds to lie between them and the rails. It was, therefore, necessary to replace them, and a special design was got out by Mr. C. A. Harrison, engineer to the line.

All low-tension cables are lead covered, mostly of 1 sq. in. section, laid solid. In certain cases, where there was not sufficient depth of ground for them to be laid solid the lead-covered cables have been replaced by others protected by armouring laid direct in the ground. Where neither of these methods has been feasible, the cables are suspended from the wall or along bridge girders in a similar manner to that adopted for high-tension conductors. The low-tension cables throughout the system were supplied by Messrs. Callender's. Considerable time and thought was expended in devising a satisfactory method of attaching feeders to the third-rail and running rails, and Figs. 23 and 24 illustrate the device which was finally evolved. The cable is brought up through an iron pipe, on which is cast a flange as shown, and the insulation is stripped off for a few inches above the top of the pipe. The annular space between the cable and the interior of the pipe is filled with bitumen and a porcelain cap fitted on to the top of the pipe. On the porcelain there is a brass cap into which the core of the cable is soldered, and the centre of this is covered by a small cap. Finally, the empty space above the bitumen is filled with hot compound, and the ends of four bonds are sweated into the lug, the other ends of the bonds being, of course, connected to the rail. The method of connecting return feeders to the running rails is similar to that just described, with the exception that the cable end is placed underground in a small cast-iron box, while those of the third-rail are several inches above ground. This enables a distinction to be made without the least trouble, and it will be seen that disconnection for testing or other purposes is a matter of ease. At crossings, the running rails are cross connected by cables laid solid under the tracks, the terminals consisting of sleeves into which the cables and bonds are sweated. The sleeves are then buried in wooden boxes filled with compound.

Rolling Stock.—There is practically no departure from standard practice in the design of the rolling-stock, and the general principles were given in *The Electrician*, Vol. LII., p. 519. Mr. Wilson Worsdell, the chief mechanical engineer to the company, designed the bodies of both the motor and trailer coaches and they were subsequently built by the company at their York works. The trucks, of which there are two four-wheeled bogies to each car, were built by the Brush Company and supplied by the British Thomson-Houston Co. There are two 150 H.P. motors to each motor

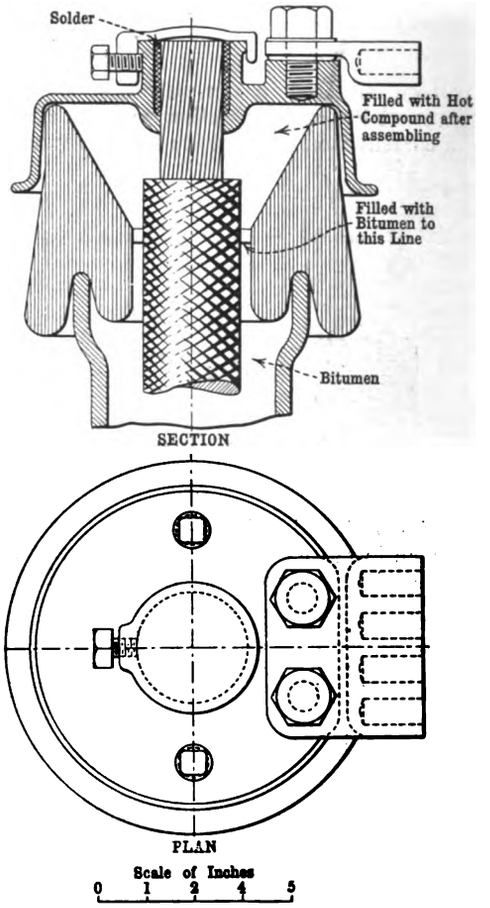

FIG. 24.—CABLE HEAD, INSULATOR AND BRASS CAP.

coach and both are carried on one truck, the other truck being simply a trailer. A feature deserving special attention is the arrangement which has been made for holding the collector shoe some 3in. off the third-rail when necessary. This is apparently the first time such an arrangement has been

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employed on any third rail shoes in this country, and it is found to be of very great convenience in isolating a coach electrically in any case of emergency, such as a fault on a train line of any particular coach or when it becomes necessary for shunting or other purposes to bridge a gap between a live section and a dead faulty section. It also affords a larger margin of clearance when the trains are being hauled over non-electrified lines. The shoes in use are comparatively light, but they do not altogether depend upon their own weight for making contact, as will be seen from Figs. 25 and 26. Two spiral springs are provided, which cause a downward thrust on a short vertical pivot bar,

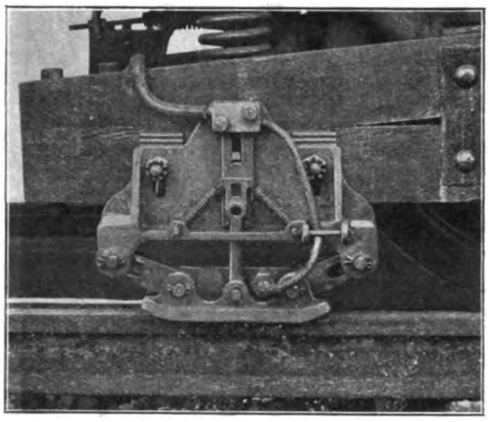

FIG. 25.—SHOE ON THIRD RAIL.

and this bar also serves as a suspension link to hold the shoe in the lifted position. To lift the shoe a short wooden rod with a ferrule at one end is carried on the train, and when inserted into a hole in the vertical bar enables the motorman to give it an upward and outward movement and to engage its upper part in the hook seen in the top of the casting. This hook has a free motion in a slot in order to prevent its fouling the top of the vertical bar during the ordinary operation of the shoe. A special feature in connection with the control equipment worthy of notice is the method of securing automatic acceleration. By means of this arrangement the rate of acceleration of the train is maintained constant until the

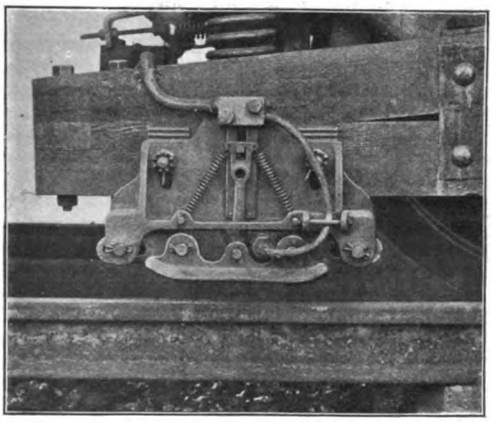

FIG. 26.—SHOE LIFTED.

full multiple position of the controller is reached. Its operation is extremely simple, the driver only being required to throw his power handle to full series or full multiple position as desired, and hold it in that position until he wishes to shut off current. The act of turning the power handle forward winds up a spring which drives the control cylinder forward at a uniform rate. To prevent the operating cylinder from moving too rapidly, its speed is regulated by a limiting device, and the rate of current input is regulated by a current relay in series with the motor circuit, which closes a local circuit, locking the master controller cylinder against movement until the accelerating current has fallen sufficiently to release the master control cylinder for the next notch. The motorman, in accelerating notch by notch, controls the train in exactly the same manner as with the ordinary manually operated master controller; the automatic feature, coming into operation only when the rate at which the operating handle is turned on, would allow more than the desired amount of current to pass through the motors if it were not limited. The entire train is synchronously controlled from the forward car, and the only current-limiting device in use on the train being under the

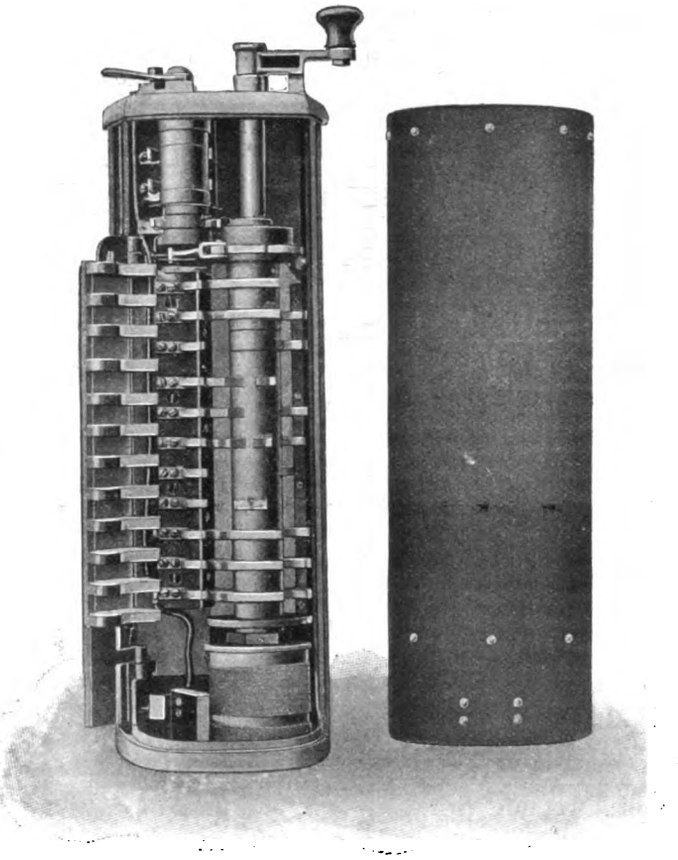

FIG. 27.—B.T.-H. CONTROLLER.

immediate supervision of the motorman, its derangement does not affect the proper handling of the train. Fig. 27 shows the controller as used on the North-Eastern Railway, and which was supplied by the British Thomson-Houston Co.

(To be concluded.)

ELECTRICALLY-OPERATED TEMPERLEY TRANSPORTERS.

Attention has been repeatedly drawn in these columns to the advantages which electrically-operated transporting appliances possess over those operated by other means, and we propose giving a brief description of electrically-driven transporters installed in two electricity works by the Temperley Transporter Co.

Fig. 1 represents a longitudinal section of the boiler house of the Hornsey Urban District Council's electricity works, which is fitted with a fixed horizontal transporter for delivering coal into the bunkers over the boilers from trucks on the railway siding. The transporter beam is bolted to the girders above the doorways and to light steel A frames on the bunkers. The portion of the beam projecting beyond the front wall of the building is supported by steel wire rope slings from a steel A frame and back stay as shown. As constructed, the transporter beam, the A frame and back stay form a self-contained structure which is quite independent of the front wall of the building and the roof. On the beam runs a double-purchase traveller (Fig. 2), fitted with the automatic dumping fall block. Single-purchase travellers are fitted in other cases, and both types may be run at speeds sometimes exceeding 1,000ft. per minute. Standard sizes of double-purchase travellers made by the firm are able to handle 35 cwt. and 50 cwt. respectively, while the single-purchase type is employed for loads up to 30 cwt.

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The double-purchase traveller is fitted with a bronze cam having a projecting tooth which engages with notches or stops on the underside of the beam, thus locking the traveller to the beam while the load is being lifted or lowered. When the fall block carrying the load is lifted by the hoisting rope into the traveller an ingenious and automatic mechanism causes the suspender hooks to close in immediately securely supporting the fall block and load, and also causes the cam to rotate, thus unlocking the traveller from the stop on the beam. It may then be travelled along the beam in either direction by hauling in or paying out the hoisting rope. Travellers are arranged to run on either inclined or horizontal beams. On inclined beams the weight of the traveller with or without its load causes it to run down the beam, and when the beam is horizontal an overhauling rope is attached to the traveller and connected to a set of counterbalance weights. After travelling along the beam to any desired position the traveller is locked to the beam at the will of the operator by reversing the engine. This action causes a toggle to rotate the cam, the tooth of which engages with the stop on the beam, securely locking the traveller to the beam and causing the suspender hooks to open out, permitting the fall block and load to be lowered, the speed of lowering being controlled by the brake. All operations—viz., lifting the load, transporting it along the beam, lowering and automatically dumping the skip—are effected by traveller; during the lifting of the load, therefore, it cannot be prematurely dumped. By dumping close to the ground breakage and dust are avoided. In cases where it is desired to weigh the material and to record the weights, a section of the beam is made to form the table of an automatic weighing machine.

At the electricity works referred to, the plant had to be so arranged that any one of the six trucks standing on the railway siding could be unloaded without shunting, and for this purpose a narrow-gauge track parallel to the siding was provided, on which a trolley runs for bringing the full skips under the transporter beam. Only one labourer is employed to fill the skips from the trucks and hook them on to the transporter.

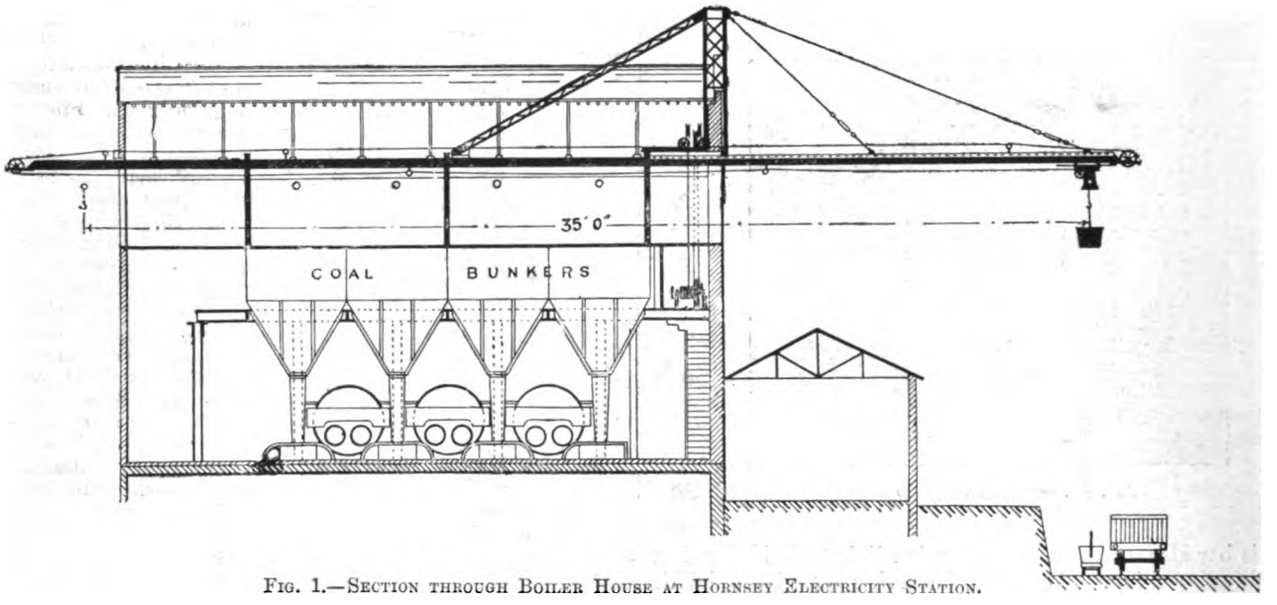

Fig. 1.—Section through Boiler House at Hornsey Electricity Station.

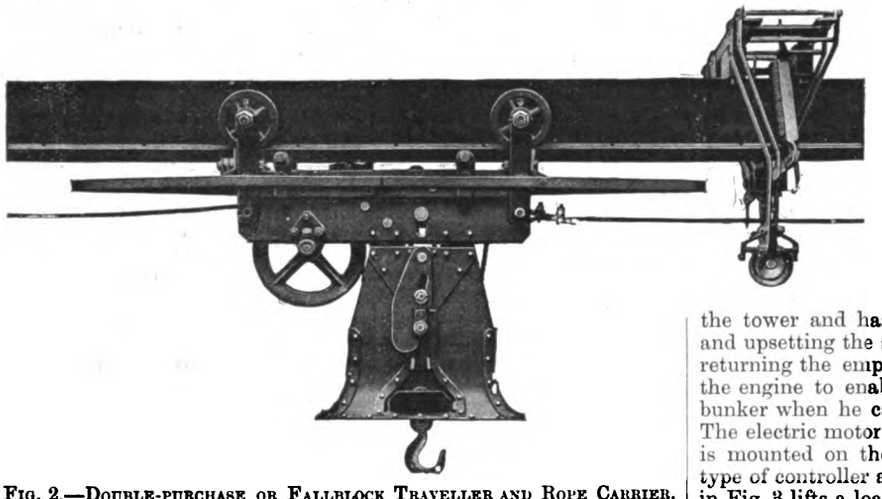

Fig. 2.—Double-purchase or Fallblock Traveller and Rope Carrier.

simply hauling in or paying out a single rope. Fig. 2 also shows one of the rope carriers, which are fitted to the beam at intervals of 40ft. to 50ft. for supporting the hoisting rope. The traveller is fitted with a shuttle, which opens the rope carrier, permitting the traveller to pass through at very high speeds.

If the matter being handled is carried in automatic dumping skips, as is the case in the plant shown in Fig. 1, the loaded skip is lowered to whatever level may be desired, and then, immediately on commencing to haul in the lifting rope, the mechanism in the fall block trips the latch of the skip, which at once dumps the load and returns empty to the starting point. The mechanism cannot act before the fall-block has entered and left the

A transporter similar in many respects to the one just described has been erected at the West Ham electric lighting and power station for discharging coal from lighters into the overhead bunkers in the boiler house. The beam, which is 316ft. long, is bolted to a steel tower erected near the river bank and to steel A-frames mounted on the coal bunkers, the portion overhanging the river and the span between the river and boiler house being supported by steel wire rope slings and stayed laterally by rigid steel bracing. The double-purchase traveller is fitted with the automatic dumping fall block, and carries automatic dumping skips of 50 cubic feet capacity to contain about 25 cwt. of coal. The height of lift is 45ft. and horizontal travel 300ft.

Power for operating the transporter is obtained from an electric motor driving through spur gearing on to a drum of large diameter, so as to enable the long length of operating rope, about 390ft., to be coiled in one lap. The speed of lowering is controlled by means of a powerful band brake acting on a brake rim cast direct on the drum and operated by a foot lever. A section of the beam within the tower is arranged as an automatic weighing and recording machine, so that the coal can be weighed before being discharged into the coal bunkers. The driver is stationed on the platform of the tower and has entire control over lifting, travelling, weighing and upsetting the skip, discharging the coal into the bunkers and returning the empty skip to the vessel, an indicator being fitted to the engine to enable the driver to empty the coal into any desired bunker when he cannot see the loaded skips within the building. The electric motor is series wound, of the ventilated enclosed type, is mounted on the engine bed-plate, and is complete with crane type of controller and resistances. The particular engine illustrated in Fig. 3 lifts a load of 1 ton at 240ft. per minute and travels this load along the transporter beam at 600ft. per minute. Occasionally loads of 2 tons are lifted at a slower speed. The end thrust due to putting the drum into gear by the friction clutch is not transmitted to the side frames, but is taken up within the drum shaft itself by means of ball thrust bearings.

Fig. 4 shows an electric crab or telpher with lifting and travelling gearing and fitted with an automatic grab of the single-chain type. These crabs generally have cast-steel side frames fitted with gun-metal bushed bearings for the various shafts. The drum, which may be grooved for either steel wire rope or chain, is driven through spur gearing by an electric motor bolted to the side frames. All travelling wheels are coupled together and driven through spur or bevel gearing by the same motor, suitable clutch gear being provided

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for putting either the drum or the travelling wheels into gear. Separate powerful band brakes are fitted to both the lifting drum and travelling gearing. The gear wheels have machine-cut teeth, and the pinion on the motor shaft is of phosphor bronze. The motor is series wound either of the totally or semi-enclosed type, complete with controller and resistances. Current is taken up by means of two hinged trolleys running on bare copper conductor wires carried by insulators bracketed off the beam on which the crab runs. The controller handle, the clutch and brake levers are assembled within easy reach of the driver, who travels with the crab and is provided with a seat attached to the side frames; he has complete and exact control over all operations of lifting, travelling and lowering the load.

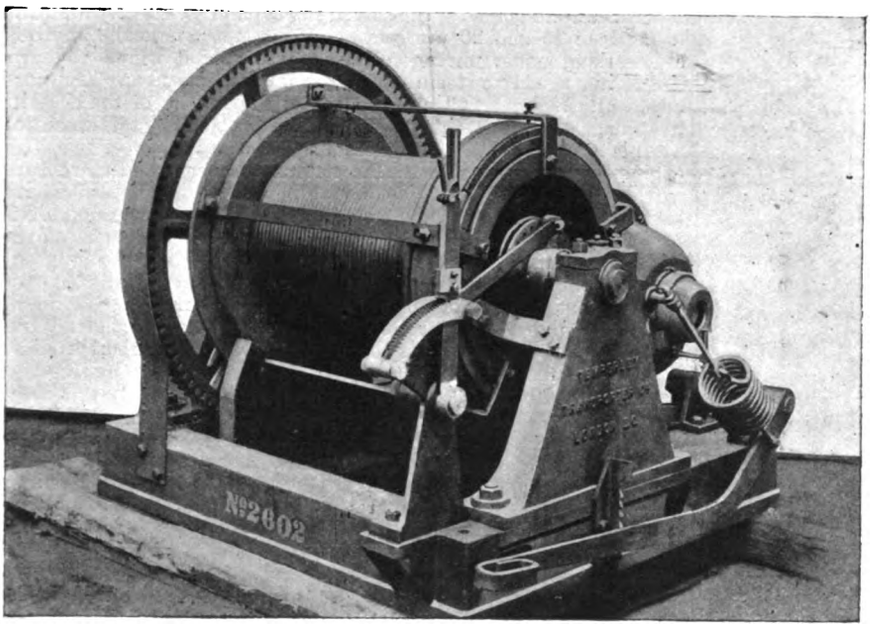

FIG. 3.—ELECTRIC TRANSPORTER ENGINE.

In the illustration the crab is shown carrying a grab, which is used when handling coal or other material in bulk in cases where a grab can be used with advantage in preference to hand-filled skips. It is of the simplest type, is self-contained, requires no special adjustment or balance gear, and the loading and discharging is entirely automatic, the method of working being as follows:—The open grab is lowered on to the heap, and when the driver starts to lift the blades close and the grab is filled, lifted and transported along the beam to the point of discharge. On lowering to the required height the grab is opened and the contents discharged by the tripping of a lever. The tripping gear can be fixed at any height.

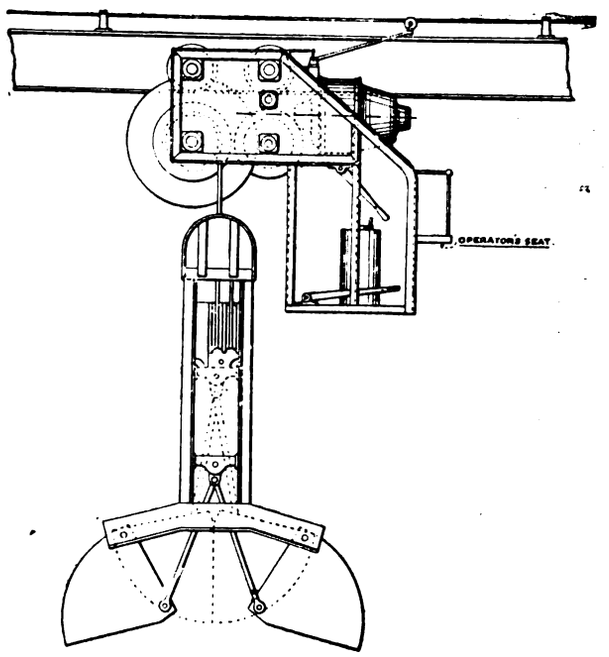

FIG. 4.—ELECTRIC CRAB AND GRAB.

BOILER HOUSE ECONOMIES.*

BY REGINALD S. DOWNE.
(Borough Electrical Engineer, Southport.)

Coal in some cases accounts for 50 per cent. of the total costs. None of the items which make up the total costs of production, with the exception of coal, are capable of being materially reduced, as the economical limit has been reached; any further reduction can only be brought about by increased output. In a Paper read by Mr. A. S. Giles, in January, 1904, before the Manchester Section of the Institution of Electrical Engineers, Mr. Giles published a table giving particulars of coal consumption, load-factor, &c.† The stations there tabulated represent fairly well the best practice now prevailing in this country, yet the particulars given are so widely divergent that it is difficult to account for them. For instance, non-condensing stations with moderate load-factor and low-priced slack consume 6·51lb. per unit generated, whereas there are condensing stations with similar-priced slack and higher load-factor consuming 10lb. and upwards.

The great majority of stations burn bituminous slack, costing from 6s. to 12s. per ton delivered in the bunkers. Where the railway rate is high and smoke conditions stringent, Welsh coal is used; in a few cases where it is available, smudge or low-grade fuels are burned. This point is entirely settled by local conditions. Assuming bituminous slack is used, in a well-designed condensing station, with economisers and superheaters, and having a load factor of not less than 15 per cent., in the author's opinion, with the experience at present available, it ought not to exceed 5lb. This quantity of coal should cover all losses between the furnace and the engine. Several private industrial plants are now generating a unit of electricity with 3lb. of cheap slack. No comparison, however, can be made between the coal consumption of private plants and public supply stations, the nature of supply being totally dissimilar.

Before this problem can be dealt with it is necessary to know where the losses are taking place; are they due to low boiler efficiency, steam range losses, excessive steam consumption of engines, or all three? To enable this to be ascertained it is necessary to have a rigid weekly analysis of units generated, together with coal and water used. In most works completed quite recently provision has been made for these measurements, and it is possible to have a daily analysis which enables a close check to be obtained and any discrepancies to be immediately looked into. A number of stations of earlier date are not so well provided in this respect. It is, however, possible for all to obtain the weekly consumption of coal, and thereby calculate the pounds of coal per unit generated. The measurement of water, unfortunately, is not such a simple matter; in many cases where the supply is not obtained from the town's mains it is not possible. Several stations have recently had water meters fixed; in some cases to each boiler, and in others to the main feed ranges. The author has tried several types of meters fitted on the suction and on the delivery sides of the feed pumps, but found after a few weeks of constant running that water was passing without being recorded. In a large number of evaporation tests recently carried out by the author, meters have been discarded and two measuring tanks used instead. Where a duplicate feed range is available, tests of this character are quite simple. If it is not possible to isolate an economiser for the purpose of a test, hot water from the economiser delivery can be run into one tank, whilst the other is being emptied and pumped into the boiler at 190°F. to 200°F.

THE EFFECT OF OUTPUT AND LOAD-FACTOR.

The effect of a bad load-factor is more pronounced in the boiler-house than in the engine room. Diagram I. attached shows Southport curves of load-factor, output and pounds of coal per unit generated for the year 1903-4. According to Stromeyer:—

Under ordinary working conditions the radiation from a boiler amounts to from 5 to 10 per cent. If we work a boiler only at half of its power the amount of radiation will still be the same, for the steam temperature is not altered, but the ratio of loss by radiation to heat put into the boiler is doubled. On the other hand, if a boiler is overworked, resulting, of course, in inefficiency of the heating surface, the relative loss by radiation is very much reduced.

* Abstract of a Paper read before the Incorporated Municipal Electrical Association.

† *The Electrician*, Vol. LII., p. 531.

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From this it appears conclusive that the number of boilers under steam should be kept to the minimum possible, and some method of assisted draught fitted to help us over the peak of the load. The author thinks it will be admitted that with the class of slack usually burnt, under natural draught, the boiler duty is much lower than the maximum ; in many cases the number of boilers under steam could be reduced 25 per cent. The station with which the author is connected has Lancashire boilers, and the coal required for lighting and banking fires has been found in the winter months to amount to between 5 and 7 per cent. of the coal consumed. There was a difference of 2 per cent. in economy between banking fires on the 8ft. 6in. boilers, and allowing fires to die out on the 7ft. boilers,

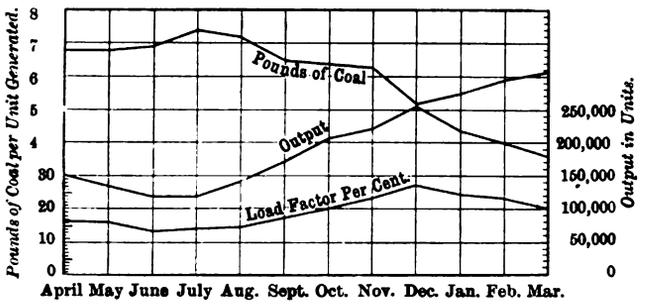

DIAGRAM 1.—RELATION BETWEEN COAL, OUTPUT, AND LOAD-FACTOR.

and vice versa. A considerable amount of coal may be saved by finding out what banking conditions are most suited to the boilers at different periods of the year.

BONUS SYSTEM FOR FIREMEN.

In a test quoted by Mr. Bryan Donkin, four good stokers were put to fire the same boiler—a two-flued 30ft. Lancashire—under the same conditions. There was a difference between the most and least expert of 23 per cent. in capacity and 18 per cent. in economy, a saving of £7 to £8 per week, with coal at 10s. per ton. All raw material from which there is no valuable by-product passes through the hands of the fireman. As a rule he does his best—*i.e.*, with a fluctuating load, he draws a fairly straight line on a recording steam pressure chart. He knows that the less coal he throws on the less manual labour he is called upon to perform; he may also have a conscientious idea that by economising coal he is husbanding the national resources. Generally speaking, beyond that he has no incentive to economy, and, provided he keeps a steady head of steam, is not interfered with. The man who actually burns the coal is the one who can effect the economies.

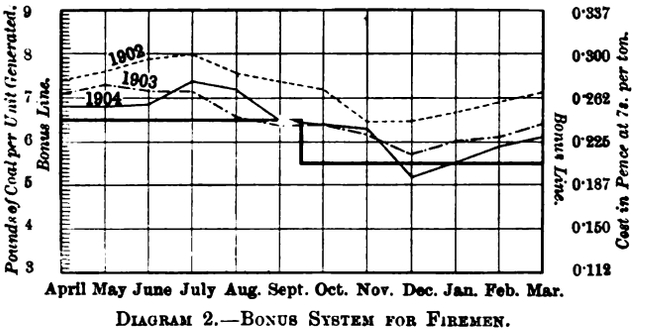

DIAGRAM 2.—BONUS SYSTEM FOR FIREMEN.

When the managing engineer has convinced himself that there are no leakages through the brickwork, when the dampers are easily accessible, draught gauges have been fitted to the chimney and each boiler, and a CO_2 recorder has been fixed, he has done all that can possibly be foreseen, and the rest must naturally be left to the leading firemen. A pecuniary incentive is a great help towards reducing the coal bill. If a central station has not reached what it considers its minimum coal consumption, it is worth while paying at least 2s. to save 20s. worth of coal, which it could not otherwise do. It would be interesting to know what results have been obtained by this means. At Southport a coal bonus has been recently introduced, and the following particulars have been added, as they may be of interest to the members :—

The present contract price of coal is 7s. per ton, delivered in the bunkers.

The approximate number of units generated per annum = 2,327,600.

The average number of units generated per week = 44,800.

A saving of one-tenth of a pound of coal per unit generated on the averaged weekly output = 4,480lb. = 2 tons, worth 14s.

Per month of four weeks = £2. 16s.

The bonus is divided amongst the four leading firemen and is distributed monthly.

It has been fixed at 1s. per week per fireman for each tenth of a pound of coal saved—*i.e.*, for every 56s. worth of coal saved, 16s. or 28·5 per cent. is given as bonus.

The pounds of coal below which a bonus is given has been fixed for the next financial year at 6·5lb. for the summer months and 5·5lb. for the winter months. If we have to pay more for our coal the saving per ton is proportionately greater. Diagram 2 shows the bonus line at present fixed, and the pounds of coal consumed for each month during the past three financial years, the load-factors being 14·22, 15·31 and 14·49 respectively.

SUPERHEATING.

No practical difficulties are experienced by using a moderate superheat up to 500°F. The saving in coal and steam may amount to between 10 and 20 per cent., and is greater where the engines are working under uneconomical conditions, and where a steam ring is in use, or the steam ranges are inordinately long. A superheater attached to a boiler may abstract 10 per cent. of the heat in the flue gases, and reduce the efficiency of the boiler by this amount; as this 10 per cent. extra heat in the steam may reduce the engine losses by 20 per cent., the net gain is very great and alone would warrant adoption. The saving in steam is greater than the saving in coal, due to fuel being required to obtain the superheat. Many stations are now working with superheaters in side flues which only increase the temperature some 50°F.; the gain in economy though great could be increased a further 5 per cent. by raising the superheat an additional 50°F. at the engine.

The author has superheaters fitted in the downtakes of all his Lancashire boilers, and has been able, by adding firebrick combustion chambers, to raise the temperature of the steam leaving the superheaters from 80°F. to 150°F. Superheaters fitted in this way give a fairly constant degree of superheat, and require practically no attention. A consideration of the various types of superheaters is outside the scope of this Paper, but the author is of opinion that where a high superheat of constant temperature is required (as in pure turbine stations), separately-fired superheaters would be preferable.

The following figures were obtained at Southport on two eight-hour tests carried out on a 250 I.H.P. horizontal Musgrave-Corliss condensing engine, supplied with steam from a 7ft. by 28ft. hand-fired Lancashire boiler, with and without a Musgrave superheater :—

——	Without superheater.	With superheater.	Saving per cent. in favour of superheater.
Water per I.H.P. per hour, lbs.	16·30	13·58	17
Water per unit, lbs.	29·27	24·24	
Coal per I.H.P. per hour, lbs	1·89	1·60	16
Coal per unit, lbs	3·40	2·86	

Average superheat at engine 85°F.

At the time of this test a ring steam range was in use, which has since been discarded; a similar test, if taken to-day, would not show quite the same saving.

MECHANICAL STOKING AND FORCED DRAUGHT.

Mr. Giles' table, referred to above, does not show that stations mechanically fired are more economical than those hand fired. In a large power house having modern coal handling plant, mechanical stokers undoubtedly save labour, and where the load-factor is high give economical results. In the class of station under consideration—viz., that having a total plant capacity not exceeding from 4,000 I.H.P. to 5,000 I.H.P., mechanical stokers are usually employed to enable bituminous coal to be burned with a minimum of smoke. Where the coal has to be thrown into the hoppers by hand there is no saving in labour, and it is doubtful whether any economy can be shown over hand firing when the interest, repairs and cost of running are taken into account, while on the other hand there may be obvious disadvantages. Many types of stokers require steam for cooling the bars, and in one station where this was tested it amounted to as much as 11·5 per cent., but this was afterwards reduced to 8 per cent. At sea, where the conditions do not lend themselves to mechanical stoking, good results are unquestionably obtained by hand firing.

A chimney is a rough-and-ready way of inducing the air to flow into the furnaces with sufficient velocity to cause the fuel to burn. It has the merit of being absolutely reliable and the upkeep is nil. Energy must be expended in bringing the air to the coal, but as a chimney may require 20 per cent. of the heat units in the coal, this work may be carried out much more efficiently by other means. The apparent advantages of forced draught are :—(1) The steaming power may be increased 30 to 40 per cent. without injury. (2) Higher temperature of combustion, giving a higher evaporative effect for the fuel. (3) Air supply under control. Stromeyer, in his Memorandum (1902), states :—

Perfect combustion is of far more importance, both as regards the efficiency of a boiler and the power to be got out of it, than is, within limits, either the amount of heating surface or its arrangement.

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The furnaces usually fitted by boiler makers are only suitable for burning anthracite coal or coke. As the majority of boilers burn bituminous coal, the efficiencies are extremely low, but could be raised if the furnaces were designed to suit the class of fuel burned. In a coal containing over 10 per cent. of volatile hydrocarbon, a high temperature in the combustion chamber (approx. 1,100°F.) is absolutely necessary for combustion. In most furnaces, when the gases have distilled they immediately come in contact with water-cooled plates, and are reduced in temperature before combustion takes place. Until the temperature of combustion is raised sufficiently high, the thermal efficiencies of boilers burning this class of fuel will remain in the neighbourhood of 50 per cent.

Fuel Analysis.

It is essential that the quality of the coal used should not be frequently changed, otherwise firemen cannot obtain the best results. Some engineers argue that by buying the cheapest slack obtainable in the district, any deviation from the contract must be in their favour, but this method of procedure cannot always be recommended. Calorimeter tests of small quantities of coal, although fairly comparative, are not of much commercial value, because the thermal value of bituminous fuel is augmented by the hydrocarbons, a large proportion of which escape up the chimney without parting with their heat. The calorific value of some soft bituminous coal is equal to that of hard South Wales coals, but in practice the evaporation is much lower. If we obtain the percentage of moisture under similar weather conditions by drying a known weight of slack, and also ascertain the percentage of ash, it is possible to keep a reasonable check on the deliveries. In the author's opinion evaporation tests made under similar conditions give the best practical results. Where a contract is placed with a colliery, fewer deviations in quality are to be expected than where supplies are obtained from a coal merchant or colliery agent; where the colliery works only one seam of coal the conditions are even more favourable. Southport has placed a contract with the nearest colliery under the latter conditions, and the following two tests carried out by Mr. J. B. C. Kershaw, F.I.C., on samples delivered over six weeks show the qualities to be practically identical.

Tests made on Sample after Drying.

Description of sample.	Per cent. moisture.	Per cent. ash.	Per cent. coke.	Per cent. volatile matter.	Per cent. fixed carbon.	Calorific value in Fahrenheit units.
Bickerstaffe slack "A"	8·48	11·00	68·60	31·40	57·60	13,879
" " "B"	7·73	10·85	67·35	32·65	56·50	13,848

Analysis of Flue Gases.

For a complete analysis of the exit gases from a boiler it is necessary to know their chemical constituents, temperature and draught. This information enables the engineer to reduce the loss up the chimney to a minimum; apparatus for carrying out these tests is now available. To obtain the greatest boiler efficiency, the excess of air must be kept as low as possible, and this can only be ascertained by individual tests, and depends upon the quality of coal and the draught available. Every pound of air which passes through the boiler in excess of the theoretical quantity represents a dead loss, as this air has to be heated up from the temperature of the atmosphere to the temperature of the exit gases. To obtain perfect combustion of the fuel, as much oxygen as possible should combine with the carbon to produce carbonic acid. For practical purposes the amount of carbonic acid produced is an index to the state of combustion. Under theoretical conditions, without excess air, 19 per cent. CO_2 would be produced, but in everyday work one might with reasonable attention obtain 12 per cent. CO_2 with an exit temperature of 600°F. The difference between 8 and 12 per cent. CO_2 represents a loss of 8·5 per cent. of the fuel burned.

Many works have recently fitted up recording apparatus to ascertain this percentage, and in most cases the results have been eminently satisfactory and have well justified the outlay. This arrangement for analysing the gases is more convenient than the "snap" method, and the readings are for all practical purposes correct, but can be checked by direct analysis. It is possible to connect the apparatus to each boiler in turn, and by reducing the air leakages, altering the thickness of fires, &c., to raise the average percentage of CO_2 considerably. Without some apparatus of this character it is not possible to keep a close watch on air leakages. Most boilers are surrounded by a quantity of brickwork which is notoriously porous, and, as this brickwork is subjected to great changes of temperature, the air leakage becomes excessive unless it is receiving constant attention. Air leakages, being inwards, are of an insidious character, as they do not show themselves, but have to be searched for.

When boilers are shut down under natural draught there is always considerable air leakage into the main flue, even when the dampers are closed. Sliding dampers require to be an easy fit in their frames, but in most cases this is overdone; an improvement on the usual type of damper might be easily fitted. The brickwork round damper frames is difficult to inspect; generally on being opened up it is found to pass cold air at every joint. This air has a considerable cooling effect on the gases; it decreases the draught and lowers the economiser efficiency. To what extent this cooling is possible is shown by the following figures taken by the author from a range of six Lancashire boilers, No. 6 being nearest to the economisers.

Boilers Nos. 5 and 6 under steam.
Temperature of exit gases taken in side flues at a point 12in. on boiler side of dampers—

Average temperature of exit gases	729°F.
" " " in centre of main flue opposite No. 6 boiler	314°F.
" " of gases entering economiser.....	496°F.
" " " leaving economisers.....	291°F.

The stream of cold air leaking past the four standing boilers passing up the centre of the main flue, and mixing with the hot gases from Nos. 5 and 6 boilers, reduced their temperature 233deg. in 10ft. of flue. The fall in temperature through the economisers was only 205deg. If it is not possible to prevent these air leakages at the dampers, on shutting a boiler down for any length of time, it is advisable to brick up the furnaces.

The author has had one form of CO_2 recording apparatus fitted in his boiler house for the past eight months, and has found it extremely useful. When first installed it was impossible to get more than from 2 to 3 per cent. CO_2 from certain boilers; on tests he has since obtained 15 to 16 per cent. as a maximum, but the average daily running works out about 10 per cent. Two boilers, even after the brickwork had been thoroughly overhauled, would not give more than 3 per cent. CO_2. On further investigation being made, it was found that there was an opening at the back dead plates, just behind the bridges, measuring 30in. by 3in. This was a drastic remedy of the boilermakers for smokeless combustion. On bricking up these openings the CO_2 was equal to that given by the other boilers, and they naturally gave a better duty.

Auxiliary Plant.

Mechanical stokers, economiser scrapers, coal elevators and ash conveyors are now generally electrically driven Most stations, however, still have steam feed pumps which are notoriously inefficient, and may require from 2½ to 3½ per cent. of the steam generated. With a careful subdivision of electrically-driven feed pumps this may be reduced to 1½ per cent. The first cost of the pumps is greater, but after meeting all charges there is a distinct saving, and they are as reliable as any other type of feed pump. It is, however, advisable to have a steam pump as stand-by in the event of any local or other failure of the supply.

Feed Water Purification and Heating.

An exhaustive Paper, entitled "An Inquiry into the Working of Various Water Softeners," by Mr. C. Stromeyer and Mr. W. C. Baron, was recently read before the Institution of Mechanical Engineers, dealing with the different impurities to be found in feed water and their effects on boilers, and the various types of softening and purifying apparatus at present to be found in the market. It is therein stated that—

Scale does not materially reduce the efficiency of a boiler, but it seriously increases its wear and tear, whereby its life is considerably reduced; it also endangers the safety of boilers. The same remarks apply to coatings of grease due to feeding the boiler with water containing condensed steam from the engine. It is highly desirable to remove every trace of grease from the feed-water. This cannot be done by filters, the only efficient method is to add mineral matter in solution to the condensed-water and then to cause precipitation by chemical means.

In every case where water is treated it should be done externally before entering the boiler. For economical steaming a boiler should be clean inside and out, because the transmission of heat is rendered easier and the evaporation is increased.

The temperature to which the feed water can be raised has a decided bearing on the subject, as the economy resulting from raising feed water from 150°F. to 250°F. is 10 per cent.

Prevention of Radiation.

When the boilers and piping have been covered with the most suitable material, it is necessary to have it periodically examined and repaired, as it is usually of a perishable nature. Where it is enclosed in a metallic envelope much waste may be caused if there is contact between the piping and the shield, which may be at nearly the temperature of the steam. Condensation may be reduced one-half if the valve-bodies and flanges are covered. The joint itself may be left exposed, but with superheated steam there is little trouble from leaky joints if the ranges are well drained.

Conclusions.

Perfect combustion of fuel cannot be obtained in any form of boiler, but it ought to be possible to considerably raise the low

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thermal efficiencies at which most of them are working at the present time. What engineers are seeking is the properly-constructed furnace, suitable for the particular class of slack to be burnt.

The author has carried out a large number of evaporation tests at different rates of combustion, and with different forms of combustion chambers, on hand-fired 7ft. by 28ft. Lancashire boilers. The evaporation per pound of coal from and at 212°F. varied from 6·62lb to 7·17lb. Coal burnt per square foot from 33lb. to 17lb. Evaporation from 5,250lb. of water per hour to 3,900lb. and the superheat from 151°F. to 80°F.

One boiler is fitted with steam blowers. On test 5,400lb. of water per hour was evaporated. After deducting the steam taken by the blowers, the evaporation per pound of coal was only 6·21lb. On a special test it was found that the steam jets when giving a draught equal to $\frac{3}{8}$in. in the ash pits required 340lb. of steam per hour, equal to 6 per cent. of the steam generated. The fine ash made by the ordinary furnaces, amounting to 3 per cent. of the coal burned, approximately 200 tons per annum, is dealt with by this boiler; it was found to have an evaporation value equal to one-half that of the slack.

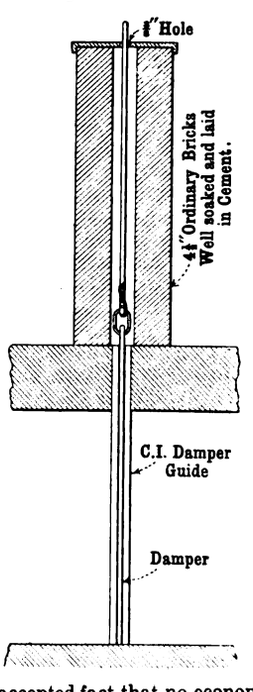
Under the conditions stated, in Southport they obtained an average evaporation of 7lb. of water per pound of coal, having a calorific value of 13,800 B.Th.U. Their average combined boiler superheater efficiency, therefore, is only 52 per cent.

DISCUSSION.

Mr. F. A. NEWINGTON (Edinburgh) said he did not think there should be any difficulty at all in measuring both coal and water accurately. He had used Kennedy water meters for 15 or 16 years, and any troubles that had arisen with them were quite mechanical. He had started a bonus system in a London supply station some 10 or 12 years ago, but it did not apply only to the firemen. It applied to the whole of the station, because the men in the engine room could effect economies equally with the firemen. But he did not think the system had much result. The men took care at first, but, perhaps, as the bonus was reduced this disheartened them. On the question of superheating, he said that moderate superheating should give 10 per cent., but he was afraid it did not. In Edinburgh there was one station with about 50 to 70deg. superheat, and another with no superheating at all. The pounds of coal for the year for the superheating station was 6·25 and at the other it was 6·34. Both stations were more or less the same size. The author must have been lucky in his firemen at Southport. In Edinburgh, firemen were the most careless and almost the most senseless class of men he had to deal with. As regards mechanical stokers versus hand firing, he had almost entirely mechanical stoking. The maintenance of a mechanical stoker was its main drawback. If the coal were burned at a high rate per square foot of grate surface—anywhere from 30lb. to 40lb.—the mere upkeep was enormous, chiefly in firebars. More than half the cost went in these. The maintenance of his stokers worked out at 6·68d. per ton of coal burned. This seemed an enormous sum, and he expected to reduce this by about half by redesigning the stoker. This figure was equivalent to 0·019d. per unit generated. The wages of firemen, trimmers and cleaners was 8·68d. per ton of coal, equivalent to 0·024d. per unit generated. He hoped that members with figures as to hand firing would compare them with these. He thought it hardly fair for the author to compare mechanical stoking on board ship with an electric supply station. On a ship there was a perfectly steady load for 24 hours, and the conditions were entirely different. Moreover, they could make as much smoke as they liked. The smoke question was a difficult one. North country or Scotch coal could hardly be used without mechanical stokers. In fact, he had some difficulty in preventing smoke with them. He was in a large power house at the beginning of the year, and saw some mysterious signals being given, such as "Black No. 1" and "Brown No. 2," &c., and on making inquiries he found there was a man stationed on the roof of each boiler house during the whole of the hours of daylight signalling down to the boiler house the condition of the chimneys. There ought to be some automatic means for recording smoke. He had been experimenting in that direction for some time, and if he were successful in his efforts he would have much pleasure in communicating the apparatus to the Association. He did not think the author would save the 20 per cent. referred to by the use of induced draught. He could not reduce the temperature of the gases altogether, and if he did it to any considerable extent it would be at the expense of a large capital expenditure, which, with cheap coal, would not pay. With a Lancashire or marine-type boiler 30 or 40 per cent. increased capacity could not be obtained without injury to the boiler. A dry-back marine-type boiler gave considerable trouble at the back ends of the tubes if they were forced. He preferred a chimney of considerable height to induce draught. He had both, but he found the chimney much more suitable and more easily regulated. It was a very easy thing for the fireman to have too much draught. With induced draught they very often forgot to shut down the fan when they shut down some of the boilers, and then there was trouble with the back ends of the remaining boilers. He thought automatic recorders were extremely ingenious and useful, although he had had one in use for some time and had not got any apparent economies from it. On a battery of 20 boilers, however, 10 to 20 recorders would be required, and they were expensive. He thought motor-driven pumps were considerably more efficient than steam pumps, but he had had a great deal of trouble with the gearing. Up to the present he had found nothing that would run well and quietly.

Mr. C. E. STROMEYER (Manchester Steam Users' Association) hoped that there would be further Papers of this character, giving details of the actual working of boilers, not only during short periods, but during 24 hours and perhaps for a whole week. It was only by this means that they could find out what was wasted during the hours that a boiler was idle. This would help to find out whether it was more profitable to bank fires or re-light them. Mechanical stokers had to be kept in the best of repair in order to be efficient. With hand stoking he thought the bonus system could be worked to advantage. The systems he had heard of were that the firemen got a real bonus paid to them every week. According to the scale in the Paper, they would only get it once or twice a year. Then they must also remember that firemen were always getting a bonus of 1s. per ton of coal from the collieries, and it was therefore eminently to the advantage of the firemen to burn more coal. Thus, if a bonus was introduced, it must have a stronger effect than the one given by the colleries. One bonus system was that £2 was always reserved. No one had a bonus until after there was £2 to his credit, and any fines for emitting smoke were paid out of this reserve. He understood it was very effective. One point with hand-firing was that two firemen could fire into a door at once, so as not to have the door open so long. With one fireman the operation of putting in a cwt. of coal meant a considerable amount of time, especially if the dampers were not lowered. This meant an enormous quantity of air rushing into the furnace and doing a large amount of harm. He thought the advantages of induced draught were exemplified by the fact that one of the largest Sheffield steel firms had introduced a system of their own which was working very successfully. They were replacing all their Lancashire boilers with others of the marine type, and they were working them very hard and were very well satisfied. The real marine boiler was capable of being forced enormously; 40lb. per square foot of grate area could be burned when necessary. Lancashire boilers would not stand this. With the real "express" boilers, such as were employed on torpedo boats, steam could be got up in 20 minutes from cold water, and the boiler could stand idle for months. He suggested their use in connection with electricity works.

Mr. S. E. FEDDEN (Sheffield) thought Mr. Newington had been rather hard on the firemen. He did not think he had a special brand in Sheffield, but they certainly seemed to be better than those in Scotland. The author gave the coal per indicated horse-power per hour at 1·89lb. This worked out at 3·4lb. per unit which made the combined efficiency of the plant very bad indeed. He rather wondered if these figures were correct. The author asked for information with regard to mechanical stoking, and he did not think he could do better than tell him what had been done with the marine-type wet boilers in Sheffield at the Sheaf-street station. Four or five years ago these boilers were hand fired and they evaporated about 11,000lb. of steam per hour from and at 212deg. The efficiency was well below 70 per cent., and a great deal of trouble was experienced from leaky tubes, cracked plates and all that sort of thing, through letting in cold air. Mechanical stokers were then fitted and the evaporation of the boilers went up to 15,630lb. per hour and the efficiency on an official test came out to 73·2 per cent. Since then he had added an arrangement for bringing the hot air from the back of the boilers through the hollow bars of the Bennis stokers. By bringing the hot air to these bars at about 319deg. the evaporation of the boilers went up to 17,652lb. per hour, and on one test he got an evaporation of 18,312lb. per hour with an efficiency of 79 per cent. He burnt on that particular test 47·3lb. of coal per square foot. The best test he got was when he burnt 39lb. with an efficiency of 80 per cent. With regard to the question of the steam used with mechanical stokers he found that for the fans and the fire bars it was 3·5 per cent. of the total evaporation of the boiler. He had evaporated from 9lb. to 9½lb. per pound of coal.



Mr. DRUITT HALPIN, speaking on the question of the leakage of air, said that the most complete set of experiments which he knew of were made at the Frankfort Exhibition 10 or 12 years ago, when tests were made upon the whole battery of boilers there. The results he showed in the table opposite. The theoretical quantity of air required was given in the first place and the other columns showed what an enormous quantity of air there was leaking through the brickwork. He had once been told of a remarkable experiment that could be made with an ordinary building brick. He got a tin tube about 1in. diameter and 2in. long, and on one end of it a funnel was placed. An arrangement of this description was placed on either side of the brick, and by blowing into one side it was possible to put out a candle on the other side. He had put the results of the tests at the Frankfort exhibition in the form of a diagram. All the boilers except a few were water-tube boilers, and it showed how gradually the efficiency dropped according to the excess of air that was present. He had adopted an exceedingly simple and cheap system for getting rid of damper loss through air leakage. This loss was occasioned from the manner in which dampers were ordinarily set. The arrangement was shown in the accompanying sketch. He could not possibly agree with the following statement in the Paper:—"It is a generally accepted fact that no economy can be obtained by raising the temperature of feed water except by heat which would otherwise be wasted." This had been a very prevalent opinion in the past, but when the fact was

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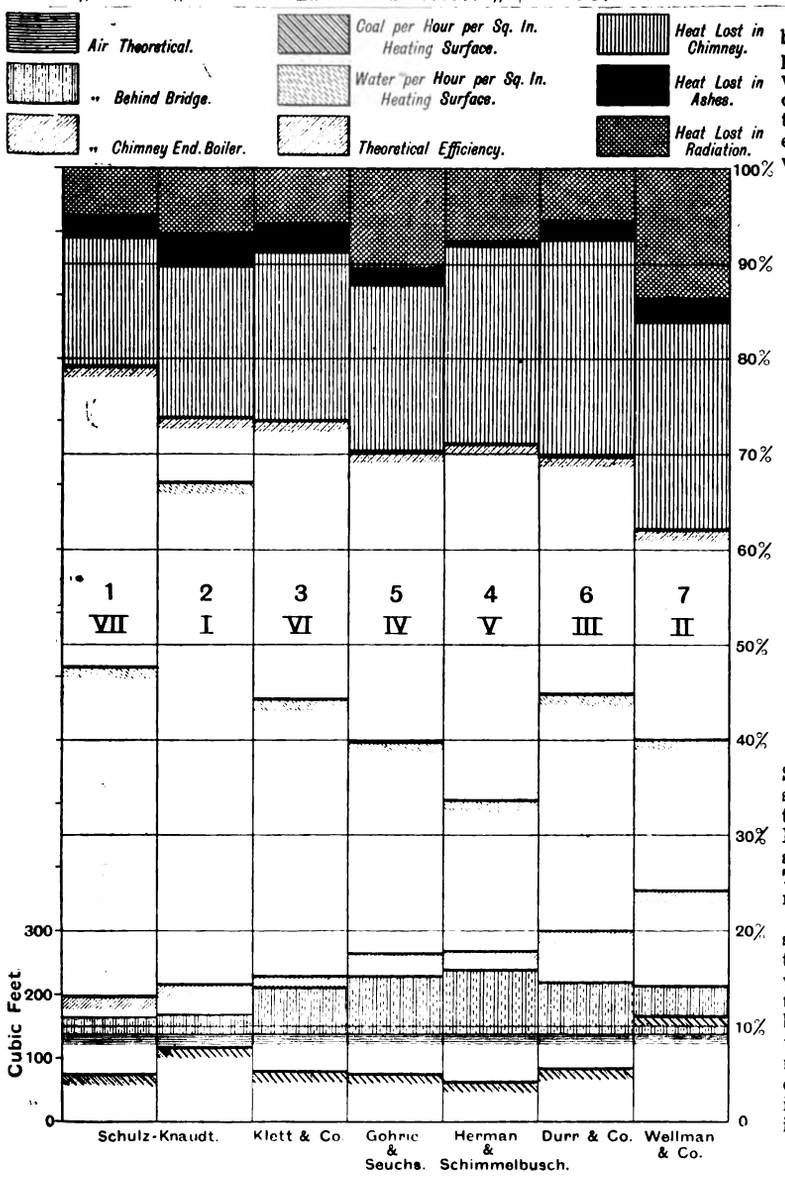
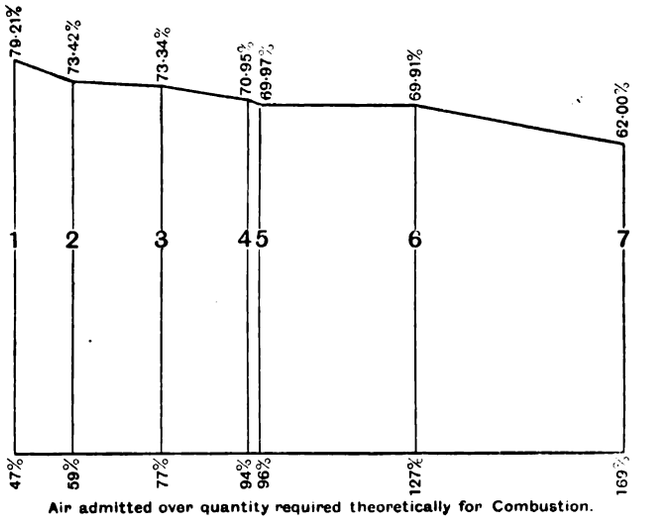
Results of Boiler Trials made at the Exhibition at Frankfort-on-Main, 1891.

Air admitted over quantity required theoretically for combustion (see diagram below).	VII. Schulz-Knaudt excct. Cornish.	I. Schulz-Knaudt exact. Cornish.	VI. Klett & Co., "Heine."	IV. Cohing & Seuchs, "Babcock."	V. Hermann & Schimmelbush, vertical multitubular.	III. Durr & Co., horizontal "Field."	II. Wellman & Co., horizontal "Field."
Heating surface ..... sq. ft.	646·0	646·0	742·0	1,650·0	1,615·0	1,690·0	1,310·0
Grate area ..... ,,	15·5	15·5	22·6	31·2	33·0	33·2	25·1
Duration of test ..... hours	20·0	19·7	18·2	19·8	19·95	17·48	18·6
Coal per hour per sq. ft. of grate.....lbs.	15·94	23·5	12·5	18·8	15·6	20·9	21·2
Do. do. heating surface .....lbs.	0·385	0·588	0·382	0·375	0·320	0·412	0·825
Ash and clinker .....per cent.	6·34	8·03	6·90	4·135	1·06	6·59	5·92
Fuel still in ash ..... ,,	33·35	1·41	43·0	38·05	38·05	28·74	38·65
Water per hour per sq. ft. of heating surface ..lbs.	3·56	5·08	3·31	2·98	2·71	3·33	3·00
Temperature of feed water .....deg. F.	67·4	64·0	57·3	59·0	63·75	56·5	70·0
Steam pressure .....lbs. per sq. in.	128·5	124·5	127·6	136·0	106·5	113·0	109·5
,, temperature .....deg. F.	354·5	352·4	354·0	360·0	342·0	346·0	343·8
Power in coal .....B.Th.U.	13,500	13,560	13,775	13,862	13,785	15,522	13,693
Thermal units taken up in steam .....per cent.	79·21	73·42	73·34	69·97	70·95	69·91	62·00
Do. lost in ashes ..... ,,	2·25	3·56	3·11	1·70	0·60	2·03	2·40
Do. do. chimney gases ..... ,,	13·52	16·07	17·73	17·71	20·82	22·62	21·96
Do. do. radiation and unaccounted for ,,	5·02	6·95	5·82	10·61	7·63	5·44	13·64
Thermal efficiency of boiler × lbs. steam per hour per sq. in. heating surface = coefficient	282·0	373 0	242·75	208·50	192·30	232·80	186·00
Temperature of chimney gases .....deg. F.	550·0	599·5	507·0	588·8	545·5	622·0	596·0
Difference chimney gases and steam..... ,,	195·5	247·1	153·0	228·0	203·0	276·0	252·2
Necessary air per lb. coal, theoretical ....cubic ft.	132·4	132·88	135·13	135·93	135·13	132·56	134·32
Actual air behind bridge..... ,,	161·10	166·25	219·2	229·48	247·4	219·2	215·63
Excess, theoretical.....per cent.	22·0	25·0	62·0	69·0	83·0	65·0	61·0
Actual air at end of boiler .....cubic ft.	194·6	211·0	228·3	263·6	264·1	300·2	361·5
Excess over theoretical.....per cent.	47·0	59·0	77·0	94·0	96·0	127·0	169·0
Boiler setting surface capable of air leakage sq. ft.	344·5	344·5	290·7	366·0	376·8	624·4	635·2
Air per second per sq. in. leakage surface leaking through setting .....cubic ft.	0·0065	0·01332	0·0052	0·01528	0·0065	0·0247	0·3380
Chimney draught.....in.	0·268	0·339	0·20	0·44	0·271	0·34	0·339
Actual evaporation .....lbs.	9·266	8·620	8·692	8·346	8·488	8·129	7·406
,, ,, 0—100°C. ..... ,,	9·355	8·696	8·820	8·470	8·540	8·240	7·414
,, ,, from and at 212°F. ..... ,,	10·97	10·20	10·29	9·88	10·05	9·62	8·77





borne in mind that the economy produced by an increase in the temperature of feed water, either by exhaust steam heaters or economisers, was very much greater than the theoretical amount, this paragraph ought to be criticised. About a year ago Mr. Hamilton read a Paper before the local engineers' society in Belfast, in which he referred to some experiments which threw a good deal of light upon some old experiments which were described before the Institution of Civil Engineers in 1872 by Sir William Anderson. It was shown that the rate of heat transmission, say, below 200 and above 212deg. per hour per square foot, was about two and a-half times as much in one case as in the other, and Sir Frederick Bramwell in the discussion gave a series of four experiments at different temperatures in which these figures were fully borne out. Therefore, live steam heating had enormous advantages. Some of the results that could be got from it were perfectly marvellous.

Mr. COLLEY (Messrs. Babcock and Wilcox) thought that the bonus scheme was a good one, but the men should have a means of seeing what they were doing. In this respect the CO_2 recorders were particularly valuable. If the men could have a rapid diagram before them showing them what they were doing from hour to hour far greater attention would be paid. The good firemen would then look after the bad ones, and by this means the work of the superintending engineer would be greatly reduced. But if the bonus line were fixed too high, so that it was only exceptionally that they got any money out of it, the firemen did not think it worth while troubling much. With regard to the following paragraph in the Paper: "A superheater attached to a boiler may abstract 10 per

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cent. of the heat in the flue gases and reduce the efficiency of the boiler by this amount," he did not understand the expression "and reduce the efficiency of the boiler by this amount." It seemed to him to be wrong. Under certain conditions, when a certain quantity of coal was burned in a boiler a certain efficiency was obtained. If a superheater was contained in the boiler the efficiency of the boiler plus that of the superheater was always higher than that of the boiler by itself. The principle of mechanical stoking was sound beyond dispute, and that it had not been more universally adopted was due to the fact that there was no universal stoker. But the difficulty was being overcome. The energies of the smoke abatement societies and the local authorities made the consumption of smoke imperative. According to his experience and knowledge, it was only those stations that were really well equipped with mechanical stoking that got down to a very low consumption of coal per unit. In America they had been trying to fit mechanical stokers on vessels, and the results had been very satisfactory. The statement that "under theoretical conditions, without excess air, 19 per cent. CO_2 air would be produced, but in everyday work one might with reasonable attention obtain 12 per cent. CO_2 with an exit temperature of 600°F." seemed to be pretty high; 450 or 500deg. was more near the normal amount. In conclusion, he expressed the opinion that not quite enough attention was paid to the exhaust steam from the auxiliary plant.

Mr. J. B. C. KERSHAW said that from 10 to 25 per cent. of the fuel burnt in electric lighting and power stations was at present being wasted owing to the non-maintenance of the best conditions for its combustion under the boilers. As fuel costs represented nearly one-half of the total works costs of generating electricity, a saving of from 5 to 12·5 per cent. on their costs per kilowatt was thus open to all electrical engineers who gave serious attention to the boiler plant. The fuel consumption in electricity works varied from 5·2lb. to 15·4lb. per unit generated. Marine engineers managed with 1·75lb. per horse-power, and since 3lb. represented the best possible for the kilowatt-hour, the figures stated above proved that electrical engineers were at present using from 1·7 times to five times the amount of coal really required to generate their current. Mr. Downe had alluded in his Paper to two of the chief causes of loss—viz., excessive air supply to the fires and too low a temperature in the furnaces. The second of these causes was in reality an effect of the first, and he would like to amplify what the author had said on this point. 12½lb. of air were necessary, theoretically, to burn 1lb. of fuel, and the 13½lb. of gaseous products produced absorbed the heat of the buring fuel. If the weight of the air supply were doubled or quadrupled the furnace temperature of the gases would necessarily be one-half or one-fourth of what would otherwise be obtained, for the same number of heat units was called upon to heat twice or four times the weight of gas. Since the transfer of the heat to the water through the boiler plates was directly proportional to the temperature of these gases, the importance of maintaining the highest possible temperature in the furnaces was evident. Taking a practical illustration, he said that Mr. Downe, when he started testing his gases found only 3 per cent. CO_2; another electrical engineer found 5 per cent., and he himself had rarely found more than 7 per cent. in plants working under the normal unscientific conditions. The maximum possible with good management was 14 per cent. It might, therefore, be taken as proved that the average percentage of CO_2 in the exit gases of electric light and power stations (where no special attention was paid to this question) was between 3 per cent. and 7 per cent., and that the furnace temperatures were only between one-fourth and one-half of what they might be under more scientific management. The proportion of the total heat of the fuel wasted in the exit gases also increased enormously as the furnace temperature fell, for the exit gases remained about 600°F. whether the initial temperature were 3,000°F. or 1,000°F.; 600°F. was only one-fifth of 3,000, but it was three-fifths of 1,000. The heat losses due to excessive air supply to the boiler furnaces would therefore explain even wider discrepancies than those mentioned above. The Paper quoted two of his analyses to prove that fuel testing was unnecessary and that reliance could be placed upon fuel obtained from one seam. He would like to point out however that a seam of coal was always found between layers of dirt or shale, and in getting out the coal a certain proportion of this latter was always brought to the bank. The lumps of shale were picked out by hand in the best house and steam coal, but for the lower priced coals this picking and cleaning operation became somewhat perfunctory. Since everybody about a pit was paid on the total weight of stuff sold as fuel, it was, obviously, no one's duty to be too particular about the amount of dirt sold as coal. Coal from one seam was, therefore, no more certain to be constant in ash contents than coal from many different seams, and that two samples taken at six weeks intervals, were tested with the same results, was no proof that the quality would be constant all the year round. On the question of calorific tests of bituminous fuels, he also disagreed with the author, who stated that since laboratory calorific tests included the heat of the gaseous hydro-carbons, therefore they were useless for practical purposes. But, surely, if these hydro-carbons could be made to yield up their heat to the water of the calorimeter, they were not utterly useless for steam-raising purposes. If the heat from these gases was at present wasted it simply meant that the present design of the boiler furnace was not adapted for their burning and utilisation. He was inclined to think that some of the notable low percentages of carbonic acid obtained by Mr. Downe and others when they had first installed the Ados apparatus, had been due to air leakage in the very lengthy connection pipes. An independent apparatus was, therefore, of value, even when a recording instrument had been set up and was in constant use. Mr. Newington had alluded to the difficulty under which the firemen laboured in the majority of generating stations in that they could not see the chimney top from their working places, and, consequently, never knew when they were making smoke. Some months ago, when visiting a generating plant in Belfast, he saw an ingenious arrangement of mirrors for overcoming this difficulty. The cost of fixing such was trifling (two or three common glass mirrors, costing 1s. each, and a few holes in the roof or walls, as a rule, sufficed), while the advantage was obvious, and he hoped some of the engineers present would adopt this cheap and effective plan.

Mr. C. D. TAITE (Salford), referring to the amount of steam taken by the steam jets of mechanical stokers, said that in carrying out a steam trial on a steam engine two years ago, he found a remarkable difference in the value of the water measured from the condenser and the water put into the boiler. The difference was no less than 14 per cent. They decided to make a test of the steam used by the steam jets, and it was found that these accounted for the whole of the difference. They immediately made an alteration and reduced this difference to 2½ per cent., and the coal per unit generated immediately fell from 5·74lb. to 5·06lb. With regard to repairs of mechanical stokers, he had found that during the last six months the cost of upkeep had amounted to 1·8d. per boiler-hour, or 3½d. per ton of coal burned. Of this figure about one-half was accounted for by the coking bars. The fire bars themselves had only cost £4 during the six months. The coking bars, of course, were subject to a very great temperature, but by water-cooling these he hoped almost to eliminate this figure, and thus reduce the cost of upkeep by about 50 per cent. With regard to gas analyses, some eight months ago he installed a recorder. At that time he was using rather over 4½lb. per unit generated, but since the recorder had been put in there had been a steady reduction month by month, and at present the figure was 4·09lb., with a falling load-factor and a falling output. There was very little doubt that nearly the whole of that saving was due to the experience gained as a result of the installation of the recorder, because he found they were putting in a tremendous amount of air which was unnecessary. All the auxiliary plant in his station was run electrically, including the condensing pumps. In winter the percentage of power taken by this plant was 5½ per cent. of the total generated, and in the summer it was 7½ per cent. The feed pumps took 1½ per cent. as regularly as possible, and on a test it had been reduced to 0·8 per cent. of the units generated.

Mr. SUGDEN agreed with the author that in the future the greatest economy in the production of steam would be obtained in the reduction of the coal bills. From 5 to 10 per cent. was lost in radiation. He remembered an instance of a Lancashire boiler which was fired with very hard coal. It burned 30 tons of coal per week, and it was thought that perhaps better results would be obtained by putting down a second boiler and working the two together. When this was done, however, the coal consumption went up to 40 tons doing the same work as was done by the one boiler previously. This was due to a large extent to radiation, and also to the bad keeping up of the fires. With regard to the firemen, he considered that they were altogether underpaid and consequently a sufficiently intelligent class of men were not obtained. As to mechanical stoking, his experience was that a mechanical stoker did its work in its own way efficiently; but if they began to force it a tremendous amount of repairs were necessary, and if it were only worked at half its rate it worked very extravagantly. Therefore to get the best results the boilers should be doing their full duty. With regard to superheating his experience substantiated the remark in the Paper that an advantage of from 10 to 20 per cent. was gained.

Mr. DOWNE, in reply to the discussion, said that the fireman was not quite the person that some speakers had given them to understand. His own experience was that the fireman had to use his brains much more than the engine driver, whose occupation was more mechanical. He paid his firemen the same wages as the engine drivers—viz., 30s. per week. With regard to mechanical stokers he had had a form of sprinkling stoker fitted to several boilers. Tests showed that the evaporation was increased from 5,000lb. to 8,000lb. One of the main reasons why the mechanical stoker had not been introduced at sea was that it implied carrying a considerable amount of dead weight, and there was also the difficulty of obtaining coal of one quality when different ports were being called at. In reply to Mr. Kershaw's remarks, the firemen themselves very quickly reported if there were any very great variation in the amount of ashes, and steps were taken to check it. He could check his CO_2 recorder by letting in nothing but air and seeing that it did not record any CO_2.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"The Elements of Plane Trigonometry." By R. Lachlan and W. C. Fletcher. (London: Edward Arnold.) 2s.

"Preliminary Practical Mathematics." By S. G. Starling and F. C. Clarke. (London: Edward Arnold.) 1s. 6d.

"Electrical Motor Installations." By F. J. A. Matthews. (Manchester: The Scientific Publishing Co.) 2s. 6d.

"Science Abstracts." July. Section A. Physics. Section B. Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

"La Transmission Electrique de l'Energie dans les Pays Industriels de Houille Noire." By R. Swyngedauw. (Paris: Ch. Dunod.) 5fr.

"Étude Economique sur la Transmission Électrique de la Force dans les Usines et les Ateliers." By R. Swyngedauw. (Paris: Ch. Dunod.) 2fr.

"British Standard Sections." Issued by the Engineering Standards Committee. (London: Crosby, Lockwood & Son). 5s.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Refractivity of a Current-bearing Electrolyte.—H. Bordier has found that the refractive index of an electrolyte is reduced when a current passes through it, and that the reduction of the refractive index—in other words, the increase in the velocity of light through the electrolyte—is proportional to the current intensity, and, inversely, proportional to the amount of electrolyte in solution. He operated with salts of such metals as copper and zinc, which do not give rise to a secondary reaction at the cathode, and containing a radicle which is largely disengaged in the gaseous state at the anode. Chlorides were employed by preference. The effect of heating by the current was first carefully determined and allowed for. There remained a substantial residual effect due to the passage of the current. Using a current of 300 milliamperes and a solution of cupric chloride, the author obtained a diminution of 0·4 per cent. with a 1 per cent. solution and a diminution of 0·3 per cent. with a 3 per cent. solution. As the author does not quote any greater dilutions, it is not evident what the limiting value at infinite dilution is likely to be. He mentions, however, that the concavity of the diminution concentration curves is turned upwards. As regards the current density, the author found a regular growth of the effect in proceeding from 50 to 300 milliamperes. He points out that we have thus a new method of measuring current densities, and also a criterion of the amount of electrolyte in solution.

[H. BORDIER, *Comptes Rendus*, July 18, 1904.]

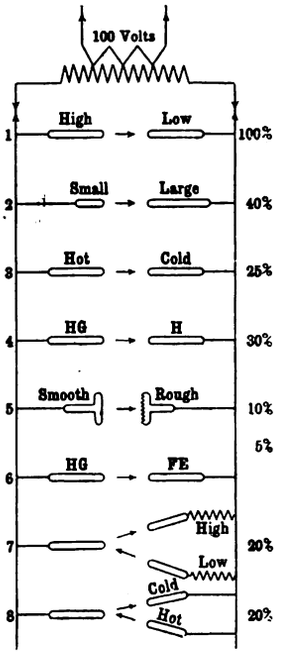
Alternate current Electrolysis.—After having shown the erratic manner in which the amount of alternate-current electrolysis varies with the frequency, A. Brochet and J. Petit have investigated the influence of the current density, using nickel electrodes and a potassium cyanide electrolyte. The efficiency-frequency curves have a very different aspect according to the current density employed. At low-current densities they are nearly hyperbolic, with the axes as asymptotes, the amount of electrolysis increasing as the frequency decreases. But from about 7 amperes per square decimetre the concavity of the curves is reversed, and the efficiency increases with the period, up to about 60 periods per second. The efficiency-current curves show a steep rise below 2 amperes, and then a fall which is very abrupt at 5 periods per second, and barely perceptible at 100 periods per second. These curves present the curious anomaly that the efficiency tends towards zero as the frequency diminishes and the current-density increases. If this were carried to the limit, there should be no electrolysis when the frequency becomes zero and the current, therefore, continuous. As a matter of fact, the efficiency is then never lower than 80 per cent.

[BROCHET and PETIT, *Comptes Rendus*, July 18, 1904.]

Silvered Fibres.—N. A. Dubois gives instructions for the preparation of allotropic silver films for electrical purposes. A mixture of 200 cubic cm. of a 30 per cent. solution of ferrous sulphate and 280 cubic cm. of a 40 per cent. solution of sodium citrate is treated with a 10 per cent. solution of caustic soda, just till no permanent precipitate is formed. This is then mixed with 200 cubic cm. of a 10 per cent. silver nitrate solution, stirred thoroughly, allowed to settle and the liquid decanted. The precipitated allotropic silver is treated with about 200 cubic cm. of distilled water, which dissolves a part of it, and is again precipitated by treatment with a saturated solution of ammonium nitrate. This process is repeated three times, and the final precipitate filtered with suction and washed with 95 per cent. alcohol. The product is transferred, in the form of a brown mud, to a bottle and kept covered with alcohol. The emulsion spread on any surface and dried gives a copper-coloured film. When these films are treated with gaseous hydrochloric acid from a reversed wash-bottle they are immediately changed to ordinary silver, and present a dull silvery appearance, which is changed to bright silver by slight friction and is highly conducting.

[N. A. DUBOIS, *Physical Review*, July, 1904.]

Gaseous Rectifiers.—P. G. Nutting describes a number of experiments made under various conditions to study the rectification often observed in vacuum tubes. The results are concisely summarised in the diagram, where the figures on the right show the percentage of the rectification observed in the experiments numbered on the left. The current was derived from a transformer of 100/2,000 volts and 600 watts capacity. In the first experiment, the difference of pressure of the gas about the two electrodes was produced by constricting the tube to a fine capillary between the electrodes and rapidly exhausting. If the exhaustion is sufficiently rapid, complete rectification occurs—*i.e.*, half the current-wave fails to pass at all. Judging by the width of the cathode dark space, the corresponding pressures in the two bulbs are about 4mm. and 0·3mm. Sudden admission of gas into an exhausted tube reverses the rectification. Tests 7 and 8 were made with tubes provided with three mercury electrodes. One of these was connected to a 2,000-volt terminal, and the other two through different resistances to the other. Current was found to enter through the low resistance and leave by the high. When connections were made with equal resistances and one electrode heated, the current passed from hot to cold.



[P. G. NUTTING, *Physical Review*, July, 1904.]

Oxidised Cathodes.—It is known, since the work of Hittorf and Goldstein, that when the cathode is brought to a white heat, the cathode fall of potential—*i.e.*, the difference of potential traversed by an ion in emerging from the cathode into the space surrounding it—practically disappears, but that no such effect is produced by the heating of the anode. A. Wehnelt has further studied this effect, especially in connection with the extraordinarily strong effect exhibited by certain oxide cathodes. These are the oxides of the alkaline earths, while magnesium, zinc and cadmium show a feebler effect, and other metals, such as sodium or mercury, owe their apparent effect to secondary causes. The quantitative measurements made by the author show that there is a profound influence of the pressure upon the sign and the amount of the ions emerging from the cathode. At atmospheric pressure, even at a dark red heat, there are more negative than positive ions given out by electrodes of the oxides of calcium, strontium and barium, whereas in the case of platinum the positive ions are in the majority, even at very high temperatures. In a vacuum, on the other hand, both the "effective" oxides and pure platinum only emit negative ions, whose number increases strongly as the temperature rises. But the number of ions emitted by the oxides is about 1,000 times greater than the number emitted by the platinum. Richardson has represented the relation between the temperature and the number of negative ions given out by pure platinum in a vacuum by an exponential formula derived from the Maxwell-Boltzmann law of the distribution of velocities. In this formula is contained the number of negative electrons per unit volume of platinum. The author finds that the same formula also applies to metallic oxides, but the calculation of the number of negative electrons contained in unit volume of the oxide gives a number which is about 100 times that of the molecules contained in the same volume. From this the author derives the interesting result that every molecule must be accompanied by numerous negative electrons.

[A. WEHNELT, *Annalen der Physik*, No. 8, 1904.]

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THE WIRELESS TELEGRAPHY BILL.

In a recent issue we called attention to an important measure introduced by the Government, and having for its object the State control of wireless telegraphy. The text of this Bill was reprinted in full on p. 564 of *The Electrician* for July 22nd, and mention was made of the fact that a Memorandum appeared on the front of the Bill setting forth its object. Now, however, a new development has taken place, in the form of a much more lengthy Memorandum, issued by Lord STANLEY, setting forth in detail the *raison d'être* of the measure, which, it will be noted, is left in the list of measures which the Government is pledged to pass this session. This Memorandum is given textually in another column of this issue.

Before proceeding to discuss the Memorandum, it may be well to call attention to the importance which attaches to it. The mere condition that a Memorandum should have been issued at all, indicates that the Bill to which it refers is of prime significance, and this is fully evidenced by the fact that memoranda of this nature which have been issued during the past few years may be counted on the fingers of two hands. There may be some potent reason which has induced the Government suddenly to become alive to the fact that the matter is one which brooks of no delay, and which really ought to have been legislated upon some considerable time ago. The essence of the Memorandum is that the object of the Bill is to secure State control of wireless telegraphy "in time of war or emergency," and it may be that this is the real and only cause for the sudden activity to which we have referred. But, on the other hand, it must not be overlooked that the present Bill will, when passed, give the Government power to prohibit absolutely individual or private operation of wireless telegraph installations. Such a policy at the present time would undoubtedly bring a storm of indignation upon the head of the Government, as the cry would be raised that all scientific and commercial interest in the matter would thereby be either terminated or considerably diminished. It is a mistake to imagine, however, that progress would be hindered if wireless telegraphy became a monopoly of the State; for in addition to the research work

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that would be carried out by the Post Office engineers, who have the advantage of being familiar with every detail and troublesome occurrence met with in the practice of commercial telegraphy, the Bill distinctly considers the question of granting licences to companies and individuals for experimental purposes as distinct from the licences the Government may grant for commercial wireless telegraphy.

Looking at the matter, however, from the standpoint of the Memorandum alone, a sufficient reason for the Government's action is at once apparent. It has been pointed out, and rightly, that the State already has control over wireless telegraphy under the Telegraph Act of 1869, but, as Lord STANLEY points out, this right of control extends only to telegraph stations of incorporated companies carrying on telegraphic business. It does not apply to the wireless telegraph installations of private individuals, which would admittedly constitute a grave source of danger in time of war. There would, for instance, be nothing to prevent a private wireless telegraph station from communicating with an unfriendly nation and conveying intelligence inimical to the safety of the country. In the case of submarine telegraph cables the Government already possesses a most effectual means of preventing the sending of undesirable messages, for it can impose any conditions it may deem fit in granting the cable companies their landing rights. But, obviously, in existing circumstances, it is not in the same position with regard to wireless telegraphy, and one of the objects of the present Bill is to place it in that position.

It is interesting to learn that an arrangement has already been made with certain other Powers whereby the establishment of wireless telegraph stations on their territory, for communication with similar stations in the United Kingdom, is prohibited until after a consultation has been held between the Power concerned and the British Government. This points to the fact that other countries are in advance of Great Britain in being able to prohibit the installation and working of wireless telegraphy within their realms. But such an arrangement is obviously unsatisfactory, since its successful operation depends entirely on the goodwill of other nations, and, as pointed out in the Memorandum, this might give rise to complications of a very serious nature in times of strained relations.

Most important of all are the clauses relating to interference between neighbouring stations, especially as they emanate from the Postmaster-General, who, of all persons, must be *au fait* with the newest developments. Demonstrations of various systems have taken place repeatedly before competent Post Office engineers, and innumerable statements have been made maintaining that syntonic wireless telegraphy is not merely a possibility but an accomplished fact; and yet we have Lord STANLEY, before whose notice all these assurances and tests must have come, publishing a warning that ". . . . a temporary installation . . . if situated near the coast, would be a source of great danger in time of war, as it would . . . . be able to intercept messages from neighbouring stations. . . ." Further, "if the number of installations were greatly increased, and they were set up without regard to strategic requirements, the interference might easily be so great as to minimise the usefulness of wireless telegraphy for communication with His Majesty's ships." But this argument applies—perhaps with less force—in time of peace as well as in time of war. In fact, Lord STANLEY emphasises what we have repeatedly pointed out, that a badly-organised system of wireless telegraphy may prove to be worse than useless and actually defeat its own object.

In conclusion, we would point out the remarks made in the Memorandum relating to the proposed international agreement to regulate wireless telegraphy. It will be remembered that, at the preliminary International Conference at Berlin last year, the British delegates refused to attach their signatures to the agreement, principally because, in the present state of the law, there would be no means of enforcing the conditions laid down by such an agreement. Here, then, is at least one cause for the introduction of the Wireless Telegraphy Bill, which proposes to remedy this defect in the law, so that at the next Conference the British delegates will have a freer hand. In view of the extreme importance of the Bill, it is to be hoped that, however near prorogation the present Parliament may be, no effort will be spared to make it law, so that wireless telegraphy may, in the words of the Memorandum, "be developed and applied with the greatest advantage to the public."

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

Modern Electric Practice. Edited by MAGNUS MACLEAN, M.A., D.Sc. Vols. II. and III. (London: The Gresham Publishing Co.) 9s. each volume.

The second volume of this work contains chapters on "Alternating-current Motors," by M. B. Field; "Static Transformers and Rotary Converters," by A. F. Berry; "Electric Storage Batteries," by J. T. Niblett; "Switches and Switchgear," by W. E. Warrilow; and "Electric Mains," by J. C. A. Ward.

Mr. Field contributes six chapters, dealing with known forms of alternating-current machinery. Although such work lends itself so admirably to mathematical treatment, and though the author usually has a predisposition in this direction, yet he has refrained, in this instance, from troubling the reader with too great a display of symbols. Vector diagrams and illustrations, however, are frequently made use of. Mr. Berry's contribution is, as might be expected, of excellent quality. The section of the book dealing with electric storage batteries consists of an introduction and two chapters. In the 47 pages covered by this part of the work many different types of batteries are considered in a somewhat perfunctory manner, while there is very little concerning the theory of the lead accumulator. No definite opinion is ventured regarding the Edison cell, and the author contents himself by giving merely an abstract of Dr. Kennelly's 1902 Paper before the American Institute of Electrical Engineers. It is a pity that more recent information could not have been inserted in a book which includes in its title the word "modern."

Under "Switches and Switch Gear" there are some 66 pages containing descriptions of modern appliances used for all kinds of switch work, from the small tumbler switch to the huge high and low-tension switchboards now in use in large generating stations. There is, however, no really detailed description of a remote control board such as it is now becoming quite common practice to erect.

One of the best sections in the series, so far, is that on electric mains. The author is obviously very fully conversant with his subject, and more space might well have been devoted to a matter which is of vast importance and which naturally lends itself to detailed treatment.

The third volume of "Modern Electric Practice" consists of seven contributions—viz., "Distribution and Transmission of Electric Energy," by W. B. Esson; "Electric Lighting and Wiring," by W. W. Lackie; "Electric Fittings," by G. Byng and V. Zingler; "Arc Lamps," by F. Billiotti; "Incandescent Lamps," by C. J. Robertson; "Electric Tramway Rails," by John R. Wignall; and "Railbonding," by V. Watlington. Just over 70 pages are occupied by Mr. Esson in a clear exposition of the subject which he has undertaken. He deals with both continuous and alternating-current working, and devotes some considerable amount of space to water-driven plants with high-tension pole lines. The chapters on electric fittings are beautifully illustrated, and those on arc lamps demonstrate the great number of different types of lamps now

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being made. Mr. C. J. Robertson's remarks on incandescent lamps give a complete summary of present-day views with regard to lamps and lamp manufacture, while the two sections on electric tramways, though short, will doubtless prove useful to certain readers.

Theorie und Anwendung des elektrischen Bogenlichtes. By H. Birrenbach. 9m.

Der elektrische Lichtbogen bei Gleichstrom und Wechselstrom. By Berthold Monasch.

Das elektrische Bogenlicht. Seine Entwicklung und seine physikalischen Grundlagen. By W. B. von Czudnochowski. Part I. 3m.

Of these three books on arcs and arc lamps, the first is photometric and practical, with a trace of theory; the second is photometric and theoretical, with a trace of practice; while the third contains more theoretical matter than one would have thought possible to introduce into a book on the arc.

Birrenbach's book is mainly a description of the construction and mechanism of arc lamps now in use. This part is excellent. The illustrations are good and the descriptions clear. The author, however, confines himself to lamps made in Germany, and to an English reader the book will prove too limited in scope. The descriptive part is preceded by a chapter on photometry and some general considerations on the efficiency and nature of the arc. This part has no pretensions to being complete, but the author has managed to get a great deal of confusion into a small space by an indiscriminate use of the various photometric standards. The following units and abbreviations are used within the limits of eight pages:—"Hefner lamps" abbreviated as "H.L.," "H.K." and "H.E.," "lights units," "candles" and "standard candles," the latter without indicating whether English or German standard candles are intended; we believe the figures given refer sometimes to one and sometimes to the other. As the German candle gives 13 per cent. more light than the English, it is often convenient to distinguish between them.

The second book, by Monasch, gives in a collected form all the important research work done on the electric arc. Though professedly a *réchauffée* of other people's labours, the book contains as much original work as most, the author, collaborating with Prof. Guye, having done a great deal of experimental work, which is embodied in its pages. The subject treated is not the *arc lamp* but the *arc*; the arc as a source of light, a source of heat and a source of music; the arc with metal electrodes and in different gases; the arc, in fact, in every condition and under every aspect conceivable to a German scientist. The matter is excellently arranged, and chapter and verse given for every reference. We should have welcomed a rather more critical treatment of the quotations, but the book is so valuable a collection of well-peptonised nutriment, that we have no right to complain. Besides, the author is very civil to the English and makes graceful references to our "fundamental researcheress, Frau Ayrton," and attaches a high value to her work.

The third book, by Czudnochowski, is an ambitious work. Part I. only is before us, and five more parts are promised. It is remarkable in being the most poetic book on an electrical subject that we have seen. The poetry, it is true, wears off towards the middle of the book, but at the start quotations in verse are freely interspersed with prose that would be blank verse if it scanned. The preface starts with these lines, which, as we understand them, are so appropriate that we cannot refrain from repeating them:—

Wo wir uns des Lichtes erfreun'
Sind wir jeder Sorge los;
Dass wir uns in ihm zerstreun
Darum ist die Welt so gross.

We are not sure whether this has a definite meaning or is only Goethe, but have made a literal translation, putting translator's additions in brackets, of course, square, to make sense.

When we rejoice in the light [of German learning]
From each care freed [we reach the verbs at last]
We nearly go distracted [for we wonder]
Why [in] the world [their literature]'s so vast.

We are diffident about the scansion, but have had it sung to as much of the "Christians, Awake" tune as could be remembered, and it does not go badly.

It is difficult to form an opinion of this book from the fraction now before us. This first part treats of illuminants generally, of photometry, of reflectors and dispersers of light, and of the distribution of light and energy in the spectrum. The preface gives but little clue to the contents of the forthcoming parts. We think, though, that the selection and treatment of the subjects dealt with show some want of balance. The distribution of energy in the spectrum, the absorption and emission of radiant energy, the pressure of light, &c., are treated in detail abstruse enough to require for their appreciation a reader fairly well versed in physics. How can such a reader need to be told, in German italics, that heat and work are equivalent, and need a long discussion on the fact? Or, again, he will not be interested in the statement that the energy of the universe is constant, although it is made in leaded type and followed by a mark of exclamation. These are not isolated instances; the book throughout, when it descends to ordinary prose, is a mixture of elementary and advanced physics. No book can appeal to all classes of readers, and every class must be assumed to have some previous knowledge; how much should depend on how far the book purposes to carry the reader. Czudnochowski has lost sight of this principle, and only inconsistency saves his book from rivalling the "Encyclopædia Britannica" in bulk. In selection and arrangement of subject we think he has failed as completely as Monasch has succeeded.

ARMATURE REACTION IN ALTERNATORS.

BY JAMES B. HENDERSON, D.SC., AND JOHN S. NICHOLSON, B.SC.

The complete experimental investigation of the various elements in the armature reaction of any alternator is a very laborious problem, and is not one which can be tackled by the manufacturer for obvious commercial reasons. It has, however, great theoretical and practical importance, especially if for any machine considered the theoretical treatment is found to agree with the experimental results. Such an agreement would not only be interesting in itself, but would be a justification of any assumptions one had to make in order to be able to treat the complicated phenomena quantitatively.

In the present research the authors have endeavoured to make a comparison between the theoretical and experimental armature reaction of the 30kw. three-phase alternator in the James Watt laboratories of the University of Glasgow. The alternator is one of the Electrical Co.'s standard type H. D. M., having rotating field poles and giving 50 ~ per second at 750 revs. per min. The normal E.M.F. is 200 volts and the current per phase winding is 87 amperes.

Theoretical.

When an alternator is running light, the E.M.F. in the armature is produced by that portion of the field flux which cuts the armature windings; hence, if we know the magnitude and distribution of the field flux and the distribution of the armature winding, it is a comparatively easy task to determine the E.M.F. on open circuit. When, however, the armature winding is supplying a current to a circuit of given power-factor, the E.M.F. at the alternator terminals is no longer produced by the same flux but by a new flux—namely, that produced by the resultant of all the magnetomotive forces acting, and although we know these magnetomotive forces, our difficulty is to determine the resultant flux which they produce.

If for a moment we consider the fluxes from the point of view of the armature windings, the main field flux becomes a periodic function of approximately sine form, the armature coils being generally distributed and the pole-pieces shaped so that the E.M.F. curve shall be approximately a sine curve. If we then consider the armature windings as a single coil, the main field corresponds to an alternating flux passing through the coil and waxing and waning according to a sine law. The armature current is also an alternating function whose form depends on the circuit supplied; but let us assume it is of sine form. The current is not in phase with the alternations of the field, its phase displacement relatively to the field depending

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on the power-factor of the circuit in which the current flows—*i.e.*, the load and the armature windings. We know this power-factor, or can determine it. In addition to the main field flux, we have a local flux in the armature coils produced by the armature current. This we call the flux of self-induction or reactance flux of the armature. The armature current produces also a component magnetomotive force which combines with the field magnetomotive force to increase or decrease the main field flux, and this component magnetomotive force varies with the power-factor of the load. Let us consider these various elements in detail.

The arrangement of the armature coils is shown in Fig. 1. A, B and C are, respectively, elements in each of the three-phase windings, the armature surface being represented by a plane in the developed form. If we send a direct current through the phase winding A it produces a magnetomotive force normal to this plane whose distribution is represented by

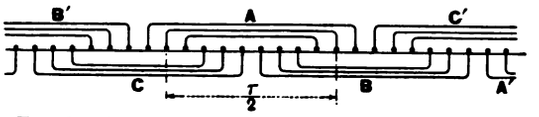


FIG. 1.—ARRANGEMENT OF THE ARMATURE WINDINGS.

the right-angled curve in Fig. 2, the curve being periodic—of period equal to double the pole-pitch. Let us denote this space period by τ while we reserve T for the period of the current. If an alternating current is sent through A, the magnetomotive force produced becomes periodic in time as well as place, but at every instant it is represented by a right-angled curve like Fig. 2, the horizontal dimensions of the curve remaining constant but the vertical dimensions fluctuating periodically with the current between certain definite equal positive and negative values. We shall follow Blondel's method of analysing such curves of magnetomotive force into Fourier series. The various terms in the Fourier series may be obtained mathematically or graphically, but in a case like this the former is much simpler.

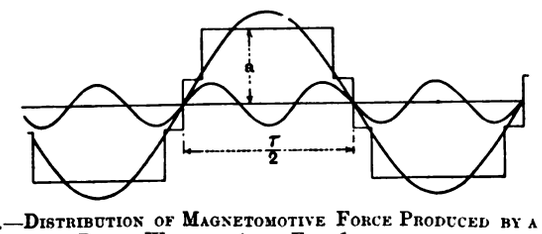


FIG. 2.—DISTRIBUTION OF MAGNETOMOTIVE FORCE PRODUCED BY A DIRECT CURRENT IN PHASE WINDING A OF FIG. 1, SHOWING ALSO THE FUNDAMENTAL AND THE THIRD HARMONIC OF THE FOURIER ANALYSIS OF THE M.M.F. CURVE.

Since the curve is symmetrically positive and negative alternately, it is evident that it can contain no even harmonics. Let us express this curve by a series of sines. Let a be the amplitude of the curve when the current is at its maximum.

$$a = \sqrt{2} n I_n / 2,$$

where n is the number of turns in the element A and I_n the effective value of the current in each of these turns. I_n will, in many machines, as in ours, differ from the line current I, the relation between them depending on the grouping of the elements of the winding in series and parallel between the machine terminals.

The function which we have to express by a series of sines is:—

$$\begin{aligned}
&y = a/3 \quad \text{from } x = 0 \text{ to } x = \tau/18,\\
&y = a \quad\;\; ,, \quad x = \tau/18 \text{ to } x = 4\tau/9,\\
&y = a/3 \quad ,, \quad x = 4\tau/9 \text{ to } x = \tau/2,\\
&y = -a/3 \;\; ,, \quad x = \tau/2 \text{ to } x = 5\tau/9,\\
&y = -a \quad\;\; ,, \quad x = 5\tau/9 \text{ to } x = 17\tau/18,\\
&y = -a/3 \;\; ,, \quad x = 17\tau/18 \text{ to } x = \tau.
\end{aligned}$$

The wave-length is τ and we must, accordingly, trace the variations throughout one wave-length. Any function $f(x)$ of wave length λ if expressed in a series of sines becomes

$$f(x) = \frac{2}{\lambda} \sum_{m=1}^{m=\infty} \sin \frac{m\pi x}{\lambda} \int_0^{\lambda} \sin \frac{m\pi v}{\lambda} f(v)\,dv.$$

Substituting for $f(x)$ the above constants and for λ the wave-length τ we get

$$y = \frac{2}{3}\frac{a}{\pi} \sum_{m=1}^{m=\infty} \frac{1}{m} \sin \frac{m\pi x}{\tau} \left\{ 1 + 2\cos\frac{m\pi}{18} - 2\cos\frac{4}{9}m\pi - 2\cos\frac{m\pi}{2} - 2\cos\frac{5}{9}m\pi + 2\cos\frac{17}{18}m\pi + \cos m\pi \right\},$$

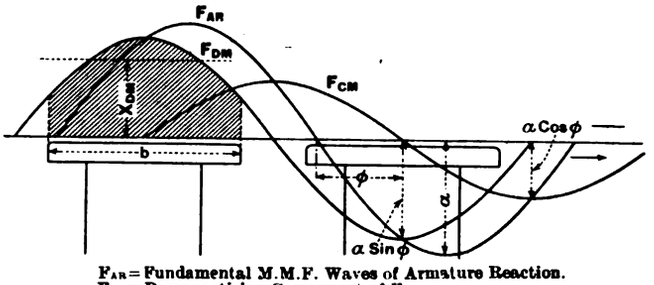
which transforms to

$$y = \frac{8}{3}\frac{a}{\pi} \sum_{m=1}^{m=\infty} \frac{1}{m} \cos\frac{m\pi}{2} \cdot \sin\frac{m\pi}{4} \left\{ \sin\frac{m\pi}{4} + 2\sin\frac{7}{36}m\pi \right\} \times \sin\frac{m\pi x}{\tau}.$$

When y is expressed in this factorial form we see at once that one factor becomes zero if m is odd and another factor becomes zero if n is a multiple of 4. The only values of m we have to consider are, therefore, the odd multiples of 2, and these are the values which give us the odd harmonics. Substituting the values 2, 6, 10, &c., for m we get

$$y = \frac{4a}{3\pi}\left\{ 2{\cdot}88 \sin\frac{2\pi x}{\tau} + \frac{2{\cdot}0}{3}\sin\frac{6\pi x}{\tau} + \frac{0{\cdot}653}{5}\sin\frac{10\pi x}{\tau} - \frac{0{\cdot}532}{7}\sin\frac{14\pi x}{\tau} - \frac{1{\cdot}0}{9}\sin\frac{18\pi x}{\tau} - \frac{0{\cdot}532}{11}\sin\frac{22\pi x}{\tau} + \frac{0{\cdot}653}{13}\times\sin\frac{26\pi x}{\tau} + \frac{2{\cdot}0}{15}\sin\frac{30\pi x}{\tau} + \frac{2{\cdot}88}{17}\sin\frac{34\pi x}{\tau} + \frac{2{\cdot}88}{19}\sin\frac{38\pi x}{19} + , \text{ &c.} \right\},$$

each coefficient being repeated every ninth term, but with the sign changed. There are only five different coefficients, but four of them are repeated in every cycle of nine terms. We have now obtained the values of the fundamental sine wave of magnetomotive force and of all the harmonics by which the right-angled curve of Fig. 2 is to be replaced. The fundamental and third harmonic are drawn to scale in Fig. 2.



FAR = Fundamental M.M.F. Waves of Armature Reaction.
FDM = Demagnetising Component of FAR.
FCM = Cross-magnetising Component of FAR.

FIG. 3.

We have so far only considered one phase winding, but every one of the three windings has a similar magnetomotive force curve and the resultant magnetomotive force will be got by adding all three together in their proper phase relations as regards time and space. Let us consider the three fundamentals for the winding A, B and C at any instant of time t. These are

$$y_{A1} = \frac{4a}{3\pi} \times 2{\cdot}88 \sin\frac{2\pi x}{\tau} \sin\frac{2\pi t}{T},$$

$$y_{B1} = \frac{4a}{3\pi} \times 2{\cdot}88 \sin\frac{2\pi\left(x - \frac{\tau}{3}\right)}{\tau} \sin\frac{2\pi\left(t - \frac{T}{3}\right)}{T},$$

$$y_{C1} = \frac{4a}{3\pi} \times 2{\cdot}88 \sin\frac{2\pi\left(x - \frac{2}{3}\tau\right)}{\tau} \sin\frac{2\pi\left(t - \frac{2}{3}T\right)}{T}.$$

Adding these together we get

$$y_{A1} + y_{B1} + y_{C1} = \frac{4a}{3\pi} \times 2{\cdot}88 \times 1{\cdot}5 \cos 2\pi\left(\frac{x}{\tau} - \frac{t}{T}\right),$$

which represents a train of waves of wave-length τ, and amplitude half as great again as the amplitude of y_{A1}, moving forward with a velocity, τ/T—that is, with the velocity of the field poles. The three fundamentals combine, therefore, to give us a series of sine waves of magnetomotive force moving forward synchronously with the field poles, and therefore stationary over the poles. Similarly, we would find that the third harmonics combine to give us a sine magnetomotive force rotating at one-third of synchronous speed in the opposite

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direction to the rotation of the field poles. The fifth harmonic moves with one-fifth of synchronous speed and in the same direction as the field poles, and similarly for the others.

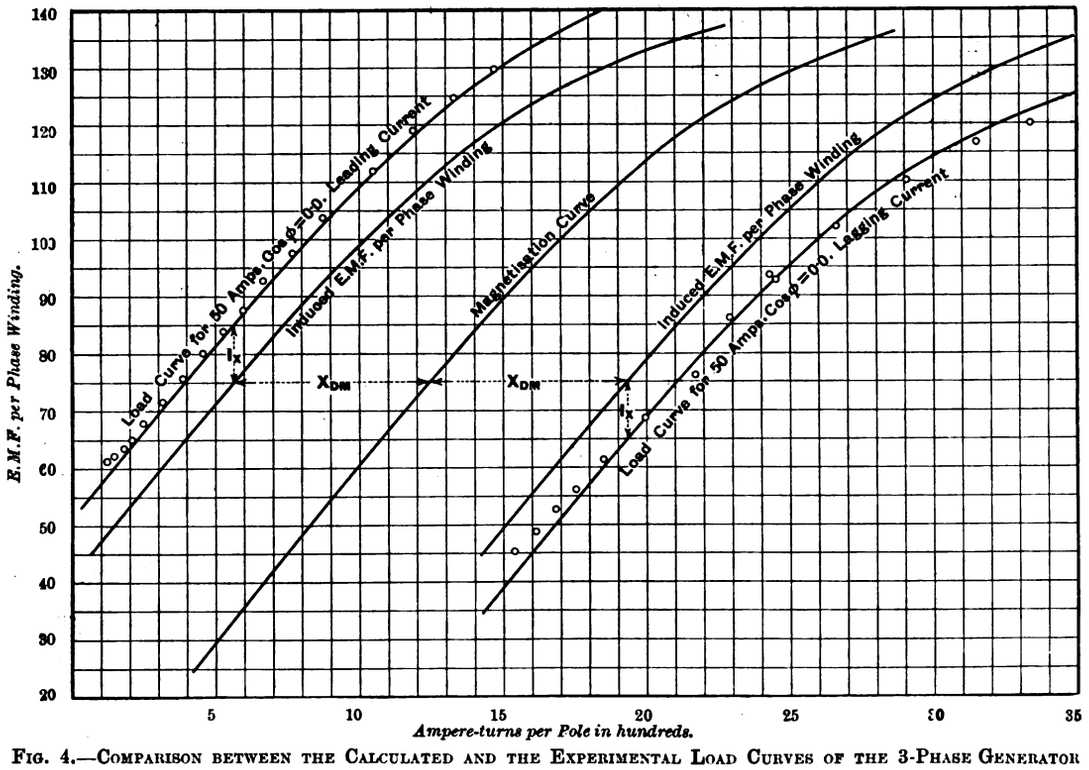

FIG. 4.—COMPARISON BETWEEN THE CALCULATED AND THE EXPERIMENTAL LOAD CURVES OF THE 3-PHASE GENERATOR FOR CURRENTS OF 50 AMPERES LAGGING AND LEADING AT ZERO POWER-FACTOR.

Full Lines = Calculated. o o o o = Experimental results.

Thus the fundamental, fifth, ninth, thirteenth, &c., harmonics revolve at their corresponding speeds in the same direction as the field poles, while the third, seventh, eleventh, &c., harmonics revolve at their corresponding speeds in the opposite direction to the field poles. Since all the harmonic magnetomotive forces move relatively to the poles, they will induce currents in the amortisseurs, the field coils and the pole faces, which will, to a large extent, annul any magnetising effect they might otherwise have. We will restrict our considerations for the present to the fundamental, which does not move relatively to the poles, and which produces, therefore, most of the armature reaction.

The position which this rotating magnetomotive force sine curve occupies relatively to the field poles depends on the power-factor of the circuit. If the current is in phase with the induced E.M.F., a little consideration of the components will show that the rotating sine curve must have its zero values over the centres of the poles, and in the general case that the sine curves will lag or lead from this position by approximately the lag or lead of the current relatively to the induced E.M.F. The sine curve must always stand over any element of the winding at the instant that the current is a maximum in that winding, and the pole position at that instant is known relatively to the element of the winding, and, therefore, also relatively to the sine curve. We must now consider the general case of these waves lagging by an angle, ϕ, relatively to the poles (Fig. 3). In order to separate the different magnetic effects produced by these magnetomotive force waves, we resolve the train of sine waves into two trains of sine waves, one of which has its maximum ordinates over the pole centres, and the other of which has its maximum ordinate midway between the pole centres. If a is the amplitude of the initial train of waves, the amplitude of the former component train will be $a \sin \phi$, and the amplitude of the latter component train $a \cos \phi$, and

$$a = \frac{4a}{3\pi} \times 2{\cdot}88 \times 1{\cdot}5$$

$$= \frac{2\sqrt{2}nI_n}{3\pi} \times 2{\cdot}88 \times 1{\cdot}5.$$

We shall now consider these two sets of waves separately, and what follows will be divided into two parts, the first dealing experimentally with the set of waves having their maximum ordinates over the pole centres, and the second part dealing similarly with the other set having their maximum ordinates midway between the pole centres. The former set we call the

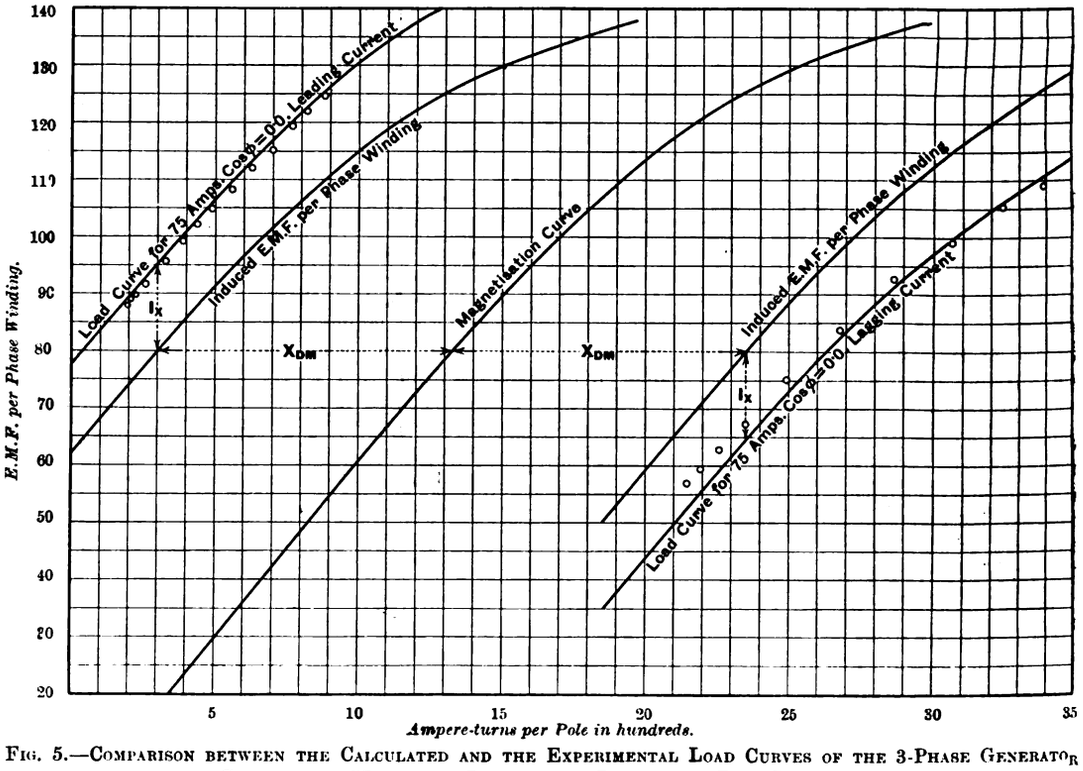

FIG. 5.—COMPARISON BETWEEN THE CALCULATED AND THE EXPERIMENTAL LOAD CURVES OF THE 3-PHASE GENERATOR FOR CURRENTS OF 75 AMPERES LAGGING AND LEADING AT ZERO POWER-FACTOR.

Full Lines = Calculated. o o o o = Experimental Results.

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demagnetising waves, and the latter the cross-magnetising waves; both are shown in Fig. 3.

EXPERIMENTAL.

The set of magnetomotive force waves which has the maximum ordinates over the pole centres will produce a direct magnetising or demagnetising action on the poles, depending on whether the current in the generator is leading or lagging. If the machine is running as a motor, the action would, of course, be the opposite of what it is in a generator.

Since the pole surface is not continuous, only that portion of a wave which stands over the pole will have any great effect on the flux in the gap. We must, therefore, find the average value of this portion of the wave, which is shaded in Fig. 3. A simple integration gives us the area of the shaded portion, and, dividing by the length b, we get the average ordinate, the value being $\frac{\sin b\pi/\tau}{b\pi/\tau} \times$ maximum ordinate.

Let us call this the *demagnetising* magnetomotive force of armature reaction, ϕ being reckoned positive for lagging current so as to give the demagnetising effect; a leading current will make ϕ negative and give negative demagnetisation or magnetisation. Let us denote the magnetomotive force by $X_{D.M.}$ We have then

$$X_{D.M.} = \frac{4a}{3\pi} \times 2{\cdot}88 \times 1{\cdot}5 \sin\phi \frac{\sin b\pi/\tau}{b\pi/\tau}$$

$$= \frac{4\sqrt{2}n I_a}{6\pi} \times 2{\cdot}88 \times 1{\cdot}5 \sin\phi \frac{\sin b\pi/\tau}{b\pi/\tau}.$$

In our generator $b/\tau = 0{\cdot}375$, $n = 27$, and since in this armature there are two paths for the current in each phase winding I_a is one half of I, the line current. Substituting these values we get $X_{D.M.} = 13{\cdot}7\, I \sin\phi$ ampere-turns.

If now a current is taken from the armature, lagging or leading by 90deg., the total armature reaction consists of the one set of waves $F_{D.M.}$, since the other set contains cos ϕ, and vanishes when $\phi = 90$deg. In this case $X_{D.M.} = 13{\cdot}7\, I$.

If, in addition to $X_{D.M.}$, we know the reactance of the armature, then from the no load or magnetic characteristic we can construct the load characteristic for any value of the current. We might have obtained the armature reactance by calculation from the dimensions of the slots, but it was easier to determine it experimentally. Having removed the poles from the machine, an alternating E.M.F. of sine form, as tested by the oscillograph, was applied to the terminals of one phase winding and readings of the current and terminal voltage were simultaneously taken. From a number of experiments a mean reactance was obtained: $x = 0{\cdot}204$ ohm. The load characteristics for 50 and for 75 amperes lagging and leading obtained from the magnetic characteristic are shown in Figs. 4 and 5 respectively. The induced E.M.F. curves are horizontally distant from the magnetic characteristic by the uniform distance $X_{D.M.}$, and the terminal E.M.F. curves are distant from the induced E.M.F. curves by the uniform vertical amount Ix, the terminal E.M.F. being lower than the induced E.M.F. for lagging currents and higher for leading currents.

In order to test these theoretical curves, load characteristics for 50 and for 75 amperes, both lagging and leading, were experimentally determined for zero power-factor. The load was obtained by means of two rotary converters which are separately excited, so that the current can be made to lag or lead at will by varying the excitation of the rotaries. The power necessary to drive the converters was supplied as direct current to the brushes on the commutator, the direct-current E.M.F. being readily varied. By varying the direct-current E.M.F. and the excitation, the current and power-factor could be varied at will. A wattmeter connected in and across one phase winding gave the necessary measure of the power-factor.

The results of these experiments are plotted in Figs. 4 and 5 beside the theoretically deduced load curves, the experimental points being marked by dots surrounded by circles. The agreement between theory and experiment is, so far, a satisfactory one, and the authors propose to continue their investigations at an early date in connection with the more complicated problem of the circuit of power-factor other than zero.

WIRELESS TELEGRAPHY BILL.

The following memorandum explanatory of the Wireless Telegraphy Bill has been issued by Lord Stanley. The Bill, which was introduced by Lord Stanley to the House of Commons on July 18th, was published in full in our issue of July 22nd, p. 564:—

The development of wireless telegraphy during the past few years, and the prospect of its further development and extended use in the near future, have rendered legislation on the subject essential in the interests of the naval and military requirements of the empire. In any future war, especially in a naval war, wireless telegraphy will probably play a very important part, and it is essential that the control of this method of communication should be in the hands of the Government. At present the Governments of nearly all the great Powers and most of our self-governing colonies have control over wireless telegraphy, both for inland and foreign messages, but, except in the case of messages between two points in the United Kingdom and in territorial waters within the 3-mile limit, the powers of His Majesty's Government are limited and inadequate. In time of war or emergency the Government can take possession of the telegraph stations of incorporated companies carrying on telegraphic business, but the power does not extend to the installations of private individuals. The Postmaster-General can also impose conditions in connection with the arrangements for the transmission of foreign telegrams over the postal wires; but advantage could only be taken of this power where facilities for transmission were required, and this, obviously, might not be the case in connection with many installations of danger to the State. Otherwise, the only means of control possessed by the Government are furnished indirectly by an arrangement which has already been made in a number of instances with foreign Powers, by which those Powers undertake not to permit the establishment of systems of wireless telegraphy for communication between their own territory and the United Kingdom, except after previous consultation with the British Government. An arrangement of this nature is obviously unsatisfactory and insecure, especially from the point of view of defence, and, in time of war or strained relations, would give rise to difficulties of a grave and far-reaching nature. It would, at such times, be of vital importance to prevent unauthorised information leaving this country, and, further, to secure uninterrupted communication between His Majesty's fleets and vessels and shore signal stations. Legislation is, therefore, needed for the following reasons:—

1. The extreme importance in time of war or emergency of exercising control and supervision of all means by which information could be conveyed to an enemy, and of preserving such secrecy as to plans and preparations as is essential for successful operations. It is not a matter of great difficulty for a private individual to set up a temporary installation on his own property. This might, for a time, escape observation, but, if situated near the coast, would be a source of great danger in time of war, as it would not only be able to intercept messages from neighbouring stations, but might further be used for communication with unauthorised persons and the disclosure of naval and military arrangements.

2. One of the great difficulties to contend with in wireless telegraphy is interference as between neighbouring stations, and this must be met by limitation of the number of stations and careful selection of sites.

If the number of installations were greatly increased and they were set up without regard to strategic requirements, the interference might easily be so great as to minimise the usefulness of wireless telegraphy for communication with His Majesty's ships. This consideration has especial weight in relation to times of war or emergency.

3. In time of war or emergency, it is important that the Admiralty should at all times be able to communicate with His Majesty's ships, and with this view the Government should have power of stopping absolutely the use of wireless telegraphy in private hands, when its use would interfere with such communication.

Thus, from the point of view of strategic requirements, three of the most important points to be considered are:—(*a*) Control of the transmission of messages, (*b*) prevention of the establishment of unauthorised stations, (*c*) disposition of stations in the most advantageous way so as to obtain the best results in working, free from interference, accidental or intentional.

It is only by means of legislation, and, preferably, by the licensing of stations, that these points can be secured. In addition to the above imperative reasons, there are others which render legislation for the control of wireless telegraphy very desirable. Proposals have been made for an international agreement to regulate wireless telegraphy in certain respects. Since international relations are concerned with wireless communication between stations in this country on the one hand, and ships on the high seas or stations in other countries on the other, it is desirable that the Government should be in a position to enter into an agreement on the subject with other countries if it should be found expedient to do so. In the present state of the law, there would be no means of enforcing the conditions laid down by such an agreement. Further, in order that the invention may be developed and applied with the greatest advantage to the public, it is desirable that matters such as the position of stations and their interference with one another should be regulated in the general interest.

It is proposed in the bill, for reasons of administrative convenience, that licences should be granted by the Postmaster-General, since the Post Office is the department which deals with telegraphs in general, and is in relation with foreign telegraph administrations. On the other hand, it is provided that licences shall not be granted except with the consent of the Admiralty and War Office, thus securing that the strategic considerations, which are of paramount importance, shall be regarded. As the progress of wireless telegraphy also affects the trade and commerce of the country, it is proposed to add the Board of Trade as a consenting party to the grant of a licence.

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SINGLE-PHASE "REPULSION-INDUCTION" MOTORS.

We are indebted to Messrs. Witting, Eborall & Co. for the following brief notes on the new class of repulsion-induction motors which they are now putting on the market, and which are covered by V. A. Fynn's patents. These commutator motors are specially adapted for crane, lift, hoist, locomotive and similar work, in which large starting torques with a moderate current consumption are required. They can be used equally well for all classes of industrial work, but for work in which the starting performance of the motor is not the primary consideration, and in which no speed

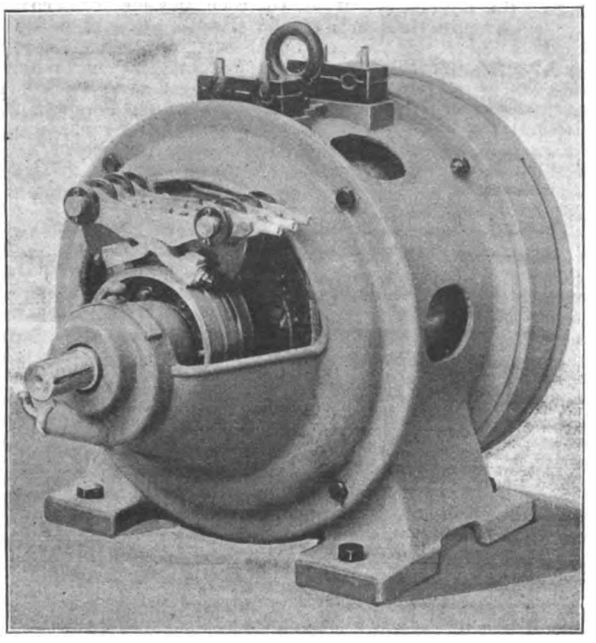

FIG. 1.—WITTING-EBORALL REPULSION INDUCTION MOTOR.

regulation is required (such as for driving of workshops, &c.), the standard induction motor is usually preferable on account of its lower price, and because of the absence of the commutator.

The construction and mode of operation of the motors is as follows:—The stationary stator is built in exactly the same way as the stator of a standard three-phase motor, while the rotor is generally similar to the armature of a rotary converter. It has two inter-connected windings upon it, the three free ends of the one being connected to slip rings, while the ends of the coils of the other are connected up to a commutator, as shown in Fig. 2, which is a

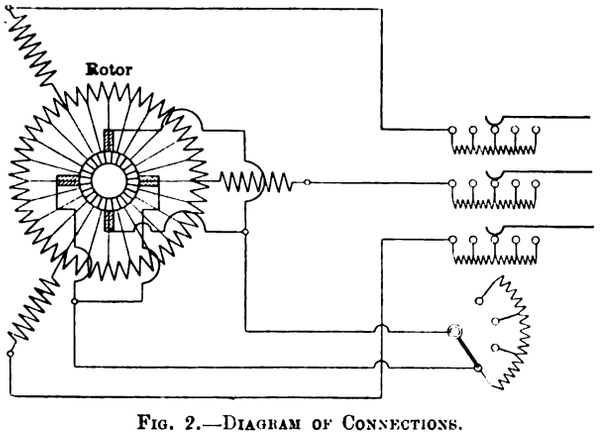

FIG. 2.—DIAGRAM OF CONNECTIONS.

diagrammatic representation of a four-pole rotor. The brushes on the commutator are permanently short-circuited in the smallest sizes, and closed through a variable resistance during the first part of the starting period in the larger sizes; they never require to be moved. The slip-ring brushes are in connection with a regulating resistance, as indicated in the diagram. The rotor has no electrical connection with the stator, and after full speed has been reached its slip rings are short-circuited. Owing to the nature of its construction, it is evident that at starting the motor works as a pure repulsion motor, and at full speed as an asynchronous motor; at intermediate speeds the motor is working partly as an induction, partly as a repulsion motor. The intermediate speeds are obtained with the help of the resistance, the speed characteristic of the motor being similar to that of a direct-current series motor.

As indicated above, the brushes always remain in a fixed position, and under these conditions sparkless running can be guaranteed at any speed. The running performance of the smaller motors is illustrated by the set of curves shown in Fig. 3, which refer to a 220-volt 50 cycle 4 B.H.P. motor, designed for a very large starting torque. With regard to the starting performance generally, the guarantee given by the makers is, that when starting with a torque equal to that at full load the starting current will not exceed three-quarters of the full-load current, or, when starting with a torque equal to twice that at full load, the starting current will not exceed one and a-half times the full-load current, constant stator pressure being assumed. Messrs. Witting, Eborall & Co. claim that this starting performance is not equalled by any other single-phase motor on the market at the present date. When this class of

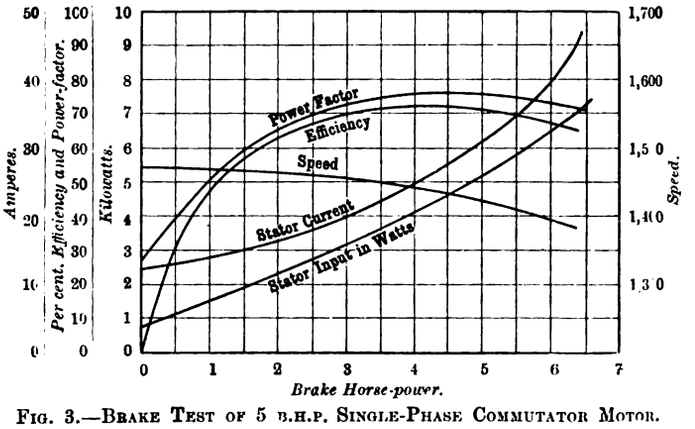

FIG. 3.—BRAKE TEST OF 5 B.H.P. SINGLE-PHASE COMMUTATOR MOTOR.
220 volts; 50 cycles; 1,500 revs. per min.

motor is employed for ordinary industrial work, and where the size of the motor warrants the additional expense, the motors can be compensated (with the help of an auxiliary stator winding) in such a way that the power-factor is nearly unity over the working range of the motor.

CORRESPONDENCE.

THE UNITED STATES GOVERNMENT AND THE FESSENDEN WIRELESS SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In No. 1,366 of your journal Mr. H. J. Glaubitz, manager of the National Signalling Co., publishes a letter to which we desire to reply as follows:—

Mr. Glaubitz alleges that we have sold and could sell to the naval administration of the United States cheaper than the Marconi or the Fessenden Company, inasmuch as we, on the one hand, manufacture cheaper than the said companies, and because, on the other hand, our experimental expenses are less. It is also alleged that we have made use of the patents as well as the experience of the Fessenden Co. without having any right to them. As far as the first assertion is concerned, we admit the greater cheapness of our manufacture. For many years we have standardised our apparatus, and these are now produced in large numbers in the splendidly furnished workshops, for manufacture on a large scale, of Messrs. Siemens and Halske and the Allgemeine Elektricitäts-Gesellschaft, Berlin. We owe this to the circumstance that we have had a largely developed business for several years, and our standard apparatus have proved themselves trustworthy and reliable. We must, however, energetically protest against the assertion that we have made use of foreign patents to which we had no right.

Mr. Glaubitz probably only began to occupy himself with the practical working of wireless telegraphy on the occasion of the formation of the National Signalling Co., which has only lately taken place. This is the only explanation which we can find for his point of view; otherwise Mr. Glaubitz would know of the extensive tests which our system has undergone during the past five years. Our own testing stations at Oberschöneweide and Berlin have already been working uninterruptedly since the year 1899. For instance, in 1900 we showed, for the

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first time, with this installation, that duplex wireless telegraphy was possible, and we published a description of the means employed. We keep other test stations going in Cuxhaven and Heligoland, in the German Ocean, and rigorous tests between these have also been made since 1899. Further, between the stations Gr. Möllen and Sassnitz, in the Baltic, an uninterrupted wireless service was maintained, a similar accomplishment not having been achieved by anyone up to that time. Finally, our station in Oberschöneweide, which has been employed for long-distance tests since 1902, is equipped with transmitting plant to the extent of 20kw. Does Mr. Glaubitz imagine that these large stations, structures and works cost less than the tests of the National Signalling Co. in the United States?

Considerable assistance in carrying out our tests was given by Profs. Slaby and Braun, who have both occupied themselves exclusively since 1897-98 in carrying out investigations in connection with wireless telegraphy. The first publications of these gentlemen appeared at a time when the Fessenden system was not yet in existence. This is hardly the right place for going into the patent question in detail. We are not aware that we have infringed foreign rights, but we are, on the contrary, thoroughly convinced of our own rights. The legal aspect of the case will, of course, be settled in the future. Mr. Glaubitz's letter must, in our opinion, have been written without Prof. Fessenden's knowledge. We had the pleasure of greeting Prof. Fessenden at our office about six months ago, and we showed him, in the most open manner, all our apparatus and erections, including even a part of our laboratory, works and our large station at Oberschöneweide. Mr. Fessenden recognised the merit on this occasion of a number of our contrivances, and praised them immensely; we even agreed to make certain tests mutually. With reference to this letter, we have therefore written to Prof. Fessenden in the following terms:—

DEAR SIR: In No. 1,366 of *The Electrician*, page 566, we read an article proceeding from the pen of H. J. Glaubitz, Manager of the National Electrical Signalling Company. We are herein reproached of being able to furnish cheaper than the Marconi or their company, because we made use of their patents and experience without being entitled so to do, and for this reason no test expenses were entailed by us. The last time you were in Berlin we showed you, in the most obliging way, our apparata, methods of switching and tests. You must, therefore, be personally convinced that we are constantly working further and that our expenditure for progressive knowledge is by no means insignificant. We are, therefore, convinced that you are in no way concerned with the article in question and that you have no cognition of the same. We politely request you to rectify this. Should you, however, not comply with this desire of ours, to which we are, in our opinion, perfectly entitled, we should feel ourselves compelled to regard the arrangement agreed to, relative to mutual larger tests, as suspended.

Enmities are always the accompanying notes of success. Our successes were not obtained by indirect means and by advertisements, but essentially by what we accomplished technically. Wireless telegraphy has so far progressed that one can now state accurately the problem to be solved. We are ready to demonstrate that we have a transmitting and receiving arrangement whose operation is so perfect that our stations can only be interrupted by a strange transmitter of equal intensity when the difference of wave-length of this strange transmitter is smaller than 5 per cent. as compared with ours. Can Mr. Glaubitz name an inventor or a system whose contrivance possesses the same degree of syntony? We are prepared to demonstrate our system in any comparative tests. —Yours, &c.

GESELLSCHAFT FÜR DRAHTLOSE TELEGRAPHIE,
Berlin, Aug. 1. Bargmann and Arco.

SELF-EXCITING AND COMPOUNDED ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: *The Electrician* of July 15th contains, on pp. 510 and 511, an article headed "Self-exciting and Compounded Alternators," in which mention is made of a new and ingenious method by which Mr. Heyland does no longer—as formerly proposed by him—compound the alternator directly with commutated current, but provides the ordinary continuous-current exciter with a compound winding that is excited by a commutated current proportional to the load current.

As you speak of this arrangement as being new, I beg to draw your attention to the fact that I have described this very same method as early as 1900 in a pamphlet of the Maschinenfabrik Oerlikon, which was widely distributed at the Paris Exhibition of the same year, and was published under the title "Sur le calcul des machines électriques."—
Yours, &c., Dr. HS. BEHN-ESCHENBURG.

Oerlikon, July 30.

THE WESTINGHOUSE CO.'S EXHIBITS AT ST. LOUIS.

The main generating plant at the St. Louis Exhibition, for which the Westinghouse Electric & Mfg. Co. received the general contract, forms the most notable item of the Westinghouse exhibits. It comprises four three-phase generating sets—each of 2,000kw. capacity—which are situated in the central aisle of the Machinery Hall. These sets run at 88·5 revs. per min., and the current is generated at 6,600 volts and 25 ∿ per second. It may be mentioned that these generating units are each almost three times the size of the 12 which the Westinghouse Company installed at the Chicago Exhibition of 1893. A full size (35ft.) plaster model of the stationary armature of one of the Westinghouse Company's 5,000kw. alternators forms a striking entrance arch to the Westinghouse exhibit in the Machinery Hall. The space occupied by the smallest of the belt-driven 750kw. sets at Chicago was about 65ft. by 27ft., but that occupied by each of the units at St. Louis is only about 35ft. by 15ft. of floor, their height being 32½ft., while the flywheels are 23ft in diameter. The total space devoted to the electric generating plant in the Machinery Hall, including the exciter units, condensers, cooling towers and the 35-panel switchboard, is 26,260 sq. ft. The entire steam and electric station was designed and equipped by Messrs. Westinghouse, Church, Kerr & Co., all the generating machinery and the steam plant in the adjacent boiler house being furnished by the Westinghouse Machine Co.

The various organisations associated with the name of Westinghouse, which have united at St. Louis under the title of the "Westinghouse Companies at Louisiana Purchase Exposition," have an additional and adjoining exhibit area in the Machinery Hall of 26,260 sq. ft.; in the Palace of Electricity—where Baldwin-Westinghouse electric trucks and locomotives are shown amongst other exhibits—an area of 10,100 sq. ft., and in the Transportation Building an area of 3,000 sq. ft. Altogether the total exhibit area amounts to 65,620 sq. ft. The manufacturing companies associated with these joint exhibits employ 30,000 employés and occupy a total workshop floor space of over 140 acres. In the Machinery Hall, in addition to the electric service plant and the main exhibit of Westinghouse gas engines, turbo-generators, rotary converters, exciters and motors in operation, which are all enclosed within ornamental staff walls and columned entrances of classic design, is the Westinghouse auditorium. This will seat 350 persons, and here biograph and mutoscope pictures of scenes in and about the various Westinghouse works in the Pittsburg district, including the first interior photography of the kind ever taken by means of the Cooper Hewitt mercury vapour lamp, are displayed at frequent intervals each day. The auditorium, which is of ornate architectural design, is rendered cool and comfortable by a ventilating system which provides a continuous supply of pure air, and is brilliantly lighted by Sawyer-Man incandescent lamps, Bremer arc lamps, Cooper Hewitt mercury-vapour lamps and Nernst glowers. The auditorium is also available as a meeting place for scientific societies and technical congresses. Cooper Hewitt lamps, by the light of which the mutoscope shop views were taken, form one of the distinct novelties of the exhibition, and several forms of such for use in general illumination, photography and photo-engraving, are shown in the booths in the Machinery Hall and in the Palace of Electricity, together with samples of photo and photo-engraving work done by some of the best operators. Demonstrations of working with these lamps were given for the benefit of the National Photo-Engravers' Association at its June convention, and others will be given at the convention of the National Photographers' Association in October.

There are in all about 10,000 Nernst lamps in use in the exhibition buildings, 6,000 of them being in the Fine Arts Museum. The big Westinghouse generators alluded to supply current for the Nernst lamps throughout the building, as also for the 200,000 ordinary incandescent lamps which outline the buildings at night. In service or on exhibition, the Westinghouse Company has altogether some 14,000 H.P. of generating machinery and 30,000 H.P. of motors and other appliances. Steam for the plant is supplied from an adjacent boiler house, in which are installed a number of B. & W. water-tube boilers built into a single setting and having a total capacity of 6,400 H.P. The equipment also includes Roney mechanical stokers operated by Westinghouse standard steam engines, a complete coal-

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conveying system furnished by the Link Belt Engineering Co., Cochrane feed-water heaters, Worthington steam pumps, mechanical draught, condensers, cooling towers, &c.—all the equipment, in fact, that constitutes a model up-to-date station. Included in the auxiliary electrical plant are three 80kw. 125-volt continuous-current directly-connected exciters, any two of which are sufficient for the work. The exhibit service plant, immediately west of the Westinghouse Company's headquarters, furnishes power for various purposes, and includes a 400kw. Westinghouse-Parsons steam turbine generating set. The latter runs at a speed of 3,600 revs. per min., and supplies three-phase current at 60 ∼ per second and 440 volts. It is at the present time the smallest turbine unit built by the Westinghouse Machine Co. Among the exhibit service plant there are also a 125 H.P. vertical and a 225 H P, horizontal Westinghouse gas engine, the former being directly connected to a standard continuous-current generator, and the latter to a standard three-wire double-voltage continuous-current generator. Both the single-acting and double-acting types of Westinghouse gas engines are represented here in their latest form. An important part of the Westinghouse installation is the pumping machinery under the cascades in front of the Festival Hall. This equipment consists of three large centrifugal pumps each driven by a 2,000 H.P. Westinghouse induction motor, and it supplies 90,000 gallons of water per minute for the cascades.

Amongst the many exhibits in the Palace of Electricity are the single-phase series-wound crane motors, similar in type and general construction to the single-phase railway motors exhibited in the Transportation Building; also the new Westinghouse unit switch system of multiple unit control. The Westinghouse Air Brake Co.'s exhibit includes a rack made up of apparatus constituting the equipment for a six-coach passenger train with engine and tender, all fitted throughout with the high-speed brake and signal equipment. The engine and tender are also equipped with the combination automatic and straight air brake which is now so much in use. An exhibit of magnetic brakes, car-heating equipments, and straight air brakes for both motor-driven and axle-driven compressors is given by the Westinghouse Traction Brake Co. The magnetic brake is applied to a truck running on a track 45ft. long, the truck being fitted at both ends with friction draught gear buffers to show the use of this extensively adopted device. Another interesting exhibit is the separate brake controller for use with the magnetic brake, when the latter is fitted to cars already equipped with ordinary controllers. The straight air-brake rack shows the equipment now used in the straight air-brake outfit on electric cars that are operated by one of the Westinghouse standard compressors. The compressors shown are of the axle and motor-driven types, and they are sectioned to permit of the inspection of their internal working parts, one of them being arranged to move with a regular compressor in operation. An exhibit by the Union Switch and Signal Co. consists of a group of full size working signals erected in the Transportation Building. Examples of electrical appliances for the operation and control of signals are exhibited, together with a signal designed for use in the tunnels of the Pennsylvania Railroad under the Hudson River to New York City, this being fitted in a full-sized model of one of the tunnel tubes. The company's most important exhibit at St. Louis, however, consists of installations in actual service, chief of which is the Westinghouse electro-pneumatic interlocking system at the Union station, which controls all the passenger yard movements, and is said to be the largest interlocking apparatus ever built.

THE BLONDEL ARC LAMP.*

What promises to be one of the most important improvements in electric lamps made during recent years is due to André Blondel, of Paris, a distinguished French engineer. This lamp is now being exhibited in New York by Col. W. S. Proskey, of 70, Wall-street. The lamp is of the open arc type, is very brilliant, gives an excellent distribution and a high efficiency The quality of the light can be varied considerably and made much whiter than the ordinary carbon arc. The peculiarities of this lamp are three: First, one of the carbons is a composite carbon—that is, it contains a proportion of certain salts which have the property of increasing the luminosity of the arc; second, in the direct-current Blondel lamps, the positive carbon is placed at the bottom; third, around the upper carbon, and just above the arc, is placed a reflector. Each of these features has a distinctive value, and adds to the effectiveness of the lamp. The arrangement is shown in the accompanying illustration.

Considering first the composite carbon, this is a cored carbon having usually three zones. The outer zone is a pure carbon, and is for the purpose of mechanical strength and providing electrical conductivity. It is thin compared with the diameter of the carbon. Within this is a large composite core, consisting of carbon and the various light-giving salts, such as lime, magnesia or similar minerals. Within this core may be an inner core, which has the same composition as the larger core, but is subjected to less pressure, and, being on the interior, is probably baked at a somewhat lower temperature. The object of this central core is to assist in maintaining the arc at the centre of the carbon, and produce a uniform consumption of the carbon itself. These carbons are of varying sizes, depending upon the size of the lamp. That for 5 amperes is about ½in. in diameter. They burn about ½in. per hour. The upper carbon, being the negative, is shorter, and is usually of pure carbon, though it may contain a very small part of the light-giving salts. It is usually smaller in diameter than the lower carbon. These carbons are of satisfactory size for shipping and handling, and while the best results are obtained by using different sizes for the different lamps, they can all be burned in any one lamp. The effect of placing the positive composite carbon at the bottom is to allow the vapours given off here to rise through the arc, and thus to become highly heated. When this composite carbon is placed at the top, the vapours given off, being lighter than the cooler air around the arc, tend to rise, resulting in a flame which licks the upper carbon. With this arrangement, also, the scoria formed runs down to the tip of the carbon, and drips off; and when the lamp is shut off an insulating layer is formed, which must be broken off, before the lamp will start again. With the reverse position adopted by Blondel, these vapours pass up through the arc, and they thus add considerably to the luminosity of the arc. In fact, the lamp is a luminous arc lamp, as the light given from the carbon electrodes is inappreciable. In this position, any scoria which might form would tend to run down the lower carbon, and hence would not form an insulating layer. The lamp may be turned on or off at will, without it being necessary to clean the carbons.

The action of the reflector—or condenser, as it is sometimes called—is to confine the vapours as they rise from the arc, until they are completely consumed, and to collect the metallic oxides formed. No objectionable vapours are given off, thus permitting the lamp to be used for inside lighting, The condenser consists of a metallic ring having a concave surface downward, and containing at the centre part a ring of some insulating refractory material. In action this condenser becomes coated quickly with white oxides, and is thus converted into a very effective light disperser. The condenser also protects the arc from disturbing air currents, so that it burns steadily, even at low values of current. The lamps are now put out for 5 and for 8 amperes, and Col. Proskey has even succeeded in constructing a lamp which burns very satisfactorily on 1 ampere. The length of the arc is considerable, varying with the voltage and being from ½in. to ¾in. The normal voltage of the lamp is 50, but by increasing the length of the arc it may be carried up to over 70, and still a satisfactory arc be maintained, and, apparently, with a similar increase in luminosity as secured by the larger lamps. One of the 1-ampere lamps was shown in operation, and, so far as could be judged by mere inspection, it was perfectly satisfactory, burning quietly and steadily and giving off a great deal of light. It is thought that these low-current lamps will meet with much success, particularly for interior lighting. The value of this lamp as a source of light is very well indicated in a report made by Dr. W. Wedding, of the Royal Technical High School, Charlottenburg, who examined the lamp for the German patent office. Dr. Wedding's results are embodied in the accompanying table:—

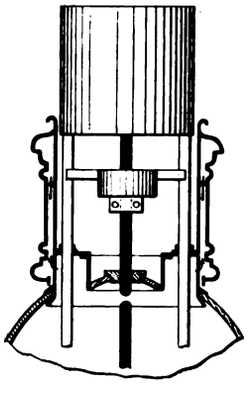

DIAGRAM OF PARTS, BLONDEL ARC LAMP.

Results of Wedding's Tests of Blondel Lamp.

Type and arrangement of carbons.	Voltage.	Amps.	Watts per lamp.	Average hemispherical c.p.	Watts per c.p.
Positive Blondel glower 9mm. dia., upper Siemens "A" carbon 7mm. dia.	57·4	2·99	171·5	1,339	0·128
Same, of 11mm. & 7mm. dia.	51·6	5·12	241·2	2,210	0·109
Upper positive Siemens "A" cored carbon 9mm. dia., lower negative Siemens "A" solid 7mm. dia.	53·1	2·9	154·2	207	0·746
Same arrangement of 11mm. and 9mm. dia.	52·4	4·94	258·9	404	0·644
Bremer lamp	..	28·6	..	..	0·100
Bremer lamp	..	12·3	..	..	0·126

These figures show that, with the same current intensity, the high-tension arc is more economical than the low-tension, and that of the Blondel inverted arrangement is about 25 per cent. better than that of the other, This arrangement causes a translation of

* From the *Electrical Review* of New York.

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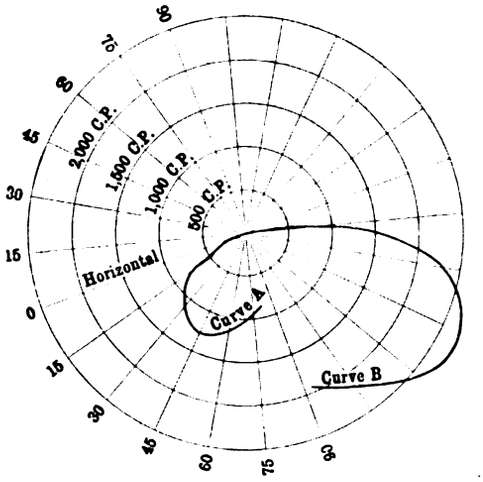
ions in the same direction as with the rising of hot gases, giving a considerably hotter burning and a steadier light.

To determine whether the Blondel lamp gives better results than hitherto-known lamps, Dr. Wedding compares it with other results of flame arc lights as follows: "The most favourable result of specific consumption has been found in the Bremer lamp, with carbons arranged side by side. This was 1·1 watt per candle. The consumption of Blondel's lamp differs from this by 9 per cent. I do not attach much importance to this difference, if one considers that the consumption of 0·1 watt in a Bremer lamp can be obtained only at the exceptionally high intensity of current of 28 amperes, and nearly the same result is obtained by Blondel with a lamp taking only 5 amperes. An important improvement has thus been made. If one considers, further, that a 12·3-ampere Bremer lamp shows the same specific consumption (0·126 watt) as a Blondel lamp taking only 3 amperes, it is clear that a new and considerable effect has been achieved by Blondel's lamp." To quote further from Dr. Wedding: "Up to the present time none has succeeded in making flame arc lamps practically useful and to burn with such small currents as 3 amperes. This M. Blondel achieves as the result of co-operation of the different elements in his lamp. Consequently, the success of Blondel's lamp rests upon the co-operation of a number of arrangements which will lead to new and hitherto unknown progress."

The accompanying distribution curves were obtained at the Lamp Testing Bureau, New York City. They show, when compared with the curves for the ordinary enclosed lamps, a high efficiency for the Blondel lamp. For instance, the measurements made by the National Electric Light Association's committee show that a 6·6-ampere 110-volt direct-current enclosed lamp, without the outer globe, gave a maximum luminosity of a little over 450 candles, with an expenditure of 726 watts. A 5-ampere 50-volt direct-



Distribution Curves, Blondel Arc Lamp.

A, Three-ampere fifty-volt lamp, without globe. B, Five-ampere fifty-volt lamp, without globe.

current Blondel lamp, without the globe, gave over 2,700 candles, with an expenditure of 250 watts. It is interesting also to compare the 3-ampere 50-volt Blondel lamp—taking 150 watts—with the ordinary enclosed arc lamps. The report shows that, for the 3-ampere Blondel lamp, operating at 50·3 volts, the mean hemispherical candle-power was 790 candles. The specific consumption was 0·191 watt per candle. For the 5-ampere lamp, without the globe, the mean hemispherical candle-power was 1,888, and the specific consumption 0·133 watt per candle. The report of the Lamp Testing Bureau states: "The lamp burns very quietly, without hissing or noise except the occasional feeding of the carbons. The arc travels very slowly and at intervals remains stationary for considerable periods of time. There are no deep shadows from the supporting arms and the bottom of the lamp, due probably to the distributing effect of the reflecting surface referred to, and, to the eye, the illumination is fairly uniform throughout the lower hemisphere, even without the globe. The globe, of course, increases the illumination in the upper hemisphere, giving a more uniform spherical distribution. The lamp, however, can be burned if desired without a globe."

The mechanism of the lamp is quite simple. There is a rocking lever connected with a train of wheels for feeding the carbon and for drawing the arc. The action of this is controlled by a series and a shunt solenoid. In other respects this lamp is similar to the familiar type. The appearance of the light is exceedingly pleasant and soft. When the 5-ampere 50-volt lamp was exhibited side by side with a 5-ampere 110-volt enclosed arc the contrast was very marked. The Blondel lamp was enclosed in a very heavy opalescent globe, and there was no shadow either on the ceiling or on the floor directly under the lamp. The ordinary arc lamp apparently added but little to the general illumination of the room.

PARLIAMENTARY INTELLIGENCE.

EXTENSION OF MUNICIPAL ELECTRIC LIGHTING AREA.

Electric Lighting Provisional Order Confirmation Bill No. 3.

This bill, to confirm a number of provisional orders made by the Board of Trade under the Electric Lighting Acts, came before a Committee of the House of Commons yesterday, the chairman being Sir James Woodhouse. The only opposed order was that granted to the Maidenhead Corporation. It will be remembered that this particular order was one of the group which came before the Committee of the House of Lords presided over by his Grace the Duke of Northumberland (see *The Electrician*, June 17).

Mr. VESEY KNOX, for the Maidenhead Corporation, said the only opposition was by the Eton Rural District Council. The order sought to extend the area of supply beyond the borough boundary, by reason of numerous applications from residents in the adjoining districts of Cookham, Bray and Taplow, which latter was in the Eton Rural District Council. This Rural District Council, however, only gave their consent on the condition that certain other districts were included in the application to the Board of Trade of the Maidenhead Corporation. The extra parishes in question were Hitcham and Burnham, and they were of very considerable area with but only small populations. Having made the application to the Board of Trade, and having been granted the order for all these districts, a very considerable opposition was made both by the Maidenhead Gas Co. and the Great Western Railway Co. The latter company opposed simply as ratepayers in Maidenhead that this trading outside the area would be unfair. On inquiry, it was found that in Burnham there was not a single application for current and in Hitcham only one applicant. Further, the distance of these parishes from the existing generating station would involve high-tension transmission, whereas the present system was the low-tension, three-wire, continuous-current. In these circumstances, feeling that there was no evidence to offer of a public demand, they offered no objection to Hitcham and Burnham being struck out by the House of Lords Committee which first dealt with the order.

The Hon. T. H. W. PELHAM, for the Board of Trade, said that the Maidenhead Corporation, in going outside its district, became in the position of a trading company, and therefore should obtain the consent of the local authority. Having obtained this consent upon certain conditions, it was the practice of the Board of Trade to insist that promoters should fight for the order as passed by the Board of Trade.

The CHAIRMAN said the only point was as to whether Taplow should be struck out of the order.

Mr. C. O. MILTON, electrical engineer to the Maidenhead Corporation, gave evidence in support of the inclusion of Taplow.

After a few remarks on behalf of the Eton Rural District Council,

The Committee passed the order with the inclusion of Taplow.

OTHER ELECTRICAL BILLS.

In the House of Lords on Thursday last week the *Radcliffe Tramways and Improvements Bill* was read a third time and passed. On Monday the *Swindon Corporation Bill* and the *Saddleworth and Springhead Tramways (Abandonment) Bill* were read a third time. On Tuesday the *London County Council (Tramways and Improvement) Bill* and the *Rotherham Corporation Bill* were read a third time and passed. The *Electric Lighting (London) Bill* and the *University of Liverpool Bill* were read a second time.

In the House of Commons on Friday the Lords amendments to the *Torquay Tramways Bill* were considered and agreed to. The *Leeds University Bill* was read a second time. On Monday the *Tyneside Tramways and Tramroads Bill* was read a third time, as also was the *Leeds University Bill*. On Monday the *Manchester Corporation Tramways Bill*, *North Wales Electric Power Bill* and the *West Riding Tramways Bill* were read a third time.

In our issue for July 22 we gave a report of the proceedings before a House of Commons Committee in connection with the *Caerphilly Electric Lighting Order*. The local gas company asked for the insertion of the Duke of Northumberland's modification of the "Bermondsey" clause, which was refused. On Tuesday a similar application was made when the order came before a House of Lords Committee, presided over by Lord Kintore. The proceedings were practically verbatim those given in our issue for July 22, and in the end the Committee refused to grant the clause.

The *Belfast and North-East Ireland Electricity and Power Gas Bill* was on Wednesday ordered for third reading by the Unopposed Committee of the House of Commons. The objects of the bill were given in our issue of July 1. A clause in the bill gave the company power to take, and local authorities power to make, transfers of electric lighting provisional orders in the same form as has already been inserted in a number of power bills this session.

The *Loch Leven Water Power Bill* came before a Committee of the House of Lords last Friday, presided over by Lord Newton. The object of the bill, as set forth in *The Electrician* for July 8, when it was before the House of Commons, is to secure an extension of time for the completion of works, &c. The only opponent was Sir John Stirling Maxwell, M.P., who had certain land scheduled by the promoters. After hearing evidence, the Committee, on a promise by the promoters not to come again for an extension of time, passed the preamble of the bill subject to a clause being inserted giving Sir John Stirling Maxwell compensation for the additional damage that he might sustain owing to the extension of time. This is in addition to the £6,500 secured to him under the company's act of 1901.

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The *Belfast Corporation Tramways Bill* came before the Unopposed Committee of the House of Commons on Wednesday. The full objects of the bill were given in *The Electrician* for April 29, when the Earl of Camperdown's Committee of the House of Lords had it under consideration. After some discussion it was agreed to give the promoters seven years in which to complete the lines, although the usual period is five years. On the question of fares permission was given to adopt a stage system, each stage being not less than 1 mile, for which 1d. should be charged. An amendment was also granted enabling the Corporation to charge 2d. if a passenger travelled over a small portion to two stages, even if he did not travel a mile. The bill was then ordered for third reading.

STREET EXPLOSIONS.

On Monday, in the House of Commons,

Sir T. DEWAR asked the Home Secretary whether his attention had been called to an accident in Regent-street on Thursday, July 21, occasioned through gas escaping into a telegraph inspection chamber and coming into contact with a leakage in an electric wire, and would he state whether any explosions arising through leakage of a similar character had been reported by the police during the last two years.

Mr. AKERS DOUGLAS, in a printed reply, said he had been informed by the police that, so far as they were aware, during the two years ended June 30 last 21 explosions of a character similar to the one mentioned in the question had occurred. The explosions resulted in injury to 11 persons and the death of two horses. It did not appear to be a matter as to which he had any power.

POST OFFICE TELEPHONE EQUIPMENTS.

In a printed reply on Friday to Sir Thomas Dewar,

The POSTMASTER-GENERAL said that since April, 1902, orders amounting to about £109,000 had been issued for the equipment of telephone exchanges in London, most of the orders being given to a foreign firm which held numerous patents for the central battery system. Circumstances were gradually altering, however, and he hoped before long to be able to obtain telephones for the use of subscribers from British makers only.

ROYAL ASSENT.

Among the bills to which Royal Assent were given on Monday were the Bournemouth Corporation Tramways Act and the Metropolitan District Railway Act.

LEGAL INTELLIGENCE.

Fixing Tramway Brackets on Property.

At Coventry Police Court last week Mr. Joseph Topp was summoned by Mr. W. P. Pearsall, engineer to the Coventry Electric Tramway Co., to show cause why a bracket should not be fixed upon his property in Fleet-street, Coventry. For the company it was stated that defendant was the only objector on the line of route of the proposed tramway extensions. Defendant had asked for £1 per year for the privilege or one £10 fully paid-up share in the company, but he afterwards dropped his request for a share in the company, it being explained that he believed they were £1 shares. In all other cases the company paid 1s. per year per bracket as a reasonable sum.

Defendant submitted that his terms were not unreasonable. The company was a private company working with the object of making profits, and for that purpose it needed his premises.

The Bench, who held that defendant's request was unreasonable, made an order for defendant to allow a bracket to be fixed on payment of 1s. per annum.

Jaeger Bros. v. Electrical Fittings Co.

In the High Court on Saturday Mr. Justice Lawrance heard an action for the recovery of £81. 3s. 5d. for electrical fittings sold and delivered. The defence was that the period of credit had not expired. Plaintiffs contended that the goods were sold on the terms of "2½ per cent. discount, prompt monthly cash," while defendants declared that they had the option of accepting those terms or of paying "net at three months."

After the evidence, his Lordship gave judgment for plaintiffs for amount claimed and costs.

Schulz v. Baker, Bauer & Co.

This case, which was heard by Mr. Justice Jelf and a special jury at Manchester Assizes last week, was for the recovery of commission. There was a counterclaim by defendants for services rendered, &c. Plaintiff (Herr E. Schulz) was the inventor of an accumulator, manufactured in Germany and patented in Great Britain and other European countries, and defendants were his agents in this country, selling on commission. Under the terms of their agency they sold a battery of cells to Batley Corporation. Afterwards disputes arose; defendants asked for better terms on account of the great expense incurred in endeavouring to introduce plaintiff's accumulator, and much correspondence took place, plaintiff holding defendants to their original agreement. Defendants, it was alleged, obtained payment from Batley Corporation for the battery and retained the money against the remuneration claimed. This plaintiff now sought to recover. Defendants' claim for remuneration was based on a collateral verbal agreement, made in Cologne on the occasion of a visit to Germany by Mr. Bauer, that his firm should be paid £350 to meet expenses, &c.

Mr. Justice JELF said the jury would have to say whether, on the evidence, defendants were promised the sum referred to on condition of their continuing the agency.

The jury answered the question in the negative, and judgment was entered for plaintiff for £520. 6s. 8d. on the claim, and the counterclaim was dismissed.

Attorney General (at the relation of the Weybridge Urban District Council) v. Urban Electric Supply Co. (Ltd.)

In the High Court on Friday last week plaintiffs applied to Mr. Justice Joyce for an injunction to restrain defendant company from supplying electric current for power, light or other purpose outside their area, and also to prevent them breaking up the streets in Weybridge for the purpose of distributing electric energy outside the district.

His Lordship adjourned the hearing until Tuesday, when

On behalf of plaintiffs Mr. HUGHES contended that what had been done by defendants in supplying the Walton Urban District Council with energy was a breach of the Weybridge Provisional Order.

Mr. YOUNGER, K.C., for defendants, contended that his clients had a right under the Order to supply Walton as a local authority having power to light its own district.

Mr. Justice JOYCE, in the result, held that the plaintiffs were entitled to an injunction to restrain defendants from supplying energy outside the area of supply specified in the Weybridge Order.

The injunction, it was stated, would not issue until Aug. 12.

Brown v. London and South-Western Railway Co.

At Brompton (London) County Court recently plaintiff (Mrs. Brown) sought to recover damages for injuries caused by a telegraph wire falling upon her. It appeared that plaintiff was passing over Putney Bridge in November last, and was struck by a telegraph wire, which had snapped. The wire was carried on the company's poles across the bridge. An inspector of the company stated in his evidence that the snapping of the wire must have been caused through the overheating of the soldering of the jointing of two copper wires. There was great tension on the wires, the span being 70yds., and the contraction would be 1ft. 9in., according to variation of temperature between 22°F. and 60°F.

For the company it was contended that there was no negligence, as no inspection would have revealed the defect, and also that the broken wire was the property of the Postmaster-General and was used exclusively by the postal telegraph authorities. The wire, however, had been put up and maintained by defendant company, together with their own wires on their own poles.

The jury found for plaintiff for £15, and the question of negligence was argued before the judge, who eventually found that there was evidence of negligence, and that the jury were right in finding that the company were guilty of negligence. Another point raised was whether the company was protected by the plea that the wire was the property of the Postmaster-General, and on this point also his honour found for plaintiff.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The governing body of the South-Western Polytechnic, Manresa-road, Chelsea, London, S.W., invite applications for the appointment of head of the Department of Electrical Engineering. Salary £250. Applications (on forms to be obtained from the secretary) by Aug. 11. See also advertisement.

A lecturer in physics is required at the Municipal Technical School, Birmingham, in September. Commencing salary £140 per annum. Particulars from the secretary (Mr. Geo. Mellor), Suffolk-street, Birmingham. Applications by Aug. 27. See advertisement.

Stoke-upon-Trent Electricity committee require a fitter driver (accustomed to Willans engine) and a switchboard attendant for direct-current low-tension system. Applications to borough electrical engineer (Mr. P. J. S. Tiddeman), Field-place, Stoke-upon-Trent, by Aug. 13. See advertisement.

The Council of the County Borough of West Ham require a lecturer in electrical engineering at the Municipal Technical Institute. Salary £200 per annum. Application to principal by noon Sept. 1. See also advertisement.

The Electricity committee of the Borough of Weymouth and Melcombe Regis require a chief assistant electrical engineer, salary £120 per annum. Applications to the town clerk (Sir R. N. Howard) by Aug. 10.

Applications are invited for the position of lecturer in electrical engineering in the University of Sydney. Salary £500 per annum, with permission to carry on a certain amount of consulting practice subject to approval of Senate. Further particulars from the Acting Agent-General for New South Wales (the Earl of Jersey), 9, Victoria-

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street, London, S.W., to whom applications by Sept. 10. See also an advertisement.

A shift engineer is wanted for a large lighting and traction station in the North of England. See advertisement.

The committee of the City and Guilds of London Institute are about to appoint a professor of Mechanical Engineering and Applied Mathematics at Finsbury Technical College, in succession to Prof. Dalby, appointed professor at the Central Technical College. The salary is £600 per annum. Applications to the hon. sec., Gresham College, London, E.C., by Sept. 15.

The Governing Body of the Northampton Institute, St. John Street-road, London, E.C., require a chief instructor in mathematics (day and evening, part time only). Salary £150 per session. Particulars from the principal (Dr. R. Mullineux Walmsley) and applications by Aug. 31.

An assistant for evening classes is required for session 1904-5 in the mechanical engineering department of the Crawford Municipal Institute, Cork. £100 per annum. Further particulars from the head master and organising secretary, Mr. E. A. O'Keefe, B.E., M.I.E.E., to whom applications by Aug. 10.

Mr. J. Owen, B.A. (Camb.), B.Sc. (London), has been appointed assistant lecturer and demonstrator in experimental physics at the Birkbeck College, London, and Mr. W. G. Burt, B.A., B.Sc., has been appointed assistant lecturer in mathematics.

EDUCATIONAL NOTICE.

Northampton Institute.—Full day courses in the theory and practice of mechanical, electrical and horological engineering will commence on Monday, Oct. 3. Entrance examination, Wednesday and Thursday, Sept. 28 and 29. The courses for mechanical and electrical engineering include periods spent in commercial workshops and extend over four years. Students also prepare for the degree of B.Sc. in engineering at the University of London. Particulars as to fees, &c., can be obtained at the Institute, St. John Street-road, London, or on application to the principal (Dr. R. Mullineux Walmsley). See also advertisement.

Ballymena.—The Board of Trade have deferred the question of the revocation of the Ballymena Provisional Electric Lighting Order, 1897, for six months.

Barking.—The Local Government Board have given their decision on the appeal of Mr. Berry and nine other members of the Council against the surcharge made by the district auditor (Mr. Dolby) for year ended March 31, 1903, of sums amounting to £2,223. 6s., as representing the general district rate account occasioned by the failure and neglect of the Council to provide for the deficiency of income in their electricity undertaking as required by sec. 52 of the Barking Town Lighting Provisional Order, 1897. The Board intimate that they have decided to discharge the surcharge. The effect of the decision is that the appellants are released from their liability under the auditor's surcharge.

Barmouth.—The Council have conditionally accepted the terms of the National Electric Construction Co. for the erection of electricity works.

Beckenham.—The gross assessment of the electricity works has been increased from £400 to £2,000 per annum, and the Electric Light committee have decided to appeal.

Belfast.—In a return by the city electrical engineer (Mr. Victor A. H. M'Cowen) it is stated that for the six months ended June 30 the output of current exceeded 1,000,000 units, while the receipts were £13,887. 4s. 7d., compared with £11,940. 2s. 8d. for the corresponding period of 1903. The average price per unit was 2·767d., compared with 3·066d.

Birstall.—The British Electric Traction Co. have intimated to the District Council intention to proceed with the work of reconstructing the Birstall and Gomersal tramway.

Boksburg (Transvaal).—Messrs. E. H. Gellender & Co., a local firm, have entered into a contract for the electric lighting of the town. Both arcs and Nernsts are to be employed.

Bombay.—In our issue of June 10 we announced that the Brush Co. had applied for a licence under the Indian Electricity Act. The company is now erecting electricity works for Bombay, and Callender's Co., which secured the contract for the mains, &c, is making rapid progress with the cable laying. Three-phase plant, which will generate electrical energy at 6,000 volts, is being put down at the station.

Cardiff.—The Parliamentary committee decided on Tuesday to insert in their next omnibus bill a clause authorising the letting of electric motors, fittings, &c., on hire.

Chartered Institute of Patent Agents.—The qualifying examination of persons desirous of being registered as patent agents will be held in November. Copies of notice giving full particulars can be obtained from the secretary, Chartered Institute of Patent Agents, Staple Inn-buildings, London, W.C.

Cheltenham.—The Council have adopted the special report of the General Purposes committee (abstracted in our last issue), expressing confidence in the Electric Lighting committee and the borough electrical engineer (Mr. M. H. Kilgour).

City of London.—A report has just been presented to the Corporation of London, prepared by Mr. D. J. Ross, M.Inst.C.E., engineer to the Corporation, dealing with the works executed by the Public Health Department during 1903.

On the subject of electric lighting the report states that the number of arc lamps used in public lighting at the end of the year was 508, the cost of each lamp being £26 per annum. On the subject of subways, the report states that there is now constructed beneath the City streets about 1½ miles of subways under the control of the Corporation, and about 1 mile 660yds. not under the Corporation's control. The utility of these subways is (the report states) shown by the fact that in the streets beneath which they have been constructed no openings have been made for access to pipes, &c. (excepting at the ends of the subways), since these were completed. 9,265 workmen and others were admitted to the subways during the year for various purposes. 103 private firms and 17 companies, in addition to the Post Office, own overhead wires in the City area, and there are now upwards of 35,000 overhead wires in use in the City, of which 673,700 spans cross public thoroughfares. The Corporation bye-law insisting upon the proper labelling of all overhead wires has been found to be of great value, as in the case of falling wires, &c., it has served to readily locate the ownership and to ensure the immediate repair of the wires.

Companies Struck off Register.—The "London Gazette" for Aug. 2 states that the following have been removed from the Register of Joint Stock Companies :—

Berrenberg Electric Lamp Syndicate.
City of Mexico Electric Power Syndicate.
Crystal Palace Light Railways & Tramways Co.
Electric Tested Lamp Co.
Gas & Electric Lighting Corp. (Mauritius).
Joel Electric Carriage Motor Battery Syndicate.
Love's Electric Traction Co.

Dalkeith.—Messrs. Crompton & Co., who are to erect and equip electricity works in this town, have offered to supply electric current to the Council for electric pumping at Bridgend at 1½d. per unit if the consumption is equal to 7,500 units per quarter, with a discount of 8 per cent. if the demand equals 10,000 units per quarter.

Darlington.—For the year ended March 31 the total receipts of the electricity department were £5,055. 3s. 2d., including £4,144. 2s. 6d. from the sale of current to private consumers and £679. 11s. 9d. from street lighting. Expenses were £2,031. 6s. 7d., leaving a gross profit of £3,023. 16s. 7d. Interest absorbed £1,226. 5s. 10d. and sinking fund £1,228. 18s. 3d., leaving a net profit of £568. 12s. 6d. Capital expenditure totals £52,091. 14s. 6d., an increase of £12,191. 5s. 8d. for the year.

Dartford.—At the last meeting of the District Council the contract with J. G. White & Co. for the construction of electric tramways was ordered to be sealed.

Derby.—The Council have voted £570 for fitting up a mechanical workshop and an electrical engineering laboratory at the Technical College, and application has been made for sanction to borrow £550 of the amount.

The salary of the tramways manager (Mr. F. Harding) has been increased to £200 per annum, with a further increase of £25 in August, 1905.

Dover.—The Council have applied for sanction to a loan of £3,500 for the purchase of meters and for "free" wiring for the ensuing three years.

Durham.—The County of Durham Electrical Power Distribution Co. will apply for a provisional electric lighting order for the district.

Electrical Exhibition.—In our issue for July 22 we referred to the opening of an interesting exhibition of electrical appliances, &c., by the Lighting committee of Shoreditch (London) Council, at the Pitfield-street Baths, from Oct. 10 to 22 next. We may now add that manufacturers of machinery used in the furniture and cabinet-making trades, in box making, printing, sewing machinery, boot making, laundry work, spring making and wire making, pumping, cranes, lifts, &c., are invited to become exhibitors, as these trades form the staple industries of the district. It is specially desired to give great prominence to the most up-to-date forms of electric motors, lamps, fittings, ventilating fans, heating and cooking apparatus, &c., suitable for business premises, factories, hotels, &c. A small charge will be made for space, varying from 9d. to 1s. 6d. per sq. ft., according to position, but no charge will be made for electric current, and the supply will be given on the direct-current three-wire system at a pressure of 240 volts for lighting and 480 volts for electric motors. Descriptive circular, forms of application, &c., may be obtained from the borough electrical engineer (Mr. C. Newton Russell), Electric Supply Department, Coronet-street, Shoreditch, N., up to Aug. 31.

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Electric Lighting Notices.—In addition to the list on p. 613 of our last issue, the following have signified their intention to apply for provisional electric lighting orders for the districts mentioned :—
Aberdeen (County Council District committee's area) —Lowdon Bros. & Co.
Chester-le-Street.—County of Durham Electrical Power Distribution Co.
Durham (Rural).—County of Durham Electrical Power Distribution Co.
Llantrissant.—G. Vaughan Fowler.
Paddington.—Paddington Elec. Supply Co. and Central Elec. Supply Co.
Penrith.—G. Vaughan Fowler. [1901.)
Ripon.—Power & Traction (Ltd.). (Ripon Council obtained an order in
Sandiacre.—F. Hooley (Ltd.).
Wanstead.—Empire Electric Light & Power Co.

Electric Railway Anniversary.—May 1, 1904, was the 25th anniversary of the first electric railway ever constructed. This was one of the attractions of the Berlin Exhibition, 1879, and was constructed as a small-gauge line covering a track of 300 metres (330yds.), the car travelling at the rate of 180 to 240 metres per minute.

Electric Supply Undertakings in the County of London.—The volume of "London Statistics" for 1903-4, just issued by the London County Council, gives an analysis of the accounts for the year ended March 31, 1903, in the case of local authorities, and to Dec. 31, 1902, in the case of companies, of the electricity undertakings established in the county of London, with miscellaneous statistics relating to the areas of supply, capacity, output, &c. The total capacity of the plants of the 11 metropolitan boroughs owning electricity undertakings was 27,644kw. at March, 1903, the capacity of the plant of the 16 companies at Dec., 1902, being 94,045kw. The local authorities generated 26,491,385 units, the figure for the companies not being given. The borough councils sold for private supply 16,093,213 units and for public lighting 5,721,093 units, a total of 21,814,306 units. The companies sold for private supply 71,294,414 and 3,259,749 for public lighting, a total of 74,554,163 units. The total amount of loans sanctioned to local authorities during 1902-3 was £2,804,770, the total amount borrowed being £2,653,649. The total net capital expenditure of the local authorities amounted to £2,620,188, or 0·12 per unit sold. The total net capital expenditure of the companies was £10,322,049 or 0·14 per unit sold. The total revenue of the borough councils was £329,106, and of the companies £1,401,223, the total annual expenditure being £193,909 and £706,535 respectively.

Electric Traction on Italian Railways.—Messrs. Ganz & Co. send us some particulars of the electric railway equipped some years ago on the Ganz system (106km., or 65¾ miles in length) near Lake Como, between the towns of Lecco, Colico, Sondrio and Chiavenna, on the high-tension three-phase system. These lines form part of the system of the Societa Italiana per le Strade Ferrate Meridionali, Rete Adriatica. The installation was, however, only regarded by the company as an experiment on a large scale (at Messrs. Ganz & Co.'s risk), the railway company having undertaken to take over the electric line only in the event of the system of traction employed, and the whole installation proving, during the guarantee period of two years, a thorough success and fulfilling all the requirements of a railway service. The guarantee period commenced on Oct. 15, 1902, and would have expired Oct. 15, 1904, but we are now informed that the railway company, being satisfied of the entirely satisfactory working of the line by electricity, decided to take over the whole plant on July 10. This is a success which Messrs. Ganz & Co. claim establishes beyond question the suitability of the Ganz three-phase system of railway equipment and working over main lines of railway.

Exeter.—The Council have decided to open a central inquiry office for the electricity department. It has been resolved to appoint a canvasser at £1 per week and a commission based upon the increase of lamp connections, as follows :—For first 3,000 lamps per annum, 3d. per lamp ; for all further lamps per annum, 6d. per lamp; for all motors, 5s. per horse-power. The price of electric current has been reduced from 6d. to 5d. per unit, and meter rents from 10s. to 5s.

Exhibitions.—There was to have been opened at Earl's Court, London, an Austria-Hungarian Exhibition for the season 1905, but this event has been postponed by request of the Austrian Government. In its place there will be held a grand Naval, Shipping and Fisheries Exhibition. The rumour diligently circulated that these exhibitions at Earl's Court are to cease after this year has been officially and emphatically denied.

Attention is called to the notification that the last day for receiving applications for space from European firms for the exhibition to be held at Cape Town from November, 1904, to January, 1905, is Aug. 15 current.

Fire.—We are asked to explain that it was at the St. Petersburg works of Felten & Guilleaume Carlswerke Actien-Gesellschaft, and not at their Mülheim factory that the recent fire occurred. The deliveries from Mülheim will not, therefore, be affected. We are also asked to state that the company's manufactures for the English and export trade will be in no way affected. The works destroyed were fully insured.

Fire Brigade Electric Bell Circuits.—Crewe Council have received a notification from the Post Office authorities that the use of electric bell circuits between the fire brigade station and the houses of members of the brigade is an infringement of the exclusive telegraph rights conferred upon the Postmaster-General by the Telegraph Act, 1869. The Council is notified that, so long as these circuits are used solely in connection with the business of the fire brigade, no action will be taken.

Folkestone-Hythe Electric Tramway.—Hythe and Sandgate Councils will support the proposals of the British Electric Traction Co. to construct an electric tramway on the overhead system between Folkestone and Hythe.

German Electro-technical Industry.—In a report on the trade of the year 1903 of Frankfort-on-the-Main, Mr. Consul F. Oppenheimer reviews the development of the electro-technical industry in this important industrial centre. Mr. Oppenheimer points out that this industry was, from the start, unfettered by any antiquated traditions or surroundings, and it was, further, cordially supported by the investing public, who supplied large sums of money to aid its development. From 1895-6 to 1900 the number of electric light and power stations increased from 180 to 774, and the horse-power increased from 10,254 to 106,368. The kilowatt capacity of machinery in operation and of electric accumulators rose from 40,471 to 230,058. Towards the middle of 1900, however, the tide of public favour changed, and it is the opinion of many in Germany that the withdrawal of public interest in the electro-technical industry was the precursor of the general trade depression from which Germany has to a greater degree than any other country on the Continent suffered during the past few years. The blow fell not the less heavily from the fact that over-production had been carried to extremes, and many leading firms had committed themselves in the matter of capital expenditure. Mr. Oppenheimer draws a distinction between those firms who became committed to the erection and equipment of complete electricity undertakings and those firms which specialised in the production of certain machines, apparatus, &c. This latter class of commercial undertakings, Mr. Oppenheimer continues, has been better able to weather the serious crisis than the former, and in some cases have been able to earn more or less satisfactory profits. The return to comparative prosperity of the German electro-technical industry, which is a notable feature at the present time, is referred to, and while in the immediate future no increase is expected in the number of electricity supply stations, but rather an extension of existing stations, and while the number of horse-drawn tramways to be converted into electric systems is now but few, the natural development of existing undertakings is likely to provide work for those engaged in the industry on a comparatively safe profit-earning basis. Mr. Oppenheimer points to the tendency of German industrial works in putting down isolated installations, and to the use of electricity in mining and agriculture as a hopeful factor in the development of the industry.

Glasgow.—The accounts of the electricity department for the year ended May 31 show gross revenue £158,190. 4s. 6d , and the working expenditure £61,738. 16s. 6d.

Out of the balance the Electricity committee had to meet interest on loans £36,023. 7s. 7d., and sinking fund £15,205. 10s. 6d., leaving £45,222. 9s. 11d., from which was deducted proportion of the cost of the lamps and fittings supplied to consumers consequent on the change of voltage charged to this year's revenue account (£2,700. 9s. 9d.), showing a net balance of revenue over expenditure of £42,522. 0s. 2d. The committee have resolved to write off capital account for depreciation for the year at the same rates per cent. as last year £32,180. 13s. 1d., leaving a surplus of £10,341. 7s. 1d. The committee during the year repaid to the gas department the amount at debit of previous year's account (£13,895. 6s. 1d.) The debit balance of £3,553. 19s. the committee have decided to carry forward. Capital expenditure during the year was £109,482. 12s. 11d., and the total capital expenditure is now £1,119,047. 14s.

Halifax.—The Corporation propose to construct the tramway route to West Vale, Greetland, at an estimated cost of £1,712.

Inverness.—The Council have granted an extension of six months to Edmundson's Electricity Corp. to commence the erection of electricity works in this town.

Isle of Thanet.—The Isle of Thanet Electric Tramways and Lighting Co. has abolished meter rents, and the advisability of adopting a flat rate of 4½d. per unit for current instead of the present maximum demand system (6d. first hour and 3d. after) is under consideration.

Italy.—The length of tramway lines in Genoa and suburbs is now 74 miles, and there are 153 cars in use. The number of passengers carried over the lines in 1903 was 35,000,000. There is under consideration the construction of a new tunnel through the Apennines. There are many difficulties in the way of the construction, which is intended to afford tunnel connection with the main line of railway at Ronco. Notwithstanding recent improved ventilation in the tunnels in this district, the smoke that collects from the steam-driven trains limits the number of trains that can be run through, and, consequently, the question of introducing electric traction on the tunnel lines between Sampier, Darena and Ronco

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is under consideration. At Spezia sanction has at last been obtained from the various authorities concerned for the construction and working of an electric tramway service between Spezia and Porto Venere, tapping all the intermediate suburbs and villages.

A small electric lighting plant has been established in the town of Civita Vecchia, and the owners are engaged in generating current for supply to private consumers. The Tuscan Gas Co., of London, is, however, in full possession of the public lighting under contract. Water power is available in this district from the River Marta, and several attempts have been made to utilise this power. It is suggested that mills erected in this district and worked by electricity would prove a profitable investment.

Kingstown.—The Council's electric lighting order, obtained in 1896, has been revoked. Expenditure of upwards of £2,000 has been incurred in connection with the order, and about £700 is still due to the consulting engineers and others.

Kingsway (London).—It having been reported that the London County Council propose to adopt gas lighting for Kingsway (the new thoroughfare between the Strand and Holborn), Holborn Borough Council last week resolved to suggest to the County Council that the Kingsway should be lighted by electricity and paved with asphalte.

Leeds.—On Wednesday, the chairman of the Tramways committee (Mr. R. A. Smithson) referred to the new agreement between the Corporation and the Wakefield District Light Railways Co. for mutual running powers.

Under the agreement, the Corporation have the option of running over the lines of the company to such points as may be selected by the latter, or to cease from such running by giving one month's notice. The company are to run their cars over the lines of the Corporation at such times and to such places as shall be arranged by the general manager of the Corporation tramways (Mr. J. B. Hamilton). Each undertaking will be entitled to the whole of the receipts taken in its own area.

Liverpool.—The income of the electric tramways department for the past year was £531,483, an increase over the previous year of £18,058. Total expenditure was £341,463, increase £1,652. After paying interest and sinking fund charges, the net surplus was £96,242, of which £64,000 was apportioned to reserve, renewal and depreciation fund, and £32,000 to relief of rates.

At Wednesday's meeting of the City Council, Councillor T. Roberts moved

That the resolution of the Tramways committee of Feb. 24, 1899, fixing a minimum height of 5ft. 6in. as the standard for tramway conductors and drivers, be rescinded.

The motion was carried by 42 to 27.

London County Council.—On the eve of their adjournment for the long vacation London County Council had to deal with a heavy agenda paper, containing, amongst other matters, several items of electrical interest, most of which stand over until the return of the Council to active work.

Amongst these items may be mentioned the question of the loan to Marylebone Borough Council in connection with the Marylebone electricity undertaking. The Finance committee have recommended that, subject to all necessary consents and to the London County Council (Money) Bill, 1904, receiving Royal assent, and other circumstances resulting favourably, the requirements of Marylebone in the way of borrowing should be provided for. The large sum involved in this transaction is to be loaned for repayment at varying terms—the loan for buildings and engineering work for 42 years, that for alterations to works and main consequent upon change of pressure for 38 years, and that for new meters or alterations to existing meters, also consequent upon change of pressure, for 10 years.

The Fire Brigade committee recommended that the Eltham brigade sub-station, which is to be opened in the autumn, should be lighted by electricity, and in this connection recommended that the necessary expenditure for wiring and supply fittings should be authorised, and that tenders be invited for the work.

The Highways committee presented quite a long list of convictions for wilful obstruction of the electric tramcars. In all cases fines were imposed. The Highways committee recommended the acceptance of the invitation of the Rapid Transit Railroad Commissioners for a representative of the Council to attend the opening of the New York tramways subway, and that Mr. J. Allen Baker, chairman of the Highways committee, should be selected.

The plans for the City and South London Railway Co.'s extension to Euston have been submitted to the Highways committee and approved.

A joint report of the Highways and Improvements committees recommended the approval of the drawings, &c., and estimate of cost (£58,800) of the paving and other work, including construction of a portion of the tramway subway, in Kingsway, and that the work should be carried out by the Works committee.

Longton.—The Council have made an arrangement with the British Thomson-Houston Co. for the supply of electric motors to be let on hire.

Lowestoft.—The total receipts of the electric tramways for the first year were £10,475. 18s.

Lucknow (India).—Messrs. Kincaid & Co. have secured a concession for establishing electricity works and for constructing electric tramways.

Middlesex Light Railways.—The Light Railways committee of the Council has been charged with making preparations for the formal opening, in about a fortnight, of the first section of the county light railway system through Lordship-lane, Wood Green.

Middlesex Tramways.—Middlesex County Council have authorised the Metropolitan Electric Tramways (Ltd.) to reconstruct and widen at their own expense Angel Bridge, Edmonton. Intimation has been given to the London United Tramways (Ltd.) that tramways will be permitted over the Middlesex half of Kew Bridge provided the company pay £300 per annum and one-third of the total cost of that portion of the bridge and its approach, and that the company maintain and repair the carriage and footways and pay one-third of the cost of future structural repairs. The scheme for the proposed widening of Kingston Bridge, submitted on behalf of the London United Tramways (Ltd.), has been rejected.

Municipal Telephony.—At its next meeting Ilford District Council will be asked to consider the question of providing a municipal telephone service.

Obituary.—We regret to announce the death of Mr. W. Brownridge, the Eastern Extension Telegraph Co.'s superintendent at Malacca, which occurred on Tuesday, Aug. 2, suddenly from heart failure. Mr. Brownridge originally joined the company's service in February, 1874, and resigned in July, 1884, to go into business on his own account in the North of England. He rejoined the company's service in 1888, and was for many years at Penang and subsequently at Singapore, Port Darwen, Roebuck Bay, Batavia and finally Malacca He was born in June, 1852.

The death occurred at Liverpool on July 26 of Mr. W. H. Walmesley, manager at St. Helens for the National Telephone Co.

Opening of Colchester Electric Tramways.—The electric tramway system which has been laid down in Colchester by the Corporation was opened to the public on Thursday last week. Powers were obtained under a tramway provisional order in 1901, and Messrs. Lacey and Sillar were retained as consulting engineers to draw up a scheme. The lines which have just been opened have a total length of slightly over 5 miles. The rails are of the 95lb. standard British type, the maximum gradient is 1 in 12 and the sharpest curve 43ft. radius. Messrs. J. G. White & Co. carried out the contract for the electrical equipment of the line, and Messrs. Dick, Kerr & Co. supplied the cars. The overhead trolley system has been adopted, the conductor being suspended on bracket arms and a few centre poles. The feeders, which were supplied by Messrs. Henley, are paper-insulated and lead-covered, and are laid solid in stoneware ducts with tiled tops under the pavement. There are 16 single-truck double deck cars, each having a seating capacity of 48 passengers, and being equipped with both a hand-brake and a Westinghouse magnetic brake. Power is taken from the Corporation electricity works, from which current for lighting purposes has been supplied for some time. A car shed has been built, with accommodation for 18 cars, with plenty of space at the rear for extension.

Oulton Broad.—The Council have decided to apply for a provisional electric lighting order.

Paddington (London).—The Council have decided to oppose proposed applications by the Paddington Electric Supply Co. and the Central Electric Supply Co. for provisional electric lighting orders.

Post Office London Telephone Service.—On July 27 an exchange, to be known as the Post Office Hampstead Exchange, in connection with the London telephone system of the Post Office, was opened.

Presentation.—The chairman of Gloucester Tramways committee (Councillor R. Fream) has been presented, on behalf of the mayor and members of the Corporation with a silver and polished oak model replica of one of Gloucester's electric cars, designed as a smoker's cabinet, in recognition of the conspicuous services rendered by him in connection with the city tramway scheme.

Prison Lighting.—Maidstone Council have offered to supply electric energy to the local prison at 3½d. per unit.

Redditch.—An inquiry was held here last week into the application of the Council to borrow £16,000 for alteration and extension of the electricity undertaking. Technical details were given by the resident engineer (Mr. W. J. Ferguson). The local gas company opposed.

Reinstatement Charges.—Lambeth (London) Council have prepared a return showing the average charges made to electric lighting companies, &c., by metropolitan local authorities for the reinstatement of trenches. These are as follows:—

York stone, re-laid per yard super., 1s. 8·64d.; new York stone, 10s. 0·82d.; new Victoria stone, 8s. 10·71d.; tar paving re-laid, 4s. 0·76d.; asphalte footway, 8s. 6·31d.; asphalte carriage-way, 14s. 3d.; kerb refix per foot lineal, 2·61d.; kerb refix on concrete, 7d.; new kerb on concrete, 2s. 7·52d.; pitched carriage-way re-laid per yard super., 2s. 4·88d.; pitched carriage-way re-laid on concrete, 4s. 10·66d.; new pitched carriage-way, 15s. 10·83d.; macadam, 2s. 2·30d.; ballast or flints, 1s. 6·35d.; concrete per yard cube, 17s. 2·25d.; wood re-laid per yard super., 15s. 11·4d.; brick

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paving re-laid, 3s. 5·75d., new paving bricks per 100 bricks, 13s. 8d.; new boxes each, 9s. 9d.; holes cut, 1s. 7·75d.; boxes re-paved, 3s. 7·50d.

Sheffield.—On the advice of the general manager of the electric supply department, the Electric Light committee recommend the Corporation to reduce the charges for electric energy for power from Dec. 25 next to the following scale:—

For all power used in motors driving hoists, cranes, passenger lifts and machinery, 2d. per unit; for other motors, 1½d.; to consumers satisfying the general manager as to continuous running of their motors throughout the whole of the working hours of each day, whose consumption does not exceed 5,000 units per annum, 1½d. per unit, above 5,000 units per annum, 1d. When the consumption equals 10,000 units per annum 5 per cent. discount will be allowed, 15,000, 10; 25,000, 15; 50,000, 20; 100,000 25; 250,000, 30; 500,000, 35; and 750,000, 40. All accounts to be rendered at the fixed price per unit, and discounts credited according to consumption at end of each half-year in September and March.

South Shields.—At the meeting of the Town Council on Wednesday the Tramways committee presented their report upon the amended offers submitted for the leasing and reconstruction for electric traction of the existing tramways, &c., and, after discussion, the Council referred the matter back for further consideration.

Spain.—At San Feliu de Guixols there is in course of construction a telephone line which will connect San Feliu with Palamas, Palafruell, La Bisbal and Gerona. A narrow gauge electric railway from Vich to Pateral, on the River Fez, is also under construction, current being generated from the water power of the Fez.

Strokestown (Ireland).—A company has been formed to take over the local electricity works of Mr. J. Hayden.

Surrey Tramways.—Surrey County Council will consent to the London United Tramways (Ltd.) constructing tramways over Kew Bridge provided the company pay a rent and agree to adopt some system other than the overhead system. The Council have rejected the proposal of the company to cross Kingston Bridge and to widen the bridge by means of cantilevers, and have resolved that the bridge must be widened to 50ft. and that the general character of the present bridge must be preserved as far as possible.

Sutton Coldfield.—For the quarter ended June 30 the electrical engineer (Mr. T. Duesbury) reports that the consumption of electric current and the revenue of the department show an increase of nearly 40 per cent. over the corresponding quarter of 1903, the working expenses being practically the same. The number of units sold was 36,659, against 29,768, private consumption accounting for an increase of 53·5 per cent. and public lighting 16·4 per cent.

Theft of Electricity.—At Maidstone Police Court last week Mary Sims was charged with stealing electricity, the property of the Corporation.

The Town Clerk (Mr. Herbert Monckton) said prisoner's house had been wired by the owner but had never been connected, and no meter had been put in. Recently suspicions attached to the house by reason of the electric light being seen in some of the rooms on several occasions by an employé of the electricity department. The chief engineer (Mr. Hoadley) subsequently visited the premises and found that the seal attached to the wiring had been broken, which showed that the prisoner had been taking current.

Prisoner, who refused to admit an employé of the department to the house, said she did use the light a few times, that she meant to pay for it, and that she did not think she was doing wrong.

The Bench inflicted a fine of 40s. or one month's imprisonment in default.

Tottenham.—The special committee, recently appointed to deal with electricity supply, reported to the Council last week and recommended them to await the passing of the Electricity Supply Bill, which would give the Council power to join with surrounding districts in a joint system of electricity supply. After discussion, an amendment by Mr. Malone that the committee be dispensed with and the matter referred to the standing electricity committee was carried.

Water-Power Stations in India.—A scheme is in course of development for the erection of electricity works for supplying electrical energy in Mussoorie and Landour. It is proposed to utilise the Rangali Gadh waterfall, 800ft. in height, which will provide 450 H.P. at the minimum normal flow. This and the public water-supply improvement scheme which will be carried out in connection therewith will cost 6¼ lakhs of rupees.

West Bromwich.—An unopposed inquiry was held on Wednesday into the application of the Council to borrow £1,300 for laying an additional electric lighting main.

Wigan.—Wigan-Pemberton electric tramway route has been opened for traffic.

Wireless Telegraphy.—*Natal* has to be added to the long list of British colonies and dependencies which have passed legislative ordinances on the subject of wireless telegraphy. The Natal Legislative Assembly has amended the Telegraphs Act, 1901, to the effect that:—

The Colonial Government shall have the sole and exclusive right to transmit telegrams from, or to receive telegrams transmitted to, this colony by sea or by land by means of any agency other than a wire continuously connecting the points of transmission and reception. No person shall, except on behalf of the Colonial Government, make, equip or use within this colony any station, machine, installation or apparatus capable of being used for the purpose of transmitting or receiving wireless telegrams.

Any person contravening this section, and any person transmitting or receiving a wireless telegram contrary to the provisions of this act shall be liable to a fine not exceeding £1,000 sterling, or to be imprisoned, with or without hard labour, for any term not exceeding five years, or to both such fine and imprisonment; and any building, station, machine, installation, or apparatus lawfully made, erected or used for the purpose of transmitting or receiving wireless telegrams may be destroyed by order of the Government.

Similarly, the Governor of *Ceylon* has assented to an ordinance providing that:—

It shall be unlawful for any person to establish or use in Ceylon any apparatus or installation for transmitting or receiving messages by means of wireless telegraphy unless a licence in that behalf has been first granted to him by the Governor, on such terms and conditions as the Governor shall from time to time prescribe. Any person contravening these provisions is liable, on conviction, to a fine extending to 750 rupees and to have the apparatus and installation in respect of which the offence is committed confiscated.

The *Basutoland and Bechuanaland Protectorate* authorities have also issued regulations as to the working of wireless telegraphy within the Protectorate. The regulations are identical in terms, and provide that—

No person shall establish or use any apparatus or installation for the transmission of messages or other communications by means of electrical energy without the aid of wires and without having previously obtained a licence. It shall be lawful for the resident commissioner to authorise the issue of a licence for either of the purposes mentioned above and to revoke the same at any time, and there shall be payable in respect of such licence the sum of £100. Any person contravening the above provisions is liable, on conviction, to a fine or imprisonment.

An ordinance by the Government of *Mauritius* has been issued regulating the erection and use of stations and machinery for wireless telegraphy. It is provided

That no telegraphic or electrical station, apparatus, machinery or implements whatsoever, for the purpose of electrical communications, transmission, emission or reception of messages, by what is generally known as wireless telegraphy, between any places in Mauritius, or between any place in Mauritius with any place out of Mauritius, shall be erected or used in any place in Mauritius, whether on public or private property without the sanction of the governor previously obtained. Any person contravening the above provisions is liable to a fine not exceeding Rs.5,000, and to have the apparatus, &c., confiscated.

This makes the group of British colonies and dependencies which have legislated on the subject to include:—

Bahamas	Ceylon	Malta
Basutoland	Gambia	Mauritius.
Bechuanaland	Gold Coast	Natal
Bermudas	Hong Kong	New Zealand
British Guiana	Jamaica	St. Lucia
British Honduras	Lagos	Seychelles
Cape of Good Hope		

Wolverhampton.—An inquiry was held here last week into the application of the Council to borrow £13,000 for extensions of the electricity undertaking.

The town clerk (Mr. H. Brevitt) explained that £3,000 was required for electric generating plant at the new refuse destructor in Crown-street. £2,800 would be spent upon feeder and distributing mains to supply a large manufacturing district near the destructor, and £7,000 for the extension of the mains throughout the borough during the next two years.

The borough electrical engineer (Mr. Shawfield) also gave evidence.

There was no opposition.

Outing.—The first annual outing of the engineering staff and employés of Ealing Corporation electricity works took place on Saturday. The party, numbering 33, journeyed to Marlow (by rail to Windsor and launch to Marlow), where dinner was served at the Crown Hotel, under the presidency of Mr. J. Douglas Knight, the borough electrical engineer, the vice-chair being filled by Mr. A. E. Pullen, the chief assistant engineer. The musical members of the staff provided an excellent programme for both the out and home journeys.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Dublin Lighting committee invite tenders for 500 alternating-current meters (single and three-phase). Specifications, &c., may be seen at the office of the city engineer (Mr. Spencer Harty), City Hall, Dublin, and at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, S.W., after Aug. 8, where copies may be obtained. Tenders to the chairman of the committee, 3, Cork-hill, Dublin, by noon Aug. 23. See also advertisement.

Warrington Corporation invite tenders for the supply, delivery, laying and jointing of stoneware conduits and cables insulated with vulcanised indiarubber. Specifications, &c., from the consulting engineers (Messrs. Preece & Cardew, 8, Queen Anne's-gate, Westminster, S.W.). Tenders to the town clerk (Mr. J. Lyon Whittle), Town Hall, Warrington, by noon Aug. 16. See also advertisement.

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Manchester Dock and Warehouse Extension Co. invite tenders for wiring (for power and light) and electric lighting of five transit sheds (now in course of erection) on the southerly side of Dock No. 9, in Salford. Tenders to secretary, Manchester Ship Canal Co., 41, Spring-gardens, Manchester, by Aug. 30.

Manchester Electricity committee invite tenders by 10 a.m. 9th inst. for high and low-pressure piping for two 750kw. turbo-generators.

Perth Corporation invite tenders for the construction and equipment of electric tramways on the overhead trolley system. Tenders by noon Aug. 16.

Leeds Corporation invite tenders for supply of two 1,000kw. turbo-alternators, with condensers, exciters, &c. Tenders by 10 a.m. Aug. 15.

Bermondsey (London) Council invite tenders (until Aug. 8) for wiring the staircase and courtyards of Fulford-street dwellings.

Glasgow Corporation invite tenders by 12th inst. for wiring the Springburn District Library.

The City of Santos Improvements Co. (Ltd.), invite tenders for the delivery f.o.b. British port and for erection at *Santos*, Brazil, of producer gas plant and gas-driven alternators of a total capacity of 400kw., and transformers. Conditions, &c., from the consulting engineers (Messrs. Mordey & Dawbarn), 82, Victoria-street, Westminster, S.W. Tenders by noon Aug. 20, to the secretary (Mr. J. E. Rimmer), 174, Gresham House, Old Broad-street, London, E.C.

The Commissioners of the Municipal Council of *George Town, Penang*, invite tenders for supply and delivery of tramcars, complete with motors, controllers, trolleys, &c. Specification, &c., from Messrs. Preece & Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders to Mr. R. M. Christie, 4, East India-avenue, London, E.C., by noon Aug. 24.

Tenders are invited until 9th inst. by the municipal authorities of *Antwerp* for the electric lighting of the new South Quays. Tenders to Le College des Bourgmestre et Echevins, Hotel de Ville, Antwerp.

TENDERS RECEIVED AND ACCEPTED.

The following tenders were received by Deptford (London) Council for the supply of (*a*) engines, dynamos and booster, and (*b*) switchboard and connections for the electric lighting of the Town Hall:—

Engines, Dynamos and Booster.

Phœnix Dyn. Mfg. Co. (*accepted*)	£777	0[1]	Johnson & Phillips	£675	0[2]
Ditto	754	0	Int. Elec. Eng. Co.	838	0[1]
Ditto	614	0[2]	Ditto	760	0
Drake & Gorham	920	0	Ditto	726	0[3]
R. Woods & Co.	905	0	Ditto	660	0[2]
W. H. Allen, Son & Co.	886	0	Mavor & Coulson	829	0[1]
Ditto	710	0	Ditto	807	0[2]
W. J. Fryer & Co.	886	0	Newtons Limited	827	8
Lancashire Dyn. Co.	877	15[1]	Thomas Parker (Ltd.)	824	0
Ditto	851	10[2]	Ditto	813	0[2]
Ditto	709	10[2]	Ditto	768	0[3]
India Rubber Co	876	0[1]	Ditto	662	0[2]
Ditto	855	0[2]	Geipel & Lange	821	13
Ditto	715	0[2]	Sunderl'd Forge & Eng. Co.	820	0*
Dewhurst's Eng. Co.	875	0	Brush Co.	816	0
Bruce Peebles & Co.	868	0[1]	Electric Construction Co.	814	0
Ditto	847	0[2]	General Electric Co.	810	0[1]
McClure & Whitfield	867	0[1]	Ditto	793	0[2]
Ditto	845	10[2]	Ditto	653	0[2]
Ditto	702	0[2]	F. Potter & Sons	798	0
Crompton & Co.	865	0	Ditto	759	0[2]
Brit. Westinghouse Co.	860	0	Lister Elec. Mfg. Co.	792	8[1]
P. R. Jackson & Co.	855	0[1]	Ditto	766	6
Ditto	690	0[2]	Ditto	626	0
Mather & Platt	846	0[1]	Morley Elec. Eng. Co.	789	0
Ditto	809	0[2]	Alliance Elec. Co.	787	10
Johnson & Phillips	845	0[1]	Laidlaw, Laidler & Co.	777	0[1]
Ditto	810	0	Ditto	756	0[2]
			Ditto	616	0[2]

[1]Belliss engine. [2]Allen engine. [3]Browett-Lindley engine.

Switchboard and connections.

Elec. & Ordnance Accessories Co. (*accepted*)	£340	0	Kelvin & James White	£507	17
James Watt & Co.	775	0	Consolidated Elec. Co.	496	0
Crompton & Co.	737	0	Ditto	456	0
Lionel Robinson & Co.	595	0	Johnson & Phillips	475	0*
Electric Construction Co.	594	0	Geipel & Lange	471	2
Edison & Swan Co.	592	11	Elec. Trades Supply Co.	448	0*
Brit. Westinghouse Co.	564	0	J. G. Statter & Co.	446	5
Drake & Gorham	563	10	Ditto	392	7
Int. Elec. Eng. Co.	560	0	Evered & Co.	408	11
Dewhurst's Eng. Co.	559	15	R. Woods & Co.	405	0*
W. H. Isherwood & Co.	550	0	Ferranti Limited	395	0
General Electric Co.	545	0	W. J. Fryer & Co.	392	9
F. Potter & Sons	543	0	Morley Electrical Engineering Co.	385	0
India Rubber Co.	527	0	J. E. Spagnoletti & Co.	382	0

*Not filled in.

Islington (London) Electric Lighting committee have provisionally accepted the following tenders:—

W. J. Oakley, at £210 for tail rods for three 1,000 H.P. engines; W. R. Renshaw & Co., for hire of 50 coal waggons at £7. 5s. per waggon per annum for five years, and a pro rata charge for waggons, not exceeding 25, for use during winter months.

Sunderland Electricity and Lighting committee on Tuesday further considered the question of the acceptance of a tender for motor generators.

On the last occasion it was decided to adjourn the matter for the purpose of considering the tender of an English company. The amount of this tender was higher than the committee could get the work done satisfactorily for in Berlin. The borough electrical engineer (Mr. J. F. C. Snell) now reported that the work done by the English firm would be satisfactory, but seeing that the present generators were put in by the Electrical Co., there were technical reasons why the committee could expect better results from the same company, who would design the generator from the same pattern as the rest of the plant, whereas another firm might not be able to do this. Another reason in favour of the A.E.G. tender was that part of the work would be manufactured in Sunderland.

The committee decided to recommend the Council to accept the Electrical Co.'s tender.

For wiring the dust destructor works Bromley Borough Council received the following tenders:—

H. J. Godfrey (*accepted*)	£634	6	0	R. G. & J. Knight	£702	17	6
E. Probert & Co.	788	7	0	Duncan Watson & Co.	694	17	11
Thos. Kesnor & Co.	771	8	6	F. A. Glover & Co.	671	1	0
Lea, Son & Co.	748	18	0	Crompton & Co.	649	0	0

Kingston-on-Thames Council have accepted the tender of Callender's Co. for 1 mile of 0·1 sq. in. concentric paper-insulated lead-sheathed armoured and double steel taped cable at £301, and that of J. R. Offer & Sons for wiring the new museum and art gallery at £119. 9s.

Southampton Corporation have accepted the tender of C. A. Parsons & Co. for a steam balancer at £2,000, and that of the Wheeler Condenser & Engineering Co. for a steam-driven condenser at £560.

Rowland Carr & Co. have secured the whole of the order for bitumen required for the Government Dockyards at Portsmouth and Pembroke. The firm have also obtained an order (through Johnson & Phillips) for 286 tons of bitumen for Handsworth.

Barrow in-Furness Tramways Co. have placed an order for two demi-cars with Raworth's traction patents to be equipped with automatic regenerative control.

Ashton-under-Lyne Guardians have accepted the tender of G. H. Coop for installing telephones, &c., at the new hospitals and nurses' home for £198.

Horwich District Council have accepted the tender of the British Insulated & Helsby Cables (Ltd.) for cables.

Gloucester Corporation have placed an order with Mather & Platt for filtering plant at the electricity works at £191. 12s.

Derby Council have accepted the tender of the Gilbert Arc Lamp Co. for 12 arc lamp carriers at £30.

Walton District Council have accepted the tender of Mr. Badois for electric fire alarms.

Correction.—Owing to an error in a printed London County Council document we stated in our last issue that the tender of the Electric Supply Co. had been accepted by London County Council for a 15 H.P. electric motor at £112. 15s. The Electrical Co. were the successful tenderers. J. Esson & Son, Fetter-lane, London, also tendered.

BUSINESS NOTICES.

The A.E.G. English Mfg. Co. (Ltd.) is starting business at 4, New Compton-street, Charing Cross-road, London, W.C., and we are informed that a large stock of A.E.G. manufactures will be kept. This company has acquired the English Nernst lamp patents from the A.E.G. of Berlin, and will, we understand, look after the Nernst lamp business in England. It is further announced that all lamps and burners will in future be marked "AEGMA." The increasing demand for Nernst lamps has decided the company to build a factory in this country for their manufacture. A price list is in preparation, and will be issued in a few days.

Messrs. Davies, Kent & Stewart, 17, Berners-street, London, W., notify that for private reasons the business has been registered as a private limited liability company under the style of Davies, Kent & Stewart (Ltd.). There is no alteration in the constitution of the firm.

Mr. A. H. Hunt, 115-117, Cannon-street, London, E.C., informs us that his agency for the Walsall Electrical Co. has been determined by mutual consent. Mr. Hunt continues to represent Messrs. Webb, Shaw & Co. in glass shades and globes for electrical fittings, and Messrs. Geoffroy & Delore for their manufactures.

Messrs. Brenchley Bros. & Holman, electrical, mechanical and general engineers, 36 and 38, New-street, Ashford, Kent, have dissolved partnership. Mr. H. F. Holman continues.

Mr. A. Vandam (late of Vandam, Marsh & Co.), informs us he has opened a warehouse and office at Hosken's-buildings, Government-square, Johannesburg, Transvaal (P.O. Box 4,941), and will trade under the style of A. Vandam & Co. as manufacturer of electrical supplies.

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BANKRUPTCIES, LIQUIDATIONS, &c.

A receiving order has been made against Warner & Co., electricians, &c., 12, Holbein-place, Sloane-square, London, S.W.

The first meeting of the creditors of Harold Powell, electrical engineer, Northumberland-street, Derby, was held on Wednesday. Debtor returned his liabilities at £56 odd. There were no assets, and failure was attributed to expenses incurred while acting as a commission agent.

In the failure of Carl Vigant Tyge de Falbe, lately trading as the Electrical & General Contracting Co., the statement of affairs shows total liabilities expected to rank £2,049. 7s. 3d., assets estimated to produce £491. 6s. 7d., total deficiency £1,558. 0s. 8d.

The receiving order was made on July 8, 1902, and on July 22, 1902, Mr. E. H. Hawkins was appointed trustee. The public examination of the bankrupt took place on Wednesday. Debtor states that in October, 1894, he came to England from Denmark. In May, 1900, he came into some property, and in July of that year commenced business as an electrical and general engineer, but transferred his interest in that business in September, 1901, to a limited company. Since July, 1901, he has been in receipt of an income of about £450 per annum from a life interest under his father's will. Insolvency attributed to extravagance, loss in trading, and loss on shares purchased in two limited companies.

Sale by Auction.—Messrs. Percy Huddleston & Co. will sell by auction at the Velox Motor Co.'s works, Parkside, Coventry, on Aug. 9, at 11:30 a.m., the plant of a motor manufacturing company; also the small stock of an electrical engineer. Further particulars are given in an advertisement. Catalogues from the auctioneers, 72, Finsbury-pavement, London, E.C., or on premises, three days prior to sale.

Water Power for Disposal.—Valuable water power (about 400 H.P.), adjacent to important seaport town, is advertised for disposal by Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C. There are numerous buildings, which may be converted for almost any trade, together with cottages and managers' residences.

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 30, Birley-street, Blackpool.

Mr. Thomas Johnson, Prescott-street, Wigan, has for sale some electrical generating plant, further particulars of which are set out in an advertisement.

Business Premises for Sale.—Some freehold business premises, close to Finsbury Park station, London, N., and suitable for factory, &c., are advertised in another column. Particulars from Messrs. Emmet & Co., solicitors, 14, Bloomsbury-square, London, W.C.

"**Duncan's Tramway Manual.**"—The 27th (1904) edition of this useful annual has been issued by Messrs. T. J. Whiting & Sons. The manual professes to give a list of all tramway, &c., companies of the United Kingdom and the foreign and colonial companies that are registered in England, with dates of incorporation, length of leases and concessions, abstract of accounts and a directory of directors and chief officials arranged in alphabetical order. So far as we have been able to test it, we have found the information given in the work accurate but it is unfortunate that a book which professes to be up to date cannot give in its analysis of accounts at least some of the accounts for 1903-4. The published price of the work is 5s.

Advertising.—The specialist in advertising is a creation of the time. He has evolved out of the rush and hurry of the 20th century, and is, therefore, a force to be reckoned with. The latest candidate for honours in the direction of advertisement making is Mr. F. E. Coe, of 19-21, High Holborn, London, W.C., who has prepared and issued a red book on advertising, a copy of which has been sent to us. Mr. Coe's book contains a good deal of matter of interest, and the advertiser will certainly profit from its perusal.

Catalogues, &c.—A fine illustrated catalogue and price list has been compiled and issued by Messrs. John Knox & Co., 210, Upper Thames-street, London, E.C., and comprises an immense variety of all classes of useful engineering tools and engineers' requirements. These are too numerous for particularisation, but comprise a varied assortment of drilling machines, hoisting crabs, lifting jacks, punching bears, blow lamps, soldering tools, furnaces, cable jointers' kits, tents and tools, grinding and screwing machines, brazing apparatus, portable forges, trucks, trolleys and wheel-barrows, contractors' tools and implements, and all the usual accessories and sundries which go to make up a comprehensive wholesale and export ironmongery list.

A pamphlet has been prepared by the Mirrlees Watson Co., Scotland-street, Glasgow, describing the "Yaryan" water distilling apparatus. It is claimed for this system that water for boilers or for domestic use can be economically distilled, the amount of fuel used for these distillers having been gradually reduced. It is stated that as much as 44lb. of water have been evaporated and condensed by this apparatus per pound of coal used.

Messrs. Snowdon, Sons & Co., of Millwall, London, E., have ready a new catalogue relating to non-conducting boiler composition.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from July 27 to 29, with the ports of destination:—

Africa—Durban, £984; East London, £396; Port Elizabeth, £51. *Argentina*—Buenos Ayres, £130. *Australasia*—Adelaide, £25; Hobart, £45; Perth, £130; Sydney, £183; Wellington, £339 (including £200 telegraph material). *Canada*—Toronto, £195. *China*—Shanghai, £287 (including £42 telegraph material). *Denmark*—Copenhagen, £127. *Germany*—Hamburg, £65. *India*—Bombay, £133; Madras, £65 (telegraph material). *Japan*—Tokyo, £105. *Russia*—St. Petersburg, £350 (telegraph cable). *Straits Settlements*—Penang, £42; Singapore, £1,848 (including £75 telegraph material). *U.S.A.*—New York, £29. *Zanzibar*, £130 (telegraph apparatus). Total (for three days)—£5,659, against £14,205 for eight days last year (July 29 to Aug. 5).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

May 12, 1904.

10,939 R. PECK. Liverpool. Electric tramways point and frog mover.
10,957 A. PRINGLE. Manchester. Facilitating placing the poles of electric cars in contact with the overhead wire.
10,962 E. W. TIMMIS. Electric signalling on railways.
10,986 R. J. SHEPHY. Printing telegraphs.*

May 13, 1904.

11,023 E. M. HORSBURGH. Edinburgh. Polar plotting paper.*
11,040 J. F. A. LUECKERT. Kingston-on-Thames. Electric fire alarms.
11,041 A. ECKSTEIN and D. B. MELLIS. Manchester. Automatic electric circuit breakers.
11,056 A. P. LUNDBERG and G. C. LUNDBERG. Ceiling or wall rosettes.
11,072 B.T.-H. Co. (A.E.G., Germany). Electric resistances.
11,073 B.T.-H. Co. (A.E.G., Germany). Electric switches.
11,074, 11,076, 11,077, 11,078, 11,079, 11,080 B.T.-H. Co. (G.E. Co., U.S.). Signalling systems.
11,075 B.T.-H. Co. (G.E. Co., U.S.). Block signalling systems.
11,081 B.T.-H. Co. (G.E. Co., U.S.). Safety devices for signalling systems.
11,086 E. A. CAROLAN (G.E. Co., U.S.). Temperature indicators for flash boilers.
11,089 B.T.-H. Co. (G.E. Co., U.S.). Electrostatic instruments.
11,090 B.T.-H. Co. (G.E. Co., U.S.). Switches.
11,091 B.T.-H. Co. (A.E.G., Germany.). Tools for bending metal-covered insulating tubes.
11,093 C. W. ATKINSON. Electric meters.
11,107 C. H. VAN ASPERN, C. B. ROBINSON and H. W. VAN RADEN. Electric lighting and heating apparatus.
11,111 A. J. GUSTIN. Electric hoisting winch.*
11,116 L. A. HARDS. Twickenham. Electrical signalling.

May 14, 1904.

11,121 E. S. W. MOORE and W. B. BENNITT. Electrically controlling the movements of a cage in a lift or of a car travelling on an inclined or other railway.
11,141 W. A. KER and PATERSON, COUPER & Co. Method of winding armatures of dynamo-electric machines.
11,156 C. J. BEAVER and E. A. CLAREMONT. Manufacture of cables.
11,161 A. J. BOULT (Wilhelm Kübler and A.G. Sachsische Elektricitats-Werke, formerly Pöschmann & Co., Germany). Regulating the speed of induction motors.
11,168 E.A.G. VORM. W. LAHMEYER & Co. Safety devices for protecting dynamo-electric machiney against excessive voltage when being switched in or out. (Date applied for, June 23, 1903, date of application in Germany.)*
11,177 I. REVILLIOD. Electricity meters.

May 16, 1904.

3,876A/03 LEE DE FOREST. Wireless signalling. (Date applied for, Feb. 18, 1903.)*
11,219 F. NUSCH (L. Hölscher, Germany). Switch for electric signs.*
11,233 UNION ELECTRICITÄTS-GESELLSCHAFT. Electricity meters for three-phase alternating circuits. (Date applied for, May 15, 1903, date of application in Germany.)*
11,237 A. BLACKMAN. Middlesex. Formation of electrolyte from water.
11,248 W. T. WATSON. Automatic wheel guards for mechanically propelled cars.
11,251 G. M. NEWBURY. Voltmeters used with distributing mains.
11,262 V. TARDIEU. Transmission of sound to long distances and telephonic apparatus therefor.*
11,264 R. THAYER. Electrically-propelled vehicles.

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11,272 J. W. MACKENZIE (Société Cousin & Co., France). Electrical safety apparatus for signalling on and controlling trains independently of driver.*
11,274 W. D. WATKINS. Telephone selecting systems.*

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1903.

10,652 MASCORD. Electric controllers or switches.
12,993 STATTER and SIMEON. Automatic electric circuit makers and breakers.
13,378 JOHNSON. Constructing dynamo electric generators.
13,852 AHLQUIST. Starting switch for electric motors.
14,079 BRITISH WESTINGHOUSE Co. (Westinghouse Co.). Controlling systems for electric motors.
14,164 LE TALL (Cooper Hewitt Electric Co.). Gas or vapour electric apparatus.
14,211 VERITYS LIMITED and SELBY. Switch and circuit breaker.
14,671 WOOD and CLIFTON. Electrical shot-firing or like apparatus.
15,369 TAYLOR, MOOREHEAD and KINGSCOTE. Operating cords of trolley arms.
16,360 AUEL and SPURRIER. Means for breaking electric circuits.
17,663 BECKER. Accumulators.
17,885 WOOD-SMITH. Ozonising air and other gases.
18,193 WOOD-SMITH. Sterilising water by means of ozone.
19,547 THOMPSON (Berliner Maschinenbau A.G. vorm. L. Schwartzkopff). Magnetic excitation of alternate and three-phase current machines.
23,978 GIRAUD. Overhead conductors. (Date applied for, Nov. 5, 1902.)
28,400 HUNT. Production of hydroxides and oxides of metals by electrolysis

1904.

3,251 BLOOD. Prevention of arcing in electrical apparatus.
3,344 SOC. DE CHAMPROBERT & CIE. Electric transmission of power for automobiles. (Date applied for, Feb. 11, 1903.)
3,677 LATOUR. Regulators for alternating-current motors. (Date applied for, Feb. 14, 1903.)
3,694 ORTEGA Y. MARQUEZ. Coherers for wireless telegraphy. (Date applied for, Feb. 16, 1903.)
4,357 PECK. Electrical transformers. (Date applied for, Feb. 28, 1903.)
4,472 PAPE and HIGGINS. Audiphones, telephones and like instruments.
4,473 PAPE and HIGGINS. Audiphones, telephones and like instruments.
4,748 OADES and GRATZE. Magnetic combined speed indicator and speed limit alarm.
6,486 SODEN. Electric lamp and socket.
6,523 TOLMAN. Electric lighting of road vehicles. (Date applied for, July 30, 1903.)
6,612 ACKERMANN and ENGISCH. Drum supports for electric lamp and other wires. (Date applied for, March 28, 1903.)
6,619 COMMELIN and VIAU. Secondary electric batteries. (Date applied for, March 18, 1903.)
6,724 ARON. Electricity meters for alternating currents.
7,012 EVERHART and DOSSERT. Electric cable couplings.
7,733 VEREINIGTE MASCHINENFABRIK AUGSBURG UND MASCHINENBAU-GESELLSCHAFT NÜRNBURG A.G. Electric ignition device for explosion engines. (Date applied for, Oct 19, 1903.)
7,869 PIEPER. Power cut-out systems for electric railways.
7,981 MERCADIER. Manufacture of spongy or porous lead and of articles therefrom. (Date applied for, April 7, 1903.)
8,394 RUSS. Automatically-operating electric switches.
8,723 LOB and FEIGELBERG. Preventing snow settling upon aerial conductors.
8,999 MCDEVITT. Protecting live parts of electric switches.
9,123 FOSTER, GROTE and ELY. Arc lamps.
9,310 BIRKBECK (Schwarzschild Dodd & Johnson). Electric burglar and fire alarms.
9,453 GIBBS. Electric shoes. (Date applied for, July 16, 1903.
9,523 DUNTLEY. Galvanic battery cells.
9,581 MCNEILL. Electric motors.
9,954 SPROWSON. Safety device for electric lifts.
9,981 WALTHER. Shade carrier for electric glow lamps and the like.
10,036 BERLINI. Cables.
10,172 IMRAY (Bullock Electric Mfg. Co.). Dynamo electric machines.
10,173 WARREN and HUNTER. Combined switch and plug connector.
10,189 WATERMAN. Heating liquids by electric current.
10,370 BOULT (Potter). Storage battery plates.
11,111 GUSTIN. Electrically-operated hoisting winch.

COMPANIES' MEETINGS AND REPORTS.

Anglo-American Telegraph Co. (Ltd.)

The half-yearly meeting was held on Friday last, under the presidency of Mr. F. A. BEVAN.

The SECRETARY (Mr. T. H. Wells) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: In accordance with usual practice at our half-yearly meetings, you will like to hear a few remarks from the chair, more particularly as we have a matter to bring before you to which I desire to call your special attention. So far as business is concerned, as you know, we do not live in prosperous times. The war between Russia and Japan has cast a gloom over commerce generally. There are many, however, who think this war will soon come to a close, and that a better state of things will then prevail. We, like everyone else, are feeling the bad times. There has been a considerable diminution in our traffic for the past half-year, the receipts falling off by £13,279. 14s. 7d. compared with the corresponding half-year of 1903, and we have earned less from our steamship "Minia" by £4,899. 6s. 9d., making the total decrease of £18,168. 19s. The expenses of the "Minia" have been less by £3,306. 6s. 2d., but our working expenses have increased by £991. 16s., due to the normal rise in salaries. This brings our total decrease to £15,854. 11s. 10d., and, owing to a smaller balance forward, there is available for dividend to June, 1904, the decreased amount of £16,432. 8s. 3d. The interim dividends paid have only absorbed £87,500, against £105,000, so that we are carrying forward a larger sum than previously. Now, these figures are not very cheering, but almost every other company is paying a smaller dividend, and we have, therefore, no special reason to complain. We have decided to effect special repairs to the "Minia," which we have now owned for 36 years. She has done a vast amount of good work, and is in many ways a first-class ship. The time has arrived when we must thoroughly overhaul her, and this will cost altogether £20,000. A newly-built boat would cost us four times as much as we are spending in this way, but we believe that with this expenditure she will be at least as efficient as she ever was, and may, therefore, continue to serve us for many years. Unfortunately we have not been able to utilise the services of the "Minia" during the past half-year as we should have wished, as the ship has been undergoing its thorough overhaul. Unfortunately, too, some of our own cables broke, and we had to charter another ship to repair them. With regard to our renewal fund, there is some kind of understanding that when this reaches £1,000,000 we shall only carry to that fund, as long as it keeps at that figure, the interest earned by itself. This fund amounts at the present time to £987,676, but the nominal value of the securities is only £940,345, on account of depreciation. With anything like good luck we hope at no very distant date that our renewal fund will reach the figure of £1,000,000, and we shall then be able to spare the amount which we now debit to our profit and loss account and credit the renewal fund only with the interest it has earned by itself. I now come to the point to which I referred in my opening remarks. This relates to a scheme of pensions for the employés of the company in lieu of the present system of endowment assurance. Everyone admits that where employés have served faithfully for a certain number of years it is fair and right that they should have a pension, but instead of this being settled arbitrarily at the time according to the ideas of the directors, it would be much more satisfactory to them, and certainly to the employés, if there were a fixed sum whereby the employés might know from the beginning what pension they would be entitled to when they retired from the service, either through age or infirmity. The figures I am about to mention are not all additional expenses. You will have certain expense to bear in any case, and I think it will be much more satisfactory for this expense to be defined and the whole scheme put upon an ascertained scale. Our employés almost all come from the General Post Office, and, consequently, there is a system of pensions. Persons joining our staff always wish to know whether they will derive from us the same benefit which they would have derived if they had continued in or were to enter the Post Office service. The success of this company depends upon the efficiency of its employés, and the conclusions forced upon the directors is that they have no option but to adopt a regular system of pensions. They appeal to the shareholders to support them in that opinion. Our scheme affects about 250 men, and under it anyone in our employ, either in our administrative or our operative departments, who is 60 years of age, or retires through illness or inability to work, or is dismissed otherwise than for misconduct or bankruptcy (in which case no pension accrues) is entitled to a life pension on completing 10 years' continuous service, or to a gratuity where 10 years' service is not completed. The pension for each complete year of service is calculated at one-sixtieth of the average pay during the last three years of service up to forty-sixtieths, but no pension will exceed £500 per annum, except in special cases where the directors decide that this sum is not sufficient. These would, of course, be very few and exceptional cases. Voluntary retirement before completing 40 years' service would disentitle an employé to either pension or gratuity, or if an employé of the company after he retired were to enter into the service of another company which in any way competes with us this would disqualify him from anything further in the way of pension. This is the kernel of our scheme. Our present endowment assurance scheme takes something like £2,000, and this sum is already paid by the company. If the new pension scheme is approved, this £2,000 falls in at once to begin with. The total cost of the pension scheme, we are assured by an eminent actuary, involves us in some £6,800 per annum. This would leave us with a further £4,800 per annum to provide. The directors propose that £4,000 of this sum should be met by reducing the contribution we now make to the renewal fund. Therefore the shareholders will not be affected in any way so far as £6,000 of the sum required for the pension scheme is concerned. This leaves us with only £400 per half-year, or £800 per annum to provide as affecting the accounts, and the shareholders will really scarcely feel this amount. We have never had any trouble with our employés, who are a most faithful and hard-working set of men. They are often called upon for extra services, and do their work cheerfully and well. It is owing to their skill and assiduity that we are able to earn the dividends we do. I feel confident the shareholders will approve this scheme, and will credit the directors with the desire to act in the real interests of the company. I now move the adoption of the report and accounts and the approval of the pension scheme referred to in the report.

Sir GERALD FITZGERALD, K.C.M.G., deputy-chairman, seconded.

In reply to questions, the CHAIRMAN said that he had been asked whether the board propose to compulsorily retire the employés at 60. No, certainly not. The scheme does not oblige the directors to do so, but

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will give them the power to do so, and so give the man who is retired his pension. The directors could retain any man's services who was considered desirable. On the other hand, the man could not claim to go on serving the company. As to the man who voluntarily retires before 40 years' service have expired, he would get nothing in that case, but the directors would have the power to take his case into consideration. With regard to questions which had been asked about the renewal fund, this was not the time to discuss that matter. The object of the directors in referring to the matter was to show the shareholders what was in the mind of the directors on the subject.

The resolution was then carried unanimously.

A cordial vote of thanks to the chairman and directors for their services to the company, and especially in connection with the pension fund which had been outlined, was proposed by Mr. NEWTON and duly seconded, and carried unanimously.

The CHAIRMAN having replied, the proceedings terminated.

BARRY RAILWAY CO.—In the report for the June half-year the directors state that they have carefully considered the question of the electrification of the railway, but are of opinion that under present conditions the application of electric power to railways which deal with a heavy mineral traffic is impossible. They consider, however, that the passenger traffic on certain portions of the company's railways would be more economically worked by the limited use of motor coaches, and a contract has been entered into for the construction of two such coaches, to be increased to four if the experiment proves successful.

BLACKPOOL & FLEETWOOD TRAMROAD CO.—The report of the directors for the half-year ended June 30 states that, including sum from last half-year, the profit, after providing for interest, was £3,529. 15s. 3d. A dividend at the rate of £4 per cent. will absorb £3,000. £500 is written off to depreciation reserve. The number of passengers carried was 779,060, receipts from all sources being £10,257. 1s. 6d.

CENTRAL LONDON RAILWAY CO.—At the meeting on Wednesday, the chairman (Sir Henry Oakley) said that, happily, during the past six months they had had no serious trouble, hardly a mischance. The business had gone on with undeviating regularity, with a satisfactory result in the way of profit. There had been a slight falling off in the number of passengers—nearly 1 per cent. The board anticipated that when trade revived they would get back the passengers they had lost. About £5,800 was expended on equipment of the line and stations, particularly on improving and strengthening the precautions for working the line electrically. In connection with the new motor cars there had been spent £7,200. This was almost the last payment in regard to the purchase of 68 cars. No large expenditure of any description was anticipated in the future. The works to be finished included the condensing plant at Shepherd's Bush. They would be left with about £200,000 or £300,000 unspent and practically not raised. Their receipts from all sources were £184,900, and they had spent £95,000, leaving nearly £90,000 as profit. Including amount brought forward, there was £133,738 available for distribution. It was proposed to divide £50,000 in dividends on the preferred and original stocks. They were setting aside £10,400 towards deferred dividend at the end of the year and they carried forward £48,700. They brought into the account of the past half-year £36,000. They had £30,000 odd to credit of contingent account and £48,700 undivided. In regard to the Royal Commission on London Traffic, the board understood that their report was in course of preparation and might be out shortly. Until they knew the Commissioners' views, and whether any recommendations or suggestions made in their report would involve expenditure on the part of the company, it was felt desirable to keep in hand all that they had, so that they might deal effectually with any recommendation which might be made as to their line.

CONSOLIDATED ELECTRICAL CO. (LTD.)—The report of the directors for the period ended March 31 states that the Anglo-Portuguese Telephone Co. (in which this company it largely interested) continues to make satisfactory progress. The Private Wire and Telephone Installation Co., which was formed to take over a branch of the company's business, has had a satisfactory year's trading. The Consolidated Co. holds £2,000 of debentures and a majority of the share capital of the Private Wire Co. The net revenue account of the Consolidated Co. shows a debit balance of £266. Until the close of 1903 business continued fairly good, but latterly there has been a great scarcity of remunerative orders in telephone and electric lighting work, and drastic economies have in consequence been effected in the administration and general management. The office of managing director has been abolished at a saving of £800 per annum. Mr. L. Redmayne has succeeded Mr. E. L. Joseph as works manager, and a further saving of £500 per annum has been effected by this change.

CROMPTON & CO. (LTD.)—The directors' report for the year ended March 31 states that the net profits amount to £14,584, and after providing for interest and other items there remains, with the sum from last year, £8,054. No interim dividend was paid for the half-year ended September last, but the directors now propose to place £750 to credit of doubtful debts account, and to pay a dividend at the rate of 2½ per cent. for the year, carrying forward £1,221, compared with £1,098. 10s. 9d. last year. The directors having registered a company under the title of The Electric Supply Corp. (Ltd.) have been engaged in obtaining business for that company. They have secured concessions or agreements in 17 towns in the United Kingdom for electric lighting and for tramways, and arrangements have recently been made for the necessary capital for carrying on the work. An agreement has been made with the new company that Crompton & Co. shall carry out all the contract work required for five years at a satisfactory profit. An agreement has also been made with the Electric Supply Corp. to sell the whole of Crompton & Co.'s interest in the Chelmsford Electric Lighting Co., Crompton & Co. taking shares and debentures in the new company in payment.

EDINBURGH STREET TRAMWAYS CO.—In the report for the half-year to June 30 it is stated that Leith Corporation have now obtained the necessary powers to purchase the company's tramway undertaking. Payment of the agreed price (£60,000) and the due transfer of the property will probably take effect about the end of October next.

LIVERPOOL OVERHEAD RAILWAY CO.—The directors in their report for the half-year to June 30 state that the gross revenue amounted to £41,927. 13s. 3d. and the working expenses to £31,739. 16s. 11d. The number of passengers carried was 5,624,421, compared with 5,514,089 in the corresponding half-year of 1903, and with 5,896,503 for the December half-year 1903. The traffic working expenses show a satisfactory decrease, but there has been a further outlay on renewal of permanent way, of which £1,000 has been charged to renewal fund. It is expected that the relaying of the permanent way will be completed this year. The contract for the construction of the northern extension to the Seaforth station of the Lancashire and Yorkshire Railway has been let, and the work is in progress. Interest absorbed £3,948. 19s. 9d., and the balance actually available for dividend was £10,370. 18s. 6d. The dividend on the 5 per cent. preference shares (less tax) required £3,193. 12s. 8d. and the directors recommend a dividend of 1¼ per cent. on the ordinary shares. The total train and tram mileage for the half-year was: Passenger trains 366,248, compared with 358,757 miles for the corresponding half-year of 1903; tramways 134,646 miles, compared with 134,599.

LONDON, TILBURY & SOUTHEND RAILWAY CO.—At the meeting yesterday (Thursday) the chairman (Mr. J. Warren) referred to the subject of electric traction and said that the directors recognised that it would be necessary for the proper development of the traffic that that system of traction should be installed as an alternative means of working from the point where the Whitechapel and Bow Railway joined the Tilbury Railway at Bow, to a point near Barking. Steps were being taken with the object of adapting that portion of the railway for electric traction, so that it might be ready for use at the time when the new mode of working was brought into operation on the Metropolitan and Metropolitan District Railways.

METROPOLITAN RAILWAY CO.—The chairman (Sir C. McLaren, M.P.) referred, at the meeting on Friday, to the progress made with the electrification of the railway. The company has completed the generating station, and all the machinery, with the exception of the turbo-generating plant, was on the ground. They were adopting steam turbines on account of their efficiency, economy and general adaptability for electrical work. The turbines which they would have running at Neasden would be the first of their size constructed in this country. Some of the turbo-generating machinery had been delivered, and the directors believed in a few weeks' time experimental tests could be made. The cables and the conductor rails had been laid, and the general equipment of the permanent way had been completed from Baker-street to Uxbridge. The Inner Circle section was now being completed. A number of sub-stations had been built, and the rotary converters and transforming machinery were installed in most of them. The arrangements of cooling towers, together with the supply and circulation of the water to and from the power station were now all in order. They intended to adopt corridor cars for the electrical working, and they had had built in England a first consignment of 70 cars, all of which had been completed and delivered. Some of these cars had been running with satisfactory results. The total amount chargeable to the installation of electric traction was £230,910.

METROPOLITAN DISTRICT RAILWAY CO.—In the report for the half-year ended June it is announced that zonal fares (authorised by the company's act of this session) will come into operation on the complete electrification of the railway. This work of electrification is making rapid progress. The power station at Lots-road, Chelsea, is virtually completed, and the machinery is being installed and the various sub-stations are nearing completion. 420 new corridor cars, making up 60 trains, have been ordered. Many miles of cables have been drawn into the ducts. Satisfactory progress is also being made with the widening of the railway between West Kensington and Hammersmith, the erection of the new car sheds and depot at Mill Hill Park, the erection of a new station at High-street, Kensington, and the necessary lengthenings of the company's stations.

NORTH-EASTERN RAILWAY CO.—In the report of the directors for the past half-year it is stated that the train-mileage run was 13,076,657, a decrease of 707,379, and the electric train-mileage had been 53,402. The substitution of electric trains for steam trains for suburban passenger traffic on the Newcastle and Tynemouth and Riverside branches had been effected during the half-year. The work had been carried out most efficiently, considering the novelty and difficulty of many of the practical problems which had to be solved in connection with the adoption of the new form of traction. A large increase had taken place in the number of trains on the branches equipped for electric traction, and up to the present there was every indication that the results, both as regarded revenue and convenience in working, would be satisfactory.

SOUTH-EASTERN RAILWAY CO.—At the meeting last week the chairman (Mr. H. C. O. Bonsor) said it was the first time since the working union that they had shown an absolute decrease in the number of passengers carried. This was principally attributable to the electrification of the tramways in the metropolitan area. One station in the metropolitan district showed a decrease of 600,000 during the half-year, and all the stations which were affected by the new electrified trams showed a considerable decrease. The managing committee had to consider whether some of those stations, which had been continued to be kept open for the convenience of the public, rather than of profit to the shareholders, should not now be closed.

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WATERLOO & CITY RAILWAY CO.—The gross receipts for the half-year ended June 30 (less Government duty) were £17,376. 3s. 9d., and the working expenses £8,263. 17s., or 47·55 per cent., compared with 46 per cent. for the corresponding period of 1903. The balance available for dividend, after providing interest, is £8,521. 15s. 5d., and a dividend at the rate of 3 per cent. per annum on the ordinary stock will absorb £8,100, leaving £421. 15s. 5d. to be carried forward. The number of passengers carried during the six months (exclusive of season ticket holders) was 2,227,350, a decrease of 53,783 compared with the corresponding period of 1903. The season ticket holders on June 30 numbered 1,611, against 1,244.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

BASTIAN MERCURY VAPOUR LAMP (LTD.) (81,674.)—Reg. July 27, capital £20,000 in £1 shares, to acquire the benefit for the United Kingdom and Isle of Man of certain inventions from Bastian & Partners (Ltd.), to adopt an agreement with said company and C. O. Bastian and A. E. Salisbury, and to carry on the business of mercury vapour lamp manufacturers, electricians, &c. Bastian & Partners (Ltd.) may nominate two directors, remainder to be appointed by subscribers. Reg. office, 39, Victoria-street, London, S.W.

BOWEN'S ELECTRIC & MOTOR BOATS (LTD.) (81,645.)—Reg. July 25, capital £20,000 in £1 shares (10,000 preference), to acquire freehold yacht building and electric works on Eel Pie Island, Twickenham, to adopt an agreement with Kerbey Bowen, to construct and establish on Eel Pie Island or elsewhere a dock with patent and other slips, workshops, buildings, machinery, &c., and to carry on the business of builders of and dealers in launches, yachts, ships or boats of all kinds, &c. First directors, Kerbey Bowen, C. G. M. Adam and H. Pritchard. Reg. office, 23, Northumberland-avenue, London, W.C.

MORRIS, HAWKINS ELECTRICAL CO. (LTD.) (81,091.)—Reg. July 27, capital £11,000 in £1 shares, to adopt an agreement with the Morris Aiming Tube & Ammunition Co. (Ltd.), and to carry on the business of electricians, electrical and mechanical engineers, ironmongers, makers of electric tramcars, motor cars, carriages, &c., manufacturers of dynamos, telephones, bells, electroliers, lamps and other electrical fittings and accessories, &c. First directors, T. Hawkins and existing directors of Morris Aiming Tube & Ammunition Co. Reg. office, 17, Charing Cross-road, London, W.C.

MORTGAGES AND CHARGES.

BRITISH ELECTRIC CALIBRATED FUSE CO. (LTD.)—Issue on July 23 of £400 5 per cent. debentures, part of series created Dec. 4, 1903, to secure £3,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £1,750.

ELECTROLYTIC ALKALI CO. (LTD.)—A trust deed dated July 9, 1904, to secure £50,000 debentures, created by resolution of even date, has been registered. Property charged, freehold land and hereditaments in Middlewich and the company's other assets for time being, including uncalled capital. Trustees, Liverpool Mortgage Insurance Co.

PERTH ELECTRIC TRAMWAYS (LTD.)—Issue on May 18 of £500 and on June 23 of £34,400 debentures, part of series created Dec. 22, 1903, to secure £50,000, charged on benefit of certain agreements, deposit, provisional order and Acts of Parliament, tramways, tramway undertaking, &c., in Perth, W. Australia. Trustees, Lord A. Butler and J. S. Austen. Previously issued of same series, £100.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26⅛d. per oz. (Aug. 4). Consols 87 1/16—87 3/16 for money, 87¼ - 87⅜ for account; 2½ per cent. annuities 86¾ - 87¼. Consols Pay Day, Sept. 1; Stocks and Shares Continuation Days, Aug. 10 and 29; Ticket Days, Aug. 11 and 30; Pay Days, Aug. 12 and 21; Mining Share Carry-over Days, Aug. 9 and 26.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—An interim dividend for the half-year ended June 30 at the rate of 9 per cent. per annum has been declared on the ordinary shares.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—An interim ordinary dividend at the rate of 4½ per cent. per annum has been declared.

CITY & SOUTH LONDON RAILWAY CO.—*Correction.*—In the report of the proceedings at the meeting of shareholders of this company on Thursday last week (p. 620 of our last issue), the expenses per train-mile should have read 1s. 2·9d., against 1s. 2 6d., and not 1·29d., against 1·26d., as there stated.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed 17th inst. as a special settling day in and have granted a quotation to a further issue of 25,000 £10 fully-paid 5 per cent. cumulative preference shares of the *London United Tramways (1901), Ltd.*

VICKERS, SONS & MAXIM (LTD.)—An interim dividend for the half-year ended June 30 of 1s. per share on 3,689,500 fully-paid ordinary shares has been declared.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	July 30	1,654	+ 403	9	13,106	+ 2,839
Airdrie	,, 22	225	...	24	4,744	...
Ayr Corporation	,, 30	487	+ 33	11	4,561	+ 49
Barnsley	,, 22	169	- 15	29	4,826	- 339
Barrow	,, 22	278	...	24	4,133	...
Bath Electric Trams, Ltd.	,, 27	688	...	30	17,919	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	...	...	...	...	...	...
Birmingham Corporation	,, 30	855	...	§17	5,168	...
Birmingham Tramways Co.	,, 30	5,489	+ 378	4	22,557	+ 1,884
Blackburn Corporation	,, 29	999	+ 144	18	17,583	+ 1,555
Blackpool Corporation	,, 28	1,258	+ 424	17	17,878	+ 1,345
Blackpool and Fleetwood	,, 30	1,292	+ 115	5	4,869	- 120
Blackp'l, St. Anne's & Lytham	,, 28	805	+ 147	39	11,555	+ 6,016
Bolton Corporation	,, 31	1,929	+ 137	18	33,852	+ 158
Bournemouth Corporation	,, 27	1,163	+ 154	†17	18,853	+ 1,253
Bradford Corporation	,, 28	4,880	+ 760	16	76,666	+ 13,208
Brighton Corporation	,, 31	1,322	+ 269	17	17,559	+ 1,194
Brisbane Tramways	June 15	2,262	+ 104	24	£5,120	+ 693
Bristol Trams & Carriage	July 29	5,809	+ 195	10	54,041	- 421
Buenos Ayres & Belgrano	,, 8	3,091	- 49	11	36,861	+ 1,504
Burnley Corporation	,, 30	986	+ 156	18	19,639	+ 4,561
Burton Corporation	,, 31	420	...	¶17	6,238	...
Calcutta Tramways Co.	,, 30	R35,707	+R3,316	5	R136,929	+ R16,553
Camborne-Redruth	Aug. 1	126	- 26	13	1,516	- 67
Cardiff Corporation	,, 30	2,256	+ 122	17	36 262	+ 925
Carlisle Tramways Co.	July 30	222	- 12	30	5,914	+ 108
Central London Railway	,, 30	5,895	- 2·0	4	24,028	- 1,421
Chatham & Dist. Lt. Rys.	,, 28	648	+ 30	30	17,923	+ 2,181
City & South London Rly.	,, 31	2,384	- 171	5	11,819	- 699
Cork Electric Trams Co.	,, 28	566	- 171	30	13 727	- 1,315
Darwen Corporation	,, 29	209	+ 2	17	4,027	- 105
Derby Corporation	,, 30	567	+ 177	1	567	+ 177
Devonport & Dist. Trams	,, 22	620	+ 35	23	15,129	+ 2,436
Dover Corporation	,, 30	296	+ 28	18	4,082	- 188
Dublin & Lucan Railway	,, 29	148	- 48	4	606	+ 65
Dublin Southern District	,, 29	1,231	+ 67	4	22,766	- 4,413
Dublin United	,, 29	4,197	- 214			
Dudley—Stourbridge	,, 22	994	+ 105	29	24,299	+ 913
Dundee Corporation	,, 20	899	+ 7	4	3,559	+ 9
	,, 27	990	+ 13			
East Ham Council	,, 30	748	+ 91	17	13,396	+ 1,289
Gateshead & Dist. Trams	,, 22	958	+ 43	29	26,012	+ 1,254
Glasgow Corporation	,, 30	12,975	+ 567	†9	123,531	+ 3,122
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 22	308	+ 32	29	7,259	+ 788
Gt. Northern & City Rly.	,, 30	985	...	24	22,3 8	...
Greenock & Port Glasgow	,, 22	873	- 23	29	16,112	+ 773
Halifax Corporation	,, 20	1,779	+ 286	17	26,330	+ 1,871
	,, 27	1,564	- 9			
Hartlepool Tramways	,, 22	372	+ 31	29	8,316	+ 848
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 30	2,270	+ 442	17	37,3 9	+ 4,672
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	,, 27	118	- 42	11	2,523	+ 202
Ipswich Corporation	...	...	...	...	...	...
Isle of Thanet Co.	,, 30	1,526	+ 203	¶44	20,764	- 117
Kidderminster & District	,, 22	182	+ 41	29	3,565	- 69
Kirkcaldy Corporation	,, 20	358	- 41	30	6,799	...
	,, 27	340	- 66			
Lanarkshire Trams Co.	,, 28	614	- 101	30	18,856	...
Leeds Corporation	,, 30	5,854	+ 248	19	105,993	+ 6,087
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	,, 23	14,144	+ 3,828	30	307,393	+ 10,827
Liverpool Overhead Rly.	,, 31	1,642	- 26	45	8,619	+ 49
*London County Council	,, 16	14,783	+ 4,035	§15	185,758	+ 33,116
Lowestoft	,, 31	351	+ 19	1	351	+ 19
Manchester Corporation	,, 30	12,818	+ 591	17	212,491	+ 7,452
Mersey Railway	,, 31	1,486	+ 110	4	5,843	+ 451
Merthyr	,, 22	211	+ 4	29	5,880	+ 144
Middleton	,, 22	432	+ 24	29	9,332	+ 146
Nelson Corporation	,, 30	118	+ 33	17	2,126	+ 855
Newcastle-on-Tyne Corp.	,, 30	3,770	+ 280	4	15,121	+ 1,590
Newport (Mon.)	,, 30	558	+ 138	17	8,985	+ 1,897
Oldham, Ashton & Hyde	,, 23	620	+ 18	29	15,783	- 772
Oldham Corporation	,, 17	1,275	...	20	23,189	...
	,, 24	1,281				
Perth (W. A.) Elec. Trams.	,, 29	1,233	+ 163	30	£9,915	+ 5,311
Peterborough	,, 22	184	+ 19	29	4,248	- 125
Poole and District	,, 22	355	+ 15	29	8,246	+ 5
Portsmouth Corporation	,, 30	2,228	+ 246	†17	35,857	+ 3,298
Potteries	,, 22	1,902	+ 368	29	49,318	+ 4,359
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 22	782	- 40	29	3 662	- 112
Salford Corporation	Aug. 1	4,537	+ 330	18	73,590	+ 5 860
Sheerness	July 20	88	- 2	29	1,679	- 410
Sheffield Corporation	,, 31	4,736	+ 38	§18	85,983	+ 2,642
Southampton Corporation	,, 28	1,031	- 77	4	4,071	- 455
Southend Corporation	,, 27	510	+ 109	17	6,176	+ 620
Southport Tramways	,, 22	417	+ 20	29	9,030	+ 491
S. Staffordshire Trams.	,, 22	785	- 308	29	2 ,310	- 2,315
Stockport Corporation	,, 23	650	+ 274	17	10,507	+ 4,582
Sunderland Corporation	,, 31	1,373	- 175	17	22,894	+ 714
Swansea Trams	,, 22	942	+ 370	29	15,412	+ 959
Taunton Trams	,, 23	63	+ 2	29	1,551	- 100
Tynemouth and District	,, 22	452	- 2	29	8,095	- 420
Tyneside Trams Co.	,, 27	421	+ 58	30	11,263	+ 2,049
Wallasey District Council	,, 30	869	+ 30	§17	13,507	+ 824
Walsall	...	...	...	...	...	...
Warrington Corporation	,, 28	339	+ 17	17	5,539	+ 149
West Ham Corporation	...	...	...	...	...	...
Weston-super-Mare	,, 20	348	+ 81	29	2,712	+ 110
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 22	413	+ 4	29	11,058	- 192
Worcester	,, 22	385	+ 228	24	7,314	+ 3,269
Wrexham	,, 21	122	- 8	29	3,207	- 384
Yorkshire Woollen District	,, 22	755	+ 358	29	17,087	+ 7,897

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 8 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Aug. 3.	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE.	BUSINESS, 6 DAYS TO AUG. 3. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
£	..	Anglo-Argentine Ordinary Shares	6 —6½	..	April, Oct	6⅛	6⅛
5	2/6	Do. 5% Cum. Pref.	5⅛—5⅝	4 13 0	..	5⅛	5⅛
St.	6%	Do. Permanent 6% Deb. Stock	137 —141	4 5 0	..	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	98 —100	5 0 0	..	99⅛	99
10	6%	Barcelona Tramways Ord.	9 —10	3 0 0	..	9 7/16	9
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	9¼	9⅜
St.	4½%	† Do. 4½% Deb. Stock (red.)	91 —96	4 14 0	..	..	..
100	5%	† Do. 5 per Cent. Debs.	96 —99	5 1 0	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	1/16—1/8	..	..	..	..
1	..	Do. 5% Cum. Pref.	3/4—1	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	..	4¼	4⅜
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs. ...	96 —101	4 9 3	..	..	..
10	8%	Bristol Tramways and Carriage Ord. ...	19½—20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 15 3½	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100 —103	5 16 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	99 —102	4 18 6	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
4'	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝—105⅝	4 6 2	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 —100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	8½—9	8 17 9	..	9	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅜—11½	5 6 7	Feb, Aug	..	..
St.	5/0	Do. 5 per Cent. Perpetual Debs	116 —119	4 5 1	..	118½	117½
1 t.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	95 —98	..	..	..	..
5	3/0	Buenos Ayres and Belgrano Ord.	2⅞—3⅛	4 16 0	..	..	..
5	3/0	Dc. 6 per Cent. "A" Cum. Pref.	5⅛—5⅝	5 4 4	..	..	..
5	3/0	Do. "B"	5 —5⅛	5 9 1	..	..	..
St.	5%	Do. 5 per Cent. Debs.	105 —108	4 12 8	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	101 —104	4 16 6	..	101½	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	94 —99	5 1 0	..	..	..
5	3/6	Calcutta Tramways	7¼—7⅜	3 17 6	..	7⅜	7⅛
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 3 3	..	105¼	..
1	1/0	Cape Electric Tram Shares .. ex rights	1⅜—2	5 0 0	..	..	..
St.	4%	Central London Ordinary Stock	89 —91	4 8 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. Pref. Stock	102 —104	3 18 5	..	..	..
St.	4%	Do. Deferred Stock	79 —81	4 18 9	..	..	..
100	4%	Do. 4 per Cent. Debs.	106 —109	3 13 5	..	108	107
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2%	City and South London Rly. Con. Ord.	46 —48	4 11 10	Feb, Aug	48	46
St.	5%	Do. 5 per Cent. Perp. Pref. (1891) ...	123 —126	4 0 0	Feb, Aug	..	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 —109	3 13 5	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 10	..	..	..
10	6/0	†Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 8 11	..	..	..
10	6/0	† Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8⅔	Gt. Northern & City Rly. Prf. Ord. (4%)	4 —4½	..	..	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	18 —19	5 5 3	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	13¾—14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	107 —109	4 2 8	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¼—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 —91	4 7 11	..	..	..
10	1½%	Liverpool Overhead Railway Ord	3¾ —4	3 8 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref..	10¼—10⅜	4 13 0	..	10⅜	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —105	3 16 4	..	..	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	1⅜—1⅝	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	1/16—1	5 0 0	..	..	..
St.	13/7	Do. 4½% Deb. Stock	97 —100	..	..	98⅜	97½
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..
100	4½%	† Do. Sterling 4½% Debs. (1922)	103 —105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 —2	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 —102	4 18 1	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	89 —92	3 7 11	June, Dec	90	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance E'ec. Co. 5% Cum. Pref.	⅝—¾	8 0 0	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	¼—⅜	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5⅞—6⅛	6 8 0	July, Feb	..	..
5	3/0	† Do. 6 per Cent. Pref.	5⅛—6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 7	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	3¼—3⅝	8 0 0	..	3 5/32	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock ...	85 —88	4 10 11	..	87	..
2	..	Brush Electrical Engineering	1/16—1	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	¾—1¼	9 12 0	Mar, Sept	1 1/16	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	71 —76	5 18 4	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9⅛—10½	5 14 3	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	101 —105	4 5 8	Nov, May	102½	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	† Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 16 10	..	..	..
1	1/2⅔	Chadburn's (Ship) Telegraph Ord.	⅞—1⅛	8 0 0	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000) ...	1⅛—2	7 9 3	Jan, July	1⅛	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	94 —97	5 3 6	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7½—8	..	..	7⅞	7⅜
5	3/0	Do. 6% Cum. Pref.	5¼—5⅜	5 4 4	..	5⅜	..
St.	4½%	Do. 4½% Deb. Stock	102—105	4 6 0	..	104½	104
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅛—¾	..	Feb, Aug	6 3/32	..
5	..	Do. (£5 paid)	1 —2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 —82	4 18 1	June, Dec	80	79
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 —83	6 3 8	..	..	..
5	4/6	†Edmundson's Elec. Corp. Ord.	5 7/16—6⅛	5 14 3	H'lf-yearly	6 3/32	6
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅜—6	5 0 0	..	5 1/32	5 3/32
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 4 0	..	106 3/32	105 3/32
2	1/7½	†Electric Construction Co.	1 —1½	11 4 0	Jan, July	..	..
2	2/9⅜	† Do. 7 per Cent. Cum. Pref.	2 —2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	96 —99	4 0 9	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref...	9 —9½	5 5 3	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	96⅛	95⅛
5	9/0	Henley's Telegraph Works Ord.	11 —12	6 5 0	Feb, Aug	11	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 6	Feb, Aug	18 1/16	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 —103	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	36 —39	6 3 0	Mar, July	37½	36
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	99 —102	3 18 5	Jan, July	..	..
5	..	Willans and Robinson Ord.	2 —3	..	Apr, Oct	2½	2⅜
5	..	Do. 6 per Cent. Cum. Pref.	3 —4	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	90 —95	4 4 0	Jan, July	..	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Aug. 3.	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE.
		ELECTRICITY SUPPLY.			
1	..	Blackheath & Gr'nwich. Dist. Ord. (f.p.)	⅜—½	..	..
1	0/8⅓	Do. 7% Cum. Pref.	1⅛—1⅜	5 1 9	..
St.	..	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	102 —106	4 5 3	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.) ...	101 —104	4 6 7	..
5	..	Bromley (Kent) El. Lt. & Power Shares	5½— 6	..	..
St.	4½%	Do. Do. 1st Debs	100 —103	4 7 5	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	10⅜—11½	4 8 11	..
5	3/6	Do. 7 per Cent. Pref.	10½—10⅝	3 5 1	Mar, Sept
5	4/0	Calcutta Electric Supply Ord.	7¼—7⅜	4 10 5	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105 —108	3 14 1	..
5	4/0	Charing Cross & Strand Electric Sup...	7⅛— 8	5 0 0	Feb, Aug
5	2/3	Do. 4½ per Cent. Pref.	5⅛—5⅜	4 1 10	Feb, Aug
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅜—5	4 10 0	..
5	2/3	Do. Do. (1903)	4⅜—5	..	..
St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 0	..
5	3/6	Chelsea Electric Supply Ord.	6½—6⅞	4 1 6	March ..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.) ...	108 —109	4 2 6	Jn, Dec ..
10	5/0	City of London Electric Lighting Ord.	10⅜—11¼	4 8 10	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	120 —125	4 0 0	Jn, Dec ..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 5 9	..
10	4/0	County of London Elec. Supply Ord...	7½—8⅛	4 14 3	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	105 —108	4 3 6	..
St.	4½%	Do. Second Deb. Stock Prov. Certs..	100 —103	4 8 0	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 —93	5 7 6	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅛—6	4 11 8	..
St.	4½%	† Do. 4½ 1st Deb. Stock (red.)	99 —106	4 4 10	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..
5	5/0	Hove Electric Lighting Ord.	7½—8⅜	5 0 0	..
St.	4½%	I of W. Elec Lt. & Power 4½% Db St (red.)	101 —103	4 7 6	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	1/32—1/16	..	..
5	5/0	†Kensingtn & Knghtsbdge Ord	12 —13	4 12 4	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..
3	..	London Electric Supply Ord.	1⅛—1⅜	..	..
5	3/0	Do. 6 per Cent. Pref.	5 —5⅛	5 9 1	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	94 —97	4 2 11	Mr, Jn, S, D
10	£6	Metropolitan Electric Sup. Ord. ex bonus	15½—16½	5 12 1	April, Oct
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5⅜	4 1 10	Jan. July
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	108 —112	4 0 4	Jn, Dec ..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 —99	3 10 6	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	93 —16	4 13 9	..
10	6.0	Notting Hill Electric Ord.	13½—14⅛	4 2 9	March ....
100	4%	Do. 4 per Cent. 1st Mt. Debs.	100 —103	3 18 3	..
5	4 0	Oxford Electric Ord.	5⅛ - 6	5 8 4	March ..
St.	4%	Do. 4% Deb. Stock	97 —100	4 0 0	..
1	..	Rand Electric	1 —1⅛	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 —103	4 7 9	April, Oct
5	5 0	†St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug
5	3/6	† Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.) ...	97 —100	3 10 2	..
5	4/0	Smithfield Markets Electric Sup. Ord...	2⅜—3⅛	6 3 1	..
St.	4%	† Do. 4 per Cent. Deb. Stock	83 —88	4 10 11	..
5	3/0	South London Electric Supply Ord.....	3⅜—4⅛	3 10 7	..
5	2/6	Urban Electric Supply Ord.	4⅛ 5	5 0 0	..
5	2/6	Do. 5% Cum. Pref.	4⅜—5⅛	4 15 3	..
5	6,6	†Westminster Electric Supply Ord.	12 - 13	5 3 10	Mar, Sept
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..
		TELEGRAPHS.			
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.	97 —101	3 19 2	Jan, July
10	..	Amazon Telegraph	2⅛—3⅛	..	Jn, Dec .
100	..	Do. 5 per Cent. Deb.	..	..	..
St.	12/6	†Anglo-American	85 —88	5 16 8	?, My, Ag, ?
St.	25/0	† Do. Preferred	90 —92	5 19 7	?, My, Ag, N
St.	2/0	Do. Deferred	6⅛—7	1 8 7	?, My Ag, N
100	$2	Commercial Cable Capital Stock	170 —190	4 4 2	Jn, Ap, Jy, (
St.	4%	Do. 4 per Cent. Deb. Stock	94 —96	4 3 6	Jn Ap, Jy, (
10	5/0	Cuba Submarine Ord.	7 —8	7 10 0	Feb, Aug
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug
5	2/0	Direct Spanish Ord.	2⅛—3⅛	5 14 4	April, Oct
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct
50	4½%	Do. 4½ per Cent. Deb.	98⅜—101⅞	4 9 2	Jan, July
20	3/0	†Direct United States Cable	10 —10⅛	5 14 3	Ja, Ap, Jy, (
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 —101	4 9 2	Jn, Dec .
St.	65/0	Eastern Ordinary .... xd & bonus	124 —129	5 8 6	Ja, Ap, Jy, (
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 —89	3 18 6	Ja Ap, Jy, (
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 6	May, Nov
10	2/6	Eastern Extension	11⅜—12¼	5 14 3	Ja, Ap, Jy, (
St.	4%	† Do. 4 per Cent. Deb. Stock	103 —106	3 15 6	Feb, Aug
100	4%	†Eastern & S. African 4% Mrt. Deb, 1900	97 —100	4 0 0	Feb, Aug
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99½—102½	3 18 9	May, Nov
10	5 0	Gt. Nrthn. (of Copenhagen) excoupon 61	2⅛—26⅛	5 13 2	Jan, July
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 —101	4 9 2	June, Dec
25	37/6	Indo-European	42 —45	5 11 2	May, Nov
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec
10	6/0	West African Telegraph Shares	6 —7	5 14 3	..
2½	..	West Coast of America	1/16—⅛	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July
10	..	West India and Panama	..	..	May, Nov
10	6/0	Do. 6 per Cent 1st Pref.	6½—6⅝	8 17 9	May, Nov
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov
00	5%	* Do. 5 per Cent. Debs.	99 —102	4 18 1	Jan, July
10	3/0	Western Telegraph	12¼—12⅝	5 10 3	Mr, Jn, O, D
00	5%	* Do. 5% Debs. (2nd Series, 1900)	101 —104	4 16 3	June, Dec
St.	4%	Do. 4% Deb. Stock (red.)	99 —102	3 18 5	..
		TELEPHONES.			
5	4 0	†Chili Telephone (fully paid, ...	4⅜—5½	6 13 4	August ..
1	7⅛	Monte Video Teleph ne Ord.	1/16—⅛	..	..
St.	6%	†national Co. Pref. Stock	103 —105	5 14 3	..
St.	5%	† Do. Def. Stock	85 —89	5 12 1	..
10	6/0	† Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 8	Feb, Aug
10	6/0	† Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug
5	2/6	† Do. 5 per Cent. Non-Cum. 3rd Pref...	5 —5⅛	4 15 3	Feb, Aug
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.) ..	97 —99	3 10 8	June, Dec
St.	4%	Do. 4 per Cent. Deb. Stock (red.).....	103 —105	3 16 2	..
..	5/9	Do. Do. Prov. Certs, 35% to be pd.	64 —66	..	..
1	0/8⅓	Oriental	1/16—1⅛	6 6 3	April, Oct
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	6 4 6	..
5	5 0	United River Plate	6 —6⅛	6 3 3	July.....
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅜—5	4 15 3	June, Dec
St.	5%	* Do. 5 per Cent. Deb. Stock (red.).....	103 —106	4 14 4	June, Dec
		FINANCIAL, INVESTMENT &c.			
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4⅞—5⅛	5 14 4	..
10	2/0	†Globe Telegraph and Trust	8⅜—9⅛	5 19 0	Ja Ap, Jy, O
10	3/0	† Do. 6 per Cent. Pref.	13½—13⅝	4 7 2	Ja Ap, Jy, O
8	4/0	Hunter's	6½—7⅛	5 6 8	April, Oct

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NOTES.

IN another part of this issue will be found an important report which has been issued by the Engineering Standards Committee. This report deals with pressures and frequencies and generators and motors, and is intended as a guide for "all future work." This saving clause is essential, for the electricity supply industry is so far advanced that, although certain "standards" have been adopted automatically, there is such a multitude of these, and so many pieces of apparatus now in use depend upon them, that a complete reversion to one single set of standards would be impossible. Thus the recommended standard voltage of 110, 220, &c., at consumers' terminals will have no far-reaching effect except for two and three-phase networks, of which there may still be many to lay down; the continuous-current and single-phase networks are now so developed that a change would be extremely troublesome in the case of those supply systems in which 200, 230, 240 and 250 volts have been selected as "declared pressures." For three-phase networks, it is apparent that the Committee assumes a decided preference for a four-wire system of distribution by its choice of 380 volts as the "recognised" pressure between the principal conductors. We predict a continued sale of 220-volt three-phase motors notwithstanding; for the four-wire system for lighting on three-phase networks is not always the most suitable when the motor load does not predominate, in spite of a slight gain in the expenditure on copper due to the higher pressures between the phases.

AS to the question of standardising frequency, we agree with the Committee that the matter is a difficult one. Fifty periods per second is still regarded as a cause of trouble with rotary converters, and rotary converter systems in which nothing but continuous current is supplied to consumers on the low-tension network are now becoming the vogue. For these 25~ is certainly preferable to 50~, and the increase in the cost of the converting plant on account of the lower frequency still leaves it cheaper than motor-generators. A conference on this question was held by the Committee in London a few months ago, and valuable opinions on both sides were expressed, but, unfortunately, we have been requested not to publish a report of it.

PERHAPS the most valuable part of the present report is that relating to the rating and speeds of generators and motors, and we look forward with interest to the further publication of the results of the experiments made on temperature rise in these machines.

ALTHOUGH 500 volts is the figure named in the report for tramway work, there is no mention of any attempt to standardise railway pressures, and this omission is praiseworthy. Lighting practice constitutes a different case, and the Engineering Standards Committee is to be commended for its efforts in this direction. There are yet several directions in which the Committee might turn its attention with considerable benefit to the electrical industry, and the thoroughness of the present report is a promising sign.

IN presenting the last of our series of articles on the North-Eastern Railway and Carville Power House, it may not be out of place to call attention to the extraordinarily rapid strides which the Newcastle-upon-Tyne Electric Supply Co. has made since its development into a power company, pure and simple. That this growth has been largely due to commercial enterprise goes without saying, but it is also due, in no small degree, to the sound engineering principles by which the undertaking has been governed. The ease and simplicity of three-phase working appealed to large users of power, and when the latter

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learned that it would be economical to scrap much or all of their existing plant, and purchase electric power direct, the success of the Company's venture was assured. It is hardly necessary to add that the contract for the supply of power to the North-Eastern Railway was a decidedly valuable acquisition, and it is extremely gratifying to learn that the results obtained on the "electrified" lines bid fair to fulfil all expectations.

VISCOUNT RIDLEY, presiding at the half-yearly general meeting of the Railway, held on Friday last week, announced that no fewer than 53,402 train-miles were run in the half-year up to June 30th at a cost of £4,911, this working out at under 1·8s. per train-mile, which is an extremely good figure. But he also mentioned that the bookings during the week ended July 9, 1904, had increased by 25 per cent. and the money taken by 22 per cent. over the corresponding figures for the week ended July 9th of the previous year. Now, although it is too early to make accurate comparisons, it can only be inferred from these figures that the Company has successfully solved the tramway competition problem. Instead of going up, the cost per train-mile must of necessity go down when conditions become more settled and when the service has been extended. Indeed, the above figures can only refer to a comparatively small section of the "electrified" lines, as several miles have been opened quite recently. It is, therefore, with all the more interest that we await the result of the first complete year's working, which, it may be anticipated, will be entirely satisfactory.

IN this issue we publish the last of the series of Papers read at the recent meeting of the Incorporated Municipal Electrical Association. Mr. BLAKEWAY, as we have already pointed out, expressed decidedly heterodox views with regard to the relative charges that should be made for electric lightiug and traction and the proportion they should bear to the average cost of generating electrical energy for all purposes. He is horrified by the fact that the charges to electric power consumers and to tramway committees are sometimes even less than the average cost of generation. To one unfamiliar with the effect of load-factor upon the cost of production, his reasoning may appear plausible, but those who have studied the matter more thoroughly will be able to detect at once wherein the fallacy lies.

IT costs less per unit to supply that part of the load which has a high load-factor than the part with a small load-factor; the latter part of the load must, therefore, be charged for above the average total cost of production, and for the load which is better distributed over the 24 hours a lower price must be charged. If, in fact, there is a very large difference in the two load-factors, the fair charge for the power load may even be considerably less than the actual works cost per unit calculated on the entire load on the station. The case may be still more clearly understood by assuming that a works had first been built for supplying power consumers and tramways only, and that the cost of generation was such that current could be sold, say, at 1d. per unit with profit. If now it were decided to supply private lighting from the same works, although the output from the station would be increased, the accession of this load with a poorer load-factor would cause a considerable rise in the average generating costs per unit, and with a large lighting load of the usual short duration each day, the result would be that the cost of generating a unit at the works might rise to more than 1d., without taking into account the cost of distribution and management and the capital charges. Surely it would not be fair in that case to increase the price charged for traction and power purposes.

MR. R. S. DOWNE'S Paper on "Boiler House Economies" and the discussion which followed it—both of which were published in our last issue—were of a thoroughly practical nature, and touched upon various points which, although not new, have up to the present hardly been given sufficient attention by central station engineers. We should, therefore, be glad to receive correspondence on the subject from other central station engineers, who were unable to take part in the discussion at Sheffield. Mr. DOWNE favours separately-fired superheaters for high temperatures, and while such a course would certainly conduce to a reliable and easily-governed service so far as the mere superheating of steam is concerned, it may reasonably be doubted whether the extra initial outlay and the additional cost of upkeep and operation would not offset any advantages gained over fixing the superheaters within the boilers. Artificial draught was also favourably mentioned by the author, and most of the speakers in the discussion expressed agreement in this respect. One of the advantages of forced draught is the possibility of reducing considerably the amount of cold air which leaks into the grate and flue, the detrimental effect of which was emphasised by the author and several speakers in the discussion. But the main advantage is the facility afforded to feed hot air instead of cold air into the furnace, by means of the system referred to by Mr. FEDDEN, and described in detail in our recent account of the new electricity works at Sheffield. The question not discussed, however, was whether the increase in economy justifies the extra capital outlay, especially where coal is cheap. It is peculiar that the home of induced draught should be in the centre of the coal district.

THE fact that steam-driven feed pumps are not economical is, of course, well known, and it is, therefore, of interest to compare the power required for steam-driven feed pumps on the one hand and electrically-driven pumps on the other. For the former, Mr. DOWNE mentions 2½ to 3½ per cent. of the total steam generated, while Mr. TAITE announced in the discussion that the electrically-driven pumps in his station consumed between 0·8 and 1·5 per cent. of the units generated. In making this comparison no account has been taken of the size of the two respective stations nor of the fact that a certain percentage of the units generated cannot be exactly compared with a similar percentage of steam leaving the boiler. However, the difference in the two figures is so large that notwithstanding certain inaccuracies in their determination the advantage of electrically-operated feed pumps can hardly be disputed. It is good to have figures from actual working results in this connection, for ordinary efficiency tests are not

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sufficient owing to the losses in speed regulation. Here again, the large difference in first cost between electrical and steam-driven pumps must not be forgotten, electrically-driven pumps being still far the more expensive.

AN inverted Vignoles rail has been employed in the reconstruction of the third-rail on the old Brooklyn Bridge, New York, as will be gathered from an article elsewhere in this issue. The reasons for the reconstruction of the electrical part of the track are peculiar to that line, and in this special case, no doubt, the adoption of a broad third-rail, such as was actually obtained by inverting a standard Vignoles rail, was the most economical way out of the difficulty. It by no means follows, however, that the inverted rail construction is to be desired on ordinary electric railways, and a closer investigation points to the fact that in ordinary circumstances the inverted-rail equipment is not more efficient than the usual third-rail design. At first sight, the increased contact surface offered by the inverted-rail appears to imply advantages as far as current collection is concerned, but a similar increase of contact area could equally well be obtained with the usual collector rail construction by either increasing the length of the collector shoe or the number of shoes. The method employed by the Rapid Transit Co. of New York for supporting and insulating the inverted third-rail although admirable in many respects is not so simple as the ordinary construction, and where the third-rail has to be guarded by wooden planks, both on the sides and on the top, this protection would be even more objectionable than it is now and would cost proportionately more.

MR. SJÖSTEDT'S experiments, which are given in abstract elsewhese, illustrate the danger of proceeding with ample means and imperfect knowledge. Mr. SJÖSTEDT tried to produce a "fonte" of nickel and iron by running down a pyrites containing nickel and copper, without fully roasting, into a crude ferro-nickel. Of course, no result of use could be expected, but the attempt was bold and worth making. It was not known how far it might be possible to substitute a high temperature capable of fusing an extremely basic slag eager for sulphur for the more ordinary method of eliminating sulphur in the process of roasting. It was reasonable enough to think that by the use of the electrical furnace a temperature might be attained so high that the calcareous slag formed could be fused, and that then it might be trusted to take care of the sulphur. But things which are reasonable are often not according to knowledge, and the endeavour was predoomed. Much more profitable would it be to roast the ore completely, electrically for choice, and run it down to a "fonte" in an electric furnace; by such an operation it would be possible to remove those last fractions of a per cent. of sulphur which would be fatal to nickel steel, and the product would take rank with commercial grades of ferro-nickel more elaborately prepared.

British Association.—We would remind our readers that the British Association meeting at Cambridge commences on Wednesday next at 8:30 p.m., when the Right Hon. A. J. Balfour, D.C.L., M.P., F.R.S., will deliver his presidential address. The sectional officers were given in our issue for June 3rd and some of the Papers down for reading in our issue for July 29th. The meeting closes on Wednesday, August 24th.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Beissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Cayenne--Paramaribo	July 13, 1904

Electrically-operated Turnstiles.—According to the *Western Electrician*, electric coin-controlled turnstiles have been installed at the St. Louis Exhibition, resulting in much saving of time when crowds are entering the grounds. 75 machines have been put in operation, and are said to work admirably. Money changers occupy the booths hitherto used at the entrance for ticket sellers, but the exhibition officials say that the turnstiles will save much in the way of salaries.

International Engineering Conference at St. Louis.—We have received from the secretary of the St. Louis International Engineering Conference a general programme of arrangements. The Conference will sit from October 3rd to 8th inclusive, and the following Papers have been promised for reading before the electrical section:—"The Substitution of Electricity for Steam as a Motive Power," by Mr. James G. White and Mr. Alexander Siemens. "Electrical Power—Generating Stations and Transmission," by Mr. L. B. Stillwell. The chairman of the section will be Mr. Frank J. Sprague.

The American Institute of Electrical Engineers.—According to the *Electrical World* of New York, the report of the Committee on Local Organisations recently presented to, and printed by, the American Institute of Electrical Engineers, shows that there are 29 branches of the Institute in as many different cities. The average total attendance at these branches is stated to be over 1,300, while the attendance at the New York meetings of the central organisation is not over 200. Consequently, through its branches, the Institute increases its attendance at meetings, for the consideration and discussion of Papers, more than sixfold. Expressed in another way, the total attendance at Institute meetings is increased by the branches from 6 per cent. of the total membership to nearly 50 per cent. In the 18 months following October, 1902, the number of original Papers contributed to the branch meetings was 80, or, on the average, nearly three per branch.

Niederschöneweide-Spindlersfeld Single-phase Railway.—Some technical information and illustrations with regard to this single-phase railway appeared in *The Electrician*, Vol. LI., p 1,039, and it now appears, according to *Elektrische Bahnen*, that a regular service of trial runs has been kept up ever since August 15th of last year, the mileage covered per diem having been gradually increased from 93 to 310 miles. Until July 4th, at which date the electric service was opened to the public, the total mileage run by the experimental train aggregated about 18,600 miles. It is stated that the average speed, excluding stoppages, comes to 25 miles per hour, and that the mean of the energy consumed per ton-mile equals 48·3 watt-hours. Our contemporary affirms that the Prussian State railways have now leased the electric system for one year, and are working it themselves. Only one train is running at present.

Thunderstorms.—From all parts of the country, and especially from the North, there are reports of severe thunderstorms occurring at the end of last week. Unfortunately, these outbursts resulted in many lives being lost and much damage being done to property. A soldier, while seeking cover under a tree at Kenilworth, was killed, and at Northwich a farmer and his sister were struck and seriously injured. A woman at Coventry was killed during one of the most severe storms which has visited that town for several years. From Middlewich it is reported that the telegraph and telephone lines were damaged in many instances, resulting in the interruption of the service between several adjacent towns. As the result of being struck, the top portion of a pinnacle of the tower of Bath Abbey became detached, and further damage was also done to some of the stonework. At Liverpool the lightning set fire to an electric car, which had to be put out of service in consequence. The fire was extinguished with sand, and the two passengers on the car at the time escaped unhurt.

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Electrical Sterilisation of Milk.—M. E. Guarini has sent us some particulars of a process for the electric sterilisation of milk. The ordinary process by heating appears to change the composition of the milk so as to detract from its nutritive qualities, but it is claimed that the new process does not involve this drawback. At first, a continuous current of 5 amperes was sent through a quart of milk, the applied voltage being 170. Milk at a certain distance from the electrodes was found to be perfectly sterilised, but it also became coagulated in the vicinity of the electrodes. Upon employing special electrodes, the coagulation was almost imperceptible. More perfect results were, however, obtained with alternating currents. With an alternating current of 110 volts and carbon electrodes, it was possible, it is said, to sterilise the milk without any coagulation effects, when the current density was properly adjusted and the frequency sufficiently high. It was found inadvisable to add any foreign substance to the milk for the purpose of increasing its conductivity. Beyond the fact that the electrodes may be of platinised carbon, no further technical data regarding the process are given by M. Guarini.

Wireless Telegraph Notes.—The *Electrical World* of New York states that the Marconi wireless telegraph station at Siasconset, Mass., has been discontinued. It is believed that the Government will instal wireless telegraph equipment of its own at both this and the South Shoals Lightship stations.

According to the *Electrical Review* of New York, wireless telegraphy is to be inaugurated between Rangoon, in Burma, and the Andaman Islands, a distance of between 300 and 400 miles. Stations are already in course of construction at Diamond Island, Elephant Point, Amherst and Port Blair. Amherst is located about 150 miles from Rangoon across the Gulf of Martaban. The distance between Port Blair and Rangoon is 450 miles.

A Central News telegram from New York states that Gen. Greeley has just received the first message transmitted by wireless telegraphy from Cape Nome. The message was sent from Cape Nome to St. Michael, from there to Dawson City, and thence to Seattle, making a total distance of 3,500 miles.

It is announced by the *Manchester Guardian* that the Government have decided to establish a naval wireless telegraph station on the coast at Marsden, some 3 miles from South Shields. The station will be erected on the edge of the cliffs, which commands a view north and south for miles along the coast.

International Research in Terrestrial Magnetism.—In a pamphlet recently issued, Mr. L. A. Bauer outlines the scope of the "Department of International Research in Terrestrial Magnetism," which was created by the trustees of the Carnegie Institution in December, 1903. Mr. Bauer is director of this department, and arrangements have been made so that the magnetic survey and observatories of the United States, under the Coast and Geodetic Survey, remain under his direction. The general aim of the work is "to investigate such problems of world wide interest as relate to the magnetic and electric condition of the earth and its atmosphere, not specifically the subject of inquiry of any one country, but of international concern and benefit." The prime purpose is not to supplant any existing organisation, but rather to supplement the work now being done, and to enter only upon such investigations as lie beyond the power and scope of the countries and persons actively interested in terrestrial magnetism and atmospheric electricity. At first, stress will be laid upon the complete reduction, discussion and correlation of the existing observational data and upon early publication of the results in suitable form, in order to exhibit the present state of our knowledge. In this way will be revealed the gaps to be filled, and the direction of future and supplementary investigations will be suggested. While, however, this will constitute at first the chief work of the department, it is likewise proposed to embrace favourable opportunity for supplementing, by observation, the existing data. It is the intention to conduct the work with the counsel of an advisory board composed of representative persons, irrespective of country. Among the investigations which this new department will undertake are magnetic surveys of ocean areas and unexplored regions, international observations of magnetic phenomena and observations in ocean depths and at atmospheric altitudes. Besides the work of organisation of the department on the lines set forth, the following office work has been authorised and has been begun :—(1) Compilation, discussion and preparation for publication of the data for the complete presentation of our existing knowledge of the secular variation of the earth's magnetism over the entire globe, and for the determination of the points at which it will be necessary to repeat observations at suitable intervals for the successful scientific investigation and determination of the causes and their modes of action, and for ascertaining the proper corrections to magnetic charts to refer them to a desired date. (2) Discussion and publication of the data on the magnetic perturbation observed during the eruption of Mont Pelée, Martinique, 1902. The data have already been obtained from observatories over the entire globe in response to a circular letter of Superintendent Tittmann, of the Coast and Geodetic Survey, and this material has been turned over by him to the Carnegie Institution for discussion and publication. (3) Compilation, discussion and publication of the existing data concerning the variations of the earth's magnetism, other than the secular variation already provided for in (1) and the perturbations of the earth's magnetism.

Sophia Tramways.—According to the *Street Railway Review* of Chicago, the electric tramways of Sophia are worked on the trolley system, and comprise at present some 14 miles of route. In order to effect economy in coal, which is a costly material in that part of Europe, electrical energy, not only for the traction system, but also for lighting the town, is generated in two stations, one driven by water power and the other by steam. The steam-operated station is situated in Sophia, and is equipped in such a manner that it serves ordinarily as a sub-station for converting the high-tension current transmitted from the hydraulic station, some 15 miles distant, but it can also supplement the water-power installation is case of need. While the Oerlikon Company were contractors for the high-tension station, the low-tension plant in Sophia was supplied by La Société Electricité et Hydraulique. Of the 3,000 H.P. which are available from the River Isker, only 2,000 H.P. are made use of by the high-tension station. Four generating sets, each consisting of a turbine directly connected to an electric generator, are installed in the turbine room, and space has been reserved for two additional sets. Each turbine is designed for about 213 gallons of water per second, a head of water of from 170ft. to 180ft. and a speed of 400 revs. per min. The turbine shaft is horizontal, and is coupled to that of the dynamo by a flexible and insulated coupling. At the turbine speed indicated the dynamos are stated to be capable of generating 1,125 kilovolt-amperes at 8,000 volts and 53~ per second. Two sets of overhead wires transmit the high-tension three-phase current to Sophia. One set conveys the lighting current, the other set transmitting energy required for traction purposes. For lighting the suburbs, the pressure is reduced in transformers from 7,200 volts to 156 volts, but for lighting the centre of the town it is first stepped down to 3,400 volts and subsequently lowered again in several transformer sub-stations situated in various parts of the town. The other set of overhead wires is led to the station in the Boulevard Marie-Louise. As already mentioned, this station is equipped with steam plant besides having all necessary equipment for converting the alternating current to continuous current at 550 volts. In the boiler house there are two B. & W. boilers, which supply steam at about 150lb. per square inch to two vertical "Sclessin" steam engines, each developing 400 H.P. at a speed of 265 revs. per min. The converting plant proper consists of two 400 H.P. 7,000-volt synchronous motors, which drive, through an elastic coupling of the Zodel-Voit type, two continuous-current dynamos at a speed of 265 revs. per min. These dynamos are designed for an output of 270kw. at a terminal pressure of 550 volts, and working in parallel with them is a 600-ampere-hour battery. The shaft of each motor-generator is in line with that of an engine, the three machines thus forming one complete set. When necessary, the engine shaft can be coupled or uncoupled to that of the motor-generator, and if the engine is driving the set then the synchronous motor either runs idle or supplies three-phase current to the lighting system of the town.

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POWER SUPPLY TO TRAMWAYS IN NORTH LONDON.

In the article on the newly-opened electric tramways in the north of London which appeared in *The Electrician* of July 29th, p. 591, a brief description of the Brimsdown power station was given. This station, which is the property of the North Metropolitan Electrical Power Supply Co., is the first in this country to supply current at 11,000 volts for tramway purposes, and, since it is a good example of sound and up-to-date engineering, we propose to give a full technical description of its equipment.

As pointed out in our former article, the station is situated on the fringe of the tramway system of the Metropolitan Electric Tramways (Ltd.). Means of transportation are afforded by a waterway which comes right up to one of the boiler house entrances, as indicated in the general plan of the station (Fig. 1). This waterway is known as the Lea Navigation, and the dock constructed at the power house is capable of holding two coal barges simultaneously. The dock was constructed by Mr. Thos. Pedrette to the engineer's plans. As an alternative means of transport, there is the Great Eastern Railway, the Cambridge main line of which passes close by the station. No siding from this railway to the power station has been constructed so far.

The general contract for erecting the station was secured by the Brush Electrical Engineering Co., who sub-let all the building work and plant to other firms. The power station buildings consist of the power house proper and a small separate building for the water tanks and pumps, as shown in Fig. 1. They are built of brickwork and steel, and were designed by Mr. C. W. Gray, from plans prepared by Mr. A. H. Pott, chief engineer to the Metropolitan Electric Tramways (Ltd.) In order to facilitate future extensions, certain walls, as is clearly indicated in the general plan, of both the engine and boiler house are constructed of corrugated galvanised iron. The sheets are of 20 S.W.G., and the laps in the vertical joints comprise at least one corrugation, while for horizontal joints the sheets overlap not less than 6in. in sloping work and 4in. in vertical work. For securing the sheets to the angle purlins and framing, galvanised wrought-iron hook bolts $\frac{3}{8}$in. in diameter are used. The iron and steel work used in the buildings was supplied by Messrs. Dorman, Long & Co. No attempt has been made to introduce elaborate architectural embellishments into the design of the buildings, which, however, have been constructed in such a manner as to meet efficiently and economically all practical requirements. The chimney consists of a steel shaft resting on a brick base. It is 125ft. high and is lined with firebrick throughout; it was supplied and erected by Messrs. Piggott & Co. A wrought-iron ladder leads up to the top.

In the basement of the small pump house are the electrically-driven pumps which feed the tanks on the top of this building with water from the well. Floats and water level indicators are provided and may easily be observed by the attendants on the ground floor. The indicators are so connected to the

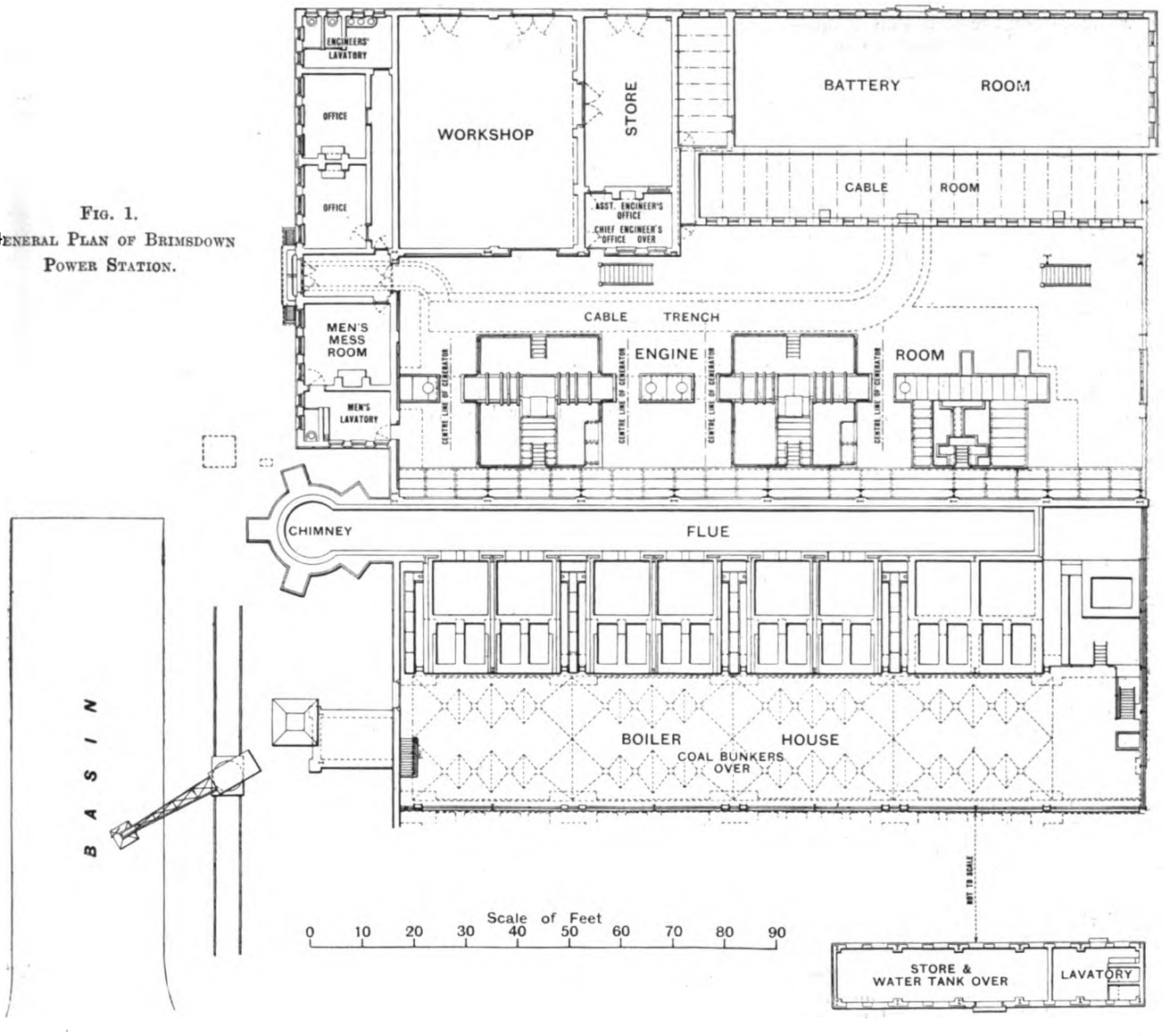

FIG. 1.
GENERAL PLAN OF BRIMSDOWN POWER STATION.

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switch gear of the motors that the pumps automatically stop and start at predetermined levels of water in the tanks. An alarm bell is also rung when the water is either above the maximum level or below the minimum. There are two sets of well pumps, each being capable of delivering 2,000 gallons of water per hour with a vertical suction of 20ft. and a vertical delivery of 15ft. The three-throw pumps are of Messrs. Hayward and Tyler's make, with 6in. stroke and a cast-iron air vessel. Each pump is supplied with a spring relief valve, by-pass and galvanised iron-wire guards for protecting the gearing. The pumps are driven by 1 H.P. 110 volt totally enclosed B.T.-H. shunt motors, running at 1,130 revs. per min. Double gearing is employed for transmitting the power from the motors to the pumps. The first reduction is obtained by a raw hide pinion on the motor shaft driving a cast-iron wheel with machine-cut teeth on the intermediate shaft, and the second reduction is effected by cast-iron spur gearing with machine-cut teeth. These motors run for one hour with an overload of 25 per cent. and withstand a momentary overload of 40 per cent.

Coal (costing about 12s. a ton) is transported from the barges, moored alongside the quay wall at one end of the boiler house, by means of a grab of about 15 cwt. capacity into the hopper of an "Ingrey" automatic weighing and registering machine. The grab is handled by an electric locomotive jib crane made by Thos. Smith, and equipped with two Siemens crane motors. From the weighing machine the coal is automatically delivered into the conveyor through a chute and continuous automatic filler. The coal is carried upwards at the left-hand side of the boiler house and then passes horizontally above the bunkers, into which it is dropped at any desired point. At the opposite side of the boiler house the bucket conveyor descends and returns horizontally along the ash vault underneath the boiler house floor, where the ashes are collected by the passing buckets. The latter then pass over the ash hopper when they are automatically tipped.

The ash tower is constructed entirely of steel and is covered with corrugated sheet iron. It is fitted with a hinged chute for discharging ashes into carts or waggons when desired. After leaving the ash tower the buckets pass on to the filler pit to be re-charged, and the cycle of operations begins afresh. Any tendency to run in a backward direction is rendered impossible by suitable balancing devices. Messrs. Babcock and Wilcox supplied the conveyor, which is of the endless chain pattern and is fitted with buckets of the gravity type. It is capable of dealing with 40 tons of coal per hour when running at a speed of about 45ft. per minute. Each bucket is stamped out of one steel plate and has a capacity of approximately 2 cubic ft. Any slack of the conveyor chain is taken up by slides on the lower run of the conveyor. Driving is effected through suitable spur gearing by one 6 H.P. totally enclosed shunt wound B.T.-H. motor, running at 590 revs. per min., with 110 volts across the terminals. After a run of 10 hours the temperature rise in the armature does not exceed 70°F., and the motor is able to withstand a momentary overload of 50 per cent without injurious effects. The bunkers measure 120ft. by 24ft. by 10ft., and on leaving them, the coal is again weighed and recorded, this time by "Ingrey" travelling and indicating weighing machines, two of which run along a track fixed underneath the bunkers and close to the top of the boilers. They may be brought under any of the bunker openings. After the coal has been weighed and its weight recorded it falls into the boiler hoppers.

At present six B. & W. boilers are installed, and these are arranged in three batteries, but there is still room for a fourth battery. With very little extra expense on buildings another eight boilers can be added, as all the necessary bunkers are now erected. Each boiler is composed of 18 sections, each of which again consists of 11 wrought-iron lap-welded tubes, 4in. in diameter and 18ft. long, connected at the ends by continuous wrought-iron headers. Altogether, the heating surface of each boiler aggregates 4,400 sq. ft. Both the steam and the water drums are 48in. in diameter and 23ft. 7in. long. A mud-drum of special cast steel is provided. It has a diameter of 10in. and a length of 130in. The boilers are suspended from wrought-iron girders resting on wrought-iron columns with cast-iron bases. In this manner the boilers are free to expand and contract without affecting the brickwork, and the latter may be removed and replaced without disturbing the boilers. The latter are erected with Mr. W. H. Miller's patent setting, as used at the Wood-lane power house and elsewhere. Of the auxiliaries provided, mention may be made of the Turnbull low-water alarm, the safety valve which is set to blow at 162lb. per square inch, and the steam gauge, having a 12½in. dial and reading to 300lb. pressure. After erection, the boilers were tested to a hydraulic pressure of 240lb. per square inch. As regards the capacity of the boilers, it is stated that they will evaporate 10lb. of water at a temperature of 212°F. to steam at a pressure of 160lb. per square inch for every pound of bituminous coal (14,000 B.Th.U.) consumed in the boiler furnace when fired by the automatic chain-grate stoker, the feed varying between 6ft. and 27ft. per hour. The above figures relate to normal conditions and natural draught. Each boiler is capable of evaporating normally 15,000lb. of water per hour. Babcock and Wilcox chain-grate stokers are fitted.

At the rear end of the boiler the ashes and clinker fall into the clinker pit, which is fitted with an ashpit door, worked by gearing from the front of the stoker. Each stoker is provided with a hopper, the cheek plates of which can be folded down to allow of access to the front of the boiler. A shutter is provided in the hopper for cutting off the supply of coal to the grate, thus allowing the fire doors and grate to be got at without having previously to empty the hopper. The stokers are driven by means of an eccentric from a 3in. shaft extending across the front of the boilers and running at 45 revs. per min. For driving this shaft there are two 15 H.P. totally enclosed B.T.-H. motors, running at 750 revs. per min. when fed with continuous current of 110 volts. Only one motor is required to work the stoker gear, the other being a spare. The motors are connected to the continuous-current supply of the station through a double-pole switch, and are protected from overloads by fuses on both sides of the circuit and by an overload release with which the enclosed type of starting rheostat is fitted. A no-voltage release is also provided.

Each boiler is fitted with a superheater of Messrs. Babcock and Wilcox's make, having a heating surface of 508 sq. ft. and capable of superheating the steam from the boilers by 150°F. The superheater is composed of 72 solid-drawn steel tubes 1½in. in diameter and bent in U shape. An arrangement of piping and cocks is provided for flooding the superheater, and a thermometer in a mercury cup has been fitted. Three compound direct-acting feed pumps of Hall's vertical type have been supplied. The high-pressure steam cylinder and the pump cyclinder are 7½in. in diameter. while the low-pressure steam cylinder is 12in. in diameter, the stroke being 15in. Normally, the pumps make 12 strokes per minute. They are lagged with asbestos non-conducting composition and covered with planished sheet iron. Each pump was specified to be capable of delivering 4,000 gallons of water per hour against a boiler pressure of 165lb. per square inch, and of drawing water at 150°F. from a depth of from 10ft. to 12ft. The pumps are suitable for working condensing or non-condensing, but at present they exhaust into the atmosphere. No economisers are used. Steam is conveyed from the boilers to the turbines in a most direct manner, the steam piping consisting of 7in. and 10in. pipes. The main steam piping is single, but arrangements have been made for interconnecting the steam mains. All main pipes are supported on cast-iron rollers with mild steel spindles. Joints are made with corrugated brass rings. This not only applies to the main steam piping, but in a large measure also to other pipe work. The lagging is of fossil meal, finished off with canvas treated with two coats of paint after completion. Removable covers are provided for the flanges. The pipe system is fitted for drainage purposes with separators and steam traps of Messrs. Geipel and Lange's make. There are three Kennedy water meters, one 6in. hot-water meter in the boiler-feed suction pipe, one 4in. hot-water meter in the turbo-cooling water-return circuit and one 4in. cold-water meter, placed in the delivery from the well motor pumps.

(To be continued.)

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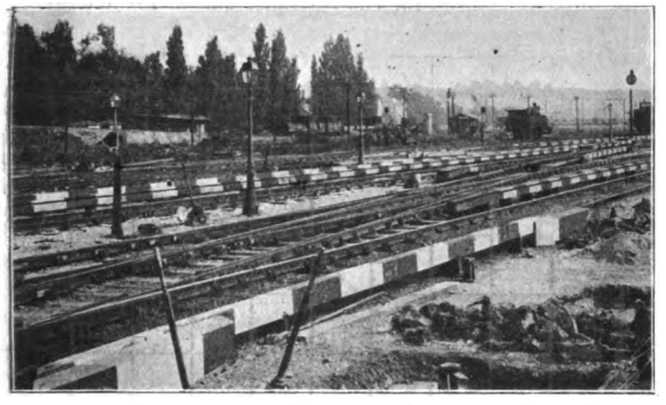
THE NEW LOCOMOTIVES AND MOTOR CARS FOR THE PARIS-ORLEANS RAILWAY CO.

BY M. VINGOE.

It will be remembered that the Paris-Orleans Railway Co., the first French steam trunk railway to make any important electric transformation of its lines, opened in May, 1900, an extension of its existing lines in Paris, creating a new terminus at the Quai d'Orsay and operating the whole of the incoming and outgoing trains electrically, by means of a special equipment, consisting of a generating station containing two 1,000kw. generating sets, two 500kw. sub-stations and two 1,100 amp.-hour buffer batteries. The locomotives used were of the Baltimore-Ohio type, having a central cab with sloping ends, each being equipped with four GE-65 motors (225 H.P. each) and mounted on heavy trucks built by the American Locomotive Co. The whole of the installation was carried out by the French Thomson-Houston Co. and the greater part of the machinery, especially the locomotives, is of American make, mostly from the General Electric Co. of Schenectady. Owing to the satisfactory working of the installation, an important extension was decided upon some time ago, and further additions have been made both to generating and sub-station equipment, but principally to the rolling stock.

There have now been put into service, in addition to the original eight locomotives, a further lot of three, of the same powerful build, mounted on trucks of identical pattern to those



PART OF TRACK, SHOWING METHOD OF PROTECTING THIRD RAIL.

on the old locomotives. The new locomotives are not quite of the same construction, being of the baggage-car type, with a cabin at each end, and the compartment for luggage in the middle. The end cabin contains a type L-7 controller and the usual circuit breaker and measuring instruments. As the original locomotives were supplied in 1900, it is not surprising that a few improvements have been introduced into their equipment. Thus, the motor leads and the shoe leads have been passed through brass flexible tubing and connection boxes are provided for the motor leads. The motor armature coils are mica insulated. The end cabins are lined with "Uralite" and the framework of the locomotive is of fire proofed wood. The body is of sheet steel; the gear ratio is 2·23 to 1.

There are, in addition to these locomotives, some five motor cars, all equipped with the Sprague-General Electric type M control, with type C-22 controllers. These motor cars have a cabin at each end, and the intermediate space is taken up with a baggage compartment and a space for third-class passengers, for which 34 seats are provided. The whole of the train control apparatus is mounted in these cabins, the rheostat equipment being, of course, properly insulated from the contactor groups. This is a departure from standard American practice. Similarly to the locomotives, the motor leads and the shoe leads are passed through flexible tubing, and motor-connection boxes are made use of. GE-66 motors with one-turn armatures are used, the gear ratio being 3·08 to 1. All the cable used in both locomotives and motor cars are covered with asbestos braid. The paint is used on the asbestos to avoid abrasion from chafing, &c. These cars are mounted on wheel base is 6ft. 6in. with 40in. wheels. They weigh 6,250lb. and are calculated to carry 26,000lb., of which 15,000lb. is the weight of the empty car body. The following are the dimensions of the locomotives and motor cars just put into service:—

	Locomotive.	*Motor car.*
Length	33ft. 4in.	56ft. 8in.
Width	9ft. 4in.	9ft. 2in.
Height	12ft. 8in.	12ft. 6in.
Weight	55 tons	30 tons
Distance between centres of trucks	18ft. 6in.	40ft. 8in.
Wheel base	7ft. 10in.	6ft. 6in.
Wheel diameter	49in.	40in.

The service which the old and new locomotives and motor cars will have to perform is as follows:—To haul from Juvisy (a suburb on the south-east of Paris), a distance of 15 miles from Quai d'Orsay terminus, to Paris and vice versa, a total of over 200 trains daily, at speeds varying from 30 to 45 miles per hour. As a rule, all trains, except those proceeding south without a stop at the terminus of the electric line, will change engines at Juvisy and proceed to Paris or to Juvisy from Paris, as the case may be, in charge of electric locomotives. Times for express trains will be about 25 minutes or less, including one or two stops. The all-stations or local service will proceed more leisurely, occupying in all about 35 to 40 minutes. For this service the motor cars will be used exclusively. There are two trains, comprising some seven or eight trailers fitted for use with the motor cars, one of which will be at each end of the train. A half-hourly service to Juvisy is maintained, together with supplementary trains at rush hours.

The Orleans Railway Co. have been experimenting with train-control cars since 1900, when a number of these cars were exhibited at the Paris Exhibition. The whole of the apparatus, especially the rolling stock, is of American pattern, the trucks being partly repeat orders and partly a new order (Baldwin trucks). The motors and train-control apparatus come from Schenectady. In connection with this plant, it is of interest to note that the Pennsylvania Company are taking the Quai d'Orsay terminus as a model for their new station in New York. Another rather striking fact is that one of the standard steam locomotives of the Orleans Railway Co. has been purchased by the Pennsylvania Railroad Co. for trials on their line, and is being exhibited at St. Louis.

THE NORTH-EASTERN RAILWAY AND CARVILLE POWER HOUSE.

(*Concluded from page 631.*)

[*Errata.*—In our description last week of the low-tension cables used in connection with the "electrification" of the North-Eastern Railway we stated that all such cables were lead-covered. Messrs. Callenders, who supplied them, inform us, however, that they are of their vulcanised bitumen type, which require no metallic sheathing, the dielectric being non-hygroscopic and waterproof.]

Locomotives.—The first application of electric motor-power for goods service is being made on the Quayside branch. This line consists principally of a tunnel about ¾ mile long, but in order to dispense entirely with steam locomotives, which are at present used for the work, it has been decided to equip some 2½ miles of sidings at either end with overhead conductors. The current in the tunnel is supplied by a third-rail, in the same manner as on the passenger lines. The service is a very severe one, as the loaded waggons have to be hauled through the tunnel up a grade of about 1 in 27, on a very sharp curve. Two locomotives have been built for this work, each capable of handling six goods trains per hour, weighing 150 tons exclusive of the locomotive. The total specified time for the up journey is not to exceed 4½ minutes. Each locomotive is capable of starting a train of 150 tons on the maximum gradient under all conditions of weather, and of drawing it at a speed of 9 to 10 miles per hour. On the level, under all conditions of weather, it is to be capable of starting a train of 300 tons and drawing it at 14 miles per hour. The general appearance of the locomotives is not unlike those first used on the Central London Railway, con-

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sisting, as they do, of a centre cab with long sloping ends, mounted on two four-wheel bogies. They are, however, very much higher and heavier and differ in many other important points. They are being supplied by the British Thomson-Houston Co., the trucks, underframes and cabs being built by the Brush Company. Each locomotive is fitted with four G.E. 55 motors geared to 36in. driving wheels, at a ratio of 3·29 to 1. The system of train control is similar to that on the passenger stock, but without the automatic acceleration feature. Two controllers are provided, one at each end of the centre cab, and all switch gear is arranged on slate panels in convenient positions. The contactors, resistances and reversers are fastened to the floor inside the sloping ends, the sides being fitted with doors so as to make all this apparatus readily accessible. The usual electrical couplings are attached to the headstocks, by means of which both locomotives can be operated together from one master controller if desired. The underframes are strongly built and are ballasted with heavy cast-iron blocks for the purpose of giving the necessary adhesion to the driving wheels. The sole bars are of girder section 12in. by 6in., with 15in. by 4in by ½in. channels at the ends. These end bars carry an 8in. by 16in. oak headstock, on which is mounted the railway company's standard screw coupling and side buffers. The cabs are built up of ⅛in. mild steel plate, suitably stiffened by an angle-iron framing. They are fitted with sliding sashes on the ends and sides, which allow a clear view of the track in either direction. With the exception of some of the smaller fittings, all the woodwork has been treated to render it non-inflammable. In order to sustain the very heavy strains which they will be called upon to bear the trucks are very strongly designed, the frames being built up of 1in. section steel plates 1ft. 6in. deep and stiffened top and bottom by steel angles. The transom and end bars also consist of heavy section steel plate, the whole being securely riveted together. Helical springs are provided under the bolster and elliptical ones over the axle box, following the same general design as in the case of the passenger motor trucks. In order to collect the current from the overhead wires a sliding bow is fitted on the top of one of the sloping ends. This collector is of the type usually met with on Continental railways, the most noticeable difference being that it is provided with a mechanical lowering attachment which can be operated from the inside of the cab. The lowering mechanism takes the form of a hand-wheel and spindle with a worm at one end which gears with a loose wheel on the horizontal spindle of the collector. This wheel engages when required with a fixed arm on the spindle. The contact surface consists of a V-shaped aluminium trough filled with grease. Switches are provided by means of which current can be obtained from the bow collectors, the third-rail shoes or both.

Each locomotive in working order is over 50 tons in weight and is equipped with Westinghouse quick-acting brake gear. The driver's valves are located close to the controllers at the right-hand side of each end of the cab.

Luggage Vans.—In order to relieve the passenger service as much as possible of ordinary passengers' luggage and to handle the fish and other perishable goods traffic, two motor vans are being built and suitably equipped. These to all appearance closely resemble the passenger motor cars, and are the same as far as the outside dimensions are concerned. For the carriage of perishable goods a special compartment has been fitted at one end. This has the full section of the coach for the length of about 8ft., and is lined with zinc and suitably drained in order to prevent brine coming in contact with the motors and other electrical apparatus. The equipment of these vans is sufficiently powerful to haul three or four of the ordinary stock fish waggons, and for this purpose they are fitted with side buffers and centre hooks suitable for coupling with the ordinary steam stock in addition to the centre coupling used on all the electrical stock. They are provided with four motors, one on the axle of each bogie, and a double set of control gear. The wiring arrangement of controllers, contactors, &c., follows the same general lines as that of the passenger motor coaches. These vans are designed to travel when hauling several trailers at the same rate of speed as passenger trains, and will, therefore, be able to work in between them without causing any delay to the accelerated passenger traffic. The entire electrical equipment of the permanent way and rolling stock has been carried out by the British Thomson-Houston Co.

General Power Supply of the Newcastle Electric Supply Co.—Newcastle, which may be considered the hub of the engineering and shipbuilding industries in this country, presents, as it were, a natural field for electrical developments, particularly with regard to the driving of workshops and shipyards. The first large works were connected to the company's mains in 1901, and the curve shown in Fig. 28 clearly indicates the rapid progress which has been made in this direction. The energy required for driving this 6,500 H.P. of motors is derived from 12 sub-stations, some of which also supply the North-Eastern Railway and the three-wire distribution network of the Supply Company. A "bulk" supply is also given to the Northern Counties Electricity Supply Co., the Tynemouth Corporation, the County of Durham Electrical Power Distribution Co., and energy for running the Tyneside Company's tramways system is also obtained from the same source. Certain of the sub-stations are equipped with plant for the supply of energy for the electric lighting and driving of the Railway Company's workshops and goods yards. Altogether, the capacity of the entire transforming plant on the system is, approximately, 31,000kw., without allowing for the 1,000kw. battery at the Pandon Dene sub-station and certain plant utilised for the re-transformation of energy.

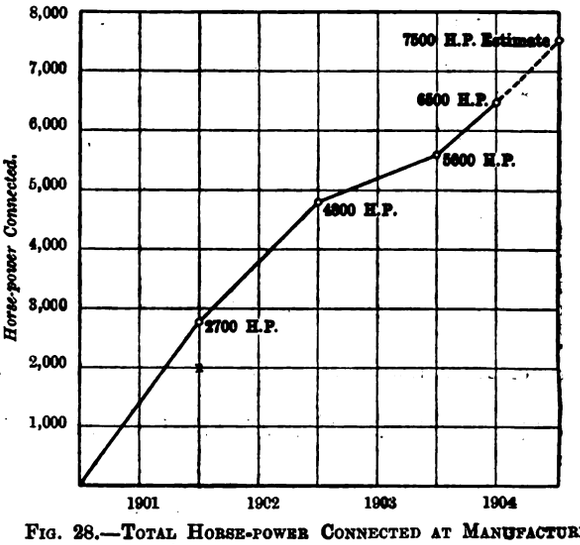

FIG. 28.—TOTAL HORSE-POWER CONNECTED AT MANUFACTURERS' INSTALLATIONS.

One of the largest installations is that of Messrs. Hawthorn Leslie's St. Peter's Works, where there are no fewer than 35 motors of the three-phase induction type, from 2 H.P. to 75 H.P., and aggregating 814 H.P. A special sub-station has been put down for these works, containing four 110kw. three-phase transformers. Two extra high-tension 0·1 sq. in. three-core cables are brought into a fireproof building through dividing boxes to high-tension oil switches. The switchboard consists of two marble transformer panels, behind which are the spark-gaps, &c. Of course, all high-tension gear in these sub-stations is under the sole control of the Supply Company, and none of the works employés are allowed admission under any pretext whatever. The high-tension gear is, in each case, separated from the low-tension gear by means of a brick wall and a locked door. Each transformer has its own low-tension panel, which carries an oil switch. The principal feature of interest in these works are the cranes, all of which, with the exception of two recently installed, have been converted from square shafting drives. No fewer than 16 cranes are driven electrically, 14 being driven by single motors of the short-circuited rotor type; the other two are provided with three motors each, of the variable speed type with slip rings used in conjunction with a controller. The remaining portion of the installation consists of motors driving all classes of engineering tools and line shafting. Shop lighting is all done by 5-ampere enclosed arc

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lamps, connected two in series across 240 leads; there are 160 of these. On the average, about 100kw., continuous current, is used for lighting, and as the works are running for about 113 hours a week when not working through the week-end, it may be imagined that the consumption and load-factor are both very large. As a matter of fact, the cost per unit for lighting works out at about 0·9d. and for power 0·88d. Other large consumers are the North-Eastern Marine Engineering Co., who have 1,400 H.P. of motors; Messrs. Armstrong, Whitworth & Co., Messrs. Swan, Hunter and Wigham Richardson, &c.

Apart from the mere generation and supply of electrical energy, the Newcastle-upon-Tyne Supply Company do quite a considerable amount of work in connection with the supply of motors and all kinds of apparatus for electric lighting and

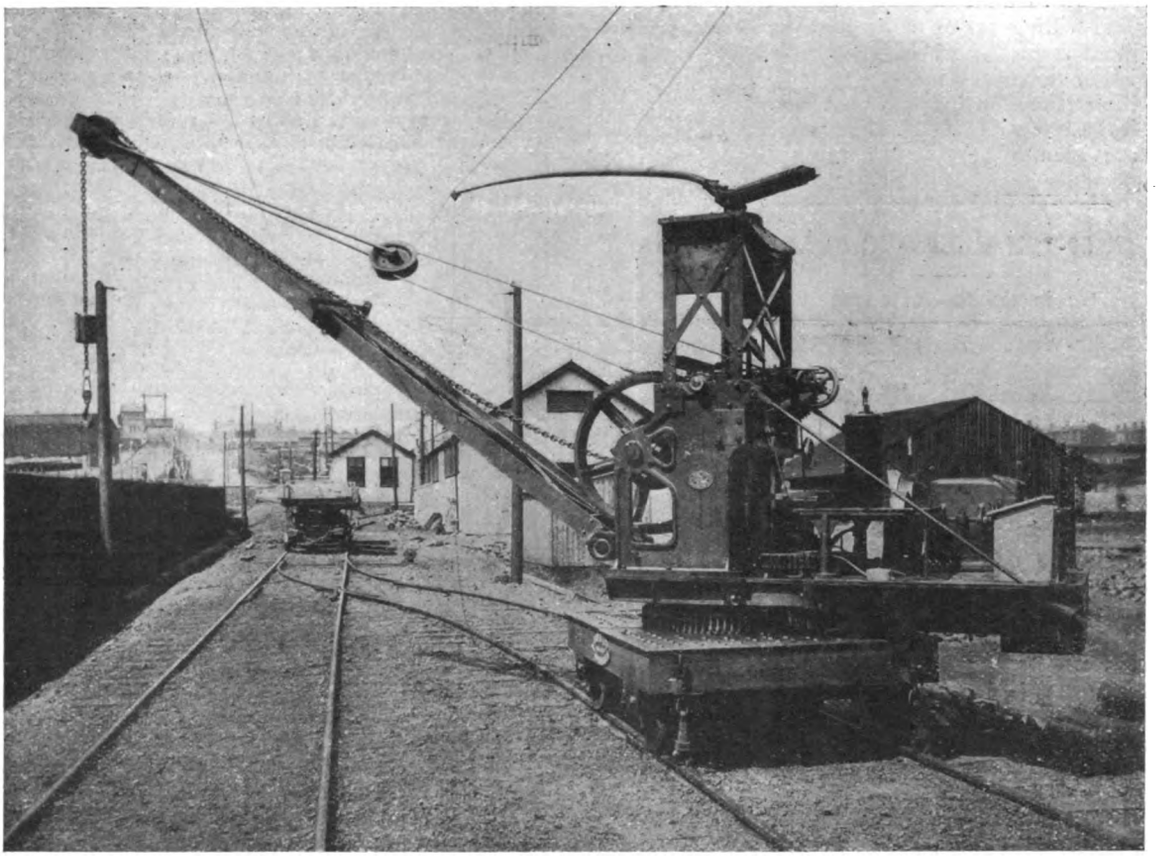

FIG. 29.—ELECTRICALLY OPERATED JIB CRANE.

power work. Naturally, this involves more or less repair work, and for carrying this out effectually the company have erected construction workshops adjoining the Carville station buildings. These shops have been extremely useful during the erection of the station, and consist of a smith's shop, a fitting shop and a carpenter's shop. They are driven throughout with three-phase induction motors, which derive their supply of energy from a small sub-station supplied from the works by means of an overhead line. Corrugated iron has been used in the construction of the shops. The electrically-operated jib crane, shown in the illustration, was supplied by the British Thomson-Houston Co. This crane, which is of the ordinary loco. type, has all the usual motions, and is equipped with a separate brake for each motion. It is built to lift 2½ tons, which load it raises at 80ft. per minute. The supply current is taken from the trolley wires at a potential of 500 volts, the return being by the rails. The crane is driven by a B.T.-H. 800 motor with a 6-turn armature, which is rated at 18 H.P.—that is to say, it will give 18 H.P. continuously for one hour, with a maximum rise in the temperature of the windings of 75°C., the temperature of the surrounding air not exceeding 25°C. The magnet frame of the motor consists of two castings of soft steel of high permeability, hinged on one side and bolted on the other, forming a dust-proof and a water-proof casing for the armature. The motor has two salient and two consequent poles, and the pole-pieces are cast as part of the frame, the field coils being secured in place around them by means of removable flanges. Asbestos-covered wire is used for the field coils, and it is covered with varnished cloth and tape, after being immersed in japan, and baked. This construction results in a coil which is impervious to moisture, efficiently protected from mechanical injury, and capable of withstanding such excessive temperatures as may result from overloading. It is, therefore, well fitted to render long service under the most exacting conditions imposed in crane work. An armature of the slotted or iron-clad type is employed, and the commutator segments are of best selected hard-drawn Lake copper, the gears being of malleable cast iron, and the pinions of soft steel. The controller is of the British Thomson-Houston Co.'s R 28 type, and consists of a contact cylinder mounted in a compact iron frame. It possesses all the essential

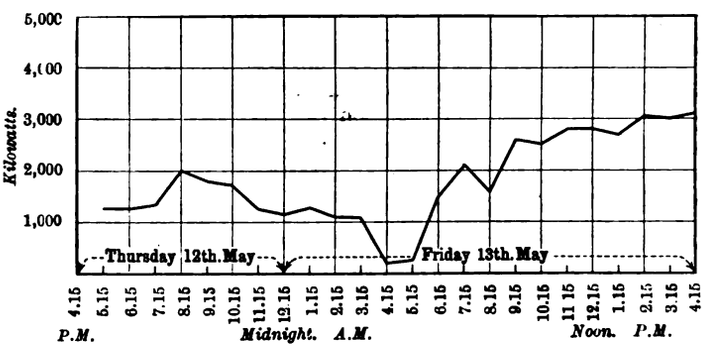

FIG. 30.—TYPICAL LOAD CURVE OF NEPTUNE BANK STATION.

features required for this kind of work. A single handle only is provided for both forward and reverse motions, as in this kind of machinery the two motions are generally equally and alternately used. With this controller, five speeds in

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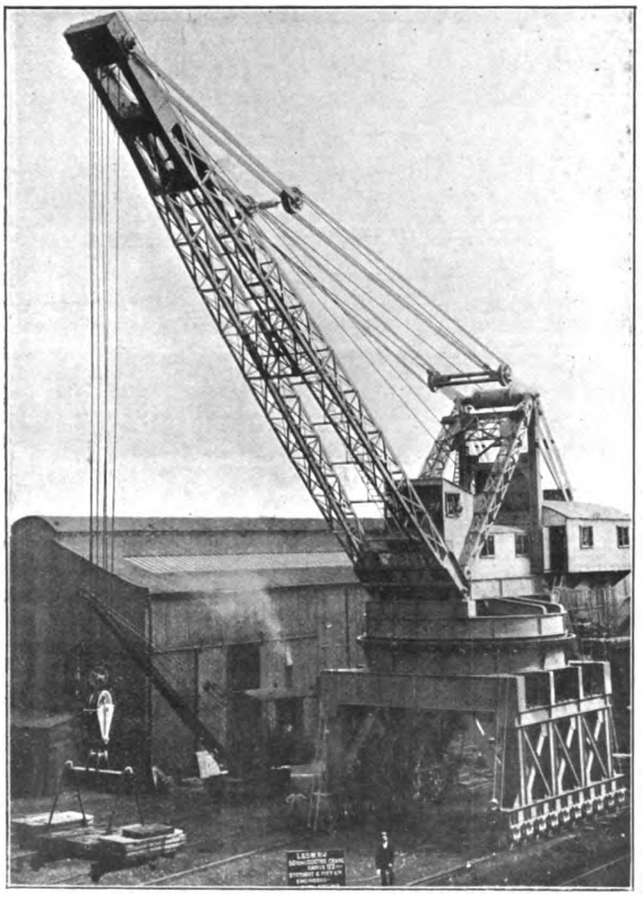
either direction can be obtained. The crane has tram wheels fitted with steel tyres to suit a 4ft. 8½in. gauge.

Fig. 30 is a typical load curve of the Neptune Bank station of the Newcastle Electric Supply Company. It shows how the diverse nature of the load tends to flatten out the peak and bring the load-factor up. At present the load on the Carville station is not very large, but it is anticipated that as time goes on it will increase to such an extent as to show even better results than those obtained at Neptune Bank.

Conclusion.—In bringing this series of articles to a close, we have to express our thanks to all those who have, by their courtesy and aid, enabled many of the particulars to be gained. Especially are we indebted to Mr. Charles Merz and his assistants, who have lent us drawings and photographs and supplied data which it would have been impossible to obtain otherwise. The whole undertaking reflects great credit upon the foresight and willingness to make new departures on the part of the directors of the North Eastern Railway, and its principal officials, more especially to the enterprise of Sir George Gibb, the general manager, Mr. Worsdell, the chief mechanical engineer, and Mr. Harrison, the engineer of the Northern division.

A 50-TON ELECTRIC CRANE.

The crane shown in the accompanying illustration has been designed and constructed by Messrs. Stothert & Pitt for use at the London and South-Western Railway Co.'s new graving dock at



50-ton Electric Travelling Crane built by Messrs. Stothert and Pitt.

Southampton, and has been built under the superintendence of Mr. Drummond, the locomotive engineer. It is electrically driven throughout, each motion being operated by separate motors. The electrical equipment has been supplied by the Allgemeine Elektricitäts-Gesellschaft of Berlin, and Mr. J. G. W. Aldridge inspected the electrical machinery on behalf of the railway company. At 87ft. radius the crane is designed to deal with 50-ton loads, and at this radius the jib lies at an angle of 22deg. from the horizontal. In addition to this it has also been tested at the full radius with a load of 70 tons. The derricking gear, which is powerful enough to raise the jib with the maximum load suspended, is capable of reducing the radius to a minimum of 47ft. when the jib stands at an angle of 15deg. from the vertical.

The following are the principal dimensions of the crane:—Gauge, 25ft. 6in. between rail centres; clearance under truck cross girders, 15ft.; diameter of roller path, 25ft. 6in. centres; wheel base, 30ft.; length of jib, 85ft.; height of jibhead from ground level at maximum radius, 60ft.; height of jibhead from ground level at minimum radius, 103ft.; height from rail level to circular rack, 28ft.; height from rails to top of king post, 56ft.; radius from centre pin to centre of tail ballast, 32ft.

There are 20 central flanged steel-tyred wheels for supporting the crane on a twin rail track. Each axle bearing is fitted with four volute steel springs on either side of the running wheels, making a total of 160 springs in all. The driving gear at the ground wheels is of Messrs. Stothert & Pitt's special construction to compensate for the play in the springs. Messrs. Stothert & Pitt have adopted a similar mode of construction to that employed on their "Titan" cranes, in connection with the under truck, which is strongly braced in all directions. The jib is a double open lattice braced boom. Each boom is composed of four main angles, and is cross-braced at the ends and middle. The derricking ropes are 12-part, 5½in. circumference, reeved double, two parts leading from the derrick barrel, which is grooved right and left hand; the lifting ropes are six-part, 4½in. circumference, reeved double, two parts leading from the lifting barrel, which is also grooved right and left. All these ropes have a factor of safety of 8 when dealing with the maximum load. Partitions divide the crane house into three sections; the back part contains the lifting and derricking crabs with their motors; the centre, the slewing and travelling gear with motors, controllers and resistances; while the front portion of the house consists of an elevated cabin, in which are all the operating levers. The position of the cabin enables the driver to obtain an extensive outlook in all directions, especially as the cabin is glazed on four sides.

Current is taken from ground connection boxes by a length of flexible cable connected to the junction box fitted on the inside of the crane truck, whence it is carried by cables through the centre pin, the top of which is fitted with a collector of the usual type. Distribution is effected from a switchboard in the driver's cabin by separate circuits to each motor and controller. The motors are as follows:—Lifting motion, two motors each of 50 B.H.P. with series-parallel controller; derricking motion, one 80 B.H.P. series motor; slewing motion, one 25 B.H.P. series motor; travelling motion, one 50 B.H.P. series motor. All the motors are completely enclosed and designed to run on a 480-volt continuous-current circuit. Machine-cut spur gear is used throughout for all first and second reductions, with the exception of the first reduction of the derrick motion, for which a worm and wheel is utilised. Both the lifting and the derricking gear are fitted with solenoid magnetic brakes in series with their respective motors, and connected to the first contacts of their respective controllers. In addition to these magnetic brakes, a mechanical foot brake is provided for lowering the load and a brake for checking the slewing motion. The derricking gear is provided with special frictional plates, which come into contact when the radius is being extended, thereby preventing or obviating any tendency of the jib to run out. These frictional plates are fitted on the end of the worm spindle, and are operated by ratchet and pawl, being automatically thrown out of action when the jib is being raised. The whole of the first reduction derrick gear is enclosed and runs in oil.

The net weight of the crane is about 250 tons, to which should be added 70 tons of ballast in concrete blocks; the total weight of the crane in running order, including the full load, thus being about 375 tons.

ELECTROTECHNICAL SYSTEMS OF UNITS.

BY PROF. DAVID ROBERTSON.

At a recent meeting of the Electrotechnischer Verein an interesting Paper on "Electrical Systems of Units" was read by Herr Fritz Emde.* He gives a summary of the various systems that have from time to time been proposed, but refrains from specially advocating any one of them himself. After stating the fundamental defining equations for the chief electrical and magnetic quantities, and explaining the proposals of Heaviside and Fessenden, he goes on to show that the various units in any system, with given units of length, mass and time, depend upon the values chosen for the following constants:—

ϵ_0, the dielectric constant for vacuum; μ_0, the magnetic permeability of vacuum; $\varkappa_e$, the number of lines of force given to a unit charge; $\varkappa_m$, the number of lines of force given to a unit pole; β_e, the number of units of energy of a unit charge at unit potential; β_m, the number of units of energy of a unit pole at

* *Electrotechnische Zeitschrift*, May 26, 1904, p. 432.

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unit magnetic potential; V, the number of current turns in unit magnetomotive force.

ϵ and μ are defined from the equations for a plate condenser thus: Electrostatic capacity $= \epsilon \frac{\text{one surface}}{\text{distance apart}}$. Magnetostatic capacity (permeance) $= \mu \frac{\text{one surface}}{\text{distance apart}}$, and they thus include the 4π which usually appears in these formulæ. It should be noted, however, that these constants are not really all independent, for they must satisfy the relation: $V/\sqrt{\epsilon_0\mu_0} = \omega_0 =$ velocity of light in vacuo $= 300 \times 10^6$ metres per second.

Herr Emde gives a table of the values of these constants in the different systems, which is here reproduced with the addition of other four which he also mentions in the text. He points out that Heaviside did not make use of a particular system of units, but proposed a method of dealing with the 4π which is equivalent to taking $x = V = 1$. In fact, Heaviside really applies his method to two systems, an electrostatic one and a magnetostatic one, both of which I have added to the table. No. 9, which seems to have been originally proposed by Giorgi (*l'Elettricista*, January, February, and November, 1902), is essentially the same as that now advocated by the present writer (*The Electrician* of April 22, 1904, p. 24, and May 27, 1904, p. 240). Like him, Herr Emde has overlooked Prof. Perry's 1891 letter, and also the proposals of Prof. Baily, to which the latter has drawn attention in *The Electrician*, June 3, 1904, p. 276.

Since ω_0 is a velocity, ϵ_0, μ_0 and V are treated in the Paper as if their dimensions differ in different systems, due really to the suppression of one of the fundamentals in the dimensional equations. I would point out that this would simply mean that any one of these letters, or of the terms "Dielectric constant," "Magnetic permeability," "Magnetomotive force," &c., is employed for quantities which are essentially different in the different systems. In other words, not only are the units different, but so also is the actual nature of the quantities dealt with in the various systems. It will, therefore, be better for the purposes of this table to regard these constants as having fixed dimensions, and to look upon ω_0 as representing the numerical part of the velocity of light when expressed in terms of the chosen units of length and time.

Systems of Electrical Units.

System.	β	$x_e\epsilon_0$.	$x_m\mu_0$.	$V\sqrt{x_e x_m}$	x	Usual name.
1. Electrostatic	$\frac{1}{2}$	1	ω_0^2	ω_0^2	4π	Clausius' electrostatic
2. Symmetrical-static	$\frac{1}{2}$	1	1	ω_0	4π	Gauss' ditto
3. Electrostatic-electromagnetic.	$\frac{1}{2}$	1	$1/\omega_0^2$	1	4π	Maxwell's ditto
4. Magnetostatic do.	$\frac{1}{2}$	$1/\omega_0^2$	1	1	4π	Electrom'gnetic
5. Symmetrical do.	$\frac{1}{2}$	$1/\omega_0$	$1/\omega_0$	1	4π	
6.	$\frac{1}{2}$	1	$1/\omega_0^2$	1	1	Heaviside electrostatic
7.	$\frac{1}{2}$	$1/\omega_0^2$	1	1	1	Heaviside magnetostatic
8.	$\frac{1}{2}$	..	4π	1	1	Fessenden
9.	$\frac{1}{2}$	$10^7/4\pi\omega_0^2$	$4\pi \times 10^{-7}$	1	1	Giorgi

β and x are mere numbers. The former is, indeed, an integration constant which is always $= \frac{1}{2}$ in the standard case where ϵ and μ are constants for a given medium. In my opinion, V and x can have no other value than 1 in a *thorough* system. To give them other values (as we do at present) is, in reality, to adopt two units for one quantity. We might as well introduce numerical factors into all our equations, by taking the unit of surface different from that of a square of unit side, unit velocity different from that of a unit distance in unit time, and so on. But the essential idea of a *system* of units, as distinct from a mere *collection*, is that all such factors should be 1 for the simplest possible case.

Herr Emde gives an exceedingly neat graphical method of showing the effect on the derived units of a change in the fundamental ones. It may be explained thus:—Let [A] and [B] be two fundamental units and [C] one derived from them, so that $[C] = [KA^aB^b]$ where [K] depends on the other fundamentals which are not supposed to alter. Then

$$\text{Log } [B] = \frac{1}{b}(\log [C] - \log [K]) - \frac{a}{b} \log [A].$$

Hence, if we plot log [A] as abscissa and log [B] as ordinate, [A] and [B] being expressed in terms of some fixed units, so as to include only the real part of the log), we shall have for each given magnitude of the unit quantity [C] a straight line whose slope is $-a/b$. Units of other kinds which depend in a different way on the same fundamentals will be represented by lines having different slopes. The lines for all units belonging to one system intersect in one point if the units in terms of which they are expressed for the purposes of the diagram belong to a consistent system. It is convenient to number the scales, after the manner of a slide rule, so as to show the units represented in terms of some well-known unit of each kind, instead of marking the actual scale to which the logs are plotted. One of these diagrams, showing the dependence of the mechanical units upon those of mass and length, is reproduced, but slightly modified in detail from that given by Herr Emde.

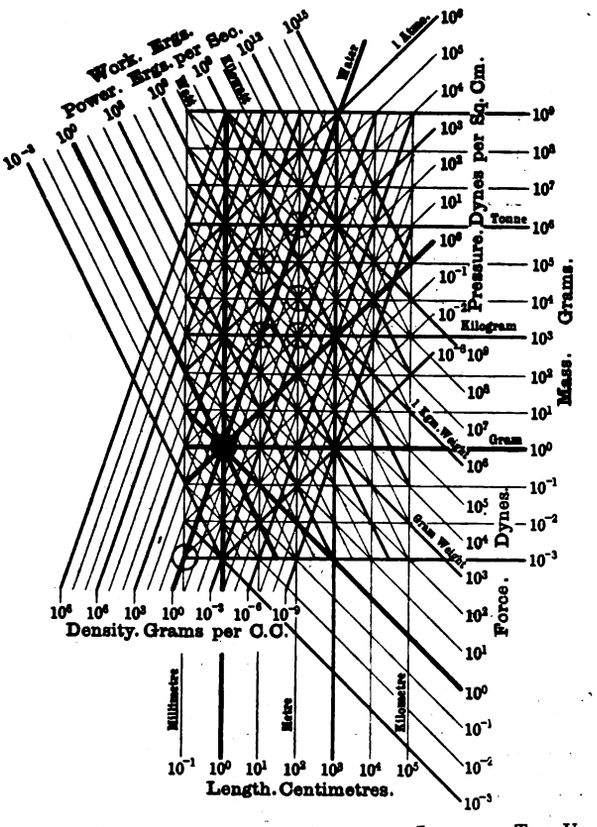
Fundamental and Derived Units.

Quantity.	Symbol.	Value of new unit. No.	Value of new unit. In terms of old unit.	Numbers proposed by Blondel.	Fleming.	Giorgi.
Mass.....	m_1	ϕ	Gramme	..	..	1,000
Length.....	l_1	χ	Metre	..	..	1
Time	t_1	ψ	Second	1	1	1
E.M.F.	E_1	$\theta^{\frac{1}{2}}\Lambda^{\frac{1}{2}}\psi^{-2}$	Volt	10	1	1
Current	i_1	$\theta^{\frac{1}{2}}\Lambda^{-\frac{1}{2}}\psi^{-1}$	Ampere	10	10	1
Quantity	e_1	$\theta^{\frac{1}{2}}\Lambda^{-\frac{1}{2}}$	Coulomb	10	10	1
Power	..	$\theta\psi^{-3}$	Watt	100	10	1
Energy.....	..	$\theta\psi^{-2}$	Joule	100	10	1
Moment of inertia	..	θ	Metre^{2}kilo.	..	..	1
Resistance	..	$\Lambda\psi^{-1}$	Ohm	1	0·1	1
Inductance	..	Λ	Henry	..	..	1
Capacity	..	$\Lambda^{-1}\psi^2$	Farad	..	..	1

The way in which he explains the algebraic relation between the derived and fundamental units is shown shortly in tabular form:

He writes θ for $\chi^2\phi \times 10^{-3}$ and puts $\theta = 10^{p(m+n)-7}$
and Λ for $4\pi\epsilon_0\omega_0^2 \times 10^{-7}$ with $\Lambda = 10^{p(m-n)-9}$.

As examples, he quotes Blondel (*Electrical World and Engineer*, Vol. XXXIV., pp. 158 and 453, 1899), whose system is given by



MECHANICAL UNITS DEPENDING ON MASS AND LENGTH. THE UNIT OF TIME IS 1 SECOND.

$\psi = 1$, $p = 3$, $m = 3$, $n = 0$; and Fleming (*The Electrician*, Vol. XLIV., pp. 324, 366 and 402), whose electrical units are given by putting $\psi = 1$, $pm = 8$, $n = 0$. I have inserted these as well as Giorgi's in the table.

If the ampere, volt, ohm, &c., are to be retained, then $\theta = \Lambda = \psi = 1$, and, if $\chi = 10^{7-u}$ then will $\phi = 10^{2u-11}$, and, numerically,

$$\epsilon_0 = \frac{10^7}{4\pi\chi\omega_0^2} = \frac{10^u}{4\pi\omega_0^2} \text{ and } \mu_0 = 4\pi V^2 \times 10^{-u}.$$

Herr Emde points out that the only practical integral values of u are 7 and 8, the former of which gives Giorgi's metre-kilogramme-second system. Smaller values of u give too large a unit of length, and larger values of u too large a unit of mass. The results of taking other values for u (not necessarily integral) will be seen from the diagram.

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An "Ideal System"—the system of the future, according to Herr Emde— is discussed in the Paper. It is based on the metre, tonne and second; adopts the Heaviside definitions; and takes the permeability of vacuum as an integral power of 10. He gives two examples, which he considers the most suitable for practical use—viz :—

$\mu_0=0{\cdot}01$ unit; $V=100$; $E_1=35{\cdot}5$ volts, $i_1=28{\cdot}2$ amperes; $M_1=2{,}820$ ampere-turns.

$\mu_0=0{\cdot}1$ unit; $V=1{,}000$; $E_1=112$ volts; $i_1=8{\cdot}92$ amperes; $M_1=8{,}920$ ampere-turns.

For my part, however, I fail to see where anything is gained by having a simple number for the numerical part of μ_0 which will anything like compensate for the inconvenience of substituting for our present practical electrical units others which are not decimally related to them. Moreover, I have already criticised the use of any other value than 1 for V. The system proposed by Giorgi (and also independently by myself) is rationalised in the Heaviside sense, but by taking a different unit of permeability to what Heaviside did it is made to fit in with our present electrical units, instead of requiring an entirely new set.

Herr Emde concludes his Paper by an appeal for the appointment of a German commission which shall fully discuss the matter and make proposals to be brought forward by the German delegates at St. Louis. He sets the following questions as the basis of the work of such a commission :—

1. In the equation $\phi=10^{6-n}\chi^3$ is the exponent $n=0$, or what other value should be adopted ?
2. Shall $4\pi\epsilon_0\omega_0^2$ or $\epsilon_0\omega_0^2$ be taken equal to an integral power of 10 (10^u) ? This is equivalent to asking whether the permeability of vacuum is to be taken as an integral power of 10 or not.
3. Is u to be chosen $=0$, or what other value shall be adopted ?
4. Shall $4\pi V$ or V be taken as an integral power of 10 (10^v), and at the same time shall $x=4\pi$, or $x=1$?
5. Shall $v=0$, or what other value is to be taken for it ?

THE FINANCIAL POSITION OF MUNICIPAL ELECTRICAL UNDERTAKINGS.*

BY COUNCILLOR H. J. BLAKEWAY.
(Chairman Electricity Committee, Borough of Southampton.)

The Paper is based on the results of working of 155 electricity undertakings, the total capital expended by which amounts to £21,983,000. The gross profit or earnings of these 155 undertakings—mostly for the year under review—amounts to £1,333,000, or an average on the capital employed of 6 per cent. It will be generally known that from this amount of gross profit provision has to be made for capital charges in the shape of interest and sinking fund, which, as a general rule, will amount to 5½ per cent. The rate of interest may, and probably does, vary, but there is no doubt that it is properly paid. The sinking fund from the figures given seems open to some doubt, as it averages only 2·62 per cent. Those of us who know the term of years for which capital for municipal electrical undertakings is borrowed, and the life of much of the plant and mains, know how desirable it is that the operation of the sinking fund should be a first principle. We now come to the net financial result of the year's trading, and to better appreciate the position the figures are given in detail for the different periods:—

Year of working.	No. of towns.	*Deficit.*	No. of towns.	*Surplus.*
First	16	£18,398	7	£8,218
Second	18	20,715	8	5,771
Third	11	8,754	10	12,759
Fourth	4	2,921	8	6,594
Fifth	2	2,080	2	2,011
Sixth	..	..	9	14,789
Seventh	6	8,659	3	2,000
Eighth	1	399	20	69,103
Ninth	2	2,195	12	45,642
Tenth.....	2	6,040	1	2,648
Eleventh	..	..	4	47,055
Twelfth	..	..	3	1,385
Thirteenth	..	..	3	14,744
Fourteenth	..	..	..	..
Fifteenth	..	..	..	..
Sixteenth	..	..	..	..
Seventeenth	..	..	..	..
Eighteenth	..	..	..	..
Nineteenth	..	..	1	33,415
Twentieth	1	1,080	1	2,814
	63	£71,241	92	£268,948

* Abstract of a Paper read before the Incorporated Municipal Electrical Association.

Thus we see that 63 towns have a deficit and 92 a surplus, and, to get a really correct idea of the net result of the working of municipal undertakings approximately to date the author deducts the deficit from the surplus. This will show a net profit on the year's working of £197,707, or 0·9 per cent. on the capital outlay. If it be urged that this is an unfair conclusion to draw, he is quite prepared to admit that in the first and second years it is rather unreasonable to expect a profit, although the returns show that even this difficulty can be overcome. But what can be said for the other losses up to the 10th and even the 20th year ? In connection with the surplus it must be remembered that coal—the principal item—was at a fairly low price; it is not pleasant to think what the results would have been had it reached the figures of two or three years ago. On a capital, therefore, of nearly £22,000,000, some of which is practically dead, we thus have a sum of under 1 per cent. which can be devoted to a depreciation or renewals fund. The author points out that he omits from his calculations a grant in aid of the local rates, as, in his opinion, before any of the surplus is used in this direction two conditions must be observed—viz., (1) current for lighting must be sold at the lowest possible rate, (2) the renewals fund must stand at a proportionately substantial figure, and it is easier to provide for both these conditions in the "years of plenty."

The main object of this Paper is to emphasise the fact that those running municipal undertakings are under an obligation to safeguard the interests of the larger body of ratepayers, whose credit is pledged to find the capital, but who cannot or do not all equally enjoy the benefits of the concern, although in the event of losses they would be called upon to provide the deficiency. It must be admitted that the main object of our undertakings is the supply of current for lighting purposes, and this at as low a rate as possible, for, undoubtedly, the lower the price the greater the demand and a correspondingly greater financial success. There has, however, grown up a natural desire for a day load—a load that will employ plant and mains during an otherwise unproductive period. Current for tramway and power purposes has been the outcome of this desire, and the author expresses his opinion here that, where the electrical works are municipal and tramways likewise, it is a matter for regret that separate works have been established and the lighting works deprived of the benefits of the combination, an arrangement certainly not in the interests of the general body of ratepayers. Dealing, first, with traction: Extra plant has usually to be installed, generally the stations have needed enlargement, and it must be apparent that, as the traction load does not go off, but probably increases as the lighting load comes on, duplicate plant is unavoidable, and it is manifestly unfair that the tramway committees should not bear a proper share of the charges on the extra capital expended. In the returns under notice, in too many instances, the rate charged is too low, and the combination really results in a loss. It must be remembered that equally with the tramways committees we must do the best we can for our undertakings, and this can only be done if every unit sent out from the station bears its proper share of the expenses of production. Stations with a traction load gladly avail themselves of the added units to reduce their costs, but they are not so keen on insisting that all such costs are covered.

Quoting from one's own town, for the year under notice the total costs were 1·6d., and on the face of it current for traction purposes could be supplied, without profit, at this figure to a Corporation department. The electric lighting department has, however, provided all feeder cables from station to section boxes, and had other considerable capital outlay for suitable plant, so that, allowing for capital charges on this work, it was bound to charge 2·25d. per unit, which provides a small margin. For the current year the price has dropped to 2·125d. This method of computation is a safe guiding rule, and the author suggests it is worthy of general adoption. To the ascertained or estimated total costs add such capital charges as can be fairly allocated, and to the resulting figure add a fair contribution for depreciation and renewals, but no profit.

Despite the probability of causing many to differ from him, the author is bound to state his opinion that, in the majority of returns, current for power purposes is being sold below cost, and without benefiting the station financially, or indeed doing anything beyond reducing, by the added units, the total costs. This is manifestly wrong and almost immoral, and, to prove that it cannot be done without loss, one need only point out that many stations are actually selling current to the public for power at a lower rate than is charged to the tramways. The author urges that a similar rule should be adopted as in the case of traction supply, only if in this instance it is not a Corporation supply there should be a margin of profit, and no current for any purpose whatever should be sold at less than the total cost of sending it out.

A word on public lighting may not be considered amiss in this connection. Referring again to the returns, we find a load that is as profitable and productive as any that can be had. But why do so many stations handicap themselves by actually charging a higher rate than for power, and thus prevent further public lighting being added to their supply ? This is another proof that the power rate is insufficient. The same rules should apply in this case and the same methods of computation.

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This question has been dealt with from the point of view of a ratepayer, who is also chairman of an undertaking which, like all others, must be run for the general benefit. Unless we are all careful and prudent, we shall find our capital expenditure grow beyond a remunerative point; we shall also in the more or less near future have to face, within the periods of our borrowing powers, heavy renewals, and the points raised in this Paper are crystallised in the following question: *Will our present and prospective revenues on their present basis meet the demand?*

The following is an abstract of the discussion that took place in connection with the above Paper;—

Dr. PANTON (Bolton) regretted that he could not agree with a good many of the conclusions arrived at in the Paper. The author had overlooked that the capital expenditure which he had given was to the end of the year, and a large portion of it was, therefore, only used for, say, half a year or even less. Then, again, the author had included first and second year undertakings, and it was well known that it was very unusual for a profit to be made during the first year, at any rate. Excluding the first and second year undertakings, there remained a total of 106 undertakings, 77 having a surplus of £254,959 and 29 with a deficit of £32,000, leaving a net surplus of £21,983. He had taken some trouble to find out how much of the capital referred to in the Paper had been brought into the undertakings during the year and had found that it amounted to 3½ millions and, deducting half of this to obtain the mean capital expended for the year, this reduced the total capital of the 155 undertakings to something over 20 millions, and the gross profit of £1,333,000 would be 6·6 per cent. on the average capital employed during the year. In like manner the figure of 2·62 per cent. given in the Paper for the sinking fund should read 2·82 per cent. If this 2·82 per cent. sinking fund were set aside year by year at 2½ per cent. interest it would produce the loan in 25 years. The surplus of under 1 per cent. given in the Paper as available for depreciation should read "over 1 per cent.," with the additions he had given. But against this they had to consider the fact that a great many municipalities were only seeking to make sufficient profit as was necessary to pay interest, sinking fund and depreciation. He did not agree that the main object of electrical undertakings was to supply electricity for lighting purposes. It was to supply electricity for any purpose whatever. In Bolton the motor was 40 per cent. of the whole, and there were no special mains necessary for it, nor any special plant. Consequently the price for power for motor purposes was lower than for tramway purposes. The cost at Bolton for generating current for tramway purposes was certainly higher than for private supply. In his opinion the cost of public lighting should not be more than for tramway current. He thought that when it was considered that Manchester was a few years ago rejoicing in a total cost of something like 1·45d., and that a small town like Rotherham now had a total cost of 0·66d., and was not going to stop there, the future outlook for municipal electric supply was rosy indeed.

Bailie WILLOCK (Glasgow) having complained as to the short amount of time allotted to Papers by councillors, expressed his surprise that a councillor should write such a Paper as this. In Glasgow light was not their chief aim. They took current from the Tramways committee at 1½d. per unit and re-sold it at the same figure for power purposes, and even gave a sliding scale down to ¾d. a unit, yet their average receipt was 3½d. per unit. He would almost go so far as to ask Mr. Blakeway to make a further study of the subject.

Ald. BRUCE (Sunderland) agreed with the object of the writer, although not with his deductions. The author's view appeared to be that, in fixing the price for any particular customer account should be taken not only of the works cost, but also of the cost for interest and sinking fund. In his view this should be qualified by the load-factor. No matter what class of consumer was being dealt with, the load-factor had a great deal to do with the works cost. The table in the Paper he considered entirely misleading. Take the station in its eighth year, which was Sunderland. This was put down with a deficit of £399. But in this year the Sunderland Corporation had just erected a new station at a cost of something like £280,000. A large proportion of that additional capital was spent in the year selected by the author, and it was, consequently, absolutely impossible to make a profit on it. In the previous year the net profit was £1,908, the year before that £1,246, and the year before that £1,246. He had no doubt that there were a great number of other stations in the same position. There was one station given as in its 20th year. But he could not conceive a municipal station at work all those years resulting in a deficit of £1,080. The probability was that the municipality had been purchasing a company. He agreed that some towns made too small a charge for tramways, and they had this difficulty in Sunderland. Towns like Glasgow could afford to do it, but it was foolish for smaller towns to copy Glasgow, which had such large resources.

Mr. J. H. RIDER (London County Council Tramways), referring to the 20th year station mentioned in the Paper, said he did not know of any municipal undertaking which was older than 15 years. It was not fair to compare a station bought up by the municipality with others started afresh.

Ald. PEARSON (Bristol) said that he was informed that the 20th year station was the Hastings station, which for many years of its life was in the hands of a company, and he was not surprised at the result if they had had to pay, as many towns did, £2 for every £1 of the capital of the undertaking. He thought it would be advisable not to attach too much weight to the figures in the Paper. In Bristol they had adopted an arrangement by which they considered the sinking fund the depreciation, because, if a sinking fund that depreciated the whole undertaking out of existence in 25 years was not a depreciation fund, he did not know what was, and so long as the machinery depreciated in an irregular way instead of by a fixed amount every year, they would be obliged to make some provision out of different years' revenue, so that when the engineer chose to knock a certain piece of machinery to pieces there would be the funds in hand to replace it. That was what he looked upon as the right position for a depreciation fund. He thought that a Corporation that went to work and rested absolutely upon its sinking fund without any regard for the future, was extremely unwise. In addition, there were accidents that would happen—as they knew at Bristol—and therefore it was also necessary to have a reserve fund. He was against setting up sufficient funds, however, first to pay all the capital borrowed for the undertaking back, and also by depreciation and reserve funds to have sufficient money to buy new works at the end of their official life. In his opinion, that was taxing the present generation for the benefit of the next.

Ald. IVEY (West Ham) asked if the author had taken into consideration the relief afforded to many municipalities by their not having to pay both interest and sinking fund sometimes during the first, second and third years. He thought the author might fairly credit himself with this in his argument. There were many points in the rest of the Paper, but the one with which many electrical engineers would sympathise was that the town councillors in the majority of cases did not know sufficient about the subject with which they were to deal. Bristol was happily situated, because Ald. Pearson was almost as good an electrical engineer as many of the engineers themselves. This fact might account for the reason why municipalities could not compete so successfully with the companies. He could not agree with the point of increasing the price. A good load-factor could not be expected if they asked for a pound of flesh from each customer.

Councillor HODGSON said that electricity was in its infancy, and it was desirable to tread gently. The difficulty of instructing members of electricity committees in the details of the business was very great indeed.

Ald. SMITH (Barrow-in-Furness) said he was pleased to find that the pessimistic view taken by the author had not been adopted by the majority of the speakers. He endorsed every word of Dr. Panton's. The author seemed to overlook the fact that, although large sums might be spent in interest and sinking fund every year without large profits being made, yet they were building up an exceedingly valuable asset in the shape of the undertaking. If he had any doubt on this point, the author should ask a company promoter for a valuation of the Southampton undertaking.

Councillor DUXBURY (Bury) said that last year they spent a considerable amount of money on tramway plant, and although the interest and depreciation came to £700, the income from the tramways was only £400. Therefore the table in the Paper should be taken with a grain of salt.

Councillor WEST (Coventry) said that in Coventry they had been under a cloud for a good many years, but within the last two or three years they had taken the matter into serious consideration, and decided that the only way to alter the existing state of things was to lower the price for lighting and power purposes. The result was that in their eighth year they had turned the corner.

Councillor McGAUL (Birkenhead) asked that in future Papers by the councillors might be taken earlier in the Convention. He had wished to speak, but there was now no time.

The PRESIDENT said he would do his best to meet this wish. The Papers were arranged some months ago, and one Paper which was offered had to be withdrawn, and Councillor Blakeway's Paper only came in at the eleventh hour.

Councillor BLAKEWAY said he would communicate his reply to the *Proceedings*, and would try to make it so clear that even his critics would be able to understand it.

INVERTED THIRD-RAIL UPON THE BROOKLYN BRIDGE.*

An innovation in electric third-rail arrangement has recently been introduced upon the "Brooklyn Bridge," the old bridge between the cities of New York and Brooklyn, by the Brooklyn Rapid Transit Co., for the operation of all its elevated trains through to New York. It involves what is probably the first use, on a large scale at least, of the T-rail in an inverted position for use as a third-rail. It may be stated that this idea of using the T-rail inverted has before been suggested, as its use in this position would offer many advantages by making possible greater available contact area between the shoe and the third-rail. But for reasons of difficulty of supporting the rail in this inverted position, undoubtedly, this idea has never heretofore been put into practice.

This change is due to the peculiar conditions met in the operation of the electric trains over the bridge between New York and Brooklyn. Very difficult and abnormal conditions have been introduced by the enormous growth of the traffic to and from Brooklyn via this route. The trains are operated across the bridge upon two lines of track in each direction, which tracks are arranged in gauntlet. The gauntlet arrangement was installed several years ago in order to facilitate the handling of the trains under the extreme service of 55 seconds headways; this arrangement avoided the inconvenience of switching at either end. When electric traction was installed upon the bridge a few years ago, it was desired to use a common third-rail for both of the gauntlet tracks to avoid the complication of the two third-rails. This was accomplished by making the contact shoes upon the cars wide enough to afford contact with the rail when on either

* Abstracted from the *Street Railway Journal* of New York.

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track. At that time, however, the contact shoes were made 10in. wide, which easily allowed for the variation of 5¾in. between the centre lines of the two tracks, giving good contacts when cars were upon either track.

Recently it has been found desirable to operate elevated trains from the various elevated lines of the Brooklyn Rapid Transit Co. over the bridge to the New York terminal. The limiting conditions upon these elevated structures prohibited a width of shoe greater than 8in., which made it impossible to use one of the gauntlet tracks on account of the shoes not making sufficient contact with the existing third-rail. Accordingly an additional third-rail on the other side, or a wider single rail in place of the former one, became necessary. The problem was solved by rebuilding the third-rail, involving the installation of a 70lb. T-rail in its inverted position for this purpose; in this way sufficient width of contact surface is presented to the car-shoes, and very little special work was required in making the change. The accompanying drawings show the details of the new work.

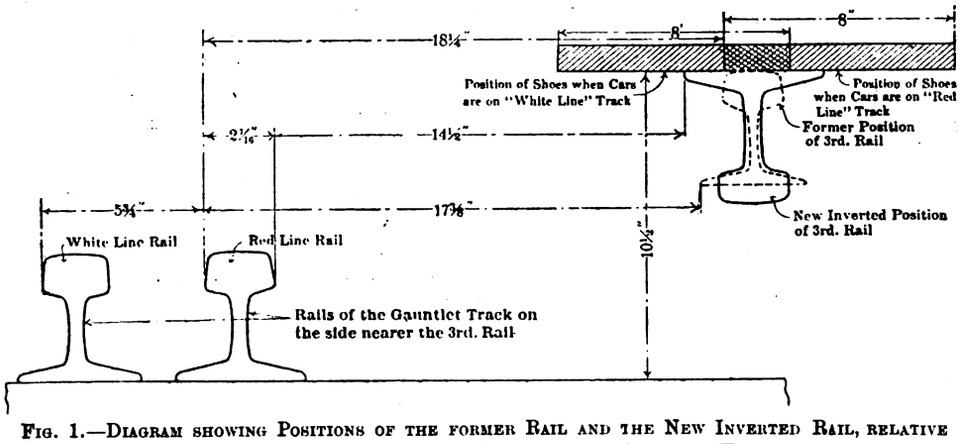

FIG. 1.—DIAGRAM SHOWING POSITIONS OF THE FORMER RAIL AND THE NEW INVERTED RAIL, RELATIVE TO THE NEARER RUNNING CENTRE RAILS OF THE GAUNTLET TRACKS.

The sectional drawing (Fig. 1) showing the location of the third-rail relative to the nearest running rails of the two gauntlet tracks, clearly indicates the advantages gained from this new arrangement of conductor-rail. The former position of the third-rail is shown in dotted lines, from which it may be seen that only the edge of the contact shoe would normally be in contact with the rail; from this it is evident that a slight jolting of the car to one side might easily move the shoe entirely off the rail. With the new arrangement, using the inverted rail, which is here shown in full lines, the minimum width of contact of the shoe with the third-rail of 3½in. will prevent any possible trouble from side jolting due to unevenness of track or other causes. It will be noted that the white and red-line rails, which are indicated on the drawing, refer merely to the arrangements of signals which are used upon the bridge; all trains upon the north gauntlet track carry red signals, which track is therefore termed the "red-line," in contradistinction to the south track, which is termed the "white-line" on account of the use of white signals for protection of trains when on that track.

The greatest difficulty encountered in the use of the third rail in this inverted position was that of supporting it. None of the present forms of third-rail insulators would permit of supporting a T-rail in its inverted position, and it was thus found necessary to design a special fitting or chair in order to thus support the rail above the insulator. A standard form of white porcelain third-rail insulator is used to support the rail, but for steadying the rail upon this is provided a special two-piece cast-iron chair fitting, which is so arranged as to support the rail flexibly and fairly loose, in a position corresponding to that occupied by the former third-rail.

Fig. 2 shows the details of the chair construction. As may be noted, the two halves are made in duplicate, an important saving in the original cost, and from an end view the opening may be seen to correspond in general with the outline of the rail in its inverted position. Considerable space is left free around the head portion of the rail—the bearing portion—which receives the weight of the third-rail, coming at the top of the casting, which here fits under the base of the inverted rail. This is provided to allow for slight inequalities of the rail between the head and base, due to unevenness of rolling.

The chair casting is of strong design, being considerably stiffened by a transverse web, to provide against breakage from side strains; from the side view it may be seen that the general contour of the casting is such as to afford maximum strength in that direction, both side plates being of a shape to resist the thrust of end motion. It should also be noted that this special construction, with loose-fitting interior contour, is such as to permit of the insulators settling with the tie as each truck passes, without introducing any strain in the insulating material; the rail will lift within the chair casting, or the entire casting will be lifted off of the insulator, if necessary, as in this case the chair is not fastened to the insulator, but merely rests upon it, the opening at the bottom being designed to conform to the general conical shape of the porcelain insulator.

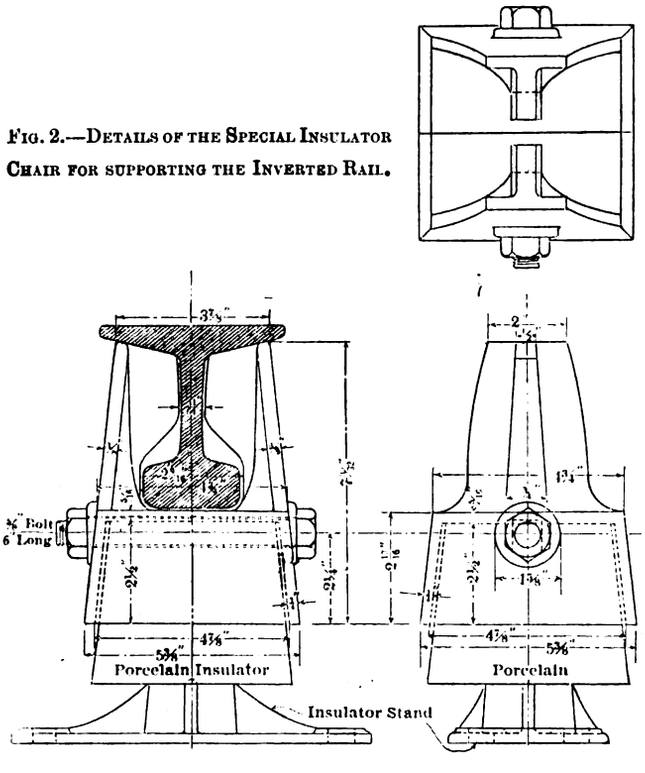

FIG. 2.—DETAILS OF THE SPECIAL INSULATOR CHAIR FOR SUPPORTING THE INVERTED RAIL.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Composition of N-Rays.—J. Becquerel shows that the N-rays and N′-rays given out by certain bodies, such as Rupert's drops, compressed wood or calcium sulphide exposed to sunlight, can be completely deflected by a magnet, whereas the N-rays given out by a Nernst filament are not affected even by a field of 10,000 units. He concludes that there are several species of N-rays and N′-rays, and that they are usually mixed up together. One of the species is not deflected by a magnet. This species is, as a rule, incapable of influencing the sulphide screen unless it is emitted by a Nernst filament. The N-rays are, as a rule, identical with the β-rays of radium and the N′-rays with the α-rays of radium, except that the magnetic curvature of the N′-rays is the same as that of the N-rays. The only species of N-rays left to be accounted for are the N-rays emitted by a Nernst filament, which affect the sulphide screen, are not deflected by a magnet, and have a definite series of very small wave-lengths. These are refracted by an aluminium prism, and seem to give rise to the α-rays and β-rays. The latter are, of course, free negative electrons, while the former, to judge from the curvature of their path in a magnetic field, seem as if they were free positive electrons.

[J. BECQUEREL, *Comptes Rendus*, July 25, 1904.]

Relations between N-rays and N′-rays.—J. Becquerel describes some experiments which enable him to obtain either N-rays or N′-rays from the non-deflected N-rays left after the rest have been deflected off by a magnet. He concentrated the rays by means of a cone of aluminium whose base was coated with exposed calcium sulphide. On bringing the cone into a strong magnetic field, the N-rays and N′-rays were deflected away from the apex, leaving only the non-deflected rays, which do not affect the screen. On introducing into the path

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of these rays a uranium salt, which gives rise to β rays, the N-rays and the N′-rays re-appear in their former distribution. This distribution is reversed by substituting a polonium preparation for the uranium salt. The author establishes a remarkable rule which connects the N-rays with the N′ rays. A surface capable of storing the N-rays emits N rays normally and N′-rays tangentially and vice versa. Also, N′-rays are emitted at right angles to the path of N rays traversing air or a wire. Similarly, N-rays are emitted at right angles to the path of a beam of N′-rays. The author proves these propositions by means of two crossed glass tubes joined in the centre.

[J. Becquerel, *Comptes Rendus*, July 25, 1904.]

Coherence.—P. E. Shaw and C. A. B. Garrett used both the boom apparatus and the balance apparatus in coherence experiments designed with a view to decide between the rival theories of the coherer. These theories are: (1) Lodge's fusion theory; (2) Branly's theory of a modification of the medium; (3) Auerbach's theory of adhesion brought about by mechanical shock; and (4) the ionic theory, according to which either a film condensed from the atmospheric gases or else an oxide film is ionised by the passage of the discharge. The authors show that for coherence to take place there must be some gap between the surfaces. This gap provides the large resistance so that enough heat is developed by the passage of the waves to fuse the surfaces. The last theory can be proved experimentally to be correct, for it is possible after cleaning the surfaces to bring them together with such slight pressure that the current passing is small. Coherence occurs even when no film existed peviously, provided there is a gap between the surfaces. When coherence is broken, the surfaces part with a snap which sounds in the telephone like the sundering of a solid body, and when the surfaces are pressed together again, the ends of the bridge are found and can be easily pressed back flat. These facts show that coherence is a solid effect and dispose of the ionisation theory and also of Branly's theory. The fact that the bridge has about the tenacity of the solid metal also supports the fusion theory. Again, the heat developed at the contact is ample to fuse the metal. Hence there is no simple adhesion, and only the fusion theory is left, and it is in accord with all the facts known.

[Shaw and Garrett, *Philosophical Magazine*, August, 1904.]

Cathode Disintegration.—Crookes compared the disintegration of a large number of metals used as cathodes in gases at low pressure by means of a rotating switch which connected alternately four cathodes in the same exhausted tube with an induction coil. In each of the experiments one of the cathodes was gold, which was chosen as the standard. Palladium and gold had the highest rates of disintegration, and iron, aluminium and magnesium the lowest. Granquist obtained somewhat different results, and latterly L. Holborn and L. W. Austin have made some new experiments, using grease instead of mercury to make the connections airtight, since they found that the smallest quantity of mercury leads to instant amalgamation of the cathodes tested. They obtained curves of remarkable regularity connecting the loss of weight with the cathode fall. The curves for the various metals all intersect at 495 volts, where the disintegration is nearly zero. They are straight lines, of various inclinations showing that above the point mentioned the disintegration is directly proportional to the cathode fall. The steepness of the line has a simple relation to the atomic weight. It is necessary to distinguish two groups of metals, to the first of which belongs silver, platinum, iridium, copper and nickel, to the second another form of silver, bismuth, palladium, antimony and rhodium. The members of each group disintegrate in equivalent proportions at the same potential, when for the individual metals valencies are assumed which are recognised in chemistry.

[Holborn and Austin, *Philosophical Magazine*, August, 1904.]

Gaseous Conduction and Radio-activity.—R. J. Strutt has endeavoured to determine the rate of loss of a charged body which gives off α-rays only. Such a body is a rod of bismuth made active by a deposit of "radio-tellurium." This was attached to an electroscope and charged in a vacuum. At pressures of from 300mm. down to 2mm., the rate of leak was found to be nearly proportional to the pressure, in accordance with the results of previous observers. But when the pressure was lowered beyond that the rate of leak diminished more and more slowly, apparently reaching a limit. Exhaustion was continued until the vacuum was so high that a discharge could not be forced through the Röntgen tube attached. Even then a considerable leakage was observed from the charged system. This leak was the same whether the charge was positive or negative. It is certain, therefore, that the current carried by the α-rays must be small in comparison with it. The nature of this conduction in high vacua is a difficult problem. It is very repugnant to modern ideas to believe that the current is carried independently of moving ions. As these cannot be derived from the gas, the only alternative seems to be that they are derived from the material of the radio-active substance, being torn away from it by the issuing α particle.

[Hon. R. J. Strutt, *Philosophical Magazine*, August, 1904.]

Rapid Radium Rays.—F. Paschen has succeeded in showing that the so-called γ-rays or non-deflected radium rays are simply an extremely rapid species of the β-rays or cathode rays, that they carry a negative electric charge, and only differ by their very much greater velocity. He employed a powerful electromagnet giving fields of more than 12,000 units. On gradually bringing up the field to that amount, the less rapid rays were eliminated one by one. Thus the Lenard rays went at 500 units, and Kaufmann's β rays between 3,000 and 5,000 units. At 10,000 units and over only the γ-rays were left. These seems to move with a constant limiting velocity which may closely approach that of light.

[F. Paschen, *Annalen der Physik*, No. 7, 1904.]

Electricity and the Panama Canal.—In an article in the *Electrical Review* of New York it is stated that some £5,000,000 were spent by the early French engineering companies in purchasing machinery and supplying equipments for excavating the Panama Canal, and a good part of this was finally left to rot and decay in the tropical climate of the isthmus; but there was scarcely any money spent for electrical machinery or implements of any kind. Even electric lighting along the route of the canal was not resorted to, and the shops and repair plants were constructed without thought of any electrical equipment. In the work of finishing the Panama Canal the latest machinery and methods will be employed. It has been variously estimated that it will require from 6 to 10 years to complete the canal even under modern engineering conditions, and from one to two years of preparation will be required. There will hardly be a machine, repair shop or operating plant that will not have electric power in some portion of it. In this respect the new machinery for the Panama Canal will differ radically from that shipped to the isthmus by De Lesseps and his engineers. Within six months the designs and specifications of some of this machinery will be finished, and the first shipments will probably be made within the current year, or the early part of the new. Electrically-driven conveyors, cranes and drills will be very much in evidence, and it is proposed to light up the route of the canal by electricity, so that work can be carried on in shifts night and day. The question of motive power on the isthmus is partly dependent upon the fuel problem. Coal is scarce and high priced in Panama; wood is not to be depended upon as an exclusive fuel for power production, and the question of harnessing the tides and currents of the mountain streams and Chagres river is difficult. While some attempt may be made to utilise the power of the river's flow for generating electricity, and coal and wood will be used for fuel purposes, it is possible that Texas oil may be used more than anything else. The cost of shipping this to the isthmus is less than that of transporting coal or wood. By running oil-tank steamers to the isthmus, it is estimated that the cost would be considerably under a dollar a barrel. There is good reason to believe that many of the portable electric power and lighting plants will burn liquid fuel entirely, while many of the steam shovels and dredges will use both oil and coal. The modern convertible type of grate, which permits of either coal or oil being used, appeals with the greatest force to those interested in work in the tropics where the fuel must be carried long distances.

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N-RAYS.

After having spent two centuries in laboriously emancipating itself from NEWTON'S conception of light, physical science has undergone one of those periodical oscillations which seem inseparable from human progress. Corpuscular theories hold the field in cathode-ray phenomena and in radio-activity. Since PASCHEN showed recently that even the undeflected γ-rays of radium convey an electric charge, the undulatory hypothesis has been relegated to pure light and to Röntgen rays. Thanks to that most brilliant and fruitful of modern conceptions, the electron theory of electricity, magnetism, light and electro-chemistry, we are now becoming familiar with processes which until lately even advanced thinkers only dared refer to in bald mathematical terms of studied generality. Electrical theories have become more and more corpuscular. Except for purposes of wireless telegraphy and dynamo design, our pioneers have largely withdrawn their attention from the medium to which FARADAY and MAXWELL so masterfully directed it, and have concentrated it more and more upon the matter which is capable of freely conveying the ultimate material of electricity, upon that "hole bored through a solid rock of air," the wire which gives a comparatively free passage to the negative electron. At such a time, and amid such preoccupations, BLONDLOT'S discovery of the N-rays came as somewhat of a shock. It came on February 2, 1903. Unlike RÖNTGEN'S sensational photographs of the bones of the living hand, BLONDLOT'S results remained practically unnoticed. Even at the present day, when the literature of the subject comprises some sixty-five Papers, nearly all physicists and journals outside France maintain an attitude of rigid scepticism or studied indifference. The reasons are not far to seek. The observed effects are slight. They require a careful training of the eye. There have been many failures to repeat the experiments; and, lastly, the practical utility of the results, apart from physiology, is by no means obvious. Yet the theoretical interest of these investigations is very great, and the theoretical interest of to-day is the practical interest of to-morrow. We have apparently to deal with light of extremely minute wave-length, a wave-length of the order

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of the size of a molecule, and about one-fiftieth of that of visible light. This means an enormous extension of the known spectrum in the violet direction, and is a worthy counterpart of its Hertzian extension in the red direction. Nor can we complain of a lack of definiteness in the manner in which these discoveries have been presented. M. BLONDLOT'S fifteen Papers are models of lucidity and scientific precision, and, in spite of the intricacy and difficulty of this species of research, he never has had occasion to withdraw or modify any of his results once published. Moreover, they have been confirmed by BICHAT, CHARPENTIER, MEYER, COLSON, BROCA, ZIMMERN, ROTHÉ, J. BECQUEREL, and a number of other physicists of repute. Not a week passes without two or three new works on the subject. BECQUEREL especially has accomplished valuable additional work, and has done much to unravel the knotty points and establish new relations with older phenomena, while BLONDLOT himself, confronted with the many failures of colleagues, has devised improved means of observation.

It may be a little premature at present to assign their proper place to the N-rays in the structure of physical science. But it seems clear that their discovery will lead us far into the unknown recesses of matter. Like two tunnels bored from each side of a mountain, radium rays and N-rays enable us to penetrate the unexplored interior of the atom. They will, no doubt, meet before long. BECQUEREL'S latest results show an intimate connection between the two forms of radiation, the former corpuscular, the latter ethereal. In radium rays we deal with the projection and impact of electrons. In N-rays we probably have the ether disturbances which accompany those processes. If, as BECQUEREL suggests, all N-rays imply a convection of negative electrons and a lateral projection of positive electrons, the intimacy of the connection between these forms of energy is apparent. But the most fascinating of all possibilities is that held out by BECQUEREL'S provisional announcement that the α-rays mixed up with N'-rays have the same magnetic curvature of path as the β-rays, only in the opposite direction. This would mean that we were at last brought face to face with the uncombined positive electron. So far, however, the only corroborative testimony we can find is MEYER'S observation of N'-rays, which are capable of penetrating 1mm. of lead or 10cm. of water, a feat to which polonium rays have proved quite unequal. The next few months will probably bring us some announcements of surpassing interest. Meanwhile, the confirmed sceptic may remain satisfied with the thought that, whatever happens, we shall know much more about the objective value of the human eye as an instrument of observation at the end than we did at the beginning of N-ray research.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Electricity in Agriculture and Horticulture. By Prof. S. LEMSTRÖM. (London: "The Electrician" Printing and Publishing Co.) 1904. 3s. 6d. net.

Those who are desirous of studying a new and promising application of electricity and a fascinating branch of electrical science should apply themselves to the subject of electricity in its relation to vegetable life. As a preliminary to this study, a perusal of Prof. Lemström's record of his investigations—presented to us in the present volume—is indispensable. The author, whose home is at Helsingfors, in Finland, had been much struck by the rich development of certain plants in the Polar regions as compared with the corresponding conditions in countries nearer south where the climate is more propitious. He noticed it particularly in the cases of rye, oats and barley, when these crops had withstood the intense frosts, although the same effect was observed in flowers and the leaf development of trees. He started his investigations to test the hypothesis that this development might be due to the peculiar electrical condition of the atmosphere in these regions, which is the cause of the phenomenon of the aurora borealis, being inclined to favour this explanation by a consideration of the fact that Nature has provided many plants with pointed projections, the function of which has hitherto not been explainable. As instances he cites the "beard" on the ears of cereals and the needle-shaped leaves of the pine. Moreover, the "year rings" on the pine trees have indicated exceptional development at periodical intervals corresponding with those of sun spots—*i.e.*, the years of frequent displays of aurora. Searching for further links with which to complete his chain of hypothesis, he first turned to electro-capillary action. Experiments were made with capillary tubes, and it was found that, if the air just above such a tube were negatively charged, the liquid rose to a certain extent within the tube. With a positive charge instead of a negative charge, however, no such effect was observed. The explanation that the accelerated and more fruitful development of the plants is due to electro-capillary action falls to the ground, therefore, for not only does the atmosphere normally possess a positive charge in relation to the earth, but in the large scale experiments on plant growth, in which the greatest increases of productiveness were obtained, the atmosphere above the fields was given artificially a positive charge. The author has, therefore, to fall back upon the supposition that the passage of the electric charge into the air produces nitrogen compounds and ozone, both of which are introduced into the capillary passages of the tubes by the electric current flowing to earth, and that these promote the luxuriant growth already alluded to.

This explanation will doubtless be received with some scepticism, but, whatever the cause of the phenomenon, Prof. Lemström has certainly been able to record results which point to a distinctly beneficial action of electricity upon the productiveness of cereals, vegetables, and even strawberry plants. The experiments were conducted on a large scale; a number of patches of ground were selected for the experimental crops, and above them was erected a conducting network with many discharge points placed at a small distance from the ground and charged positively. "Control" crops were also raised on patches alternating with the experimental patches, the soil for both being prepared in precisely the same way, but no electrically-charged net being employed over the "control" patches. Prof. Lemström gives many particulars as to the preparation of the ground and as to the crops obtained, and it may be mentioned that the experiments recorded were carried out in various countries, including Great Britain. One observation, however, is rather antagonistic to his theory of the cause of the phenomenon—viz., that the effect (measured quantitatively) of electricity applied in the manner indicated is more marked in fertile and well-manured soils than in poorer ones. If the electricity actually brought nitrogenous nutriment to the plant, one would expect that the *percentage* improvement in the case of nearly barren soils would be much greater than with soils already supplied with a sufficiency of digestible food for the crops. However, it is not certain that the comparison, by comparing the weights of edible results in the two cases, is not too complex for purely scientific deductions to be based upon it.

In continuing his experiments, we trust that Prof. Lemström will endeavour to improve the electrical part of his equipment, and that he will also give us more specific data with regard to this part of the investigation. Up to the present he has employed influence machines, using in the more recent tests a double cylinder machine of his own design. Even with this improvement, however, the methods do not appear to be sufficiently certain; in some tests, for instance, he doubts whether the polarity of the machine was not the reverse of that intended, and, moreover, the machine has apparently failed in damp weather, when it might otherwise have done the most good owing to the prevailing natural conditions. The voltage used has not been measured, and the only guide we have as to this is in the sparking distances observed between the terminals of the machine, which have varied between such wide limits as 0·1

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and 2·2mm., while some are even recorded merely as "very short." This represents a maximum of between 5,000 and 6,000 volts, so that it is evident that a dynamo could be employed with advantage in place of the less reliable influence machine, and this would, moreover, permit of the voltage being accurately adjusted and maintained constant. We would also suggest that double-lipped insulators instead of single ones should be made use of for supporting the air-wire, as leakage currents through the earth may give rise to effects extraneous to the real object of the experiments. Such oversights are, perhaps, inseparable from pioneer investigations such as these, and Prof. Lemström is none the less to be congratulated for drawing attention to a line of research which may eventually have a wide influence upon the agricultural industries of the world. Is it indiscrete to express a pious hope that some of the leading physicists who have the opportunity will endeavour to throw fresh light on the subject? Such men as Lord Rayleigh and his son, not to mention half a dozen others, possess both the laboratory equipment and the necessary acres to enable them to pursue a course of systematic enquiry into this most attractive mystery of Nature. F. C. R.

Electricity and Matter. By J. J. Thomson, F.R.S. (Constable & Co.) 5s. net.

Here we have in book form the six Silliman lectures delivered at Yale by Prof. Thomson in May, 1903. The volume, though of small bulk, is of considerable importance. In it the author expounds concisely his views of the nature of electricity and matter, as "suggested by the results of recent investigations." The book is thus in the main a speculation wrought from the author's disciplined imagination, but is also in part the result of the ingestion and turning over of ideas which have become common property during the past dozen years. In physics, more perhaps than in any other experimental or observational science, careful speculation has been found to pay; and at all periods of rapid advance the well-informed dreamer is worth close attention. Nowadays, especially, when the most productive parts of physical science are those which deal with entities whose properties are far beyond the ken of our five senses, the assistance afforded by an imagination is almost necessary that an investigator may be successful. Prof. Thomson in this collection of lectures places the inventiveness and perspicaciousness with which he is gifted at the service of his readers.

Appropriately enough his opening pages emphasise strongly the insight of Faraday, the electrical seer of 70 years ago; for, like Faraday, Prof. Thomson believes that lines of electrical force have a real existence. From this and a connected assumption is developed the scheme of the universe with which the interest of the book culminates. This other assumption consists in supposing that if the velocity of a moving line of force has a component perpendicular to the line, a part of the dense surrounding ether, in amount proportional to that component, is carried with the line. Starting from this, he shows that many new problems as well as the old can be attacked with confidence. The methods used are already familiar to readers of his "Recent Researches." One example is worthy of special mention since its result is the foundation of the most fascinating portion of the book. A moving charged sphere has momentum greater than that of an equal uncharged sphere moving with the same velocity by the amount due to the mass of ether entangled or "bound" by the radiating Faraday tubes. If the speed of the sphere approach that of light the lines set themselves more perpendicularly to the velocity and the mass of "bound" ether is therefore greater. We might remind our readers that the ordinary way of regarding this phenomenon is that the existence of the magnetic field set up by the motion of the charge implies a distribution of energy throughout the medium, or, in other words, more kinetic energy is associated with the motion of a body which is charged than with that of one uncharged, *ceteris paribus*. The mass of this "bound" ether per unit volume is calculated proportional to N^2, where N is the number of lines per unit area. This leads, by the way, to the result that the energy stored in an electro*static* field and the mass of the ether "bound" by the Faraday lines are proportional—a very suggestive fact, as our author remarks. This law of the distribution of the mass of the "bound" ether shows, however, in the case of a very small charged body moving slowly, that, since N is inversely proportional to the square of the distance, the "bound" ether has a volume distribution following an inverse fourth-power law. Put roughly, we may say that for a very small charged body the part of the mass which is electrical is concentrated very near the origin of the lines of force. This leads naturally to the idea that the mass of an electron is wholly electrical. If so, its mass should increase with increasing velocity. The result of Kaufmann's measurements of the velocities and the ratio e/m for the particles projected from radium are, therefore, now compared with the calculations of the author based on this conception. The general close agreement between the experimental and the computed figures is very striking. Thus we arrive at a stage at which on any electronic theory of matter its chief property—namely, massiveness—is referred back to the mass of the ether. As the author admits, the density of the ether necessary to account, in the manner sketched, for the mass of a portion of matter is enormous. This high-density difficulty recalls the state of affairs which accompanied the introduction of the "elastic solid" theory of the luminiferous medium, when a fluid possessing rigidity was perforce postulated. Perhaps this present embarrassment will gradually fade as did the other.

Chapter III. breaks the thread of the story to deal with the radiations due to the acceleration of the materialised lines of force. It is interesting to notice that here the author embraces another of Faraday's conceptions. This is the view that light (including Röntgen rays) and other electromagnetic disturbances consists of tremors propagated along the stretched lines of force. This implies that a wave-front is not continuous, but consists of a finite number of wavelets in the same phase. It explains, in the author's hands, the relative smallness of the dissociation produced in a gas by Röntgen rays. It also seems to us, by the way, to remove a classical difficulty regarding the nature of unpolarised—*i.e.* ordinary—light. Various authorities, it will be remembered, have supposed that in unpolarised light the direction of vibration at a point in the path of a ray assumes regularly or irregularly all possible azimuths in turn. With the view now under notice, however, we need only suppose that, as seems probable, the vibration of each Faraday line penetrating the wave-front has its own azimuth. This conception of Faraday's, it should be noted, implies that the luminiferous medium possesses a highly complex, finely fibrous structure.

Chapter IV. deals with the considerations which have led to the conclusion that electricity is atomic in nature, and includes a description of the chief methods of measuring the ratio e/m and the quantity e for the ions occurring in the electrolysis of gases and liquids. Chapter V. takes up the tale of the constitution of the atom. Starting ambitiously with a uniform universe of primordial units the building up of complex atoms of the Kelvin type is minutely traced. The primordial unit is taken to be a doublet consisting of a corpuscle and an equal positive charge. Hitherto, when positive electrification has been mentioned it has been regarded as the condition of lack of negative electricity. Here it is suddenly produced as a thing as real as its opposite; and nowhere does the author vouchsafe a hint to shed a light upon the dark mystery of its nature and origin. Still, to allow the negative partner of the doublet to account almost wholly for the mass of a doublet is easy. It is only necessary to suppose the positive electricity spread through a volume much greater than that occupied by a corpuscle. Perhaps this diffusiveness is that very quality of positive electricity which has enabled it to evade discovery and discussion. To return to the universe of moving doublets: Prof. Thomson traces the manner in which mutual accelerations between passing pairs cause radiation and consequent loss of energy. The mean kinetic energy of the universe may thus be conceived as diminishing till speeds low enough to permit of permanent aggregates forming are reached. These aggregates are atoms of matter. Their positive portions fill a region within which, the author supposes, provisionally, the negative corpuscles move in orbital motion. The mean kinetic energy

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of this motion is named the "corpuscular temperature of the atom." Accepting the term, we may say a fall of corpuscular temperature makes possible the formation of larger atoms. In this connection the author very carefully and skilfully points out that there is not, necessarily, any simple relation between corpuscular and molecular (*i.e.*, ordinary) temperature. The introduction into physics—we trust not prematurely—of this expressive term, is an indication of the confidence with which Prof. Thomson regards in the main these views he gives of the building of the atom.

The lightest atom known is the hydrogen atom, which contains a thousand corpuscles. For the purposes of illustration prehistoric atoms possessing but few corpuscles are discussed. It is shown, for example, that the larger the number of corpuscles and the smaller their velocity the less is the rate of fall of corpuscular temperature through radiation produced by the centripetal acceleration of their circular motion. But apart from calculation, a well-known experiment of Prof. Mayer's is given a new significance by being utilised as a model of an atom. The experiment indicated is made by placing a number of small magnets, floating vertically in water, in the radial magnetic field of a magnet held with a pole near the water. The little magnets, seeking positions of equilibrium under their mutual repulsions and the central attraction, arrange themselves in concentric circles in modes varying with their number. For instance, a ring of three magnets occurs when totals of 10 or 20 or 35 are present; a ring of five with totals of 12, 25 or 45. It is the author's belief that in this simple experiment we have a crude representation of the reasons underlying the periodicity of the elements, and in his hands it yields with almost magical facility beautiful explanations of various physical and chemical properties shadowed in Mendeleeff's table of the elements. The general electrochemical properties of a typical family of the elements are entered into very fully and perfectly, and the discussion leads to an illuminating consideration of chemical affinity and the "bonds" of the chemist. But all this must be read in the book itself that an adequate idea may be formed of the power and elegance, the suggestiveness and probability of the views of the constitution of matter there outlined. One regret only we experienced. No clue is offered tending to an explanation of the very varied magnetic qualities of the elements; though it was in this connection that, 80 years ago, Ampère gave in his theory of atomic currents the first suggestion based on physical reasoning, of an electric theory of matter. The last chapter consists of a summary of the experimental facts of radio-activity and an application thereto of the hypothesis on atomic structure set forth in the preceding pages. It concludes with a few noteworthy words on the possibility of an external origin for the observed evolution of energy from radium. After considering the probability of Le Sage corpuscles or penetrating electro-magnetic radiation being this external source as well as the cause of gravitation, and remarking that then the absorption of energy by matter must be enormous Prof. Thomson says:—

"I think that the magnitude of the energy radiated from radium is not a valid argument against the energy being derived from radiation. The reason which induces me to think that the source of energy is in the atom of radium itself . . . . is that the radio-activity of substances is, in all cases in which we have been able to localise it, a transient property. . . . . This is what we should expect on the view that the source of radio-activity is a change in the atom; it is not what we should expect if the source were external radiation."

Notes on Alternate Currents, for Students. By HAROLD H. SIMMONS. (London: Cassell & Co., Ltd.) 1904. 1s. 6d.

According to the preface, this little book consists principally of a portion of a larger work on the outlines of electrical engineering, which the author has in preparation. The theory is sound and the analogies simple, but, considering the extremely elementary nature of the book, it is rather surprising that the calculus has been made use of in the early chapters. On the whole, it is a book which first year students may, provided their mathematics are sufficiently strong, use with considerable advantage.

BRITISH STANDARDS FOR ELECTRICAL MACHINERY.

The following is a copy of an interim report on Generators, Motors and Transformers issued by a sub-committee of the Engineering Standards Committee. Reports of the work of the committee have appeared from time to time in *The Electrician*:—

In publishing the interim report of the sub-committee on Generators, Motors and Transformers, the Engineering Standards Committee desire to draw attention to some of the important points which have arisen in carrying out the work entrusted to the sub-committee by the Electrical Plant committee. The sub-committee on Generators, Motors and Transformers was appointed at a meeting of the Electrical Plant committee on Dec. 18, 1902, and confirmed by the main committee on Feb. 13, 1903. This interim report was approved by the main committee at their meeting on July 26, 1904. At the earlier meetings it was decided that no attempt should be made to prescribe standard dimensions or shapes which might hamper future development in design, but to confine the recommendations of the sub-committee to such points as would ensure uniformity in nomenclature, outputs and test conditions. The recommendations which the committee have arrived at with reference to standard pressures, frequencies, outputs and speeds were prepared after the views of both users and manufacturers had been very carefully considered. Before standard test conditions can be laid down, the safe limit of temperature at which electrical machinery can be allowed to work for lengthened periods of time has, of course, to be determined. A sub-committee under the chairmanship of Dr. Glazebrook was, therefore, formed to experimentally investigate this matter at the National Physical Laboratory, supplemented by tests at the works of those manufacturers who were willing to assist. The points to be investigated were the following:—(1) The maximum temperature to which the insulating materials at present used in the manufacture of electrical apparatus could be exposed for lengthened periods of time without electrical or mechanical deterioration. (2) The permissible rise in temperature deduced from these experiments. (3) The relation between the mean temperature of any coil obtained by measurement of rise in resistance and the maximum temperature at the hottest portion of the same coil. In addition to these experiments, some of the coils which were tested singly at the National Physical Laboratory were subjected to a second series of tests when mounted on the machines for which they were intended at the maker's works. The reports of this experimental work are likely to be of very great interest and value to the electrical industry at large, and the committee hope to publish them in full at an early date.

It will be of interest to designers to note that the experimental work has made sufficient progress to indicate with considerable certainty that the temperature limits ultimately to be recommended by this sub-committee are likely to be more liberal than those laid down by either the American or German Electrical Standardisation committees. The experiments have also demonstrated that the temperature of the hottest part of the coils, taken by thermo-junction, is no more than 25°C. in excess of the mean temperature of the coil, taken by rise in resistance. The question of settling the standard electrical pressures did not meet with as much difficulty as was anticipated. Care was taken to select those standard pressures which, with the allowable variation of 10 per cent. on either side, would enable nearly all the pressures at present existing to be served by the proposed standard machines. These standard pressures have now been fixed, and it is hoped that *in all future work* they will be universally adopted by engineers who are advising power companies, corporations, supply companies and others engaged in the distribution of electrical energy, so that in these cases the permissible variations will gradually cease to be necessary. The standard frequencies proved to be a debatable matter, and after several circular letters had been addressed to, and replies received from, both users and makers, it was deemed advisable to convene a conference, so that the matter might be thoroughly discussed. This conference was held early in January, and the advisability of adopting two or three standard frequencies was fully considered, especially from the point of view of the future developments in power schemes. Strong evidence was brought forward in favour of standardising one frequency only, and the sub committee, after due consideration, decided to recommend 50 periods per second as the standard frequency, placing 25 periods per second in a secondary category. The question of recommending standard lists of motor speeds, which appeared so desirable from the users' point of view, was found to be an extremely dificult one. The sub-committee felt that they could not materially assist manufacturers in reducing the number of patterns to be kept in stock if a greater number of speeds were retained than those recommended in the standard lists. Happily, one list of speeds—namely that for prime movers—was practically fixed for the committee by the conditions of the frequency and the number of the poles in the alternators, so that the committee decided to put forward this one list of speeds for the whole of the direct-coupled machinery of both classes. The sub-committee on Generators, Motors and Transformers are indebted to the Transformer sub-committee for the recommendations with reference to alternating-current generators. They have still under consideration the very important subjects of the standardisation of transformers, test conditions and permissible variations from the adopted standards, and the complete report cannot be published until such time as these investigations are concluded. The committee, however, feel that the interests of the electrical profession will best be served by the early publication of a portion of the information which will

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ultimately be embodied in the report when complete.—(Signed) R. E. B. CROMPTON, Chairman of Sub-Committee on Generators, Motors and Transformers.

Pressures and Frequencies.—The following are the resolutions with reference to British standard pressures and frequencies.

1. Resolved that the standard low pressures for direct and alternating current work, measured at the terminals of the consumer, be 110, 220, 440, 500 volts. Though not included in these standard pressures, 380 volts shall be considered as the recognised pressure to be maintained between the principal conductors in a three-phase system with neutral wire, the pressure then being 220 volts between the three conductors and the neutral.

2. Resolved that the standard high pressures for alternating-current work, measured at the terminals of the generator, be 2,200, 3,300, 6,600 11,000 volts.

3. Resolved that the standard primary pressures for alternating-current transformer work, measured at the primary terminals of the transformer, be 2,000, 3,000, 6,000, 10,000 volts.

4. Resolved that the standard secondary pressures for alternating-current transformer work, measured at the secondary terminals of the transformer, be 115, 230, 460, 525 volts at no load.

5. Resolved that the standard direct-current pressure for tramway work, measured at the terminals of the motor, be 500 volts.

6. Resolved that the standard frequency for alternating-current work be 50 periods per second. But where the circumstances of the case demand a lower frequency a standard of 25 periods per second shall be adopted.

N.B.—The above standard pressures are subject to a permissible variation of 10 per cent. on either side, as explained in the introduction.

Rating of Generators and Motors (except for traction motors).—(1) Two ratings shall be recognised by the British Engineering Standards Committee—(A) continuous working. (B) Intermittent working. (A) The output of generators and motors for continuous working shall be defined as the output at which they can work continuously for *six hours* and conform to the prescribed tests. (B) The output of motors for intermittent working shall be defined as the output at which they can work for one hour and conform to the prescribed tests. N.B.—The duration of test for machines above 250kw. is still under consideration.

2. Every generator and motor shall carry, in a conspicuous position, a name plate giving the output and other particulars enumerated below. In the absence of any statement to the contrary, the output given shall always be understood to mean the output for continuous working under rating (A). Name plates for machines under class (B) shall bear the word "Intermittent."

3. The output and full-load speed marked on the name plate shall be those taken when the machine is at its normal working temperature, as determined at the close of the test run referred to above.

4. All generators shall have their outputs stated in kilowatts (kw.) All motors shall have their outputs stated in brake horse-power.

5. The following information shall be given on the name plates:—

Generators.	Direct current.	Kw.	Volts.	Amps.	R.p.m.
	Alternating current.	Kw.	Volts.	Amps.	Power-factor
		Full load. Excitation.	Volts. Amps.	Frequency.	R.p.m.
Motors	D.C. (continuous working)	B.H.P.		Volts.	R.p.m.
	D.C. (intermittent working)	B.H.P. (intermittent)		Volts.	R.p.m.
	A.C. (continuous working)	B.H.P.		Volts. Frequency.	R.p.m. Power-factor
	A.C. (intermittent working)	B.H.P. (intermittent)		Volts. Frequency.	R.p.m. Power-factor

The above applies to combined machines, such as motor-generators, boosters, rotary converters, which shall have name plates giving information applying both to input and output.

Direct-current Generators.—6. The list numbers represents the kilowatts which the machine can work at when continuously as a generator.

List Numbers and Speeds of Different Current Generators (up to 100kw.)

List number.	Standard motor carcase.	Revs. per min.	List number.	Standard motor carcase.	Revs. per min.
6	7½	1,075	32	40	750
8	10	1,000	40	50	675
12	15	900	60	75	625
16	20	850	80	100	575
24	30	800	100	...	500

British standard generators of 100kw. and above, whether for direct or alternating-current work, shall conform to the following list of sizes and speeds recommended for generators to be directly coupled to steam or gas engines.

Kw.	Revolutions per minute.		
	Slow.	Medium.	High.
100	...	250	500
150	...	250	428
200	...	250	375
250	...	250	375
300	94	214	375
400	94	214	375
500	83	214	300
750	83	188	250
1,000	83	188	250

N.B.—The "slow" speeds in the above table are tentative.

Alternating-current Generators.—(7) British standard alternators of any type, in addition to the requirements laid down in previous clauses, in so far as the latter apply, shall conform to the following regulations:—(*a*) They shall give an E.M.F. curve which, under all working conditions, shall be as nearly as possible a sine wave. (*b*) For exciting the field magnets the standard pressures shall be 65, 110 or 220 volts. (*c*) The term "alternator" shall not include an "exciter." The latter, when necessary, shall be separately specified and subject to the regulations for standard direct-current generators. (*d*) The regulation of an alternator shall be defined as the difference between the rated full load pressure and the no load pressure with the same speed and excitation. This difference expressed as a percentage of the rated full load pressure shall be termed the percentage "pressure rise" of the alternator. (*e*) They shall not have a greater percentage pressure rise than 6 per cent. on a non-inductive load and 20 per cent. on an inductive load, the latter being here considered as one having a power-factor of 0·8.

This pressure rise may be tested on a non-inductive or inductive load according to the requirements of the specification.

The figures in (*b*) and (*d*) shall not apply to compounded alternators.

Motors.—8. All motors for the purposes of tests shall be rated under the following classes:—(1) Open. (2) Protected. (3) Ventilated. (4) Totally enclosed. (1) and (4) require no definition. (2) A *protected* motor is defined as a motor in which the armature, field coils and other live parts are protected mechanically from accidental or careless contact, so as not to materially interfere with ventilation. (3) A *ventilated* motor is defined as a motor in which, while ventilation is provided for, access to the armature, field coils and other live parts is only to be obtained by opening a door in, or removing a portion of, the enclosing case.

N.B.—An alternating-current motor, Class 3, in which the slip rings are outside the protection, shall be considered as coming under Class 2.

List of Motors.—9. The list numbers represents the brake horse-power which the machine can work at when running continuously as a motor, at the standard pressure of 220 volts, up to and including 2 B.H.P., and above that size, at the standard pressure of 440 volts.

10. The following are the list numbers of British standard sizes of motors:—List numbers (direct current), ¼, ½, 1, 2, 3, 5, 7½, 10, 15, 20, 30, 40, 50, 75, 100. List numbers (single-phase) 50 ∿, 1, 2, 3, 5, 7½, 7½A, 10, 10A, 15, 20, 25. List numbers (two and three-phase) 50 ∿, 1, 2, 3, 5, 7½, 7½A, 10, 10A, 15, 20, 25, 30, 40, 50, 50A, 75, 100.

11. List numbers and speeds of motors (up to B.H.P.).

Direct-current Motors.

List No.	Revs. per min. at full load.	List No.	Revs. per min. at full load.	List No.	Revs. per min. at full load.
¼	1,600	5	1,000	30	750
½	1,400	7½	1,000	40	700
1	1,400	10	900	50	650
2	1,100	15	850	75	600
3	1,100	20	800	100	550

Alternating current Induction Motors.

Single-phase, 50 ∿.

1	1,500	7½	1,500	15	1,000
2	1,500	7½A	1,000	20	1,000
3	1,500	10	1,500	25	750
5	1,500	10A	1,000	...	...

Two and Three-phase, 50 ∿.

1	1,500	10	1,500	40	750
2	1,500	10A	1,000	50	750
3	1,500	15	1,000	50A	600
5	1,500	20	1,000	75	600
7½	1,500	25	750	100	500
7½A	1,000	30	750	...	...

The figures referring to alternating-current motors give the no-load or synchronous speeds; allowance should, therefore, be made for a reduction in speed at full load of from about 7½ per cent. in the smallest motors to 2½ per cent. in the largest motors.

High-tension Power Transmission in Spain.—According to *L'Eclairage Electrique*, Bilbao is to be supplied with electric energy from three power stations, situated in Quintana Martingalindez, Puentelarra and San Sebastian respectively. At present, only the first-named station is in operation; the second one is to be equipped with plant aggregating 6,000 H.P. and is in course of construction; the third station is projected only. The power station at Quintana Martingalindez, nearly 50 miles distant from Bilbao, is equipped at present with four 1,000 H.P. sets, consisting of a water turbine directly coupled to a three phase generator. At a speed of 375 revs. per min., the current is produced at 3,000 volts. The voltage is then raised by transformers to 30,000 volts, at which pressure the energy is transmitted to Bilbao.

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ELECTRIC SMELTING EXPERIMENTS FOR THE MANUFACTURE OF FERRO-NICKEL FROM PYRRHOTITE.*

BY ERNST A. SJÖSTEDT.

A few years ago I was entrusted with the interesting task of carrying out a series of smelting experiments for the manufacture of ferro-nickel metal from poorly roasted pyrrhotite.

The problem presented for solution consisted in the utilisation, to the best advantage, of the nickeliferous pyrrhotite of the Sudbury district (a monosulphide of iron or "magnetic pyrite," with 2 to 3 per cent. Ni and 1 to 2 per cent. Cu), with special reference to the saving of the sulphur and iron, as well as the nickel and copper contained in the ore—the common practice being to allow the sulphur to escape in the process of heap roasting, and the iron to be fluxed off and wasted in the slag. After having made some attempts at magnetically separating the nickel from the copper ore and the barren gangue, and this not proving satisfactory, it was decided to hand-sort the ore at the rock house, using the grade higher in copper and gangue for the ordinary matte smelting, and the grade low in copper and gangue but high in sulphur and nickel for the ferro-nickel industry. This latter grade of ore usually averages about 3 per cent. of nickel, 0·5 per cent. of copper, 28 per cent. of sulphur, 50 per cent. of iron and 0·01 per cent. of phosphorus.

Our first electric smelting experiments were made in a plumbago crucible, 8in. high and 4in. inside diameter, using only one ½in. carbon pencil, but subsequently two, four and six carbons were bunched together. The crucible was placed on strips of copper, resting on copper wires, which were connected with the electrodes. The power used was 75 amperes, from a 100-volt dynamo. Different proportions of finely-crushed ore, lime and coke were used, and the resulting metal beads analysed, thereby clearly establishing the following facts:—(1) Raw pyrrhotite is only partially and with difficulty converted into a metal, no good arc being obtained in these experiments, the indicator oscillating from 0 to 150 amperes, proving the mixture to be too good a conductor (the raw ore possibly being too magnetic?). (2) A partially roasted pyrrhotite in a mixture of lime and coke or charcoal will be reduced to a metal, the carbon in the coke combining with the oxygen of the roasted ore, and the sulphur partly volatilising or oxidising, and partly combining with the lime, which also combines with the silicious matter in the ore and the coke, forming slag, and with part of the carbon to calcium carbide (the presence of which was always noticeable). (3) The larger the lime charge, the smaller will be the amount of sulphur in the metal produced. For instance, an ore containing 7 per cent. of sulphur produced, with a charge of 20 per cent. lime, a metal of 1·6 per cent. sulphur contents; with a charge of 50 per cent. lime, a metal of 1·5 per cent. sulphur contents; with a charge of 150 per cent. lime, a metal of 0·06 per cent. sulphur contents; with a charge of 200 per cent. lime, a metal of 0·02 per cent. sulphur contents.

These interesting data being established, it was decided to continue the electric smelting experiments on a larger scale. A stationary rectangular furnace was, therefore, built of firebrick, having two carbon electrodes 4in. square by 18in. long, suspended in the middle of the furnace, about 8in. apart, and a current of 50 amperes and 175 volts used. The result of the first heat gave, from a charge of 32lb. of roasted ore, 29lb. of lime and 8lb. coke, 9·5lb. of metal, nicely collected in the bottom of the furnace, and showing every evidence of having been perfectly liquid before cooling, the impressions on the joints between the bricks being sharp and distinct. This furnace was followed by a larger one, with 5in. by 17in. crucible and a 10in. by 22in. body, provided with a tapping hole, for drawing off the slag opposite each carbon, and about 2·5in. above the bottom. The stock was a mixture of 100 parts of ore, 150 parts of lime and 25 parts of coke, and the character of the metal obtained from these charges (*b*), as well as from the above-mentioned mixture (*a*), will be seen from the following table:—

—	(*a*) Per cent.	(*b*) Per cent.
Chemical composition—		
Silicon	1·07	0·23
Sulphur	0·76	0·07
Copper	0·05	0·06
Nickel	5·72	5·67
Transverse strength—		
Breaking load, lbs. per sq. inch	813	1,642
Deflection, inches	7/64	7/32

In subsequent experiments ore screenings from partly-roasted pyrrhotite of the following composition were used:—Metallic iron (mostly as sesquioxide) 50·90 per cent., sulphur, 8·68 per cent. in (*c*), re-roasted (*d*) 5·81 per cent., insolubles 13·96 per cent., nickel 3·47 per cent., copper 0·07 per cent., and phosphorus 0·003 per cent. The results from a couple of experimental heats (*c*), with 150 per cent. lime and 28 per cent. coke, and (*d*), with 200 per cent. lime and 25 per cent. coke, were analysed and found to have the following composition:—

—	(*c*) Per cent.	(*d*) Per cent.	(*e*) Per cent.
Combined carbon	..	0·05	0·81
Graphitic carbon	..	3·25	1·28
Silicon	1·79	3·97	1·35
Manganese	..	0·18	0·27
Sulphur	0·28	0·063	0·27
Phosporus	0·037	0·039	0·008
Copper	0·045	0·075	0·02
Nickel	5·55	6·22	5·77
Cobalt	0·20	0·20	0·24
Arsenic	trace	trace	..

Noticing all along that the metal did not contain the expected full percentage of Ni, Co and Cu, and looking for an explanation of the same we observed, in tearing up the bottom of the furnace, under the ferro-nickel slab and directly below the carbons, a peculiar looking yellow mass of a hard and brittle metallic nature, which, upon examination, was found to have the following composition:—

	Per cent.		Per cent.
Fe	28·5	Si	17·0 | carborundum?
Ni	40·0	C	7·3 |
Co	3·5	S	0·2
Cu	3·5	P	0·04

A series of new furnaces were constructed, which, after a run of eight to 12 hours each, were torn down and reconstructed with such improvements as were indicated by the results of the successive experiments, which culminated in the electric furnace here described.

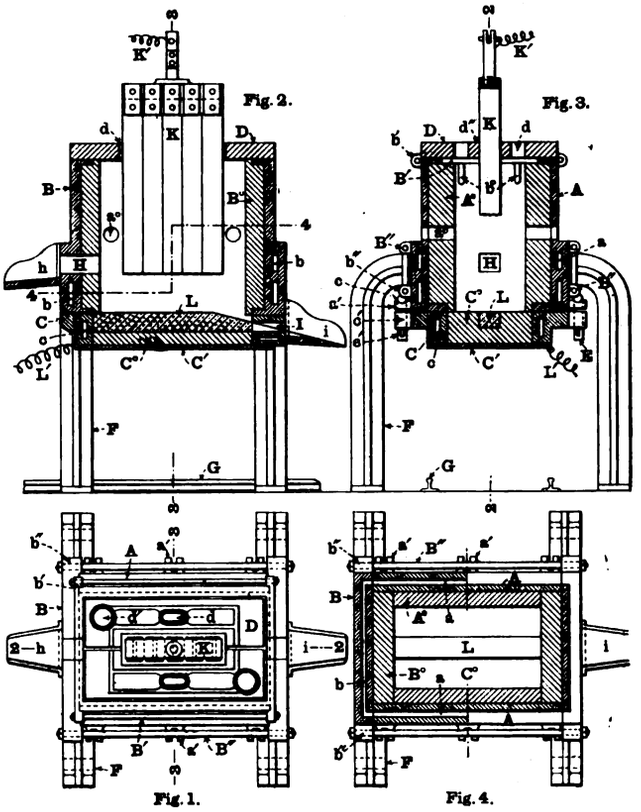

Fig. 1 shows the top view; Fig. 2, a vertical longitudinal section on line 2-2, Figs. 1 and 3; Fig. 3, a vertical transverse section on line 3-3, Figs. 1 and 2, and Fig. 4 showing a horizontal section of the same on broken line 4-4, Fig. 2.

The furnace body is of rectangular shape, and constructed of cast-iron sides and ends A and B, and a bottom frame, C, with an interior lining A°, B°, C° of refractory material, the bottom lining C° being retained by a steel plate, C', secured to the frame C. The lower parts of the sides and ends and the bottom frame are water-jacketed, as shown at *a*, *b* and *c*. The end-plates are provided with projecting lugs *b'*, *b''*, through which the ends of stay bolts B', B' are passed, and by means of which the frame plates are bolted securely together. Another feature of importance is the exchangeable bottom. Registering slotted lugs *a'*, *c'* are provided on the lower parts of the sides A and the bottom frame C respectively, and these receive cross-headed bolts E, resting with the heads *e* on the upper lugs, and being provided at the lower ends with mortices *e'* to receive wedges, driven in below the lower lugs, as shown in Fig. 3. One of the ends is provided with an opening, H, for drawing off the slag, the same being some distance from the bottom

F

* Abstract of Paper read at the fifth general meeting of the American Electro-Chemical Society at Washington, D.C.

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and provided with a spout, *h*. The iron notch H, for drawing off the metal, is formed within the bottom frame C, at the end opposite to that of the slag notch and below the upper surface of the bottom lining. In the sides AA°, and above the level of the slag notch, are vent holes *a*°, and in the ends stoke-holes *b*°, the former enabling the escape of the gases of combustion and reduction, and the latter the breaking up of the slag crusts that may form, and for facilitating the even settling of the stock. The cover D is provided with feed and vent holes (*d* and *d'* respectively), and, besides, an opening, *d''*, for the electrode. K and L are the upper and lower electrodes, with connecting wires K' and L', the former consisting of a battery of square carbons, suitably connected at the top and held adjustably suspended, and the latter of a carbon bar, embedded within the bottom lining, and extending longitudinally from the metal notch to the end of the bottom frame, with which it is in contact. The furnace is supported by legs F, at an elevation above the floor, to make room for the ladle cars running on rails G, as well as for the convenience of readily exchanging a burnt-out bottom for a new-lined one. The furnace lining is made of magnesia brick, the only material that we have found to withstand the heat and the chemical action between the charge and the lining. These bricks have the following composition: SiO_2, 4·41 per cent.; Al_2O_2, 23·07 per cent.; CaO, 9·40 per cent.; MgO, 63·12 per cent.

In this furnace ferro-nickel was made for several days from poorly-roasted ore (with about 3 per cent. sulphur and 53 per cent. iron) at the rate of 60lb. per hour (equivalent to 225 gross tons per annum), with an expenditure of 108kw. (135 amperes at 80 volts) =144 H.P., or at the rate of 0·64 H.P. per gross ton-year, or 230 H.P. per gross ton-day, or about 5 500 H.P. per gross ton-hour.

With a furnace of 300 H.P. to 500 H.P., which would be more economical, 200 H.P. would probably suffice for obtaining a gross ton of ferro-nickel per 24 hours. At a rate of $10 per horse-power per annum for the power, $5 per ton for the ore, $5.50 per ton for coke, and $2.50 per ton for limestone, the cost items for the manufacture of 1 ton of ferro-nickel pig in the electric furnace at this place would probably have been as follows:—

2 tons partly-roasted pyrrhotite, at $5	$10.00
500lb. coke, at $5.50	1.37
1·5 tons limestone fines, at $3	4.50
Labour and salaries	2.50
Electrodes and repairs	2.50
Power, 200 H.P., at $10	5.50
Total cost per ton metal	$26.37

The value of this product—a ferro-nickle pig with 3 per cent. nickel contents—should be that of the nickel contained in the metal, plus that of the pig iron; so that, if we assume the value of nickel at 30 cents per pound, and pig iron at $14 per ton, the product would be worth (60 by 0·30=$18+$13.57=) $31.57—showing a profit of over $5 per ton metal produced.

Simultaneously with the above work, experiments in dead roasting the pyrrhotite were also carried out, and these were sufficiently encouraging to warrant the belief that this could be done at small cost, while at the same time the resulting SO_2 gas would be profitably utilised in the sulphite pulp industry. As the electric smelting plant on the large scale intended would necessitate the completion of a large power plant, it was decided to carry out the original intention of roasting the ore, briquetting the roasted fines, converting the briquettes, and, finally, converting this pig metal by means of the open hearth or Bessemer process into a ferro-nickel steel.

ELECTRIC TRAMWAYS IN THE EAST.

Messrs. Dick, Kerr & Co. inform us that they have recently obtained a contract for electric tramway plant and material for Bangkok tramways, owned by the Siamese Tramways Co. (Ltd.) The contract includes power-house equipment, which consists of three 200kw. 500-volt continuous-current generators coupled directly to three Browett-Lindley vertical compound engines and the usual accessories, including surface condensers, pumps, &c. There are also 40 single motor equipments of standard 25B type, mounted on Brill 21E trucks, which, together with the whole of the rails, fish-plates and tie-bars for the 13½ miles of line, will be supplied by Messrs. Dick, Kerr & Co.

Among the other contracts which this firm is carrying out, are the Mandalay tramways, recently opened by the Lieut.-Governor of Burma, Sir Hugh Barnes, K.C.S.I., K.C.V.O., the system being now in operation. The total length of these tramways is 12 miles of single track laid to a gauge of 3ft. 6in. with girder rails, weighing 85lb. per yard. Span-wire overhead construction is employed. There are 24 single-deck open cross-bench cars, each of which will accommodate 48 passengers; these were built by the Electric Railway & Tramway Carriage Works, Preston. The cars are mounted on Brill maximum trucks, each car being supplied with a complete electrical equipment consisting of two Dick-Kerr standard 25B motors with DB1 form "C" controllers. The power-house equipment consists of three Dick-Kerr continuous-current compound-wound 200kw. 500-550-volt generators, running at 400 revs. per min. and directly coupled to three Belliss compound engines; the switchboard is in accordance with standard traction practice, and consists of four feeder panels, three generator panels, one testing panel and one panel for motor and lighting circuits.

Hongkong electric tramways are rapidly approaching completion, the contractors here being Messrs. Dick, Kerr & Co. The total length of single track is 14½ miles, and is laid to a gauge of 3ft. 6in., with girder type rails weighing 86lb. per yard. Centre pole construction is adopted within the city, but outside the city boundary side poles have been employed. The power house is as nearly as possible in the centre of the system, the plant consisting of two continuous-current compound-wound 300kw. railway generators of the multipolar type, running at a speed of 100 revs. per min. at 500 volts, and directly coupled to the main shafts of two engines built by Messrs. Yates & Thom. In addition to the two traction sets, two combined sets for arc and incandescent lighting of the depot have been installed. The switchboard consists of two generator panels, two feeder panels, three lighting panels, one main station panel and one Board of Trade panel. In the boiler house are two B. & W. water-tube boilers with the usual accessories. 26 single-deck cars are provided, 10 being of the combined type, with an enclosed portion in the centre and an open platform with seats at either end, and each capable of seating 32 passengers; the remaining 16 cars are of the open cross-bench type, to seat 48 passengers, and all were built by the Electric Railway & Tramway Carriage Works. Each car is mounted on a Brill 21E truck, and is fitted with two of Dick-Kerr's standard four-pole series-wound motors of 25 H.P., and at either end of the car is one of the same firm's standard DB1 form "C" controllers. This is the pioneer system of electric traction in China, and it is to be hoped, therefore, that the venture will meet with success.

Singapore tramways are in the hands of the same contractors, and considerable progress is being made. The power house contains eight Lancashire boilers, with the usual accessories, including two fuel economisers and four feed pumps. Of the three engines, two by Messrs. Yates & Thom, of the horizontal cross-compound condensing type, are coupled directly to two Dick-Kerr standard 500kw. 500-volt compound generators running at 100 revs. per min. For lighting purposes a 150kw. set, consisting of a Dick-Kerr continuous-current generator directly coupled to a Willans engine has been installed, and there is also a 50kw. motor-driven generator working off a circuit of 550 volts. A suitable switchboard has been supplied and erected by the contractors. The overhead work has been carried out on the span-wire system, the total length of single track being 27 miles, laid to a gauge of 1 metre. Girder type rails weighing 95lb. per yard, upon a continuous beam of concrete, have been employed in the construction of the permanent way. Of the 50 cars comprising the rolling stock, 20 are of the single-deck, single-truck combination type with a seating capacity of 32 persons, and 30 are of the open cross-bench type to seat 40 persons. They are mounted on Brill 21E trucks and equipped with Dick-Kerr standard 25B motors and DB1 form "C" controllers. In addition, there are 33 goods vans mounted on Brill 21C trucks, each with a double motor equipment, the whole of the rolling stock being built for Dick, Kerr & Co. by the Electric Railway & Tramway Carriage Works, Preston.

Considerable extensions are being carried out by the Calcutta Tramways Co., and this work has been entrusted to Messrs. Dick, Kerr & Co., who were the original contractors. This work includes 10 additional open-type motor cars, in all respects similar to those supplied before—*i.e.*, single-deck open-type cars mounted on Brill trucks and equipped with two standard motors each with a form "C" controller. The main station plant is being increased by a standard 500kw. three-phase alternator which generates 6,000 volts at 94 revs. per min. and a frequency of 25 ∽ per second. This machine is directly coupled to a Yates & Thom horizontal cross-compound engine. Two sub-stations are being erected, in each of which will be placed a 300kw. rotary converter with the necessary transformers and switch gear.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Electro-Chemistry." Part I. General Theory, by R. A. Lehfeldt. With chapter on the Relation of Chemical Constitution to Conductivity, by T. S. Moore. Text Books of Physical Chemistry Series. Edited by Sir William Ramsay, F.R.S. (London: Longmans, Green & Co.) 5s.

"Die Verwertung des Koksofengases, insbesondere seine Verwendung zum Gasmotorenbetriebe." By B. Baum. (Berlin: Julius Springer.) 4m.

"A Technological and Scientific Dictionary." Part IV. Edited by S. F. Goodchild and C. F. Tweney. (London: Geo. Newnes.) 1s.

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CORRESPONDENCE.

DYNAMO DESIGN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In *The Electrician* of September 11th last, and later, the cost of machines was taken up. The following note may, then, not be amiss. Let the cost equation be: Price $= aD^x l^y$. Then for $D^2 l = \kappa$, $l = \kappa/D^2$, and Price $= aD^{x-2y}\kappa^y$. Hence, if large diameters cost proportionately more than small ones, formulæ of the form Price $= aDl$, Price $= aD^2 l$, Price $= aD^{1.8} l$ must be erroneous, since $x < 2y$ makes price vary inversely as D^{2y-x}, and for $x = y$ the price is independent of the diameter. It follows, then, $x > 2y$. The cost per unit radiating surface $= aD^x l^y / b\pi Dl$, since, if the length of the core is taken proportional to the pole-pitch $\pi D(L + l)$ is proportional to πDl. It is to be observed that the angle subtended by the end convections is invariably the same over an extremely long range. If $l = c\pi D/p$ and, as before, $\kappa = D^2 l$, the specific cost of radiation reduces to $\frac{a}{b}(c\pi)^{\frac{2y-x-1}{3}} p^{\frac{x-2y+1}{3}} \kappa^{\frac{x+y-2}{3}}$. It is pretty well agreed that increasing the number of poles p increases the price of a machine, and it is, furthermore, quite reasonable to assume that the specific cost of radiation should be independent of $\kappa = D^2 l$. This latter supposition is in accord with what Mr. Hobart found in the machines he investigated—that is, that in the index for κ, $x + y - 2 = 0$ or $x = 2 - y$ and x *is less than* 2. Substituting this value in the index of p, $x - y - 2y + 1 > 0 < 3(1 - y)$ and y *must be less than* 1. In reality this is known to be the case. The actual values will generally be found to be in all probability about the mean of the value of x given by Mr. Hobart—to wit, unity—and the value 2 deduced as the superior limit above. The price equation may then be written: Cost $= aD^{1.5} l^{0.5}$. It will be seen that this agrees with the condition first derived above, $x > 2y$. The presumption is that in the cost of machines investigated by Mr. Hobart the great majority of the machines had about the same number of poles.—Yours, &c, A. PRESS.

London, E.C., Aug. 5.

THE DURHAM COLLEGE OF SCIENCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your remarks concerning the splendid gift of Messrs. G. Armstrong, Whitworth & Co. to the above college appeared to throw cold water upon the efforts of those who are trying to arouse the manufacturers of this country to follow the lead of their confrères in America. So far as I can understand your views, you are afraid that such endowments will mean cheaper fees for the students in applied science and, consequently, a general lowering of the status of the engineering profession by the admission to its ranks of men who, to put it bluntly, are not gentlemen. But such endowments need not mean cheaper fees. Take the case of the Birmingham University. In the Midlands they have collected about a half a million sterling, most of which is for the endowment of applied science. The fees for engineering students are about £50 a year for four years. I would also refer you to p. 452 of the May *Journal* of the I.E.E. You will there see the points to which Mr. Hirst, of the General Electric Co., attaches most value, when he interviews applicants for posts under him. He places first of all "gentlemanly bearing," and then "good physical development." It seems, therefore, that "the rough castings" you fear would never make headway, even though "certificated."

Money is badly needed at present in nearly all university colleges for proper laboratory equipment, as well as for research work. It is surely better for the profession that you should encourage wealthy manufacturers to help them, than to accept the all-too-infrequent generosity in a doubtful spirit. In short, Sir, quarrel with, and freely criticise, the methods of spending the money, but do not attempt to dry up the spring of (for the needy colleges) living water at its source.—Yours, &c.,

C. ALFRED SMITH.

PARLIAMENTARY INTELLIGENCE.

WIRELESS TELEGRAPH BILL.

In moving the second reading of this bill in the House of Commons in the small hours of Thursday morning,

The POSTMASTER-GENERAL (Lord Stanley) said: There are two principles that I have endeavoured to embody in this bill: First, that safety for the nation in the time of danger should be secured by the Government being allowed to exercise control o er wireless telegraphy; and, secondly, that we should not allow a big monopoly to grow up which at some time the State might have to purchase. The advisability of securing the latter is very obvious when one regards the results of the telephone monopoly. Fears have been entertained in certain quarters that this bill would be in some way harmful. I have endeavoured to meet, and I think that in each case I have succeeded in meeting, the views of hon. members who entertained those fears by amendments which will be passed by agreement. The class with whom I have the greatest sympathy are those who wish to go in for experiments in this science, and I have been able to frame a clause which will give absolute freedom in that direction, merely requiring registration on the part of those who wish to engage in experiments. In a matter of this description the House will doubtless desire that the act should be administered as liberally as possible, and I shall certainly do my best in that direction. For what it is worth I will give an undertaking that no request for a licence for experiments shall be refused unless the refusal has been approved by me personally. I will also insert a clause limiting the operation of the bill to two years, so that at the end of that period, with the experience that will then have been gained, any necessary alterations may be made.

Mr. LOUGH, who had given notice of his intention to move the rejection of the bill, said he would agree to the second reading only on the understanding that substantial amendments be placed on the paper, in the sense indicated by the noble lord, for the purpose of minimising, if not altogether removing, the objections entertained to the bill. Having been a long time in the House, he was naturally somewhat sceptical about the promises of Ministers, and he was not at all sure that the amendments which had been promised would be such as to make it possible to regard the bill with any favour. He objected to a bill of this character being rushed through at such an hour and at such a period of the session; if the matter was of so pressing a character it ought to have been dealt with earlier. If any mistake were made through its being taken under pressure much harm might result, and in assenting to the second reading he wished to reserve to himself full rights to object to the bill, if necessary, after the promised amendments had been placed on the paper.

The bill was then read a second time.

Lord Stanley, in accordance with his promise, has placed upon the paper the following amendment to the Wireless Telegraphy Bill:—

To add to clause 2:—Where an applicant for a licence satisfies the Postmaster-General that a wireless telegraph station is to be used solely for the transmission of telegrams which are within the first or second exception from the exclusive privilege of transmitting telegrams conferred upon the Postmaster-General by the Telegraph Act, 1969, a licence for that purpose, if granted, shall not be subject to any rent or royalty.

To insert the following clause:—

In the application of this act to the Channel Islands and the Isle of Man

(1.) The lieutenant-governor of the island of Jersey or the island of Guernsey, and the governor, lieutenant-governor or deputy governor of the Isle of Man, as the case may require, shall (except with respect to the grant of licences), be substituted for the Board of Trade;

(2). Offences may be prosecuted, fines recovered, proceedings taken and search warrants issued in such courts and in such manner as may for the time being be provided in the Channel Islands and the Isle of Man by law, or, if no express provision is made, then in and before the courts and in the manner in which the like offences, fines, proceedings and warrants may be prosecuted, recovered, taken or issued therein by law, or as near thereto as circumstances admit, and the bailiff or his lieutenant, or any jurat of the Royal Court in the island of Jersey or the island of Guernsey, and the judge or any jurat of the Court of Alderney, and the high bailiff or two justices of the peace in the Isle of Man shall respectively be substituted for a justice of the peace.

Mr. Lough, by agreement with the Postmaster-General, will move the addition of the following sub-sections to Clause 3:—

(3.) His Majesty in Council may order that this act shall, subject to any conditions, exceptions and qualifications contained in the order, apply during the continuance of the order to British ships whilst on the high seas.

(4.) A person shall not work any apparatus for wireless telegraphy installed on a foreign ship whilst that ship is in territorial waters otherwise than in accordance with regulations made in that behalf by the Postmaster-General, and the Postmaster-General may by any such regulations impose penalties recoverable summarily for the breach of any such regulations not exceeding £10 for each offence, and may provide for the forfeiture on any such breach of any apparatus for wireless telegraphy installed or worked on such ship. Save as aforesaid, nothing in this act shall apply to the working of apparatus for wireless telegraphy installed on any foreign ship.

Also, by arrangement with the Postmaster-General, Sir Walter Plummer proposes to add the following to clause 2, the amendment really being the outcome of negotiations between the Postmaster-General and the Newspaper Society:—

It shall be lawful for the Postmaster-General, due regard being had to the maintenance and exercise of effective control over wireless tele-

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graphy, to grant special licences at reduced terms for the establishment and working of wireless telegraph stations to be used exclusively for the transmission within the United Kingdom of news to public registered newspapers. A schedule of all reduced rents or royalties imposed by any special licence shall be laid before both Houses of Parliament within 14 days of the commencement of the session next succeeding the grant of any such licences.

Lord Stanley will move a clause limiting the duration of the act to Sept. 31, 1906, "unless Parliament otherwise determines."

SUPPLY OF ELECTRICITY BILL.

This bill passed through Committee in the House of Lords on Monday without amendment.

OTHER ELECTRICAL BILLS.

In the House of Lords on Thursday last week, the *University of Liverpool Bill* passed through Committee and was ordered to be reported for third reading. On Friday the *Loch Leven Water Power Bill*, the *Leyton Urban District Council Bill* and the *University of Liverpool Bill* were read a third time and passed. On Monday the *Middlesbrough, Stockton and Thornaby Tramways Bill* was read a third time and passed, as also were the *Electric Lighting (London) Bill* and the *University of Leeds Bill.*

In the House of Commons on Thursday last week, the Lords' amendments to the *Saddleworth and Springhead Tramways (Abandonment) Bill* were considered and agreed to. The *Ilford Urban District Council Bill* and the *Newcastle-on-Tyne Corporation Bill* were read a third time. On Friday the *Bridlington Corporation Bill, Bristol Corporation Bill, Trafford Park Bill* and the *Stretford Urban District Council Bill* were read a third time. On Monday the *Belfast and North-East Ireland Electricity and Power Gas Bill* and the *Belfast Corporation Tramways Bill* were read a third time.

THE GOVERNMENT AND THE NATIONAL TELEPHONE CO.

Lord STANLEY, in answer to Mr. Ross in the House of Commons on Monday, said that he was still in negotiation with the National Telephone Co., but while these negotiations were in progress it was undesirable to make any statement as to the nature or terms of the arrangement under discussion. He would certainly not be in a position to make any communication to the House on the subject this session, but if an agreement were arrived at it would, as he had already promised, be laid before Parliament before it became binding, in order that the House might have an opportunity of considering it.

TELEPHONE TRUNK CALLS.

In the House of Commons on Monday,

Mr. BROTHERTON asked the Postmaster-General whether he would grant six-minute telephone trunk calls from 8 p.m. on Saturdays till 8 a.m. on Mondays.

Lord STANLEY, in a printed reply, pointed out that the suggested change would involve an increase of staff for Sunday duty at most of the larger trunk exchanges, and he was unwilling to take any steps which would tend to increase unnecessarily the amount of Sunday duty. The use of the trunk system was available on Sunday at any hour to meet cases of emergency.

STREET EXPLOSIONS.

In the House of Commons on Tuesday,

Sir THOMAS DEWAR asked the Postmaster-General whether he was aware that during the two years ended June 30 last the Metropolitan Police had reported 21 explosions resulting in injury to 11 persons and the death of two horses, caused through leakages of electricity coming into contact with escaped gas. Would the Postmaster-General state how many of these explosions occurred in the streets of the metropolis in connection with telegraph and telephone plant, and to what extent the persons injured had been compensated.

Lord STANLEY, in a printed reply, said he was quite unable to admit that any of the explosions mentioned could have been caused by the leakage of electricity from telegraph or telephone wires. There had been several explosions of gas in the street boxes belonging to the Post Office, but in none of these had it appeared that the department was liable to pay compensation. Some of the recent cases were under investigation to ascertain the true cause of the explosions.

LEGAL INTELLIGENCE.

Reynolds v. Wm Ashby & Son (Ltd.)

On Friday, the House of Lords (the Lord Chancellor and Lords Macnaghten, James of Hereford and Lindley) delivered reserved judgment in this case, which raised an important point of law as to the hire-purchase of machinery, &c. Separate judgments were delivered by the Lord Chancellor (in which Lord Macnaghten concurred), Lord James of Hereford and Lord Lindley, but all were in favour of dismissing the appeal. The following abstract of Lord Lindley's judgment sets out the facts of the case:—

Lord LINDLEY said this was an action brought to recover certain machines bought from plaintiff on a hire-purchase agreement. Holdway (the hirer) did not pay the instalments of his purchase-money as they became due, and the machines, therefore, never became his property. Plaintiff knew the machines were wanted in order to fit up a factory which Holdway was building, and he put the machines into the factory on beds of concrete prepared for them. The machines were worked by steam power. Each machine was complete in itself, and each was fastened down to its concrete bed by bolts and nuts. By unscrewing the nuts each machine, although heavy, could no doubt be raised up and removed without injury to the building containing it, and without injury to its concrete bed and to the bolts embedded in it. Whilst the factory was being erected, but before any of the machines in question were put into it, Holdway mortgaged the land on which the factory was being built, together with the buildings, fixtures, machinery and fittings erected thereon. Holdway afterwards executed a second mortgage, and at a later date a third mortgage (the latter to the defendants). The machines in question were put into the factory soon after it was mortgaged to defendants. After they had been fixed, the second mortgagee took possession, and defendants then paid off the two prior mortgages and took transfers. The purpose for which the machines were obtained and fixed seemed to him unmistakable; it was to complete and use the building as a factory. It was true the machines could be removed if necessary, but the concrete beds and bolts prepared for them negatived any idea of treating the machines when fixed as movable chattels. The question was whether they passed by the mortgage. But for the fact that Holdway had not paid for them the question would not, in his opinion, be open to the slightest doubt. There was a long series of decisions of the highest authority showing conclusively that, as between a mortgagor and a mortgagee, machines fixed as those were to land mortgaged passed to the mortgagee as part of the land. In that particular case it was, in his opinion, impossible to hold that the machines did not pass with the mortgage. Whether the fact that the mortgagor Holdway had not acquired the ownership of the machines by paying for them entitled plaintiff to recover their value from defendants was the question. The title to chattels might clearly be lost by being affixed to real property by a person who was not the owner of the chattels. Holdway agreed to buy the machines, but plaintiff knew what he wanted them for, and that before paying for them he intended to put them up in his factory and to use them. He knew that the factory was mortgaged, and he ran the risk of the machines being claimed as fixtures. In effect, Holdway was authorised by plaintiff to convert the chattels into fixtures, subject to the right of the plaintiff to enter and retake them if he did not pay for them. After the machines were fixed, and before plaintiff claimed them, the second mortgagee took possession; plaintiff's right to enter and remove the machines, resting as it did on the contract with Holdway, ceased to be exerciseable. Plaintiff had no greater rights against defendants than he had against the second mortgagee, whose rights defendants had acquired. The machines had ceased to be chattels belonging to plaintiff; they were not chattels wrongfully detained by defendants. The machines had become fixtures which plaintiff was not entitled to remove from the possession of the mortgagees. There were really no facts in dispute, and nothing would have been gained by leaving any question to the jury. The legal questions arising on the undisputed facts were, in his opinion, rightly decided, and the appeal ought to be dismissed, with costs.

Brunlees v. Mersey Railway Co.

This case came before Mr. Justice Lawrance in the High Court on Friday, and was an action by Mr. John Brunlees to obtain a declaration that an agreement made between himself and defendants was still subsisting. The agreement had reference to his appointment as joint chief engineer of the company. Plaintiff also claimed damages for not having been engaged in connection with the electrification of the railway when defendants entered into a contract (of the value of £250,000) with the British Westinghouse Co. Defendants disputed the validity of the agreement, and urged that it had lapsed and did not apply to the particular works in question.

Mr. DUKE, K.C., stated that the company's engineers had been Sir James Brunlees and Sir Douglas Fox. The former was in partnership with his son (the present plaintiff), and Sir Douglas Fox was also in partnership. In 1881 the company commenced their undertaking and on May 24, 1881, the agreement was made which was in question in this case. By this agreement the then Mr. James Brunless and the then Mr. Fox were engaged as engineers to the company, and there was a clause that upon the death of Mr. James Brunlees his partner, Mr. John Brunlees (the plaintiff), should be employed, and upon the death of Mr. Fox his partner should be employed. Sir James Brunlees died in 1892 and plaintiff was then retained with Sir Douglas Fox as one of the chief engineers. In 1901 the company entered into a contract with the British Westinghouse Co. for the introduction of electric traction on their railways and for carrying out very considerable engineering works for a total sum of £250,000. Plaintiff claimed that he was entitled to be employed by the company in connection with these and other works in accordance with his contract. Plaintiff claimed 5 per cent. on the Westinghouse contract, and the total amount of his claim was £10,000. His contention was that the company were bound to employ him as long as he lived, and to pay him 5 per cent. on all rolling stock they bought, extensions they made, and changes they effected in the working of the line.

Mr. LEWIS STRIDE, C.E., said that on the electrification of a steam railway a large part of the work ought to be done by a railway engineer, though joint action between him and the electrical engineer was desirable. There was no difficulty in such co-operation.

Mr. LUSH, K.C., for defendants, submitted that the action could not be maintained. The appointment of the engineers was only for the construction of the line, including any extensions that might thereafter be authorised. The electrification of the railway was not in the contemplation of the parties when the contract was made. There could not be a valid

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contract of employment of a skilled person for an unlimited time. The contract was ultra vires on the part of the then directors.

Mr. JAS. FALCONER, chairman of defendant company, said all extensions of their railway had been either abandoned or completed. Defendants had expressly stipulated in their contract with the Westinghouse Company that their (defendants') engineer should not interfere in the work of electrification. There was no position under that contract for a consulting engineer.

At the conclusion of the arguments of counsel, his Lordship reserved judgment.

Pattison v. J. G. White & Co.

In the Court of Appeal on Friday, the Master of the Rolls and Lords Justices Stirling and Mathew had before them this appeal by defendants against an award of the judge of the Darlington County Court, acting as arbitrator under the Workmen's Compensation Act, 1897. The facts, which were not in dispute, were these:—Defendants were employed by the Corporation of Darlington in the construction of a system of light railways in Darlington. Plaintiff is the widow of a man named Pattison, who was employed as a cartman by a contractor named Wilkinson, who had contracted with defendants (inter alia) to haul some sand in connection with the works. While engaged in carting sand Pattison was accidentally killed, the scene of the accident being 2½ miles from the works. Defendants admitted that they were undertakers within the meaning of the act in respect of the work, but it was urged on their behalf that the case did not fall within the meaning of sec. 7 of the act, as the accident happened at a distance from the works, and that, therefore, the employment of Pattison could not be said to be "on, in or about" the engineering work in question. On behalf of plaintiff it was argued that inasmuch as by clause 89 of the specification defendants were bound to use the best river or grit sand, the employment of deceased in bringing such sand from a distance to the works was employment "about" an engineering work. The County Court judge came to the conclusion that even if the words "on, in or about" imputed locality or proximity in the case of a quarry, mine, &c., it did not necessarily do so in the case of an engineering work, and taking a broad view of the meaning to be placed upon the word "about," it seemed to the learned judge to be clear that the deceased at the time of the accident was employed in going to fetch sand necessary to his employers for the construction of the engineering work which they had in hand. In his judgment defendants were "undertakers" in respect of the employment of the deceased "about" the engineering work, notwithstanding the fact that the accident occurred at a considerable distance from the scene of work where the sand would be ultimately unloaded or used. The learned judge, therefore, made an award in favour of plaintiff for £187. 4s. In the present appeal defendants argued that the learned judge had put a wrong construction on the meaning of the word "about."

The MASTER OF THE ROLLS, in giving judgment, said that this appeal must be allowed, the case clearly being covered by previous decisions of the Court. The County Court judge had apparently emancipated himself from those decisions and arrived at a broad decision. For plaintiff to recover, the scene of the accident must be the physical locality where the work was being carried out. In this case the accident having occurred a considerable distance from the engineering work, the case was outside the act.

Lord Justices Stirling and Mathew concurred, and the appeal was allowed with costs, and the award of the County Court judge set aside.

Re Manchester Tramways.

In the King's Bench Division on Monday, Mr. Justice Bigham delivered judgment in the special case arising out of the arbitration proceedings connected with the acquisition by Manchester Corporation of the Manchester Carriage & Tramways Co.'s undertaking. A question arose whether the Corporation were bound to take the depot at Ashton-under-Lyne and also whether the company had a proper title to the depot.

Mr. FLETCHER MOULTON, K.C., for the Company, contended that the depot was the company's property and not that of Ashon-under-Lyne Corporation.

His LORDSHIP said he thought the Corporation must take the Ashton depot and its contents, they being suitable for the undertaking which they had acquired. He thought that the value of the undertaking included not only the cost of obtaining Parliamentary powers to construct the tramways but also the cost of the powers to maintain and work it, this being properly part of the cost of construction. But the cost of the company's opposition to private bills in Parliament, which threatened to interfere with the working of the undertaking, ascertained by the arbitrator to be £120, ought not to be paid to the company, as it could not be regarded as part of the cost of construction. Judgment was entered for the company for £13,970, £8,750 and £3,107 and costs.

Suart v. Electromobile Co.

On Wednesday, Mr. Justice Ridley heard an action to recover damages for alleged breach of contract in regard to the sale of an electric landaulette, or (alternatively) damages for breach of warranty. Plaintiff had been owner of a garage, and used to let electric landaulettes on hire. He purchased one from defendants for £250, which he averred he was told was capable of running 30 miles on one charge and which was warranted "in thorough working order and complete in every particular." Subsequently plaintiff discovered that it was defective.

Defendants contended that the warranty was not given with their authority or by their instructions, and, after hearing the evidence, judgment was given for defendants without costs.

Lowndes v. Postmaster-General.

On Wednesday Mr. Justice Farwell heard a motion to set aside the writ on constitutional grounds.

Mr. UPJOHN, K.C., for plaintiff, said the cause of action was that the Postmaster-General had put up a pole on plaintiff's private property, and he agreed that, so far as the plaintiff's position was doubtful—that the Postmaster-General was the right person to sue—the obligation imposed upon him was a serious one, inasmuch as there was a penalty of £20 a day for anybody who interfered with the telegraphic system of the country. It was a case of alleged trespass. Plaintiff's case was that there were quite sufficient authorities to show that defendant was liable for the acts of his subordinate servants.

Ultimately, on the suggestion of his lordship, it was agreed that the Postmaster-General should appear without prejudice, and the hearing was fixed for November.

Holmes v. Halifax Corporation.

At Leeds assizes on Wednesday plaintiff sought to recover damages for injuries sustained during a visit to the Corporation tramway depot in Skircoat-road.

For the defence it was contended that plaintiff was a trespasser or bare licensee, and that the injuries were caused by his own negligence.

Plaintiff's case was that as he (a saddler) was going home on Dec. 15 last he met the tramway manager (Mr. Spencer), who said, "I wish you would call some time, as I have two cars, and want some covers made for them." Mr. Spencer suggested that plaintiff should go to the depot to see exactly what was required, and it was agreed that he should call next evening, which he did. Several cars were standing there partly lighted up, but it was a dark night, and he could not see his way clearly, and fell into one of the pits excavated under the lines for repairing purposes, about 4ft. 6in. deep, and both bones of his right leg were broken.

After the evidence the jury found for plaintiff, assessing the damages at £250.

Stoker v. National Telephone Co.

At Portsmouth County Court last week, Judge Gye concluded the hearing of an action brought by a late canvasser of defendant company to recover £16. 17s. 4d. commission alleged to be due to him.

Mr. BECHERVAISE, for plaintiff, said his client was an experienced canvasser, whose duty it was to obtain customers on commission. From October, 1899, to May, 1900, the commission went on satisfactorily, but shortly after that time the company adopted a series of new expedients to get customers to plaintiff's detriment. Subsequently plaintiff was approached by Portsmouth Corporation as to their employing him in connection with their municipal telephone scheme, but he refused. Shortly after he was suspended. The company declined to pay him any money in lieu of notice, but subsequently a month's salary was paid. They would not at the time give him the money he had paid towards his pension, though that had since been paid in.

After argument, Judge GYE held that the company had abrogated their agreement with plaintiff, and that such a clause as the agreement contained (that the company would not pay commission upon orders they did not execute) did not mean that such commission should not be paid if the company were unable to execute such orders.

For the defence, Mr. HAINES (district superintendent of the defendant company) said that in May last he told plaintiff that his report as to his movements was untrue, and he suspended him. He had made up his mind to suspend plaintiff for the same sufficient reason.

Mr. HOWE (district manager of the National Company) said there were various reasons why the company might not be able to carry out orders. In one district where they would have wanted to open up a new street permission was refused by the Corporation, and the orders for that neighbourhood had not been carried out. Further, in the case of party wires, if one party was not complete, the others had to wait for the remaining members to come in.

His HONOUR said there was nothing in the agreement to the effect that plaintiff would not receive commission until he had got 10 orders in a ten-party line agreement. Judgment would be for plaintiff, with costs on the higher scale.

Anderson v. London Electromobile Syndicate (Ltd.)

Mr. Justice Farwell in the Chancery Division on Wednesday appointed a receiver and manager of the defendant company's undertaking.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Electric Supply committee of St. Marylebone (London) Borough Council invite applications for the position of resident engineer and manager of their electricity undertaking. Salary £600 per annum. Candidates must have had experience in successful electricity supply undertakings with not less than 2,000 consumers, and have had control of change of pressure of supply of a large undertaking. Further particulars are set out in an advertisement. Applications to town clerk (Mr. James Wilson), Town Hall, Marylebone-lane, London, W., by Sept. 5.

Applications are invited for the position of lecturer in electrical engineering in the University of Sydney. Salary £500 per annum,

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with permission to carry on a certain amount of consulting practice subject to approval of Senate. Further particulars from the Acting Agent General for New South Wales (the Earl of Jersey), 9, Victoria-street, London, S.W., to whom applications by Sept. 10. See also an advertisement.

A lecturer in physics is required at the Municipal Technical School, Birmingham, in September. Commencing salary £140 per annum. Particulars from the secretary (Mr. Geo. Mellor), Suffolk-street, Birmingham. Applications by Aug. 27. See advertisement.

The Council of the County Borough of West Ham require a lecturer in electrical engineering at the Municipal Technical Institute. Salary £200 per annum. Application to principal by noon Sept. 1. See also advertisement.

An instructor in electric wiring is also wanted at West Ham Municipal Technical Institute for one evening per week for the ensuing session. Particulars from the principal until Sept. 1. See also advertisement.

Weymouth and Melcombe Regis Electricity committee require a jointer, a fitter driver and a switchboard attendant. Applications to the town clerk (Sir Richard N. Howard) by Aug. 20. See advertisement.

Glasgow Corporation invite applications for the position of chie electrician of the telephone department. Applicants must be well acquainted with the construction and maintenance of telephone switchboards and instruments. Salary not to exceed £225. Applications to the town clerk (Mr. James G. Monro) by 22nd inst. See also advertisement.

A thoroughly capable cable jointer, used to triple concentric paper cables, is wanted for Hornsey (London) electricity department. Applications to the borough electrical engineer (Mr. Norman Staniland), Electricity Works, Tottenham-lane, Hornsey, N. See advertisement.

Southport Electricity committee require an engineer-in-charge. Salary £2. 5s. per week. Applications to borough electrical engineer (Mr. Reginald S. Downe) by Aug. 22. See advertisement.

The governing body of the Battersea Polytechnic, London, S.W., require the services from September of an assistant lecturer in the department of mechanical engineering. Commencing salary £170 Particulars from secretary. See also advertisement.

The committee of the City and Guilds of London Institute are about to appoint a professor of Mechanical Engineering and Applied Mathematics at Finsbury Technical College, in succession to Prof. Dalby, appointed professor at the Central Technical College. The salary is £600 per annum. Applications to the hon. sec., Gresham College, London, E.C., by Sept. 15.

The Governing Body of the Northampton Institute, St. John Street-road, London, E.C., require a chief instructor in mathematics (day and evening, part time only). Salary £150 per session. Particulars from the principal (Dr. R. Mullineux Walmsley) and applications by Aug. 31.

A junior demonstrator in physics is required at Leeds University. Salary £100. Applications by 31st inst.

Kilmarnock Town Council on Wednesday appointed Mr. Burbidge, assistant to Messrs. Kennedy & Jenkin (consulting engineers to the burgh), as engineer and manager of the electricity supply and tramways departments for three years at a commencing salary of £320, rising by £30 annually.

Mr. Brand, formerly of the Glasgow Corporation tramways department, has been appointed resident engineer to the Buenos Ayres Electric Tramway Co.

Mr. C. Jefcoat, of Limerick, has been appointed assistant lecturer in physics and electrical engineering at the Municipal Technical Institute, Belfast.

EDUCATIONAL NOTICE.

Battersea Polytechnic (London, S.W.).—The next term commences on 19th prox. Technical day college courses in mechanical and electrical engineering and day and evening courses in preparation for London University engineering degree are provided at this polytechnic. Prospectus from the secretary.

Durham College of Science (Newcastle-on-Tyne).—Courses are provided at this college for students proceeding to the degrees in Science or Letters or the diploma in the Theory and Practice of Teaching, and special facilities are offered for the study of agriculture, chemistry, mining, engineering and naval architecture. Matriculation and exhibition examinations begin Sept. 26, and lectures Oct. 4. Prospectuses from the secretary. An advertisement gives some additional particulars.

King's College (London).—The session 1904-5 commences on Wednesday, Oct. 5. Evening classes are also held for civil, mechanical and electrical engineering workshop practice, metallurgy, physics and all science subjects. Prospectuses from the secretary.

Northampton Institute.—Full day courses in the theory and practice of mechanical, electrical and horological engineering will commence on Monday, Oct. 3. Entrance examination, Wednesday and Thursday, Sept. 28 and 29. The courses for mechanical and electrical engineering include periods spent in commercial workshops and extend over four years. Students also prepare for the degree of B Sc. in engineering at the University of London. Particulars as to fees, &c., can be obtained at the Institute, St. John Street-road, London, or on application to the principal (Dr. R. Mullineux Walmsley). See also advertisement.

Aberavon.—The scheme for the construction of an electric tramway between Briton Ferry and Aberavon Beach has been conditionally approved. Messrs. H. Lewis & Fletcher, Cardiff, are consulting engineers.

Aberdeen.—The estimates of revenue and expenditure of the tramways department for the ensuing year put the income at £73,474 and the outlay at £61,000. After providing for sinking fund, interest, proportion of preliminary and Parliamentary expenses, this leaves £12,383 to be applied to renewal account.

Acton.—The chairman of the Council (Mr. J. W. Jarratt) laid the foundation stone of the transformer station on the 3rd inst., when the first length of cable was laid by the chairman of the Electricity committee (Mr. T. H. Morris). The Council have entered into an agreement with the Metropolitan Electric Supply Co. for supply of electricity in bulk.

Arbroath.—The Electric Light committee are to have another interview with representatives of the Empire Electric Light & Power Co. in regard to the terms for the transfer of the Arbroath electric lighting order.

Argentina.—The "Review of the River Plate" states that Messrs. Kincaid, Waller, Manville & Dawson have been retained by the City of Buenos Ayres Tramway Co. as consulting engineers in connection with the conversion of the company's lines to electric traction.

Buenos Ayres Public Works Department will oppose the petition to Congress of Lacroze & Cia. for a concession for the conversion of their tramway to electric traction, the Department contending that such concessions should only be granted by the Corporation.

A co-operative telephone company is being promoted in Mar del Plata.

An amalgamation of the Cordoba tramway companies and the conversion of their lines to electric traction is under consideration.

A municipal electricity supply undertaking has been inaugurated at Pehuajó.

It is stated that the Buenos Ayres Municipal Commissioners intend to revoke Messrs. Doll & Salazar's and Mr. Gaston Roux's tramway concessions.

Ashton-under-Lyne.—At Wednesday's Council meeting reference was made to the negotiations with the Stalybridge, Hyde, Mossley and Dukinfield joint electricity and tramways board as to mutual running powers over the various sections of the lines of the two authorities. The Corporation had offered certain terms, and, failing acceptance of these by the board, the matter is to be submitted to arbitration.

Australasia.—The "Australian Mining Standard" states that Mr. J. Willard, of Sydney, has obtained a concession for electricity supply and electric tramways at Townsville, Queensland.

Mr. F. E. Bradford (Noyes Bros.), who is preparing plans, &c., for the Fremantle (W. Australia) electricity supply and electric tramway projects, has also been retained by the South Australian and Victorian Governments to report on the advisability of converting certain suburban railways to electric traction.

The city electrical engineer of Launceston, Tasmania (Mr. Wm. Corin) has reported to the Council that £21,000 will be required to be expended on the electricity undertaking during the ensuing three years and £12,000 during the following two years, which will make the total capital expenditure £160,000, and legislative authority is to be obtained to borrow up to £30,000. The demand for electrical energy is increasing, especially for power, motors totalling 190 H.P. being connected to the mains, an increase of 30 per cent. on last year's figures.

The Great Southern Consols Gold Mining Co. have put in a third Ganz electric locomotive for underground haulage at their mines.

Boston.—The Council are recommended by the Paving and Lighting committee to carry out an electricity supply scheme at an estimated cost of £17,263.

Bridgend.—At the Council meeting on Tuesday it was reported that there was a profit of £150 on the past year's working of the electricity undertaking.

Burton-on-Trent.—The first 12 months' working of the Corporation tramways shows total traffic and other receipts £18,528. 1s. 10d. The car-mileage run was 433,739, and the receipts per car-mile 10·25d. 3,987,900 passengers were carried, being 9·19 passengers per car-mile. 540,191 units of current were consumed, or 1·28 units per car-mile. Special expenses incidental to the starting of the tramways have been charged, and the operating expenses, which were 7·57d. per car-mile at the end of the first eight months, were reduced to 6·9d. at the end of the 12 months. The net surplus on the year's working is approximately £2,000.

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Bury (Lancs.)—The Bolton-road section of the Corporation tramways was officially inspected and opened for traffic on Wednesday.

Cardiff.—Attached to the report of the borough electrical engineer and manager of the electric light department (Mr. Arthur Ellis) for the year ended March 31 is a series of tables setting out the financial position of the department.

The total capital expenditure is £183,766. 19s. 10d., an increase of £26,599. 18s. 10d. during the year. The receipts for private lighting were £21,783. 18s., for power, &c., £1,893. 19s. 8d., meter rentals £554. 10s. 3d., public lighting £5,190. 15s. 8d., the total income being £29,368. 8s. Total expenses were £17,838. 4s. 8d., leaving a gross profit of £11,530. 3s. 4d. Interest absorbed £5,774. 15s. 9d., repayment of loans £3,359. 19s. 7d., and, after making certain allowances, the net profit was £2,378. 15s. 5d. 2,912,248 units were generated, 1,720,313 were supplied to private consumers, 647,918 to public lamps and 16,841 sold by contract. The total maximum supply demanded was 1,713kw. The load-factor was 15·81 per cent., compared with 12·42 per cent. in the previous year. There are 1,012 consumers, representing an equivalent of 109,570 8 c p. lamps connected, increases of 195 and 25,668 respectively on the year. The works costs were 1·11d. per unit, a decrease of 0·12d., and the total costs 1·41d., a decrease of 0·21d. per unit. There are 120 motors, representing the equivalent of 582·25 H.P. connected, 478·3 H.P. to direct current and 105·95 H.P. to alternating current. 44 per cent. of the units used for lighting were supplied on the maximum demand system of 7d. and 2d., the total reaching 603,815 units, realising £8,186, against £10,857 for 578,971 units on the flat rate of 4½d. per unit. Mr. Ellis states that prepayment meters have not been taken up to the extent anticipated, and he attributes this to the fact that most of the consumers are business people, "who cannot be bothered with putting pence into meters." In view of the increased demand for electrical energy for power, Mr. Ellis recommends that orders should at once be placed for the special three-phase power plant which will have to be put down to enable the department to meet the demand, as the existing plant will be fully loaded this winter.

Carnarvon.—The Council have received sanction to borrow £17,315 for electricity works. The contract for the buildings has been let at £2,900.

Chingford.—Negotiations are proceeding between Walthamstow and Chingford Councils as to the supply of electricity by the former in a portion of the area of the latter authority.

Cricklewood.—Hampstead (London) Council have decided (with the consent of Hendon Council) to lay electric lighting mains for the supply of electric current to a block of buildings at Cricklewood belonging to the Midland Railway Co.

Dumbarton.—The Council have referred to the Bills and Electric committee an application by the Electric Supply Corp. for six or nine months' delay before starting work under their provisional electric lighting order, to enable them to make arrangements with the company which is to utilise Loch Sloy Falls in the generation of electrical energy.

Dumfries.—The Council propose to transfer their provisional electric lighting order to the India Rubber, Gutta Percha and Telegraph Works Co.

The agreement provides for the payment by the company of £620, expenses incurred by the Council, £80 as fees for engineer's expenses and a yearly sum of £30 for an annual inspection by the Council's engineer. The Council is to purchase land for the station, and the company is to pay the Council £100 per annum as rent. The Council is also to have the right to purchase the undertaking after the expiration of 7½ years for the amount of capital expended plus 25 per cent. The maximum prices to be charged by the company for electric energy to private consumers is to be 7d. per unit for lighting and 3d. for power.

Duties on Colonial Imports.—Recent decisions are that 10 per cent. ad val. shall be charged by the colonies included in the African Customs Union on imports of electrical cutouts and fittings, Gamewell's fire alarms and fittings, and conduit piping for electric wires.

East Barnet.—The Council's consulting engineer (Mr. W. P. Adams) has reported favourably upon the offer of the National Electric Construction Co. for the erection and running of electricity works which can be acquired by the Council after 15 years, when £12,000 of the capital borrowed (£22,000) will have been repaid, or after 25 years when the whole amount has been redeemed. Offers have also been received from the North Metropolitan Electric Power Supply Co. and the Sir Hiram Maxim Electrical & Engineering Co.

Egypt.—A British syndicate recently submitted to the Egyptian Minister of Public Works proposals for taking concessions for establishing electricity works for Damanhour, Luxor and Assouan.

The Société de la Basse Egypte, who hold a concession for the electric lighting of Tantah, expect to supply electric current in September.

Electrical Machinery in Collieries.—Among important contracts which Messrs. Ernest Scott & Mountain (Ltd.) have in hand for electrical mining machinery are the following:—

Complete electrical transmission of power plant for Mickley Colliery, near Stocksfield-on-Tyne, including two sets of horizontal coupled compound slow-speed engines of 360 effective H.P. each and two direct-current generators, each of 270kw., mounted on engine crankshaft. These dynamos are of the firm's latest type, each fitted with 18 poles and arranged to give the output stated above when running at 110 revs. per min. This contract includes a booster which will raise the pressure of the current at the far end to compensate for the loss in the cables, a 150 H.P. main and tail haulage complete with friction clutches and electric motor and two electric winding gears, together with main and branch cables, main and distributing switchboards, starting switches and small motors for smiths' shops, &c.

For Littleton Collieries, near Durham, an electrical pumping plant, consisting of a quadruple centrifugal pump to deliver 350 gallons of water per minute against a head of 250ft., the pump being driven by a Scott & Mountain multipolar electric motor of 66 effective H.P. running at 1,220 revs. per min., the motor being placed between the pumps—*i.e.*, a series of two pumps being placed on each side of the motor. The firm are also supplying for the colliery a 30 effective H.P. electric motor for driving an existing haulage gear and a complete arrangement of motor-room switchboards and cables.

For the Globe Phœnix Gold Mining Co., Rhodesia, the firm are supplying one of their latest types of three-phase alternating-current generators of 112kw. and a three-throw mining pump to deliver 170 gallons of water per minute against a vertical head of 1,000ft., complete with three-phase induction motor of 40 effective H.P., switchboards, cables, overhead equipment, starting switches, &c.

In regard to coal cutting by electricity, Messrs. Scott & Mountain have lately designed a disc machine suitable for working in thin seams, the height of the coal-cutting machine being 14in. This machine can be made to work on rails or skids, the total height from floor to top of machine when on rails being 22in., and when mounted on skids 20in. The firm have already supplied several machines of this class, and at present have in hand coal-cutting machines for Hamsterley, Shilbottle and Old Silkstone Collieries and for Messrs. Newton, Chambers & Co. and others.

Electricity in Agriculture and Horticulture.—This subject at the present time is attracting attention in many places. Various experiments have been made at Lecce, Italy, in assisting the germination of tobacco seedlings by the aid of the electric current. It is stated that the experiments have not proved sufficiently encouraging to justify their repetition.

Exmouth—The Electric Supply Corp. have secured a site for their electricity works and expect to commence supply by January next. Contracts for buildings, plant, &c. (amounting to about £20,000), have been let.

"Faraday House Journal."—We have received a copy of the August issue of this "Journal," the organ of the Electrical Standardising, Testing and Training Institution. The articles from students and old students include Papers upon "The Theoretical Consideration of the Steam Turbine," by H. W. Swann; "The Advisability of Earthing the Middle Wire in Three-wire Installations," by D. M. Hutchison; "The Method of Reducing the Pressure Drop in Rails of Electric Tramway Systems," by A. Murray Coombs; and "Electricity in Use in Gold Mining," by G. M. Dyott. There is also an interesting article upon the Reading Electric Supply Co., which is affiliated to the Institution. The opening paragraphs deal with the appointments obtained by former students, and reference is also made to the new establishment which is being erected in Southampton-row, which will afford about twice the accommodation provided by the existing premises. The Institution, which was the first to combine instruction in scientific knowledge with practical engineering training, has, it will be seen, met with considerable and, we think, deserved success.

Glasgow.—Last week the Corporation authorised the Tramway committee to procure covers for 100 tramcars. The committee reported that they had shown several types of covered car working on the streets. The one recommended for adoption was a material improvement, architecturally and otherwise, on those that had been in use for some time. In order that all the routes in the city should share the new cars, the committee have been authorised to lower the roadway under bridges where at present there is not room for the cars to pass. It was stated that the adoption of the new cars would more than double the carrying capacity of the cars in inclement weather.

Gravesend.—The Council offer to pay Northfleet Council £250 provided the latter consents to the Gravesend Council's application for a provisional electric lighting order for Northfleet.

Greenock.—There is a deficit of £2,100 on the past year's working of the electricity department, and this is attributed mainly to the award of the Board of Trade arbitrator in the arbitration between the Corporation and the tramway company as to the price of electrical energy.

Hales Owen.—The Empire Electric Light & Power Co. will shortly commence work in connection with their electricity supply and tramways scheme.

Hawarden.—The Council have authorised Saltney Parish Council to adopt electric lighting in East Saltney.

Haydock (Lancs.)—The Council recently decided to apply for a provisional electric lighting order in consequence of their having received notice from the Lancashire Electric Power Co. that they were applying for an order.

Hull.—The traffic receipts of the tramways department for the past year were £100,642. 5s. 1d., gross profit £38,064. 14s. 1d., and,

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after paying interest and sinking fund instalments, the net profit was £18,985. 3s. 2d. £7,485. 3s. 2d. has been transferred to reserve.

Ilford.—The accounts of the tramways department for the year ended March 31 show total receipts £28,217. 17s. 9d. and expenditure £13,568. 1s. 3d., including £3,701. 9s. 2d. for power, traffic expenses £7,131. 15s. 6½d., maintenance and renewals £1,162. 16s. 11., management expenses £704. 4s. 4½d. and rates and taxes £691. 7s. 3d. After paying interest (£3,345. 4s. 4d.) and sinking fund instalment (£2,291. 0s. 6d.), the balance profit was £4,570. 17s. 9d. The total capital expenditure was £132,874. 3s. 11d.

King's Norton.—The Council are proceeding with the negotiations with companies which have submitted offers for the erection and working for a number of years of electricity works. The Council's consulting engineer is Mr. C. H. Gadsby.

Leeds.—The City-square–Hyde Park Corner tramway route was opened for traffic on Monday.

Leyland.—The Council have obtained an extension of a year to carry out the terms of their provisional order.

Light Railways.—The Board of Trade have, after modification, confirmed the Woodbridge and Bawdsey Light Railway Order, 1904, and the Bideford, Westward Ho! and Appledore Light Railway Order, 1904.

The Light Railway Commission have rejected the Tarporley and Cuddington light railway scheme.

The Kidderminster and District Electric Lighting & Traction Co (Ltd.) propose to apply for an extension of time to complete the Kidderminster and Bewdley light railway.

The Light Railway Commissioners recently held an inquiry into the application of the Penmachno, Corwen & Bettws-y-Coed Light Railway Co.'s application for an order to construct a light electric railway between Corwen, Bettws-y-Coed and Penmachno, about 28½ miles in length. The Commissioners have decided to grant an order, but stipulate that the promoters must come to an agreement with their single opponent, a local landowner. The estimated cost of the line, which will be of 2ft. gauge, is £130,000.

Londonderry-Moville Electric Railway.—An Order in Council has been issued authorising the construction of this line.

Lyons (France).—In a recent report upon the trade of this district it is announced that there is a growing tendency to make greater use of water power for generating electrical energy in connection with the chemical industry. The new law recently promulgated governing the regulation of watercourses comes opportunely, and private enterprise is to be safeguarded.

The manufacture of steel tools by the electric furnace is making satisfactory progress. The factory of the Société Electro-métallurgique Française at Praz is turning out excellent material, and a new factory on the river Romanche is beginning to produce the steel. The transmission of electric power over considerable distances is also being developed, and it is stated that 3,000 H.P. is to be transmitted from the Alps, distant 100 miles from Lyons, for the working of the electric tramway company's system. On the other hand, electro-chemistry does not appear to make satisfactory advance, owing to the unprofitable prices of the products (chloride of lime, chloride of carbon and chlorate of soda).

Maidstone.—For the year ended March the gross profit on the electricity undertaking was £2,508. 4s. 8d., against £1,472 6s. 4d. for the previous 15 months. Interest and sinking fund charges absorbed £3,783. 5s. 5d , so that there was a deficiency of £1,275. 0s. 9d. Capital expenditure was £9,389. 13s. 8d. for the year.

Mansfield.—An inquiry was held here on Wednesday into the application of the Council for permission to borrow £15,000 for electricity supply. The consulting engineer (Mr. Robert Hammond) gave evidence in support of the application, and explained that a portion of the loan was for excess expenditure over the original estimate, the balance being for extensions of mains, &c.

Municipal Telephony.—Last week Bournemouth Telephone committee recommended the Council to apply for a municipal licence, but, after discussion, it was decided to withdraw this recommendation.

Mynynddislwyn.—The question of applying for a provisional electric lighting order is under consideration by the District Council.

Neath.—The Council have decided to borrow £2,000 for electricity supply. Current in bulk will be taken from the South Wales Electrical Power Distribution Co.

Newcastle-on-Tyne.—The controversy between the City Council and the Tyneside Tramways Co. as to mutual running powers has been closed, and on Saturday the Corporation cars commenced to run from Newcastle Central Station to Gosforth Park, half of the route being on the company's system.

Oldham.—The Council are applying for sanction to borrow £48,114 to cover excess expenditure on Greenhill and Rhodes Bank stations and for extensions of plant and mains.

Pembroke.—Sanction to a further loan of £25,000 for electric lighting extensions has been obtained by the Council.

Penrith.—The Council have decided to proceed with their electric lighting scheme, and tenders for plant (particulars of which are given in another column) were accepted.

Personal.—Mr. W. B. Esson, who has held the position of chief engineer to Messrs. Johnson & Phillips, Victoria Works, Old Charlton, for the past 10 years, retires from active service at the end of the month. During the above period Mr. Esson has been responsible for all the important electrical work done by this firm at home and abroad.

Poplar (London).—A recommendation of the Finance committee that the profit on the electricity undertaking (£3,908) be transferred to reserve has been referred back until the report on the Council's finances has been presented.

Pudsey.—The Corporation will apply for a tramway provisional order.

Reading.—The total receipts of the tramways department for the year ended July 21 were £31,702, the total operating expenses £18,267, leaving gross profit £13,434 to meet interest and sinking fund charges, which absorbed £12,177, the net profit on the year being £1,258. The passenger receipts averaged 9·08d. per car-mile, and the operating expenses 5·28d.; adding interest and sinking fund charges, the total expenses were 8·78d. per car-mile. The number of passengers carried was 7,657,569.

Simla.—According to the "Pioneer Mail," a committee appointed by the Punjab Government to inquire into the question of increasing Simla's water supply is about to present its report. The committee have decided to generate electric power from Nauti Khud, which will be transmitted to the pumping station situate in the valley below Phagu, where Simla's extended water supply will be located. Current is not only to be provided for pumping by day, but will be utilised for electrically lighting the town at night and for supply to private consumers.

South Africa.—The "British and South African Export Gazette" says:—

Bloemfontein (Orange River Colony) Corporation are having specifications prepared for electric tramways, and will invite tenders for the construction of the system. Messrs. Robert Hammond & Son are the consulting engineers.

The consulting engineers to Port Elizabeth (Cape Colony) Municipal Council (Messrs. Robert Hammond & Son) have presented their report on the electricity supply and electric tramway scheme prepared by the resident engineer (Mr. R. Pape), and recommend the adoption of a high-tension system. The estimated capital expenditure is £90,000.

Amongst other electricity supply schemes in progress or in contemplation are those of Heidelberg and Vryheid (Transvaal), which are now under discussion, and that of Umtala (Cape Colony), where plans are invited for a combined electricity and water supply scheme.

An electric tramway is to be constructed from Kimberley to Alexandersfontein, a distance of 6 miles.

Natal's imports during 1903 included electrical machinery to the value of £86,400 from the United Kingdom, £24,000 from America and £16,000 from Germany. Electrical fittings from America and Germany were £6,000 and £5,000 respectively.

Spalding.—The Council have resolved to apply for a provisional electric lighting order.

Stourbridge.—At the inquiry in April into the Council's application for permission to borrow £16,000 for electricity supply the Local Government Board inspector advised the Council to consider the question of taking current in bulk from the Midland Electric Corp. for Power Distribution. It has now been decided to adopt this course, and an inquiry was held on Thursday into an application by the Council for sanction to a loan of £4,000 for mains, &c.

The clerk (Mr. GODDARD) said the agreement with the company was not quite completed, but it was proposed that the charges should be 1·5d. per unit for current for power, subject to discounts, and 2·55d. for lighting.

The electrical engineer (Mr. J. B. CLARKE) said £2,940 was required for mains, &c., and £1,000 for meters and services.

Mr. J. HARDIE MCLEAN, on behalf of the company, said the latter were willing to accept the general terms of the agreement.

The INSPECTOR said the Local Government Board would not sanction the loan till they had the completed agreement before them.

Swindon.—A plebiscite of the ratepayers is to be taken on the question of running Sunday trams. The Council have rejected the proposal by 19 votes to 18.

Theft.—At Clerkenwell (London) Police Court on Friday, three men named Lawrence, Taylor and Birch were charged on remand with being concerned in stealing from the Islington Council's electric lighting station at Holloway three half-ingots of lead. Alfred Wall was charged with receiving the lead, knowing it to have been stolen. Lawrence and Taylor were each sentenced to one month, Birch to six weeks and Wall to six months.

Transmitting Designs by Telephone.—Messrs. W. T. Glover & Co. have worked out the following ingenious method for transmitting single designs and sketches by telephone. Before telephoning, the sender draws the design he wishes to transmit on a squared chart, specially prepared for this purpose by Messrs. Glover & Co.

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Then he puts down into words and figures a description of it by noting the numbers of the horizontal and vertical lines of the chart, at the intersection of which are the corner points of the design, always stating the number of the horizontal line before that of the vertical. Curves are fixed by noting their centre and radius. This description in figures is now telephoned to the supplier, who is able to reconstruct the drawing on a similar chart by reference to the figures communicated. We are informed that this system of transmitting information of a technical nature was developed by the works engineer of the company as a means of overcoming difficulties experienced in transmitting information which could not be clearly explained by telephone in the ordinary way. These charts, which have been copyrighted, are supplied gratis to the firm's customers and to business people generally, and the system is said to have proved so successful in practice that the firm has already received applications from several firms who desire to use the chart.

Urmston.—The District Council have given notice that they intend to exercise the powers and assume the obligations conferred upon them by the Manchester Southern Tramways Act, 1903.

Wakefield and District Tramways.—The Board of Trade inspection took place on Tuesday.

Wallasey.—The accounts of the tramways department of the Council for the year ended March 31 show gross receipts of £35,873. 1s. 4d., against £31,474. 15s. 11d. in previous year.

Working expenses were £24,174. 8s. 5d., against £19,194. 12s. 11d. Gross profit was £11,698. 12s. 11d, which, together with £2,806. 18s. 11d. from previous year, made the disposable balance £14,505. 11s. 5d. Interest and sinking fund instalment absorbed £5,682. 2s. 5d., depreciation and renewals £4,500, insurance £806. 0s. 10d.; £2,650 was devoted in aid of rates, leaving £867. 8s. 2d. 47 per cent. (£11,277) of the total working expenses, was paid to other departments of the Council during the year, the main items being for electrical energy, repairs to overhead equipment and rates. 6,564,493 passengers were carried, an increase of 879,311. The Tramways committee have adopted roof coverings on all their cars. The total capital expended is £127,949. 1s. 3d.

Walsall.—In moving the adoption of the Electricity committee's report, recommending the revision of the charges for electric current, the chairman (Ald Brownhill) stated at the Council meeting on Monday that

They were sacrificing nearly £1,000 per annum, but they felt it would be for the ultimate good of the undertaking. They anticipated that the latter would become a financial success, and in addition to reducing the charge for current supplied to the tramways department, the committee were able to reduce the charge to other consumers. It was proposed to charge 4d. per unit on a flat system for current for lighting, and 1½d. per unit for power. The gross profit at present was as much as the total income had been a year or two ago. Cost of production was 1·48d. per unit.

On the recommendation of the Tramway committee, it was decided to purchase six car tops at £80 each.

Wiring of Consumers' Premises.—Stepney (London) Council have decided to support London County Council in their effort to obtain powers for local authorities to wire premises and to supply electric light fittings to consumers, and to borrow money for these purposes.

Wolverhampton.—The report on the working of the tramways undertaking for the year ended March states that horse traction has entirely ceased, and its conversion to electric traction was completed and the line re-opened in April.

On the electric tramways the receipts were £23,522. 13s. 3d. Deducting expenses, there was a deficit on the electric tramways for the year of £1,090. 0s. 10d., against a profit of 1,828. 5s. 8d. in 1903. The total loss on horse and electric traction combined since the acquisition of the undertaking is £4,201. 11s. 10d., of which £486. 6s. 10d. has been sustained by the electric lines, after placing £4,517. 13s. 7d. to renewals fund. The Tramways committee regard the electric traction account as very satisfactory, and are of opinion that as soon as the system is completed and traffic developed the undertaking offers every prospect of financial success.

The tramway from Waterloo-road to Bushbury-lane was officially inspected on Wednesday.

Workmen's Compensation.—The report of the Departmental Committee of the Home Office, appointed in November to inquire into the law relating to compensation for injuries to workmen, has been issued in Blue Book form, and with appendices extends over 200 pages. With regard to the extension of the application of the Workmen's Compensation Act, 1897, the Committee recommend (inter alia):—

The adoption of the principle of extension to special industries or classes of employment after consideration of the circumstances of each class. That the benefits of the act be extended (*a*) to carriers, not including foot carriers; (*b*) to workers in workshops where five or more persons are employed; (*c*) to persons employed in the care or management of horses and locomotives, including farriers. That power should be given to the Secretary of State to extend, after inquiry, the application of the act to other industries or kinds of employment, subject to Parliamentary approval.

In a memorandum, Sir B. C. Browne and Capt. O. J. G. Chalmers say: "While we agree generally with the report, and consider that it is absolutely necessary in common justice to extend the workmen's claim to compensation for accidents happening away from, as well as in or about, the factory to which he belongs, we think this should be coupled with some substantial modification of the liability of the so-called undertaker for accidents to workmen employed by some who may at present be classed as sub-contractors."

In a second memorandum Mr. G. N. Barnes declares himself in favour of "compulsory insurance, provided insurers are offered national insurance as an alternative to that with the ordinary companies."

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Hove Corporation invite tenders for the supply, delivery and laying in the parish of Aldrington of low-tension vulcanised bitumen, dialite or leadless paper cables, conduits, boxes, meters, &c. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Handcock & Dykes), 1, Victoria-street, Westminster, and can be obtained from the town clerk (Mr. H. Endacott), Town Hall, Hove, to whom tenders by 6 p.m. of 30th inst. See also advertisement.

The Council of the County Borough of *West Ham* invite tenders for the reconstruction of certain existing horse tramways of a route length of about 3 miles 3 fur. double track. Plans, &c., may be inspected at the office of the consulting engineer, Mr. J. E. Waller, M.Inst.C.E. (Messrs. Kincaid, Waller, Manville & Dawson), 29, Great George-street, Westminster, from whom copies of specification may be obtained. Tenders to the town clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, by 4 p.m. Sept. 7. An advertisement contains further particulars.

Stoke-upon-Trent Guardians invite tenders for two 13 H.P. and one 2 H.P. electric motors, electric cable, piping and tubing, junction boxes and frames. Specifications may be seen at the Workhouse, between 10 a.m. and 4 p.m. Tenders to the clerk, Mr. C. Daniel, Union Offices, Stoke-upon-Trent, by 9 a.m. of 24th inst. See also advertisement.

Farnworth Council invite tenders by 15th inst. for a weighbridge for the electricity works.

Tenders are required by 15th inst. for the electric lighting of the Technical School, *Plymouth*.

Ilford District Council require tenders by noon 29th inst. for steel coal bunkers and weighbridge for the electricity works.

Bootle Corporation want tenders by noon 22nd inst. for alterations of and additions to offices and stores at Pine-grove electricity works.

The Roumanian State Railway authorities, *Bucharest*, invite tenders until 27th inst. for additional plant required at the electricity works at the new railway workshops.

Tenders, which must be sent in by the morning of Sept. 4, will be opened at 11 a.m on Sept. 6 at the office of the Director of Posts and Telegraphs, Carretas 10, *Madrid*, Spain, for the supply of 9,000 metres of 7-conductor overhead indiarubber insulated cable; 2,000 metres of 28-conductor paper-insulated telephone cable and 11,000 metres of suspension cable of seven steel wires, at the upset prices set out in the "Madrid Gazette" for Aug. 7.

Tenders will be opened at noon of Aug. 31 at the Central Railway offices of *Brazil* for the supply of material required in the installation of the new metallic circuit telephone system. Further particulars of this contract are published in the "Diario Officiale" of Brazil for July 19.

TENDERS RECEIVED AND ACCEPTED.

Wigan Corporation have accepted the tender of the Lancashire Dynamo & Motor Co. for hand, reversible three-wire battery booster and switchboard, compound-wound double-field balancer and cables. The following also tendered:—Bertram Thomas, Siemens Brothers & Co., Bruce Peebles & Co., J. G. Statter & Co., Electric Construction Co., Chloride Electrical Storage Co., Phœnix Dynamo Mfg. Co., Ferranti Limited, Kelvin & James White, British Westinghouse Co., British Electric Plant Co., and General Electric Co.

Dartford Council have accepted the following tenders:—

Reason Mfg. Co., meters (1 ampere £1. 10s., 2 ampere £1. 10s., 3 ampere £2. 4s. each) and demand indicators (electrolytic type £1. 8s. 6d., magnetic type £1 each).

W. T. Burbey & Co., house service boxes (15 ampere two-wire 7s. 6d. each, 15 ampere three-wire 11s. each).

Western Electric Co., service cables and accessories.

Vacuum Oil Co., lubricating oils.

W. H. Willcox & Co., G. Angus & Co., E. E. Beaven and Hy. Green & Co., engineers' stores.

The Midland Railway Co. have entrusted Dick, Kerr & Co. with the contract to construct over 10 miles of light railway linking up Burton-on-Trent, Ashby-de-la-Zouch and Swadlincote. The main

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roads are being followed with the exception of a short length where sleeper construction will be used. The work will be carried out to the drawings and specifications of the company's engineers, Messrs. Chas. H. Gadsby & Co.

Fulham (London) Council have received the following tenders for two boilers capable of evaporating 14,000lb. of steam per hour:—

Stirling Boiler Co. (*accepted*)	£2,600	R. Hornsby & Sons	£2,973
Stirling Co.	3,391	Richardsons, Westgarth & Co.	2,966
B. R. Rowland & Co.	2,995	Babcock & Wilcox	2,680

Fulham (London) Council have accepted the following tenders for the supply of coal, to be delivered as and when required in barges alongside the wharf at Townmead-road generating station:—

Firmston & Co., 2,000 tons Shirebrook double-screened nuts at 12s. 6d. per ton; Charrington, Sells, Dale & Co., 1,000 tons "Crynant" Welsh nuts at 14s. 9d. per ton, and 1,000 tons of Albert nuts at 11s. 11d. per ton.

Rochdale Corporation have accepted the tender of the British Thomson-Houston Co. for two steam alternators, that of the Electric Construction Co. for one motor alternator, and that of W. A. Peters & Sons for extension of engine-room.

Penrith Urban District Council have received the following tenders for electricity generating plant:—

Lancashire Dynamo and Motor Co., suction gas plant, engines and dynamos; Kelvin & James White, switchboard and boosters; Pfluger Accumulator Works, storage battery; British Insulated & Helsby Cables (Ltd.), mains.

Bradford Corporation have placed an order with the Hart Accumulator Co., Marshgate lane, Stratford, London, E., for 260 of their standard central lighting-type cells, automatic reversible booster and switch gear.

Messrs. John Brown & Co., Clydebank, N.B., have placed an order with the Power Gas Corp. for a complete Mond gas plant of 4,000 H.P. for generating electricity for general use in the shops.

The contract for bitumen for the Portsmouth and Pembroke Dockyards obtained by Rowland Carr & Co. was placed with them through Messrs. Johnson & Phillips.

Warrington Corporation have accepted the tender of R. W. Blackwell & Co. for overhead equipment of a length of tramway at £737. 14s. 8d.

The A.B.P. Accumulator Co. (Ltd.), Stockton-on-Tees, have secured an order for 230 cells of their standard S.4-11 plate type for shipment to Calcutta.

Brighton Corporation have placed an order with the British Westinghouse Co. for a switchboard gallery for the Southwick power station at £1,291.

Exeter Corporation have accepted the tender of Mr. W. E. Blake for the erection of a car depot at £1,130.

Swindon Town Council have accepted the tender of S. Rawlinson & Son for a tramway tower waggon.

Folkestone Council have accepted the tender of Smith & Co. for supply of electric light fittings for the Town Hall at £157. 9s.

Batley Council have placed an order with the British Westinghouse Co. for a steam dynamo.

Salford Corporation have accepted the tender of Heap & Co. for wiring Pendleton Town Hall at £345.

Walsall Corporation have accepted the tender of Babcock & Wilcox for a water-tube boiler at £1,060.

Bristol Corporation have placed an order with Bruce Peebles & Co. for two 500kw. Peebles-La Cour motor-generators.

Wolverhampton Corporation have accepted the tender of Herbert Holloway for the track work of tramway extension at £2,752.

At the meeting of Sunderland Council on Wednesday the tender of the Electrical Co. for motor generators was accepted.

Dewsbury Council have accepted the tender of J. & J. Horsfield for a boiler at £620.

BUSINESS NOTICES.

The Electric & Ordnance Accessories Co. have appointed Messrs. J. & A. Anderson, 231, St. Vincent-street, Glasgow, as their representatives for Scotland in place of Messrs. Morris, Warden & Co., who have ceased to act in that capacity. Messrs. Anderson will carry a stock of the company's goods at the above address, and will be in a position to deal promptly with orders.

In future the telegraphic address of the St. Helens Cable Co. (Ltd.) will be "Dialite Warrington" instead of "Filature Warrington."

Messrs. W. H. Heath and J. J. Reynolds (trading as the Electrical Power Engineering Co.), St. Mary-street, St. Paul's, Birmingham, have dissolved partnership. Debts by Mr. Heath, who continues under old style.

In consequence of the death of Mr. Julius Harvey, head of the firm of Julius Harvey & Co., the business will be transferred to Messrs. Price & Belsham, 52, Queen Victoria-street, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

Fredk. Wm. Parkes and Edward Sadlier (trading as Parkes & Sadlier), electrical fitters and engineers, the Dingle, Colwyn Bay, were examined at Bangor Bankruptcy Court on Friday. Liabilities £108, assets £25. Debtors commenced business in 1901, Mr. Sadlier, who had had no previous experience, putting £200 into the concern. Examination closed.

H. B. Binko, electrical engineer, 34, Leadenhall-street, London, E.C., came up for public examination at the London Bankruptcy Court last week.

An amended statement of affairs was furnished showing liabilities ranking £4,633. 6s. 2d., estimated surplus £6,960. 7s. 9d. The assistant receiver said that an action was pending in which debtor was interested and he hoped, as the result, to pay the creditors in full. Examination adjourned to Oct. 26.

In the winding-up of Shippey Bros. (Ltd.), the first meetings of creditors and contributories will take place on 19th inst. at 33, Carey street, London, W.C.

At a meeting on July 29 it was resolved to wind up voluntarily Ferranti Limited, and Mr. J. M. Henderson, 2, Moorgate-street-buildings, London, E.C., was appointed liquidator.

Water Power for Disposal.—Valuable water power (about 400 H.P.), adjacent to important seaport town, is advertised for disposal by Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C. There are numerous buildings, which may be converted for almost any trade, together with cottages and managers' residences.

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 30, Birley-street, Blackpool.

Mr. Thomas Johnson, Prescott-street, Wigan, has for sale some electrical generating plant, further particulars of which are set out in an advertisement.

Bristol Corporation have for immediate disposal two Lancashire boilers, four 210kw. and two 88kw. Siemens alternators and one 52kw. Siemens-Willans direct-current generator, a quantity of steam and water valves, piping, &c. Offers to the city electrical engineer, Mr. H. Faraday Proctor, by Aug. 30. See also advertisement.

Business Premises for Sale.—Some freehold business premises, close to Finsbury Park station, London, N., and suitable for factory, &c., are advertised in another column. Particulars from Messrs. Emmet & Co., solicitors, 14, Bloomsbury-square, London, W.C.

"The Journal."—Part 167 of the Journal of the Institution of Electrical Engineers is now ready, price 5s. Particulars and contents are given in an advertisement.

Catalogues.—We have received from Messrs. Ferranti Limited catalogues Nos. 4, 5 and 6 relating to their switchboard integrating type of wattmeter and to their current and potential transformers respectively. The integrating wattmeter was fully described in *The Electrician*, Vol. LII., p. 422. In all potential transformers of this firm's make one end of the low-tension secondary is connected to the case, and a holding-down screw is provided on the latter by means of which an earth wire can be connected thereto. An insulated bush of suitable material is also provided so that, if desired, the leads from the secondary winding can be brought away from the transformer without earthing any of them. The transformers are all dried in vacuo and impregnated with insulating compound at several different stages of their manufacture. Above 5,000 volts the transformers are oil insulated and cooled. All transformers are guaranteed to withstand a test pressure of twice the working voltage for any length of time, and a pressure equal to three times the working pressure for one minute. They can be used, it is stated, for operating synchronisers, as the greatest temperature rise of the transformers, after giving 150 watts for one hour, does not exceed 50° F. It must be understood that the synchroniser is not permanently connected to the transformer, but only during the time required for synchronising. This is of importance, as the increased load on the transformer due to the synchronising current may alter slightly the ratio of transformation, and thereby introduce a small error into the wattmeter readings. This error, however, is negligible, as the synchroniser is only connected for a few minutes during the day. The secondary winding is designed for a standard pressure of 100 volts. Any other secondary voltage below this, or up to 250 volts, can be supplied, we understand, at the same price. The current transformers for 500-volt circuits are enclosed in water-tight cast-iron tanks, constructed in such a manner that after the cables are connected up they may be sealed by means of bitumen or some similar insulating compound, which is poured in through a hole which communicates with the sealing chamber. Up to 800 amperes the terminals are covered in; above 800 amperes this is not the case. In all cases cable sockets are supplied, so that the supply cables can be sweated and pinned in to the sockets, which are afterwards bolted to the primary conductor. These transformers have a larger number of ampere turns than the ordinary transformers, and are designed with more margin of material so as to be specially suitable for use with integrating wattmeters, giving an absolutely constant ratio over the entire range. The average number of secondary ampere-turns is 1,600. In current transformers

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for 5,000-volt circuits the ends of the primary winding are brought through bushes of insulating material in the top of the cast-iron case. Above 5,000 volts the cases are to be filled with oil. Further particulars with regard to price, weight, &c., may be gleaned from the catalogues.

A new list of Hookham patent prepayment meters has been prepared by Messrs. Chamberlain & Hookham, 4, New Bartholomew-street, Birmingham, from whom copies can be obtained, or from the agents for the sale of these meters in the United Kingdom, Messrs. Venner & Co., 6, Old Queen-street, Westminster, London, S.W.

The new pamphlet on Nernst electric lamps promised by the A.E.G. English Mfg. Co., 4, New Compton-street, London, W.C., is now ready, and, besides giving illustrations and descriptions of all types of these lamps of latest patterns, and of accessories and water-tight fittings for the lamps, gives a brief historical account of the development of the lamp and directions for their installation.

The Improved Electric Glow Lamp Co. (Ltd.), 7, Great Newport-street, London, W.C., forward a copy of their catalogue, which gives particulars and prices of D.C. and A.C. desk, ceiling and ventilating fans, motors and dynamos.

Ernest F. Moy (Ltd.) send us sheets giving prices and particulars of quick-break switches.

Improvements in the "Simplex" Conduit System.—In order to render all types of "Simplex" conduits electrically continuous and efficiently earthed, the Simplex Steel Conduit Co. have brought out a new contact nipple of which a sample, applied to a length of tubing, has been submitted for our inspection. The nipple is hollow and screws into the fittings. It is also split, and the act of screwing it into the fitting has the effect of clamping tightly the end of the ordinary unscrewed conduit which it embraces. It will thus be seen that the advantages referred to have been obtained by simple means, the tightening of a single nut being sufficient to secure excellent mechanical and electrical connection. This system, it is claimed, involves lower costs, both for material and labour, than any other system possessing similar electrical advantages.

Anchors for Poles, &c—Mr. F. J. Down, of 6–8, Crutched Friars, London, E.C., is placing upon the market a useful series of patent guy anchors for staying poles, iron chimneys, tents, &c. These anchors bore into the ground in a similar manner to a wood screw boring into timber. The illustration, Fig. 1, shows the style of 3½in., 5in. and 6in. sizes of anchor, Fig. 2 the 8in., 10in. and 12in. sizes. These latter can be set in from 10 to 20 minutes, can be taken out in less than half that time, and are, consequently, specially recommended for temporary guying work. The larger sizes are coming into general use for telephone, electric light and tramway work, for pulling up poles, drawing up heavy cables, trolley wires, and many other uses. Another purpose which the 12in. anchor serves is to tie a block and tackle to pull obstructions off a tramway or railway line where a car or locomotive has become derailed or wrecked. A pair of these anchors can be promptly put up, a hawser attached, and the weight which they will hold is found fully sufficient in these emergency cases. Fig. 3 shows a rodless anchor, in which the eyes are drop-forged to make them strong and durable. It is claimed for these that they will hold equally as great a strain as the longer anchors. A special form of wrench has to be used in the smaller sizes of anchors up to 6in. The holding strain of these anchors is claimed to be from 5 to 60 tons. Mr. Down is issuing printed particulars relating to these goods, which give additional information and can be obtained on application.

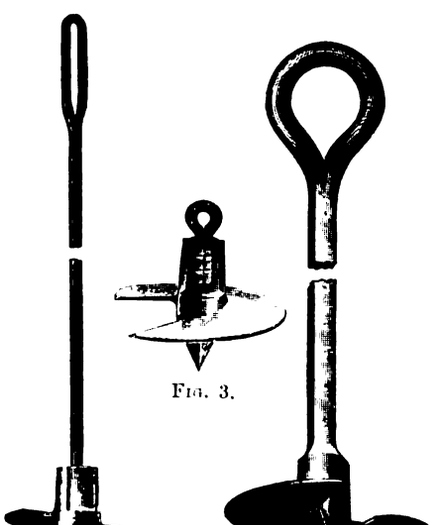

FIG. 1.

FIG. 2.

FIG. 3.

Imports.—The following are official values of imports of electrical machinery, material and apparatus into this country during July:—

Electrical machinery, £46,732 (an increase of £1,988 compared with July, 1903); telegraph cables and apparatus, £3,946 (increase £355); other electrical goods £50,401 (decrease £10,085). The total imports of the three classes during the seven months ended 31st ult. were respectively £316,176 (decrease £41,570)), £20,431 (decrease £13,300) and £434,499 (increase £13,099.)

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from July 30 to Aug. 9, with the ports of destination:—

Africa—Alexandria, £255 (telegraph material); Beira, £67; Cape Town, £652 (including £178 telegraph material); Delagoa Bay, £491; Durban, £2,544 (including £495 telegraph material); Larache, £30; Port Elizabeth, £63; Port Said, £22. *Argentina*—Buenos Ayres, £395. *Australasia*—Adelaide, £35; Auckland, £392; Brisbane, £483 (including £367 telegraph material); Fremantle, £126; Lyttelton, £47; Melbourne, £298; Perth, £1,786; Sydney, £2,639; Wanganui, £25; Wellington, £59. *Belgium*—Ghent, £48. *Brazil*—Pernambuco, £10,400 (telegraph cable); Rio Janeiro, £200. *Ceylon*—Colombo, £276. *China*—Shanghai, £881 (including £65 telegraph material). *France*—Boulogne, £60. *Germany*—Hamburg, £20. *Gibraltar*, £68. *Holland*—Amsterdam, £264; Rotterdam, £63 (including £18 telegraph wire). *Hong Kong*, £461 (including £306 telegraph material). *India*—Calcutta, £2,037; Madras, £94. *Italy*—Genoa, £250. *Japan*—Kobe, £179; Nagasaki, £30; Yokohama, £1,114 (including £62 telegraph wire). *Madeira*—£130 (telegraph instruments). *Malta*, £65 (telegraph instruments). *Mexico*—Coatzacoalcos, £20. *Portugal*—Lisbon, £25. *Russia*—St. Petersburg, £375 (including £170 telegraph cable). *St. Vincent*, £26 (telegraph material). *Siam*—Bangkok, £179. *Straits Settlements*—Penang, £77; Singapore, £167. *West Indies*—Trinidad, £86. Total (for 11 days) £28,004, against £7,642 for six days last year (Aug. 6 to 11).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

May 17, 1904.

11,284 H. HIRST and J. H. COLLINGS. Counterweights for electric fittings.
11,288 A. RICKS. Germany. Accumulator electrodes or plates.
11,309 S. W. MARTYN. Sheffield. Devices for connecting cables having two or more stranded wires.
11,350 J. ROBERTS. Indicating when supply of a predetermined amount of electric current is being exceeded.
11,359 A. HEISCHMANN. Liverpool. A damping arrangement for the index vibrations of electrical measuring instruments.
11,363 A. F. BERRY. Apparatus for use in distributing alternating currents.
11,364 C. H. MERZ and B. PRICE. Alternate-current distributing systems.
11,368 E. A. GRAHAM. Switches for telephonic apparatus, &c.

May 18, 1904.

11,390 H. BRECKNELL and BRECKNELL, MUNRO & ROGERS. Bristol. Hangers for suspending overhead trolley wires or other conductors of current.
12,405 C. T. POUNSFORD and F. T. LOVE. Bristol. Automatic switch for the intermittent lighting of electric lamps or groups of lamps.*
11,409 H. V. BOWEN and C. H. SCHILL. Manchester. System of regulating and varying speed in direct-current motors.
11,439 D. J. O'BRIEN. Appertaining to incandescent lamps (Date applied for, May 25, 1903, date of application in U.S.)*
11,443 J. LEIGHTON and R. HACKING. Electric ignition for internal combustion engines.
11,444 and 11,447 B.T.-H. Co. (G.E. Co., U.S.). Dynamo-electric machines.
11,448 B.T.-H. Co. (G.E. Co., U.S.). Switches.
11,449 B.T.-H. Co. (G.E. Co., U.S.). Coil winding apparatus.
11,465 I. H. HEGNER. Electric arc lamps.
11,470 G. J. ATKINS. Electrodes of electrolytic apparatus and the like.
11,471 SIEMENS BROTHERS & Co. (Siemens & Halske A.G., Germany). Dynamo-electric machines.*

May 19, 1904.

11,481 R. P. SKINNER. Sheffield. Electric light fog signal.
11,522 MORGAN CRUCIBLE Co. and C. W. SPIERS. Commutator brushes.
11,531 B.T.-H. Co. and A. H. CUBITT. Switches.
11,532 B.T.-H. Co. (A.E.G., Germany). Prepayment meters.
11,542 J. SAHULKA. Transforming a single-phase alternating current into single-phase or polyphase alternating current of lower frequency.*
11,545 G. E. GAIFFE. Induction coils.
11,568 J. HALL and A. HACKBLOCK. Switches.
11,571 P. HENSEL (O. Rennert, ——). Apparatus operable by thermostatic instruments and the like.
11,572 P. HENSEL (O. Rennert, ——). Thermostatic indicators.
11,573 P. HENSEL (O. Rennert, ——). Thermostatic indicators and in thermostatic systems.
11,574 P. HENSEL (O. Rennert, ——). Electrical thermostatic apparatus and similar instruments.

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May 20, 1904.

11,595 E. Goulding. Manchester. Knock-off finger arrangement for electric slubbing intermediate and roving frames at any part of the lift.
11,603 B.T.-H. Co. (A.E.G., Germany). Prepayment mechanism.
11,604 L. Wilson. Dynamo-electric machines. (Date applied for, June 1, 1903, date of application in U.S.)*
11,607 H. B. Bullingham. Tooting. Method of electromagnetic motor control to be operated from a distance.
11,649 and 11,650 H. Winkler. Arc lamps.
11,651 A. Collet Portable insulated support for double wire lines. (Date applied for, Aug. 4, 1903, date of application in France.)*
11,665 L. A. Gianoli. Distributing switch chiefly designed for use in high-tension electric ignition gear for multiple-cylinder explosion engines.
11,668 A. Muirhead. Telegraphy.

May 21, 1904.

11,695 G. A. N. Baum. Microphones.

May 24, 1904.

11,777 M. Lawton and H. W. Whatson. Birmingham. Tumbler switches.
11,814 F. Ainsworth. Bury. Emergency automatic cutout for overhead traction wires.
11,831 and 11,832 M. von Recklinghausen. Gas or vapour electric apparatus.
11,842 H. Wright. Apparatus for lighting railway vehicles by electricity.
11,848 W. Sandar. Electric igniters for explosion motors.*
11,857 F. Stevens. Switches.*
11,862 H. J. Haddan (firm trading as Allgemeine Beleuchtungs und Heiz-industrie Actiengesellschaft, Germany.) Arc lamps.*

May 25, 1904.

11,873 U. Horsfall, J. Crowther and A. G. Brown. Manchester. Electrical motor-starting switches.
11,878 L. C. Fuchs. Burglar alarm.
11,880 Albion Motor Car Co. and T. B. Murray. Glasgow. Magneto-electric generators.
11,884 F. W. Hayward and R. C. Fox. Norwich. Safety device for overhead conductors.
11,887 J. Dugdill. Manchester. Rotary switch for electrical conductors.
11,890 A. J. Bowerman. Stereoscopes, electroscopes and the like.
11,917 F. T. Warburton. Obtaining electrical energy from peat.
11,920 C. Bruno. Manufacture of electrodes for accumulators.*
11,928 M. Otto. Draw-off water-tap for electric filters.*
11,930 B.T.-H. Co. (G.E. Co., U.S.). Alternating-current motors.
11,931 B.T.-H. Co. (G.E. Co., U.S.). Electric locomotives.
11,932 B.T.-H. Co. (G.E. Co., U.S.). Vapour generating apparatus.
11,933 B.T.-H. Co. (G.E. Co., U.S.). Rheostats.
11,943 J. P. Rees. Electric miners' safety lamps.

May 26, 1904.

11,951 T. Blackmore. Birmingham. Wire-coiling tools.
12,017 J. B. R. Swan. Switches.
12,020 H. C. Jenkins. Magnetic ore separators.

May 27, 1904.

12,056 J. Watson, Jun. Edinburgh. Electromagnets.
12,060 Cie. Française de l'Ozone. Apparatus for mounting and cooling statical ozonisers. (Date applied for, Nov. 20, 1903, date of application in France.)*
12,061 Cie. Francaise de l'Ozone. Sterilisation of water by electric current. (Date applied for, Nov. 20, 1903, date of application in France.)*
12,076 J. H. Ward and S. H. Goldstone. Manchester. Lining and insulating chambers carrying switches or fuses or both.
12,082 G. A. Nussbaum. Microphones.
12,087 F. Conrad. Prepayment electrical measuring instruments. (Date applied for, June 24, 1903, date of application in U.S.)*
12,097 A. G. Brown, Boveri & Cie. Regulating apparatus for automatically maintaining accumulator charging-current constant. (Date applied for, June 26, 1903, date of application in Germany.)*
12,101 J. Bonham, H. Rennie, F. Taylor and K. J. Henderson. Electric motor.

May 28, 1904.

12,123 F. W. Davies. Derby. Alternating-current motors.
12,136 T. Taylor. Sutton Coldfield. Welded conduit for electric wiring.
12,160 W. Collins and J. Morgan. Preventing accidents from explosion in mines and other places where electrical energy is employed.
12,187 G. Ritter. Liverpool. Telephone and telegraph systems.*
12,188 H. Tourneur. Liverpool. Producing electric energy by direct utilisation of chemical energy of any suitable combustible. (Date applied for, June 11, 1903, date of application in France.)*
12,191 B.T.-H. Co. and A. S. Cubitt. Controllers, switches and the like.
12,192 B.T.-H. Co. (G.E. Co., U.S.). Brush-holders.

May 30, 1904.

12,197 I. H. Davis. Birmingham. Switch for motor vehicles and the like.
12,206 A. Rees. Richmond. Improved sparking mechanism for internal combustion engines.
12,213 A. E. Nichols and A. C. Brown. Electrical timing devices.
12,214 British Prometheus Co. and H. Skipwith. Liverpool. Electric cooking and heating apparatus.
12,217 J. Munro. Croydon. Wireless signalling.
12,245 B.T.-H. Co. and A. S. Cubitt. Switches, circuit-breakers, &c.
12,246 and 12,248 E. A. Carolan (G.E. Co., U.S.). Starting flame arc lamps.
12,247 E. A. Carolan (G.E. Co., U.S.). Electrodes and lamps for arc lighting.
12,267 W. J. Davy. Electrical resistances.
12,268 J. A. E. Mariage. Automatically putting alternating current transformers in or out of circuit.*

May 31, 1903.

12,298 J. H. Luby and W. Harris. Bristol. Gripping and supporting overhead wires.
12,321 R. W. Eloy. Combined automatic sparking device and carburator.*
12,332 A. J. Boult (Coloman de Kandó, Hungary.) High-pressure motor connections.*
12,333 B.T.-H. Co. (A.E.G., Germany.) High-tension switches.
12,334 and 12,335 B.T.-H. Co. (A.E.G., Germany). Dynamo-electric machines.
12,336 B.T.-H. Co. (A.E.G., Germany). Alternating-current meters.
12,337 B.T.-H. Co. (G.E. Co., U.S.). Thermal cut-outs.
12,338 B.T.-H. Co. (G.E. Co., U.S.). Switches.
12,339 B.T.-H. Co. (G.E. Co., U.S.). Brush-holders.
12,340 B.T.-H. Co. and A. S. Cubitt. Cut-outs, switches and the like.
12,344 and 12,345 J. A. Heany. Arc lamps.*
12,346 A. P. Zani. Switches.
12,365 Siemens Brothers & Co. (A. S. Clift, Germany). Telephers.*
12,372 J. T. Armstrong and A. Orling. Telegraphy.
12,373 Nalder Bros. & Thompson (R. S. White, U.S.). Maximum demand indicator.
12,375 G. B. Bowell. Electric clocks.
12,376 A. H. McNeil and the Pearson Fire Alarm. Electric fire alarms and thermo-indicators.

June 1, 1904.

12,379 J. G. Irving. Nottingham. Adjustable support for electric light fittings.*
12,382 H. J. Trautmann. Insulators.
12,418 T. H. de Veulle. Coventry. Switches.
12,423 L. Kamm. Printing telegraphs.
12,433 B.T.-H. Co. (A.E.G., Germany). Production of insulating materials.
12,434 B.T.-H. Co. (A.E.G., Germany). Electricity meters.
12,435 J. R. Spurrier. Circuit breakers.
12,439 F. Hubber and W. G. Higgs. Electric fire-alarms and the like.*
12,445 H. A. Jones, H. Parks and Phœnix Dynamo Mfg. Co. Drilling machines.
12,449 F. Reiss and R. Klemm. Liverpool. Small motor for alternating current.*
12,455 F. C. Newton. Electric motor starting switches.

June 2, 1904.

12,467 Veritys Limited and C. B. Walker. Birmingham. Electric fans.
12,469 J. R. Penning and S. H. Penning. Sidcup. Network distributing or feeder boxes for electric light purposes.
12,487 H. C. P. Jean and H. Peirson. Loose electrical weight plug.
12,517 V. W. Delves-Broughton and J. A. Colf. Induction coils.
12,541 Count A. de Montlaur. Employment of X-rays and cathode rays in chemical reactions produced by electric discharges. (Date applied for, June 3, 1903, date of application in France.)*
12,543 T. D. Whitehead. Trolleys for electrically-driven vehicles.
12,545 A.E.G. Alternating-current meters. (Date applied for, June 2, 1903, date of application in Germany.)*

June 3, 1904.

12,568 J. D. F. Andrews. Electricity meter.
12,572 A. Cairns. Glasgow. Manhole covers and frames.
12,585 J. C. Anderson. Manchester. Ignition plugs for explosion engines.*
12,593 A. E. Hubert and W. Edwards. Self-locking joint for connecting canes or rods used for passing telephone wires and the like through conduits.
12,607 E. C. H. Tiffin. Northwood. Combined electric lampholder and candle nozzle.
12,615 I. Katz. Thermo-electro piles.*
12,623 B.T.-H. Co. (G.E. Co., U.S.). Electric controllers.
12,633 W. L. St. J. Alton and W. Ramsay. Separating zinc by electrolysis.
12,643 A. Mégroz. Continuous-current motors for traction. (Date applied for, June 4, 1903, date of application in Switzerland.)*
12,644 J. J. Bate. Liverpool. Electric conduits or the like.

June 4, 1904.

12,679 H. James and A. West. Sheffield. Trolley heads for electric tramcars.
12,691 C. Turchi. Simultaneous transmission of telephonic and telegraphic currents over the same line.*
12,707 W. P. Thompson (Chemisch Elektrische Fabrik "Prometheus" G.m.b.H., Germany). Production of electrical resistance bodies from amorphous or crystalline carbide of silicon, or boron, or of silicon or other like suitable materials.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

11,706 Jones. Switch apparatus.
13,741 Midgley and Wright. Dynamo-electric machinery.
13,746 Young. Method for operating signals on electric railways.
13,822 Siebers. Dynamo brushes.
14,173 Le Tall (Cooper Hewitt Electric Co.). Breaking and controlling circuits.
16,534 Schneider and Beissbarth. Secondary batteries.
18,253 Carolan (G.E. Co., U.S.). Magnetic controlling devices.
18,255 Carolan (G.E. Co., U.S.). Sealing metal into glass, &c.
18,343 Carolan (G.E. Co., U.S.). Electric vapour lamps.
18,344 Carolan (G.E. Co., U.S.). Electric lamps.

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19,366 ABEL (Siemens & Halske A.G.). Process relating to reduction of metallic compounds and fusing of metals in the electric furnace.
20,838 WOOLLEY and COONEY. Fire alarm and signalling systems.
23,173 WILSON. Protecting devices for parallel feeders.
26,850 FAIRWEATHER (Stromberg Carlson Telephone Mfg. Co.). Selective signalling systems.
26,851 FAIRWEATHER (Stromberg Carlson Telephone Mfg. Co.). Central telephone exchange apparatus and connection.
27,044 HARDINGHAM (Electric Boat Co.). Submarine and submergible boats.
27,044B HARDINGHAM (Electric Boat Co.). Steering gear for ships or boats. (Date applied for, Dec. 10, 1903.)

1904.

2,098 COMPAGNIE POUR LA FABRICATION DES COMPTEURS ET MATERIEL D'USINES À GAZ. Electric induction motor meters. (Date applied for, Feb. 26, 1903.)
3,221 BROWN and HARDIE. Telegraph apparatus.
3,692 HEYES and HEYES. Electric bells or gongs.
4,507 EASTWOOD. Electric controllers.
7,824 FAIRWEATHER (Benjamin Electric Mfg. Co.). Cluster sockets for electric lamps.
9,375 VEDOVELLI (née del Castillo). Electrical resistances. (Date applied for, Oct. 19, 1903.)
9,647 PICHARD and MEUNIER. Electromagnetic ignition for explosion motors.
9,950 KANDÓ. Collector rings of alternating-current generators and motors.
10,171 MÜLLER. Electric converters.
10,376 JACOBSEN. Electric alarm signalling apparatus. (Date applied for, May 7, 1903.)
10,623 NICHOLS. Automatic trolley controlling devices.
10,646 BOULT (Entz). Controlling or regulating means for electrical apparatus.
10,647 DE KANDO. Bearings for motors of electric vehicles.
10,648 DE KANDO. Electric motor systems.
10,709 STÖCKIGT. Dry cells.
10,811 THOMPSON (Stewart). Ignition devices for internal combustion engines.
10,858 CEREBOTANI and SILBERMANN. Receiving apparatus for wireless telegraphy.
10,986 SHEEHY. Printing telegraphs.
11,668 HALL and HACKBLOCK. Switches.

COMPANIES' MEETINGS AND REPORTS.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—The directors' report for year ended June 30 states that the trading profit was £17,510. 9s. 1d. After deducting directors' and auditors' fees (to June, 1903), debenture interest, depreciation, provision for bad debts and interim preference dividend, the available balance is £5,073. 14s. 4d., added to £7,312. 9s. from last year, making £12,386. 3s. 4d. The directors propose payment of the balance preference dividend and a dividend of 8 per cent. on the ordinary shares, tax free, requiring £4,520, and to carry forward the balance of £7,866. 3s. 4d.

COMPANIA ALEMANA TRANSATLANTICA DE ELECTRICIDAD (BUENOS AYRES).—The report of the directors for last year states that the River Plate Electricity Co.'s undertaking was purchased in April last for £150,000, of which £2,500 was in cash and the remainder in 5 per cent. bonds. In June the undertaking of the Primitiva Gas & Electric Light Co. was acquired on a yearly rental of £30,000, payable for 41 years. The consumption of electric energy was 17,360,170 units, against 10,281,188 in 1902. In July, 1903, the company took over the station of the Anglo-Argentine Tramways Co., and now supplies them with current at a fixed price. The number of private consumers increased from 3,861 to 7,685. The reconstruction for electric traction of the metropolitan tramways (owned by the company) is nearly completed. The disposable balance, after providing for interest, rental, &c., is 2,434,484.51m., from which 1,212,839.09m. is deducted for depreciation, &c., leaving net profit 1,221,645.42m., of which 59,172.05m. is placed to legal reserve, and after paying a dividend of 6 per cent. on 16,000,000m. share capital, interest on bonds, &c., 65,974.07m. is carried forward.

CONSOLIDATED ELECTRICAL CO. (LTD.)—At the meeting on Monday the chairman (Mr. Herbert Allen) stated that the report and accounts covered a period of 11½ months, from the incorporation of the company in April, 1903, to March 31, 1904. The delay in presenting them had arisen in connection with stocktaking. The surplus of assets over liabilities amounted to £52,730, but, of course, the correctness of the figure depended largely on the valuation placed on the investments and on the plant, machinery and stock-in-trade. The directors were responsible for the valuation of the freehold and leasehold buildings, and the staff was responsible for the plant, machinery and stock-in-trade. Personally, he would rather rely upon a valuation by the staff than that of an outside firm. The factory results were now being carefully watched, and if they proved unsatisfactory the works would be closed down. He was not able to speak with confidence as to the future, because so much depended on the trade outlook, which was not very satisfactory; indeed, it was becoming more and more difficult to get profitable orders in their business. He estimated the company's income at £4,000 to £5,000, which would show a margin of profit for the preference and ordinary shareholders. Should the manufacturing business prove unsuccessful, the board might decide to wind up the company and distribute the assets amongst the shareholders.

CROMPTON & CO. (LTD.)—The chairman (Mr. John Trotter) said, at the meeting on Monday, that it was very disappointing to the board, after a year of hard work, to find that they were left with a profit only sufficient to permit of the payment of a dividend of 2½ per cent. In their previous report a hope was expressed that they had passed through the bad times, and that better times were in store for them. There were good reasons for entertaining that hope. Steps had been taken to obtain the best technical advice and to overhaul all the company's designs, with a view to cheapening and improving the output of their machines. At the beginning of the year they had so far proceeded with that work as to be in a position to sell goods at less than their previous cost price, and yet leave a profit. Unfortunately, every step taken to cheapen processes was followed by a steady drop in the market value of the regular goods made by electrical manufacturers, and he regretted to say that that was still the tendency. The only remedy he could see for such a state of affairs was the clearing out of weak houses. In these circumstances every effort had been made to put their house in order, so that that they might not, in the end, suffer as much as others might possibly do. With that object they had launched an infant company—the Electric Supply Corp.—and an arragement had been made which he felt confident would prove to be mutually satisfactory. Orders put up to public tender were now hardly worth having, and so the directors were seeking for work such as they could do for the companies affiliated with this company rather than tender for contracts out of which it was scarcely possible to make a decent profit. With regard to their interest in the Chelmsford Electric Lighting Co., an agreement had been arrived at to transfer this to the new Electric Supply Corp. The gross profit for the past year was £61,050, against £66,798 in the previous year. They had, however, turned out a larger number of machines than in 1903, yet the net profit was only £14,584, or about £5,000 less than in the previous 12 months.

ELECTRO-PEAT COAL CO. (LTD.)—At the statutory meeting on Tuesday the chairman (the Earl of Mayo) replied to the criticisms of the company which have appeared in the financial press, and also dealt with the subject of the company's patents. The most difficult point they had to meet (he said) was the question of the calorific value of the peat fuel. He and his fellow-directors knew nothing of those extremely technical issues. On that question they were in the hands of their experts, and it would be for the latter to explain the mistake it was asserted had been made.

Mr. A. J. DE HAILES, analytical and consulting chemist to the company, stated that he had received samples of peat-coal from the engineer (Mr. Scoones) to analyse, and that his calculation of results was based on the kilo and not on the pound. In answer to a request from the chairman, he proceeded to explain the method he had adopted in making his analysis, and asserted that he had only followed the usual course and was not responsible for deductions based on his figures. He merely experimented on certain samples sent to him, and had always been careful not to commit himself to any comparison of peat-coal with commercial coal.

Mr. T. J. SCOONES said when the discrepancy was first brought to his notice he thought a serious mistake had been committed. He had, therefore, gone most carefully into the matter, and had come to the conclusion that they were not in such a bad way after all. The calorific power of a fuel was a scientific way of estimating its value, and what they really went upon was how did it compare with some article they were well acquainted with. He gave a number of reasons, based on recent investigations he had made, why it was still possible to regard peat-coal as having on the average a calorific value of 13,000 units. He had a firm belief in the possibilities of peat-fuel and he was confident the shareholders need not be alarmed at the mistake that had been made.

Mr. STOREY said he was not satisfied with these explanations. He considered the prospectus was misleading on material points. He had applied for a large number of shares, but should certainly not pay any more money as matters now stood.

Mr. J. MACGREGOR said he thought directly they got the order to go ahead everything would be found to be all right. The German syndicate had placed an order for machinery with his firm. The early machinery was undoubtedly a bit crude, but now they had so perfected their designs that the new plant would do its work thoroughly well.

GREAT NORTHERN RAILWAY CO.—At the meeting on Wednesday the chairman (Lord Allerton) said that during the past half-year they had expended about £70,000 on the Great Northern & City and the Great Northern, Brompton & Piccadilly tube railways. The estimated capital expenditure for the current half-year included £55,000 on the two lines in question. He referred to the effect of tramway competition on their passenger traffic, and said they were going to have further competition, particularly in the London district. Electric tramways were now competing with them between Finsbury Park and Wood Green, and considerable extension in that district was contemplated. Since their last meeting the Great Northern & City line had been opened, and some negotiations had been going on with regard to working arrangements, which, it was hoped, would soon be completed. Good progress had been made with the Great Northern & Piccadilly line, and the tunnel was very nearly through.

GREAT NORTHERN & CITY RAILWAY CO.—The directors' report for the half-year ended June states that the receipts for the 19 weeks and five days to June 30 amounted to £19,354. 17s. 6d. The number of passengers carried (excluding season ticket holders) was 2,711,152. The number of season tickets in use at June 30 was 758. The working of the railway has been in every way satisfactory, but traffic receipts are disappointing, owing almost entirely to the fact that the negotiations with the Great Northern Railway for interchange of through booking facilities have not as yet been completed. Receipts from local traffic are steadily increasing, and, when the arrangements with the Great Northern Co. are completed, which it is hoped will be very shortly, the revenue will show a more satisfactory result. The station at Highbury was opened to the

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public on June 28, and, as anticipated, has already given a considerable increase of traffic, although the lifts are not yet working. Although the successful development of the traffic may take somewhat longer than was anticipated, the contractors are sanguine that the ultimate results of the railway will fully justify its construction, and in this view the board concur. The agreement for working the railway by the contractors for three years from its opening provides that S. Pearson & Son shall retain in respect of such working 65 per cent. of the gross receipts from all sources, and that the remaining 35 per cent. shall be paid over to the company. The contractors have guaranteed while they so work the railway a minimum interest of 4 per cent. per annum on the A shares, if the net receipts paid over to the company be insufficient, and also a minimum interest of 3 per cent. per annum on certain B shares.

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY CO.—The chairman (Sir Henry Fowler, M.P.) stated at the meeting on Tuesday that good progress had been made with the construction of the line, and all was going on satisfactorily. A dividend of 4 per cent. per annum was declared out of the revenue received from the Underground Electric Railways Co.

LANCASHIRE & YORKSHIRE RAILWAY CO.—The chairman (Sir George Armytage) referred, at the meeting on Wednesday, to the electrification of the Liverpool and Southport Railway. From the beginning of April to the present time the number of electric trains run between Liverpool and Southport and Liverpool and Hall-road had been gradually increased from 25 to 110 trains per day, and more trains were being put on to displace the steam trains as the machinery was handed over by the contractors. Considering the magnitude of the change and the new problems to be faced, which had not hitherto been dealt with by any other railway company, the initial troubles had not been as great as might have been expected. The general public had shown its appreciation of the more rapid service by travelling in much greater numbers over the railway. The figures for the three months ending June showed that 113,000 additional tickets had been issued, and in July there was a further increase of 57,000 passengers over that line.

LIVERPOOL OVERHEAD RAILWAY CO.—At the meeting on Tuesday the chairman (Sir Wm. Forwood) said the contract for the construction of the northern extension to Seaforth station of the Lancashire & Yorkshire Railway had been let, and it was expected that the work would be completed by February next. When that connection had been made the company would be able to run a through service in connection with the Lancashire & Yorkshire Railway.

LONDON AND SOUTH WESTERN RAILWAY CO.—The chairman (Sir Chas. Scotter) stated at the meeting yesterday (Thursday) that the Company had lost about £5,000 in receipts owing to the electrification of the tramways in the suburban districts.

LONDON, DEPTFORD & GREENWICH TRAMWAYS CO.—The chairman (Mr. Geo. Ennis) said at the meeting this week they had had a long contest with the London County Council extending over five years. The Council first offered £42,250, which would have been barely sufficient to discharge the mortgage bonds and debts; then the Council increased their offer to £54,250, but the board determined to proceed to arbitration, which resulted in the value of the company's lands, buildings, works and plant being fixed at £91,363. They were not yet, however, quite through their arbitration proceedings. They claimed from the Council a further £22,773, the amount by which the undertaking had been enhanced by reason of its being freed from the liability to contribute to certain street widenings, which at the date of the notice to purchase the company would have been required to make, had they sought powers to construct the tramways at the time of such notice. The arbitrator agreed to raise the matter in a special case, awarding the company £22,773 in the event of the Court's deciding that their contention should prevail. The arbitrator further directed the costs and expenses of the reference and award to be paid by the Council. Negotiations were pending for the sale of the company's unexercised powers in respect of the Creek Bridge section of their route.

METROPOLITAN DISTRICT RAILWAY CO.—At the meeting on Friday last the chairman (Mr. R. W. Perks, M.P.) gave a sketch of the progress made in connection with the electrification of the company's line. Before they again met they would be running electrically on the greater portion of their line, which would not be suddenly converted to electric traction, but only gradually. They would instal electricity alongside of steam trains during the period of conversion, but by Jan. 1 they would be running a considerable portion of the railway by electric power, and from early in the year the old District Railway would be transformed and be wearing its completely new garb. They expected, as a result of the conversion, an enormously increased traffic. He had been looking into the figures of the Manhattan Railway, New York, to see what the effect of conversion from steam to electricity was there. That line was 36 miles in length, but was an overhead railway working under conditions far more attractive than those of the District Railway. The result of conversion had been amazing. In 1900 the company earned £1,800,000 gross, its working expenses being 60 per cent. In 1903 its earnings rose, under electric traction, to £2,400,000, and the working expenses had fallen to 45 per cent. It carried 320,000,000 people for the year, against 200,000,000, practically at no increased cost. If those results, or anything approaching them, could be accomplished on the District, the shareholders' prospects were brighter than they had been in the whole of the company's history. 1,000 people were employed at night upon the conversion, and the work was done under circumstances of great difficulty. Their electrical engineer (Mr. J. R. Chapman) told him that the great Chelsea generating station, which would cost ultimately £1,400,000, was completed, that 16 boilers had been under steam, and that the remaining 48 boilers were rapidly approaching completion. Everything, in fact, at that station was complete and ready for working, except the turbo-generators, which were already overdue, and were being made at the Westinghouse Co.'s works at Old Trafford. 72 miles of cables had been laid under the streets from Lots-road to Earl's Court, whence they were distributed all over the railway. They had completely finished many of their sub-stations, Whitechapel, Earl's Court, Ravenscourt Park, Mill Hill Park, Hounslow, Sudbury and Putney. At the Mansion House their sub-station was practically ready, as the machinery would be there in September. At Charing Cross the sub-station would be finished in about six weeks, as would the sub-stations at Victoria and South Kensington. West of the Mansion House they had laid 7,500 tons of conductor rails over 18 miles of track. They had laid 86 miles of cable ducts in their permanent way and 23 miles beneath their station platforms. They had laid 68 miles of high-tension three-phase cable. Their signal system was practically complete, except upon the eastern joint lines. At Mill Hill Park the great car sheds, which were costing nearly £70,000 to build, and covered an area of 4 acres, would be finished by October. As to rolling stock, the Underground Electric Railway Co. of London had placed contracts for 420 cars, delivery of which would commence in October, and a large portion of the stock would be ready for service at the close of the year. For 280 of their 420 cars (40 trains) orders had been placed on the Continent, as the tenders of the English car builders were 30 to 40 per cent. above those of the Continental car builders on exactly the same specification and for identically the same article. The Underground Co. (continued Mr. Perks) had used their utmost endeavours to persuade English car builders to reduce their price, but without effect, but no sooner was this order for 40 cars placed on the Continent than the English car builders reduced their figure to the same standard as their Continental competitors, and the remaining 20 trains of 140 cars were taken at the same price, practically, as the foreign builders had quoted. He could not say which branch of the railway they would first work electrically. Under their new act they had authority, and they had instituted certain zone rates governing by a uniform charge long lengths of their railway. For example, the rate from Hammersmith to Aldgate East, and any station on that section, be the distance long or short, would be a uniform rate of 2d. When passengers travelled beyond Hammersmith the rate from that station to Hounslow or to Ealing would be a further 2d. The rate from Ealing to the City would be 3d., and the same from Putney to the City. He had always advocated and was still in favour of a uniform rate over the whole of the railway, and if this were his own property, and he had to administer it as a private concern, he would not hesitate to impose a uniform rate of 2d. for long or short distances. He then referred to the opposition of the London County Council, and said that, with the exception of the engineering department of the Council, there was no department with which the railways had come into contact where they had not been met by a persistent and sometimes childish obstruction and opposition. That had not, however, been the case, with one single exception, with the borough councils of London, from which they had received adequate and reasonable consideration for any project submitted. They were doing their best to abolish through bookings, having given notice to all railway companies with which they had dealings to abolish through bookings wherever they had the right to give such notice. They were anxious to make their railway a self-contained railway, without any intricate arrangements with neighbouring lines. With regard to season tickets, they had decided nothing definitely, but he thought the existing system could be easily supplanted by the issue of books of tickets, such as were now in use on some of our English railways, and which were universally used upon American electrical lines.

MIDLAND RAILWAY CO.—The chairman (Sir Ernest Paget) announced, at the meeting on Friday, that there had been a decrease of 405,000 in the number of passengers carried in suburban districts where electric tramways existed. Resolutions were passed authorising the creation and issue of new capital stock under the Burton and Ashby Light (Electric) Railway Order, 1903, and authorising the directors to exercise the borrowing powers conferred under it.

NORTH-EASTERN RAILWAY CO.—In referring to the electrification of the Newcastle-on-Tyne suburban lines the chairman (Viscount Ridley) stated, at the meeting on Friday, that from the point of view of traffic the service had been very satisfactory, but, of course, the great novelty of the system had caused them to be beset with many difficulties which, though he was glad to say they were surmounting gradually, still were somewhat real difficulties—difficulties both as to the safety of their workmen and the public and passengers, and the convenience of passengers upon the line. In these matters they had been fortunate in their advisers. They had no reason to be dissatisfied with the progress made, and there was a feeling that in these difficult circumstances they had given a very much improved service in that part of their system. As regarded the point of view of profit or loss, it was very early to speak. It was impossible to have accurate figures, but 53,402 train-miles were run in the half-year at an expenditure of £4,911. A good deal of that expenditure included experimental running, both for the satisfaction of their own officers and for the education of those who were to be in charge of the trains. The capital expended in the conversion of the line was £186,000. As to the passengers carried he might take the week ending July 11, 1903, and the week ending July 9, 1904, and making allowances for the fact that one might be a fine week and the other a wet week the number of bookings between the stations affected by the electrification had increased by 25 per cent., and the money by 22 per cent. In the week ending July 18, 1903, and the week ending July 16, 1904, the number of bookings from those stations to and from Newcastle had been increased by 31 per cent., and in money by 36 per cent. They were considering most carefully all the plans that could be thought of by electrical experts for avoiding the danger of the live rail, as well as for promoting the convenience of passengers.

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TYNESIDE TRAMWAYS AND TRAMROADS CO.—The chairman (Lord Armstrong) stated at the meeting on Monday that the surplus of receipts over expenses for the last six months had been £1,455, and a dividend at the rate of 2 per cent. per annum, similar to that of the corresponding period of last year, was declared. The chief event had been the fight with Newcastle Corporation for running powers, and that had caused the directors great anxiety and trouble. The directors were convinced that an equitable arrangement would yield profit to all parties, but negotiations they had twice entered into with Newcastle Corporation having been broken off, their only recourse had been to appeal to Parliament. The arrangement come to was a reasonable one. All the junctions had been made, and there would now be little delay in starting the new service. So far as could be seen up to the present, the electrification of the North-Eastern Co.'s system had had no effect on their receipts.

WATERLOO & CITY RAILWAY CO.—At the meeting yesterday (Thursday) the chairman (Sir Charles Scotter) said that the working expenses for the past half-year came out at 47·55 per cent., against 46 per cent. a year ago, the increase being entirely due to an unfortunate accident to a passenger who met with a serious injury whilst alighting from a train.

NEW COMPANIES, STATUTORY RETURNS, LIENS, REGISTERED, &c.

NEW COMPANIES.

IMPERIAL ENGINEERING SUPPLIES CO. (LTD.) (81,710.)—Reg. July 29 capital £1,500 in £1 shares, to carry on the business of suppliers of electrical and engineering fittings and accessories, contractors for the supply of electric light and power, electrical and mechanical engineers, electricians, &c.

ELECTRICAL FITTINGS CO. (LTD.) (81,756.)—Reg. Aug. 5. capital £15,000 in £1 shares, to acquire business of Electrical Fittings Co., carried on by A. E. Parker, and to carry on business of electricians, mechanical engineers, suppliers of electricity, manufacturers of and dealers in apparatus and things capable of being used in connection with the generation, distribution, supply and employment of electricity, &c. First directors are A. E. Parker, R. Holmes and W. R. Portch. Reg. office, 38, Conduit-street, W.

STATUTORY RETURNS.

NEW CENTURY ARC LIGHT CO. (LTD.)—The return to May 20 gives capital as £30,000 in £1 shares (25,000 ordinary and 5,000 preference), of which 14,306 ordinary and 5,000 preference shares have been taken up. £1 per share called up on 2,506 ordinary, and £2,506 has been received. £16,800 is considered as paid on 11,800 ordinary and 5,000 preference. Mortgages and charges £7,500.

MORTGAGES AND CHARGES.

ELECTRIC SUPPLY CORP. (LTD.)—A trust deed, dated July 18, 1904, to secure £50,000 debenture stock has been registered. Property charged, company's undertaking and property, present and future, including uncalled capital. Trustees, C. F. Tufnell and J. G. B. Stone.

YORKSHIRE ELECTRIC TRAMWAYS CONSTRUCTION SYNDICATE (LTD.)—A debenture, dated July 22, 1904, to secure £70,000 has been registered. Property charged, company's undertaking and property, present and future, including uncalled capital as first floating security. Holder H. S. Leon.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26⅛d. per oz. (Aug. 11). Consols 88—88¼ for money, 88⅛—88¼ for account; 2½ per cent. annuities 87—87½. Consols Pay Day, Sept. 1; Stocks and Shares Continuation Days, Aug. 29 and Sept. 13; Ticket Days, Aug. 11 and 30; Pay Days, Aug. 12 and 21; Mining Share Carry-over Days, Aug. 26 and Sept. 12.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—An interim dividend at the rate of 8½ per cent. per annum has been declared for the half-year ended June 30.

CHANGE OF TITLE.—The title of the Blackheath & Greenwich District Electric Light Co. (Ltd.) has been altered to the South Metropolitan Electric Light & Power Co. (Ltd.).

EDWARDS' AIR PUMP SYND. (LTD.) -An interim dividend for the half-year ended June 30 at the rate of 10 per cent. per annum is declared.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—An interim dividend has been declared at the rate of 4½ per cent. per annum on the ordinary shares for the half-year ended June 30.

NORTH LONDON RAILWAY CO.—The directors (in the report to June 30) attribute the decrease in the passenger traffic partly to the competition of the Great Northern & City Railway.

RAND CENTRAL ELECTRIC WORKS (LTD.)—During July 887,050 units of electrical energy were generated, yielding gross revenue of £8,850, compared with 727,715 units and £6,200 in the corresponding month last year.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have ordered £50,000 5 per cent. debenture stock of the *Madras Electric Tramways (1904), Ltd.*, to be quoted.

WEDNESBURY.—The General Purposes committee report that until the questions between the South Staffordshire Tramways (Lessee) Co. and the South Staffordshire Tramways Co. are disposed of there is little likelihood of the electrification of the steam tramways in the district.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 6	1,664	+ 186	10	14,756	+ 3,110
Airdrie	July 29	197	...	25	4,941	...
Ayr Corporation	Aug. 6	449	- 15	12	5,011	+ 84
Barnsley	July 29	173	- 24	30	4,999	- 363
Barrow	,, 29	290	...	25	4,428	...
Bath Electric Trams, Ltd.	Aug. 3	1,150	...	31	19,069	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 7	1,217	+ 1	...	...	...
Birmingham Corporation	,, 6	865	...	§18	5,529	...
Birmingham Tramways Co.	,, 6	6,222	+ 650	5	28,779	+ 2,584
Blackburn Corporation	,, 5	1,012	+ 178	19	18,546	+ 1,767
Blackpool Corporation	,, 4	2,871	+ 798	18	20,750	+ 2,808
Blackpool and Fleetwood	,, 6	2,251	+ 109	6	7,214	- 41
Blackp'l, St. Anne's & Lytham	,, 4	1,127	+ 177	40	12,682	+ 6,201
Bolton Corporation	,, 7	1,981	+ 48	19	25,888	+ 201
Bournemouth Corporation	,, 3	1,718	+ 49	§18	20,571	+ 1,602
Bradford Corporation	July 30	4,800	+ 789	18	86,795	+ 15,017
	Aug. 6	5,929	+ 1,021			
Brighton Corporation	,, 7	2,211	+ 489	18	19,770	+ 1,682
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage	,, 5	7,008	+ 395	11	61,949	- 26
Buenos Ayres & Belgrano	July 10	3,477	+ 409	12	39,888	+ 1,918
Burnley Corporation	Aug. 6	1,044	+ 142	19	20,083	+ 4,643
Burton Corporation	,, 7	606	+ 14	¶18	6,744	...
Calcutta Tramways Co.	,, 6	R37,382	+ R3,662	6	R174,311	+ R20,415
Camborne-Redruth	,, 8	128	- 8	14	1,639	- 101
Cardiff Corporation	,, 6	2,818	+ 216	18	89 085	+ 1,162
Carlisle Tramways Co.	,, 6	251	+ 1	31	6,195	+ 209
Central London Railway	,, 6	5,666	- 449	5	30,294	- 1,670
Chatham & Dist. Lt. Rys.	,, 4	862	+ 47	31	18,186	+ 2,229
City & South London Rly.	,, 7	2,742	- 111	6	14,061	- 810
Cork Electric Trams Co.	,, 4	555	- 416	31	14,283	- 1,781
Darwen Corporation	,, 5	180	+ 8	18	4,217	- 97
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	July 29	565	+ 43	30	15,695	+ 2,479
Dover Corporation	Aug. 6	870	+ 29	19	4,452	- 100
Dublin & Lucan Railway	,, 5	177	+ 45	5	788	+ 109
Dublin Southern District	,, 5	1,562	+ 189	5	29,118	- 3 967
Dublin United	,, 5	4,790	+ 317			
Dudley—Stourbridge	July 29	990	+ 81	30	15,269	+ 993
Dundee Corporation	Aug. 3	876	+ 4	5	4,425	+ 18
East Ham Council	,, 6	995	+ 6	18	14,891	+ 1,295
Gateshead & Dist. Trams	July 29	948	+ 8	30	26,961	+ 1,162
Glasgow Corporation	Aug. 6	14,901	+ 1,804	†10	138,432	+ 4,926
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	July 29	291	+ 26	30	7,550	+ 814
Gt. Northern & City Rly.	Aug. 6	991	...	25	23,129	...
Greenock & Port Glasgow	July 29	680	+ 23	30	16,802	+ 726
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 29	339	+ 19	30	8,055	+ 866
Huddersfield	...	...	...	...	...	...
Hull Corporation	Aug. 6	2,588	+ 486	18	39,892	+ 5,159
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	,, 3	207	- 47	18	2,781	+ 155
Ipswich Corporation	,, 6	832	...	18	9,704	...
Isle of Thanet Co.	,, 6	2,860	+ 51	¶45	28,124	- 66
Kidderminster & District	July 29	145	+ 8	30	3,709	- 66
Kirkcaldy Corporation	Aug. 3	240	- 32	31	7,039	...
Lanarkshire Trams Co.	,, 4	670	+ 7	31	19.525	...
Leeds Corporation	,, 6	7,909	+ 1,245	20	113,902	+ 7,882
Leicester Corporation	,, 6	2,087	...	...	...	...
Liverpool Corporation	July 30	10,953	+ 253	31	318,847	+ 11,08
Liverpool Overhead Rly.	Aug. 7	1,768	- 193	†6	10,387	- 14
*London County Council	July 30	18,708	+ 4,084	§18	213,906	+ 41,25
Lowestoft	Aug. 6	499	+ 40	2	880	+ 59
Manchester Corporation	,, 6	13,820	+ 671	18	226,311	+ 8,123
Mersey Railway	,, 6	1,484	- 23	5	7,827	+ 428
Merthyr	July 29	202	+ 4	30	6,082	+ 147
Middleton	,, 29	370	- 2	30	9,702	+ 144
Nelson Corporation	Aug. 9	128	+ 31	19	2,249	+ 887
Newcastle-on-Tyne Corp.	,, 6	3,965	+ 214	5	19,086	+ 1,604
Newport (Mon.)	,, 6	777	+ 60	18	9,763	+ 1,956
Oldham, Ashton & Hyde	July 29	579	+ 1	30	16,312	- 772
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams.	Aug. 5	1,241	+ 61	31	41,156	+ 5,872
Peterborough	July 29	170	+ 4	†0	4,418	- 122
Poole and District	,, 29	328	+ 1	30	8,570	+ 6
Portsmouth Corporation	Aug. 6	3,841	+ 822	†18	39,198	+ 3,620
Potteries	July 29	1,748	+ 96	30	51,067	+ 4,453
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 29	284	+ 17	†0	4,046	- 94
Salford Corporation	Aug. 8	4,242	+ 176	19	77,881	+ 6,035
Sheerness	July 27	84	- 8	30	1,763	- 417
Sheffield Corporation	Aug. 7	5,289	- 600	§19	91,271	+ 2,244
Southampton Corporation	...	...	...	...	...	...
Southend Corporation	,, 3	805	+ 146	18	6,981	+ 854
Southport Tramways	July 29	409	+ 51	30	9,497	+ 542
S. Staffordshire Trams.	,, 29	725	- 248	30	23,065	- 2,568
Stockport Corporation	Aug. 5	806	+ 594	18	11,314	+ 4,977
Sunderland Corporation	,, 7	1,786	- 69	18	24,180	+ 646
Swansea Trams	July 29	599	+ 14	30	16,011	+ 973
Taunton Trams	,, 29	64	- 6	†0	1,615	- 106
Tynemouth and District	,, 29	377	- 57	30	8,472	- 477
Tyneside Trams Co.	Aug. 3	628	+ 46	31	11,891	+ 2,095
Wallasey District Council	,, 6	1,100	+ 52	§18	14,607	+ 876
Walsall	,, 6	651	...	31	15,108	...
Warrington Corporation	,, 4	380	+ 22	18	5,539	+ 172
West Ham Corporation	,, 4	1,472	...	23	19,178	...
Weston-super-Mare	July 27	242	+ 13	†0	2,954	+ 122
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 29	398	- 2	30	11,456	- 194
Worcester	,, 29	861	+ 204	25	7,675	+ 3,474
Wrexham	,, 29	113	- 55	30	3,319	- 419
Yorkshire Woollen District	,, 29	726	+ 202	30	17,823	+ 7,600

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Aug. 10	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Aug. 10.	
				£ s. d.		Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	..	Anglo-Argentine Ordinary Shares	6 —6¼	..	April, Oct	6⅝	6
5	2/6	Do. 5% Cum. Pref.	5⅛—5⅜	4 13 0	..	5⅜	5¼
St.	6%	Do. Permanent 6% Deb. Stock	137 —141	4 5 0	..	138	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	98 —100	5 0 0	..	99½	99
10	6%	Barcelona Tramways Ord.	9 —10	3 0 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 0	..	..	..
100	5%	Do. 5 per Cent. Debs.	96 —99	5 1 0	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	1⅛—1⅜	..	..	..	..
1	..	Do. 5% Cum. Pref.	⅞—1	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1¾—2⅛	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96 —101	4 9 3	..	97	..
10	8%	†Bristol Tramways and Carriage Ord.	19½—20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107 —109	3 13 4	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	99 —102	5 17 7	..	100	..
St.	5%	Do. Pref. Ord. Stock	99 —102	4 18 6	..	101½	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝—105⅞	4 6 2	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 —100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	8⅜—9⅛	6 9 9	..	9⅛	8⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅜—11⅛	5 6 7	Feb, Aug	11⅛	11
St.	5/0	Do. 5 per Cent. Perpetual Debs	116 —119	4 5 1	..	118⅛	117⅝
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	95 —98	..	..	96½	..
5	3/0	Buenos Ayres and Belgrano Ord.	2⅞—3⅛	4 16 0	..	2⅞	3⅛
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼—5½	5 4 4	..	..	..
5	3/0	Do. "B"	5 —5⅛	5 9 1	..	..	..
St.	5%	Do. 5 per Cent. Debs.	105 —108	4 12 8	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	101 —104	4 16 6	..	..	..
5	3/6	Calcutta Tramways	7¼—7⅜	3 17 6	..	7⅜	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 3 3	..	107	..
1	1/0	Cape Electric Tram Shares	1⅜—2	5 0 0	..	1⅜	..
St.	4%	Central London Ordinary Stock	89 —91	4 8 0	June, Dec	90½	90
St.	4%	Do. 4 per Cent. Pref. Stock	102 —104	3 18 5	..	..	..
St.	4%	Do. Deferred Stock	79 —81	4 18 9	..	..	..
100	4%	Do. 4 per Cent. Debs.	106 —109	3 13 5	..	107½	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2%	City and South London Rly. Con. Ord.	44 —46	4 17 10	Feb, Aug	47⅛	45
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —126	4 0 0	Feb, Aug	..	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	105 —108	3 14 9	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 10	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 8 11	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8½	Gt. Northern & City Rly. Prf. Ord. (4%)	4 —4½	..	..	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19⅛—20½	4 17 7	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 9	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 —91	4 7 11	..	..	..
10	1½%	Liverpool Overhead Railway Ord	3⅜ —4	3 8 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10¼—10⅜	4 13 0	..	10⅛	10⅞
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —105	3 16 4	..	104⅜	103½
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅛—⅜	..	..	¼	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	..	1⅛	..
St.	13/7	Do. 4½% Deb. Stock	97 —100	..	..	98½	98½
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 —105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 —2	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99—102	4 18 1	..	100½	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	89 —92	3 7 11	June, Dec	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	⅝—⅞	8 0 0	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	⅞—1	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5⅞—6⅛	6 8 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5⅛—6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 7	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	3½—3⅝	8 0 0	..	3⅝	3½
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	85 —88	4 10 11	..	..	..
2	..	Brush Electrical Engineering	½—1	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1—1½	9 12 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	71 —76	5 18 4	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½—10⅛	5 14 3	Jan, July	10⅜	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	101 —105	4 5 8	Nov, May	102⅜	101½
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 16 10	..	..	..
1	1/2½	Chadburn's (Ship) Telegraph Ord.	¾—1⅛	8 0 0	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—2	7 9 3	Jan, July	1¾	1⅝
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	94 —97	5 3 6	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7½—8	..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5¼—5⅜	5 4 4	..	5½	5⅛
St.	4½%	Do. 4½% Deb. Stock	102—105	4 6 0	..	104⅛	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅛—⅜	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 —82	4 18 1	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 —83	6 3 8	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6 —6⅛	5 12 0	H'lf-yearly	6⅜	6⅛
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅜—6	5 0 0	..	5⅛	5⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 4 0	..	106½	..
2	1/7½	Electric Construction Co.	1 —1½	6 8 0	July	1⅝	1½
2	2/9⅜	Do. 7 per Cent. Cum. Pref.	2 —2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	96 —99	4 0 9	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 —9½	5 5 3	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	96½	95½
5	9/0	Henley's Telegraph Works Ord.	11 —12	6 5 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	1½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.	107 —111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 6	Feb, Aug	19⅜	..
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.	100 —103	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	35 —38	6 6 2	Mar, July	36	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	99 —102	3 18 5	Jan, July	..	..
5	..	Willans and Robinson Ord.	2 —3	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3 —4	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	75 —80	5 1 0	Mar, Nov	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord. (f.p.)	⅝—¾	..	..	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅛—1⅜	5 1 9	..	..	..
St.	..	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	102 —106	4 5 3	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11⅛—12⅛	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9⅜—10⅛	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10⅜—11⅛	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 —105	4 6 3	..	..	..
5	..	Bromley (Kent) El. Lt. & Power Shares	5⅛—6	..	..	..	..
St.	4½%	Do. Do. 1st Debs	100 —103	4 7 5	..	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	10⅜—11⅛	4 8 11	..	11⅜	..
5	3/6	Do. 7 per Cent. Pref.	10⅛—10⅜	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7⅛—7⅜	4 10 5	..	7⅛	7⅛
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 —109	3 13 11	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7⅛—8	5 0 0	Feb, Aug	7⅛	7⅛
5	2/3	Do. 4½ per Cent. Pref.	5⅛—5⅛	4 1 10	Feb, Aug	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅜—5	4 10 0	..	5⅛	..
5	2/3	Do. Do. (1903)	4⅜—5	..	..	4⅜	..
St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 0	..	..	..
5	3/6	Chelsea Electric Supply Ord.	6⅛—7	4 2 2	March ..	6⅜	6⅛
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 2 6	Jn, Dec ..	107	..
10	5/0	City of London Electric Lighting Ord.	10⅛—10⅜	4 13 0	Feb, Aug	10⅜	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅜	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	120 —125	4 0 0	Jn, Dec ..	121⅜	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 5 9	..	..	..
10	4/0	County of London Elec. Supply Ord.	7⅛—8⅛	4 14 3	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	11⅛	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	105 —108	4 3 6	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	100 —103	4 8 0	..	..	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 —93	5 7 6	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅜—6⅛	4 8 0	..	6	5⅞
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 —106	4 4 10	..	..	..
10	..	Havana Electricity Co. Shares	9⅛—10⅛	..	..	..	..
5	5.0	Hove Electric Lighting Ord.	7⅛—8⅛	5 0 0	..	..	..
St.	4½%	I. of W. Elec Lt. & Power 4½% Db. St (red.)	101 —103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	1⅜—1⅝	..	..	..	..
5	5.0	Kensingtn & Knghtsbdge Ord.	12 —13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	..	..
3	..	London Electric Supply Ord.	1⅛—1⅜	..	..	..	..
5	3/0	Do. 6 per Cent. Pref.	5 —5⅛	5 9 1	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	94 —97	4 2 11	Mr, Jn, S, D	..	..
10	£6	Metropolitan Electric Sup. Ord.	15⅛—16⅛	5 12 1	April, Oct	16⅜	16
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5⅜	4 1 10	Jan. July	5⅜	5⅜
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	108 —112	4 0 4	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 —99	3 10 6	..	..	..
St.	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	93 —96	4 13 9	..	..	..
10	6.0	Notting Hill Electric Ord.	14 —15	4 0 0	March	14⅜	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	100 —103	3 18 3	..	..	..
5	4.0	Oxford Electric Ord.	5¾ · 6⅛	5 4 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	97 —100	4 0 0	..	..	..
1	..	Rand Electric	1 —1⅛	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb	100 —103	4 7 9	April, Oct	..	..
5	5.0	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	..	..
5	3.6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 2	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2⅜—3½	6 3 1	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 —88	4 10 11	..	..	..
5	3/0	South London Electric Supply Ord.	3⅜—4¼	3 10 7	..	..	..
5	2/6	Urban Electric Supply Ord.	4½ 5	5 0 0	..	4⅝	..
5	2/6	Do. 5% Cum. Pref.	4⅜—5¼	4 15 3	..	4½	4⅜
5	6/6	Westminster Electric Supply Ord.	12⅜ 12⅞	5 0 0	Mar, Sept	12⅝	12⅜
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6⅛	3 16 11	..	6⅜	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	97 —101	3 19 2	Jan, July	..	..
10	..	Amazon Telegraph	2⅛—3⅛	..	Jn, Dec .	..	..
St.	12/6	Anglo-American	45 —48	5 16 8	F, My, Ag, N	..	..
St.	25/0	Do. Preferred	89 —91	6 0 11	F, My, Ag, N	90½	8 ⅛
St.	2/0	Do. Deferred	6½—7	1 8 7	F, My Ag, N	..	..
100	£2	Commercial Cable Capital Stock	176 —180	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 —96	4 3 6	Jn Ap, Jy, O	94⅛	9 ⅛
10	5/0	Cuba Submarine Ord.	7 —8	7 10 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2⅛—3⅛	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅝—101⅞	4 9 2	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10⅛	5 14 3	Ja, Ap, Jy, O	10⅜	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.	99 —101	4 9 2	Ja, Ap, Jy, O	..	..
St.	65/0	Eastern Ordinary	124 —129	5 8 6	Ja, Ap, Jy, O	127	121½
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 —89	3 18 6	Ja Ap, Jy, O	87	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 6	May, Nov	107	..
10	2/6	Eastern Extension	11⅜—12⅛	5 14 3	Ja, Ap, Jy, O	12⅜	11⅞
St.	4%	Do. 4 per Cent. Deb. Stock	103 —106	3 15 6	Feb, Aug	105	103
100	4%	* Eastern & S. African 4% Mrt. Deb, 1908	97 —100	4 0 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞—102⅞	3 18 9	May, Nov	..	..
10	5.0	Gt. Nrthn. (of Copenhagen) excoupon 61	25⅞—26⅛	5 13 2	Jan, July	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 —101	4 9 2	June, Dec	..	..
25	37/6	Indo-European	42 —45	5 11 2	May, Nov	43	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	99½	..
10	6/0	West African Telegraph Shares	6 —7	5 14 3	..	..	..
2½	..	West Coast of America	⅛—⅜	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅝—¾	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½—6⅝	8 17 9	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 —102	4 18 1	Jan, July	..	..
100	3/C	Western Telegraph	12 —12½	5 12 0	Mr, Jn, O, D	12⅜	12⅛
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 16 3	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99 —102	3 18 5	..	..	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5 —5⅛	6 7 3	August ..	5⅜	5⅛
1	7⅛	Monte Video Telephone Ord.	7/16—9/16	..	..	..	..
St.	6%	National Co. Pref. Stock	103 —105	5 14 3	..	104½	103
St.	5%	Do. Def. Stock	86 —89	5 12 1	..	87	86
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 8	Feb, Aug	14	13½
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5⅛	4 15 3	Feb, Aug	5⅛	5⅛
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 —99	3 10 8	June, Dec	98⅛	97⅜
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 —105	3 16 2	..	104⅛	..
..	5/9	Do. Do. Prov. Certs. 35% to be pd.	64 —65	..	..	66	65⅜
1	0/8⅝	Oriental	1/16—1⅛	6 6 3	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	6 4 6	..	..	..
5	5/0	United River Plate	6 —6½	6 3 3	July.....	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅜—5⅛	4 15 3	June, Dec	5⅛	4⅞
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 —106	4 14 4	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4⅞—5⅛	5 14 4	..	..	..
10	2/0	Globe Telegraph and Trust	8⅞—9⅛	5 19 0	Ja Ap Jy O	8⅞	8⅞
10	3/0	Do. 6 per Cent. Pref.	13¾—13⅞	4 7 1	Ja Ap Jy O	13⅛	13⅜
8	4/0	Reuter's	6¾—7⅛	5 12 6	April, Oct	7⅛	..

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NOTES.

THE seventy-fourth meeting of the British Association was inaugurated at Cambridge on Wednesday with the delivery by the Right Hon. A. J. BALFOUR of his presidential address. Though the Corn Exchange, the scene of the ceremony, is a large hall accommodating about 2,000 people, several hundreds of disappointed members who had arrived during the past few days were unable to obtain admission. This year's meeting boasts, in fact, a record attendance, the total of members and associates up to noon yesterday reaching the unprecedented figure of 2,700. The personality of the President, the convergence towards the University of former students, and the nearness of Cambridge to the metropolis have joined in producing this result. Perhaps this figure will not be surpassed till the authorities bethink themselves of holding for once the annual meeting in London.

THE last Cambridge meeting was in 1862, when the Rev. ROBT. WILLIS was President. A glance at the report of that year's doings, and at the names of the men who figured in its transactions, gives an impression more vivid than does the mere date of the distance in time, as measured by scientific achievement, between that meeting and this. In the sections of mathematics and physics and mechanical science electrical matters had but slight attention, and were touched upon in a manner which now reads as almost archaic. The presidential address in the mechanical section was, in fact, a long note of exclamation at the recent application of steam to quick locomotion, and at the success of WHITWORTH's rifled gun in penetrating 4in. of wrought-iron armour-plate. The names which stand out most prominently ("there were giants in the earth in those days") are STOKES, HAMILTON, CAYLEY, FAIRBAIRN, JOHN SCOTT RUSSELL, WHITWORTH, WHEATSTONE and RANKINE.

MR. BALFOUR showed, however, within the first few minutes of his address, that he believes we have at the present moment giants at Cambridge; "men of renown," who, with the Cavendish laboratory as their base, are making this particular epoch as illustrious as any in the history of science. No doubt this commendatory allusion to the work of the savants of the great University was in part but a compliment to the place of meeting, and in part the result of the natural bias of the speaker in favour of his *alma mater*; but it strikes the key-note to the whole of the address. The address was, in fact, an epic telling of the great deeds of our English heroes in the field of intra-atomic physics. It is, in itself, however, one of the most lucid expositions, and quite the broadest as well as most eloquent survey, of the electrical theory of matter in its general issues that has yet been given. And delivered in so impressive a manner by such a personage as is its author, it could not fail to imprint on the mind of every hearer—and most of all such as are interested only in sciences other than physics—a sense that the hypothesis in question is intellectually of wider interest and importance than any scientific theory brought forth since the momentous birth of the Darwinian theory.

BUT, as was perhaps to be expected, it was in his discussion of the relations between the new physics and philosophy that the President was most original, most monitive. Here much of what he expressed of the connection between the two subjects of study and of the legitimate bearing of philosophy on physics must have found a ready echo in the mind of every physicist who has endeavoured to tread, even for but a little distance, the vast mazes of philosophy. The lesson is, put crudely, that the man of science, in developing his science, may and must ignore all question of the reality of the external

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world. Mr. BALFOUR raised another point, which amounts to the old question: Are we capable of knowing the truth regarding matter? Our intellectual machinery has been evolved along with our modes of sense-perception and, therefore, may be as far from understanding the truth as our sense-perceptions are known to be from perceiving things as they are—from feeling heat, for example, as molecular motion, matter as congeries of electrons. An analogy occurs to us which will help the plain man to appreciate Mr. BALFOUR'S point, an analogy which is, we admit, so rough-hewn, that its perpetration is scarcely pardonable. Let the intellect be represented by, say, a planing machine with a bed of unknown imperfections. A theory or conception might then be likened to a piece of work turned out by the machine. The two creations here parallelled might each fulfil many functions very excellently though still far from "truth." The "truth" of the products of the machine might be estimated, however, by a proper series of comparisons among themselves. To devise methods of testing the products of the intellect is equally desirable; but, in the words of Mr. BALFOUR, philosophy, not science, must undertake the task.

THE addresses by the sectional presidents were delivered yesterday morning; those of Section A (Mathematics and Physics) and G (Engineering) following one another so that members interested in the work of both sections could attend both. The Hon. C. A. PARSONS' presidential address to Section G is a plea for better treatment of the British inventor. Complaint is made that the Patent Office does not render that amount of assistance to would-be patentees that it ought to, and that foreign patent offices are far more obliging in this respect. Certainly, if there is a man in this country who has had unfortunate experience as an inventor that man is the President of Section G. For years he has laboured at his steam turbine in most discouraging circumstances, and now that the value of the invention is realised, his patent, although specially extended some years ago, has expired, leaving the field open to competitors. Admittedly there is room for improvement in the ways and means of procuring and maintaining patents, but we venture to think that it would be almost impossible to give effect to Mr. PARSONS' suggestion, that the conditions under which patents are granted should be analogous to those governing the formation of gas, electric light and other companies. Such undertakings have a certain monopoly, it is true, but that monopoly is limited, and in many instances there is competition in the sale of the same commodity, whereas a patentee enjoys exclusive right of manufacture and sale. Nevertheless, we are entirely in agreement with Mr. PARSONS that invention should be stimulated as much as possible by adequate protection; and that when the commercial development of an invention is likely to require some considerable time, it would be highly desirable that this should be taken into account in granting the patent, if the practical difficulties in the way of such a system are not insuperable. Mr. BALFOUR proposed the customary vote of thanks, and expressed his opinion that effective legislative action to remedy inventor's grievances would never be taken till harmonious international movement in the question came about. Mr. BALFOUR'S announcement that the German Society of Engineers had, at their recent Frankfort meeting, awarded the Grashof gold medal to Mr. PARSONS, and that Prof. SCHRÖTER, of Munich, was there to present it, caused great enthusiasm.

AN abstract of Mr. PARSONS' address will be found in this issue, and also the first part (slightly abridged) of Prof. HORACE LAMB'S address to Section A.

THE annual report of the chief engineer to the Engine Boiler and Employers' Liability Insurance Co., an abstract of which appears on another page, reveals the fact that ignorance among users of electrical plant is still rampant. Mr. LONGRIDGE says that inspectors are frequently sent for when nothing more is needed than the trimming or adjustment of a brush, the clearing away of a little dust, the cleaning of a contact, or the tightening of a screw. Such instances as these we have kept out of our abstract, and have merely given those possessing special interest. In the statistics relating to breakdowns it will be observed that in both dynamos and motors the accidents to armatures or rotors are numerically greater than those to the rest of the equipment put together, and, unfortunately, the cause of the breakdown is frequently bad workmanship. Perhaps the most curious instance of all is that in which field coils designed for a 250-volt motor were put on to a 500-volt machine, with the natural result that the temperature of the magnets reached something over and above the boiling point of water. Regarding the case in which "electricity was escaping from the motor," it is questionable whether the inspector's explanation was the correct one: indeed, it is far more probable that the belt was acting on the principle of an influence machine than that electricity was being generated by friction. A similar phenomenon may be observed with a large belt in almost any engine room when the atmosphere is sufficiently dry.

THE Return that has just been issued with regard to the year's working of the Pacific Cable hardly comes as a surprise, but yet it must be decidedly unpleasant reading to the Colonial Governments which have undertaken to contribute towards making good the enormous deficit which is disclosed. The actual expenditure has exceeded the gross receipts by £25,000, and, when allowance is made for capital charges, the total deficit is slightly over £88,000. No reason, excuse or apology is offered in the report (which we abstract on p. 700), and the estimates for the year 1904-5 do not give any encouragement for hope that a better state of affairs will be evolved. It is, in fact, estimated that the deficit for the next financial year will be £89,810, or nearly £2,000 more than this year, "if no unforeseen interruptions of the cable should take place and no other contingency affecting its earnings should arise." In the meantime this highly-subsidised line is competing severely with the cable service established by private enterprise; and the nature of this competition will be evident when we point out that for every pound paid by the public for the transmission of messages over the Pacific route, the combined Governments have to contribute a guinea. The general feeling is that, however great may be the strategical importance of the Pacific Cable, too high a price is being paid for it.

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THE electron theory has been led to further conquests by the researches of PAUL DRUDE, who has reached some remarkable generalisations along the lines indicated by PASCHEN, THOMSON, LORENTZ and PLANCK, as well as his own well-known researches on the optical properties of metals. It is encouraging to notice that he frankly adopts THOMSON'S view that metallic conduction is due to negative electrons only. This unifies the electron theory in the hands of its chief exponents to an extent which could hardly have been hoped for at this stage. One of the first achievements of these new researches is the deduction of another independent value of the ratio e/m, this time from the Ketteler-Helmholtz dispersion formula. It comes out as $1{\cdot}55 \times 10^7$, whereas the standard value from other methods is $1{\cdot}86 \times 10^7$—a close agreement as methods go. But these new researches, of which we give an abstract on p. 701, are most fruitful from the point of view of electro-chemistry. They shed a flood of light on the phenomena of conduction, and enable us to test THOMSON'S ingenious speculations on the structure of atoms. DRUDE shows that cations contain a number of electrons separated into two distinct groups, one group being loosely held and the other firmly attached to the atom. The former are never in excess of the valency, and they determine conduction and dispersion. The more closely connected ones have a very much higher frequency of oscillation, and one cannot but connect this fact with the high frequency of the new N-ray oscillations. Intermediate degrees of mobility exist in metals which, like iron, exhibit various valencies at different times. Anions, on the other hand, may possess a large excess of negative electrons loosely held. The fact that the loosely-bound electrons determine both conduction and dispersion establishes an intimate bond between what may be called corpuscular electricity and light, which appears likely to be exceedingly fruitful. DRUDE himself has garnered the first fruit by finding the number of free electrons in the molecules of 72 chemical compounds.

ON Thursday next a party of members of the Institution of Electrical Engineers will leave England on the ss. "Republic" for America. They will arrive at Boston on September 2nd, and will spend the intervening days between that date and September 12th on a special circular tour organised under the auspices of the American Institute of Electrical Engineers. In the course of this tour many engineering works will be visited, as well as several places of non-technical interest. On the latter date the International Congress at St. Louis will commence, numerous Papers being down for reading during the ensuing four days. Visits will subsequently be paid to Pittsburg, Washington, Philadelphia and New York, and the return for home will be commenced on September 23rd, the party travelling on board the ss. "Arabic" from New York. From the final official programme, which is before us, it is perfectly evident that if all the works and other places of engineering interest named therein are visited the educational value of the trip will be very great, and the labour involved proportionally hard. In any case, a large debt of gratitude is owing to the American Institute of Electrical Engineers, who are preparing to entertain their guests on a very lavish scale, and have thought out and arranged beforehand those small but necessary matters of detail such as train and luggage arrangements that are all-important for the convenience and comfort of the travellers. We cordially wish those members of the Institution who are going to America *bon voyage*.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Beissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Cayenne—Paramaribo	July 13, 1904
Marseilles—Barcelona	Aug. 16, 1904

Honorary Degrees.—In connection with the British Association meeting now being held at Cambridge, honorary degrees will be conferred upon the following gentlemen on Monday next:—Henri Becquerel (Professor of Physics in the Ecole Polytechnique, Paris); Julius Wilhelm Bruhl (Professor of Chemistry in the University of Heidelberg); Vito Volterra (Professor of Applied Mathematics in the University of Rome); Sir Norman Lockyer, K.C.B. (Director of the Solar Physics Observatory, South Kensington); Major Percy Alexander McMahon, F.R.S. (late Royal Artillery, formerly Professor of Physics, Ordnance College, Woolwich); Sir William Ramsay, K.C.B. (Professor of Chemistry at University College, London); Arthur Schuster, F.R.S. (Professor of Physics in the Victoria University of Manchester).

Wakefield and District Tramways.—A large tramway system owned by the Wakefield and District Light Railways Co. was opened on Monday. The routes at present opened branch out in four directions from the Wakefield Market-place, one line going to Sandal Magna (2 miles), a second to Agbrigg (2 miles), the third to Ossett via Horbury (nearly 5 miles) and the fourth to Thwaite Gate (about 7 miles), the whole representing about 24 miles of single track. At Thwaite Gate the line connects on to the Leeds tramway system, and mutual running powers have been arranged between the Corporation and the company so that in a few days there will be a through connection between all parts of Leeds and Wakefield. Standard gauge has been adopted, and, with the exception of about 200yds. of single track, the whole line between Wakefield and Leeds is double track. The worst gradient is about 1 in 16, extending for some 500yds. Other lines are in course of construction. A high-pressure three-phase system of generation has been adopted, current being supplied to the tramways at 500 volts from sub-stations. Messrs. Dick, Kerr & Co. were contractors for the whole of the work. Mr. C. E. Davies is resident engineer and Mr. H. England tramways manager.

Personal.—We are pleased to announce that Prof. W. E. Dalby has been appointed professor of civil and mechanical engineering at the Central Technical College, in place of Prof. Unwin, who has recently resigned. Prof. Dalby succeeded Prof. Perry at Finsbury Technical College eight years ago. Prior to that he had been demonstrator and lecturer in the Cambridge University engineering laboratory under Prof. Ewing. Before occupying this latter position, however, he served as a practical engineer for eight years at Crewe under Mr. Webb, in the locomotive department of the London and North-Western Railway, and for two years at Stratford with the Great Eastern Railway. He is B.Sc. of London and M.A. of Cambridge. In response to a request from Mr. Yarrow he visited Germany, Switzerland and America, in order to investigate the conditions of technical education in those countries, and as a result, read a Paper last year before the Institution of Mechanical Engineers. His chief success in scientific investigation has been his work on engine-balancing. His models, to illustrate his theory, have been exhibited at various conversazioni. Of late, Prof. Dalby has been called into consultation as to engine-balancing on various important undertakings. He has had to cure the vibrations of numerous engines, including those at St. Pancras, of which his treatment was entirely successful, and one of the largest German-American liners. At the last conversazione of the Institution of Civil Engineers, he exhibited a new valve-gear model, for getting out the diagrams of any kind of valve

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gear with any eccentric angle. Prof. Dalby is also an occasional contributor to *The Electrician*. We congratulate the Central Technical College on having secured the services of Prof. Dalby, and at the same time we sympathise with Finsbury Technical College on losing one of its most able, energetic and popular professors.

Institution Visit to America.—The following is the official list of members of the Institution of Electrical Engineers who will visit America :—

R. Kaye Gray (President and Delegate), London; *Lieut.-Col. R. E. Crompton, C.B. (Past President and Delegate), London; *Prof. John Perry (Past President and Delegate), Miss A. M. Perry, and Miss Stower, London; *Dr. R. T. Glazebrook (Member of Council and Delegate), Teddington; *F. E. Gripper (Member of Council), London; *Robert Hammond (Hon. Treasurer and Member of Council) and Miss Hammond, London; *H. E. Harrison (Delegate), London: *W. Duddell (Hon. Sec. to the Institution Delegation), London; *A. F. T. Atchison, Birmingham; *George Balfour, London; *R. S. Ball, London; *W. A. Barnes, Manchester; *D. Bates and Mrs. Bates, Liverpool; *G. Conrad Blair, Paisley; R. Blennerhassett, Schenectady, U.S.A.; *John T. Connolly and Mrs. Connolly, Manchester; Prof. J. D. Cormack and Mrs. Cormack, London; *J. R. Dick, Brighton; *James Edgar, Wrexham; *R. S. Erskine and Mrs. Erskine, London; W. P. J. Fawcus, Manchester; *T. Feilden, London; *J. A. Foster, London; *W. Geipel, London; Prof. W. E. Goldsborough, Purdue, U.S.A.; E. C. Handcock, Lynn, U.S.A.; W. A. Harris, Trinidad; *C. C. Hawkins, Bedford; *M. Hayashi, London; C. Hering, Philadelphia, U.S.A.; *Thomas Hesketh and Mrs. Hesketh, Folkestone; O. Higman, Ottawa, Canada; *F. Hope-Jones, London; S. Insull, Chicago, U.S.A.; *M. Jennison, Manchester; Dr. A. E. Kennelly, Cambridge, Mass., U.S.A.; W. N. Kernot, Melbourne; *F. C. Kidman, Wallsend-on-Tyne; J. D. Knight, London; *E. H. Liebert, Rochdale; G. C. Lloyd (secretary), London; *F. M. Long, Norwich; *B. Longbottom, Manchester; *R. S. McLeod, Manchester; C. O. Mailloux, New York, U.S.A.; *J. L. Marr, Sunderland; *W. B Marr, Sunderland; *J. Marshall, Cheltenham; *R. B. Matthews, Swansea; *F. O. Mills, Manchester; *Dr. D. K. Morris, Birmingham; *J. T. Morris, London; A. E. Morrison, Prince Edward Island; *L. G. E. Morse, London; *F. H. Nalder, London; F. Nichols, Toronto, Canada; Prof. R. B. Owens (local hon. sec. for Canada), Montreal, Canada; *R. B. Perring, Buxton; *W. G. T. Pope and Mrs. Pope, Lisbon; *A. P. Pyne, Gateshead; Calvin W. Rice, New York; *G. H. C. Risch, Johannesburg; E. B. Schattner, Schenectady; E. Kilburn Scott, London; *W. H. Scott, Norwich; *P. S. Sheardown, Dublin; H. B. Simons, Manchester; W. Summerscales, Leeds; *C. D. Tait (chairman, Manchester Local Section), Manchester; Prof. Elihu Thomson, Mass., U.S.A.; *M. J. E. Tilney, London; *R. Tree (chief clerk), London; J. M. Wallwin, Manchester; G. G. Ward (local hon. sec. for U.S.A.), New York; A. C. F. Webb, Sydney, N.S.W.; *H. G. Whiting, Cork; *G. Wilkinson, Harrogate; Capt. R. Ff. Willis and Mrs. Willis, Barbados; L. Wilson, Pittsfield, U.S.A.; *E. B. Woollan, Tunbridge Wells.

* Sailing with the ss. "Republic."

Communications for members whilst in America should be addressed care of Mr. Ralph W. Pope, Secretary, American Institute of Electrical Engineers, 95, Liberty-street, New York, from whence they will be forwarded to the party en route. The latest date for posting in London is Wednesday mid-day, September 14th. The words "Volt-ampere Newyork," have been arranged as the telegraphic and cable address for the party, messages to be marked "Via Commercial."

The Roads Improvement Association and Electric Tramways.—The Board of Trade has addressed a letter to the hon. secretary of the Roads Improvement Association with reference to the matters connected with tramways and light railways on public roads and bridges over railways and canals, which formed the subject of the representations made by a deputation from the Association to the Board on July 18th.

As reported in *The Times* of July 19th, Mr. Worby Beaumont, who accompanied the deputation, expressed the opinion that central posts were unnecessary, and gave rise to the dangerous practice of racing to get by between vehicle and post. The Association asked the Board of Trade to refuse to sanction such central posts. Col. Crompton said they desired to have a minimum with of 33ft. for a double line of rails and 27ft. for a single line, which was in accordance with the recommendation of a departmental committee on the subject of highway authorities and administration in England and Wales. There were roads on which the London United Tramway cars were running where the margin to pass was absolutely insufficient and extremely dangerous, and he was sure that if the officials of the Board of Trade saw them they would never sanction such a state of things in the future. Mr. Rees Jeffreys (hon. secretary of the Association) urged that the main roads should be paved by the same material where tramlines were laid. Having regard to the enormous number of motor cars and cycles upon the main roads out of London, he urged that it was absolutely necessary that the Board of Trade should take action in the matter. Mr. Howard Humphreys urged that power should be given to county councils to call upon private owners of bridges to keep them in repair, or in default to do it themselves and charge the owners with the cost.

The Board of Trade has now replied as follows :—

1. *Centre Poles.*—The Board do not see their way to recommend total prohibition of the use of centre poles, as there might be cases of exceedingly wide roads where such poles might be the best arrangement, or other cases where for some reason centre poles might be necessary. The Board feel, however, the force of the objections stated by the deputation, and will be prepared to enact in tramway and light railway orders that centre poles shall not be used without the express consent of the Board of Trade. They will also communicate with the Parliamentary authorities concerned in private bill legislation as to the desirability of such a provision. In this way promoters will be required to justify the use of such poles in each case as it arises.

2. *Width of Roads.*—The Board do not consider that it would be advisable to fix a statutory limit that might have the effect of prohibiting by severance urgently needed lines. In dealing with applications for tramway and light railway powers, the Board always keep in view the 9ft. 6in. space referred to in sec. 9 of the Tramways Act, 1870 (a limit which would appear to be reasonable), and make provision to secure it wherever practicable. The representations made by the deputation on this point will, however, be borne in mind.

3. *Road Bridges over Railways and Canals.*—Most of what was urged by the deputation with regard to this matter would appear to be for the consideration of the Local Government Board, and not of the Board of Trade, this department being only empowered to deal with appeals from owners of road locomotives who may feel aggrieved by restrictions placed on the use of bridges over railways by such locomotives, either by notice under the Locomotives Act, 1861, or by bye-law under the Locomotives Act, 1878. With regard, however, to the request for legislation to enable a county council to require the owner of a bridge to maintain it at its original strength, I am to point out that sec. 65 of the Railways Clauses Consolidation Act, 1845, provides a procedure under which either a road authority or any two householders in the locality interested may take steps to compel a railway company to repair their bridges.

The Pacific Cable.—A Parliamentary return has been made giving a series of accounts showing the financial position of the Pacific Cable project, and also the report of the chairman of the Board (Sir Spencer Walpole, K.C.B.) The capital expenditure at March 31, 1904, was £1,992,967. 0s. 7d., an increase of £32,185. 8s. 7d. for the year :—

Sir Spencer Walpole's report states that throughout the year 1903-4 the cable was maintained and remained in efficient working order, and no interruption of any kind occurred. The gross message revenue received was £81,832. 16s. 5d., from which had to be deducted £2,008. 11s. (paid to the Atlantic and Canadian Pacific Telegraph Companies, for supplying the date and time of filing all messages to or from the United Kingdom and the Continent) leaving the net message revenue £79,824. 5s. 5d., of which £12,440. 17s. is on account of messages transmitted during 1902-3, and an approximately similar amount is outstanding. The numbers of messages and words transmitted during 1903-4 were approximately 176,351 and 2,095,573 respectively, of which 107,747 messages and 1,226,460 words were intercolonial. In January, 1904, the Fiji Government opened telegraph communication (partly overland and partly by cable) between Suva and Levuka, the cable having been brought from England and laid in the previous June by the Board's staff. At the request of this Government, the Suva end of this cable is worked by employés of the Board. The sum received for working it amounted to £32. 2s. 7d.

The actual expenditure on the service of the cable during the 12 months ended March 31st last was £54,824. 19s. 8d., made up as follows :—

Head office (including some £1,250 for royalties, advertising, engineer's fees, &c.	£5,828	1	7
Stations	31,763	7	2
Ship	15,933	11	5
Provident fund	1,299	19	6

The actual expenditure was £25,000 less than its gross receipts. As, however, the Board set aside £35,500 as a renewal fund, and as it had also to pay an annuity of £77,544. 18s. to meet interest on capital and to replace the whole capital in 50 years, the actual deficit is over £88,000, and this sum has to be provided (in the agreed proportions) by the contributing Governments. The renewal fund amounted on March 31st last to £52,000. £12,500 of this sum was held in spare cable. The Board hesitates to make any exact forecast of its probable revenue and expenditure during 1904-5. If, however, no unforeseen interruption of the cable should take place, and no other contingency affecting its earnings should arise, the financial results of the year may be approximately :—

Traffic revenue	£79.000	Annuity	£77,545
Deficit	89,810	Renewal fund	35,000
		Working expenses	56,265
	£168,810		£168,810

Thus £89,810 may have to be provided by the contributing Governments.

The Board acknowledges its obligation to the staff at home and abroad. Notwithstanding the severe climatic conditions under which the work is done, the health of the staff has, on the whole, been excellent.

The general manager during the year paid a visit to all the stations of the Board.

A conference is to be held in London between representatives of the various Governments interested in the cable, under the presidency of Mr. Lyttelton, Secretary of State for the Colonies (as the representative of the United Kingdom) with the object of settling certain matters at issue.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Optics and the Electron Theory.—P. Drude has made an extension of the electron theory which marks a notable advance in the linking of optical with electric phenomena. He starts from the Ketteler-Helmholtz dispersion formula

$$n^2 = b^2 + \Sigma \frac{M_h}{\lambda^2 - \lambda_h^2},$$

which, according to Paschen and Rubens and Nicholls, exactly represents the dispersion in some solid substances, such as fluorspar. With the help of the electron theory of proper oscillations as developed by Planck and Lorentz, he deduces the further relation

$$\Sigma' \frac{M_h}{\lambda_h^4} \cdot \frac{m_h}{e_h} = 0,$$

where e_h and m_h represent the charge and the inertia of the electron of type h. This implies that in all bodies possessing ratios $M_h : \lambda_h^4$ of two different orders of magnitude occurring at the same time, the ratio e/m must also have two different orders of value. Now, since in all bodies this ratio is much larger for the violet than for the red, it follows that for the proper oscillation in the ultra-violet the ratio e/m must be very much larger than the ratio for the infra-red proper oscillation. This points to the conclusion that the infra-red oscillation is that of the whole positive molecule or a portion of it, whereas the ultra-violet oscillation is that of the negative electron. The author then establishes formulæ for the calculation of the number of electrons in the molecule, and obtains results of exceptional interest. He finds that the proper oscillations of the molecule of fluorspar CaF_2 must be due to four negative electrons—one for each valency—swinging in the ultra-violet, and either the atoms or the molecule swinging in the infra-red. The equations are not exactly fulfilled, and from the residuum the author extracts the further conclusion that the molecule contains other electrons which have a much shorter period, and are much more tightly held by the molecule. Fluorine and chlorine especially seem to contain a superabundance of negative electrons beyond the requirements of their valencies. In water, on the other hand, the number of electrons is just four, or the sum of the valencies of the atoms. In all cations the number of electrons capable of influencing the refractive index by their superior mobility must be equal to, or smaller than, the valency. In the anions such a condition does not hold.

[P. DRUDE, *Annalen der Physik*, No. 9, 1904.]

Fluorescence Spectra.—E. L. Nichols and E. Merritt have obtained some interesting general results in the course of their "studies in luminescence." They have conclusively established Lommel's contention that, in some cases of fluorescence, Stokes' law is not fulfilled. Eosin, naphthalin roth, fluorescein, rhodamin, resorcin blau, quinine sulphate, chlorophyll, canary glass, green fluorspar, white fluorspar and æsculin all exhibit fluorescence of the same type. The fluorescence spectrum in every case consists of a single band situated near the infra edge of the absorption band with which fluorescence is associated. The position of the maximum of the fluorescence band is in all cases independent of the wave-length or composition of the exciting light. The distribution of intensities in the fluorescent spectrum is independent of the wave-length of the exciting light. Fluorescence occurring at the red end of the spectrum is traceable to a greater distance towards the violet, and fluorescence at the violet to a greater distance towards the red, than is the case with fluorescence bands in the middle of the spectrum, because of the increase of luminosity in those directions. Stokes' law hold for none of these fluorescent substances. Fluorescent substances having absorption bands of shorter wave-length than that with which the fluorescence is associated are capable of excitation by the absorbed light in each band, whatever its wave-length. Fluorescent substances may also have absorption bands of greater wave-length than that with which fluorescence is associated, as in the case of green fluorspar and chlorophyll. The light absorbed in these bands does not, however, produce fluorescence. Where more than one fluorescence band exists, as in the case of chlorophyll, it is probable that each band is due to a distinct fluorescent material contained in the solution. No case is known of double or multiple fluorescence where only one substance capable of fluorescence is present. The authors are now engaged in an investigation of the influence of fluorescence upon the absorption and electric conductivity of fluorescent solutions.

[NICHOLS and MERRITT, *Physical Review*, July, 1904.]

Mercury Ammeter.—C. Camichel describes a thermal ammeter in which the wire is replaced by a thread of mercury. A mercury resistance is placed in the interior of the reservoir of a mercury thermometer, and a constant current is made to traverse it for one minute. The ammeter thus constituted is placed inside an enclosure maintained at the temperature of melting ice. The increase in length of the thread of mercury measures the current. The instrument is graduated from another ammeter, the curve being very nearly a parabola. To avoid delay in the cooling down of the mercury, the reservoir is placed over another whose level can be raised by plunging a block of iron into it. The mercury thus raised surrounds the thermometer reservoir and quickly cools it down to the zero position, and the plunger is raised. In one of the models constructed, a current of 10 milliamperes displaces the thread by two divisions. The usual precautions taken in the case of barometer tubes must be observed. Instead of sending the current through for the space of one minute, it is possible to continue the current until a stationary value is attained. This is, however, only advisable in the case of long-continued currents, as the time required to attain a steady value is about 20 minutes.

[C. CAMICHEL, *Comptes Rendus*, August 1, 1904.]

Electrification and N-rays.—E. Bichat has observed some facts which go to prove that electrification has a notable effect in the observation of N-ray phenomena, and may often act as a disturbing element. The electrification may affect the screen, the source of N-rays, or the observer, and should, therefore, be carefully taken into account. The manner of observation adopted by the author was the following:—A Bunsen burner was enclosed in sheet iron, and served to heat a platinum spoon to incandescence. The radiation from this source was observed through aluminium foil. It penetrated a number of parallel slits cut in a sheet of lead or moist cardboard. Its impact upon a linear sulphide screen produced a diminution of luminosity. On earthing the platinum spoon through a bright copper wire, there was an increase instead of a diminution of luminosity. No change was produced if the wire was oxidised. A more extraordinary effect is that the observer, who perceives a number of maxima behind an aluminium prism beholds a corresponding number of minima when he is electrified, either directly or by induction. Further, the maximum of luminosity perceived vertically below a coin and attributed by Blondlot to the "ponderable emission," may be converted into a minimum by carefully insulating the coin, and reconverted into a maximum by electrifying either the coin or the observer. The author does not attempt any explanation of these observations.

[E. BICHAT, *Comptes Rendus*, July 25, 1904.]

Italy and Wireless Telegraphy.—We have received the following item of news from a Rome correspondent:—The *Elettricista* announces that the Board of Audit has rejected the convention stipulated between the Italian Government and Mr. Marconi. This journal also states that the convention is illegal, and that the newly-inaugurated wireless telegraph route between Bari and Antivari (Montenegro) must be taken over by the Government, who alone have the right of distance communication by telegraph, and, finally, that Mr. Marconi should not be allowed to go on with the Coltano (Pisa) plant at his expense, such being against the fundamental law regulating communication.

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LIVERPOOL CORPORATION TRAMWAYS.

The following is a joint report of the engineers and general manager of the Liverpool Corporation Electric Tramways upon the permanent way, wheels and electrical equipment :—

Permanent Way.—The permanent way adopted for the first experimental line, 6 miles long, consisted of 30ft. girder rails, weighing 95lb. per yard, laid directly on the concrete foundation and held to gauge by tie-rods 10ft. apart, the points, crossings and all special work being built up with scarfed joints, and having inverted rails running through under the cut lengths. No room whatever was left at the joints for expansion. When the extensions were proceeded with, alternative quotations were obtained for the original section and for a rail of similar weight but having the lower flange no wider than the upper surface, the quotations in each case being for rails of such a length as could then be manufactured. As rails of the alternative section could not then be obtained in greater lengths than 45ft., the quotation for 60ft. rails to the original section was accepted, and this length, which was first used in Liverpool, became the standard length for all extensions of the Liverpool system. Short experimental lengths of line to the alternative section have been laid, and from his experience in connection with repairs to paving alongside rails the city engineer considers it an advantage not to have the base of the rails projecting underneath the setts. Where the lines have sharp curves, as at the corners of streets, the grinding action is very severe, and the renewals on the earliest line were very frequent. The life of rails on sharp corners has been very greatly extended through the introduction of hard steel guard rails, which take the wear of the flanges and can be readily and cheaply renewed when required without removing the rails. In some cases, notably on the heaviest traffic lines first laid, considerable trouble has been experienced through the rising and loosening of the setts, caused principally by the vibration, cold-rolling, or movement of the rails allowing water to find its way beneath the bed of the rails and the setts, but this trouble with setts, though reduced, is not entirely avoided even in those cases where the rails are embedded in solid concrete to a depth of 3in. and held down by bolts to rail sections or chair fastenings at frequent intervals embedded in the concrete. Where room for expansion has been left between the lengths of rails, water also finds its way down at the joints, and sooner or later trouble arises. It is of the greatest importance that the joints between the setts, and between the rails and the setts, should remain perfectly watertight, and in this connection the engineers expect to find that considerable benefit will result from the continuous welding of the rails. Difficulty has also arisen through the roughening or corrugating of the rail surface. This trouble usually starts at the joints in the outer rails on slow curves, and has a tendency to extend in each direction from the joint. Whilst experience shows that this can be considerably minimised, the engineers are not aware of any lines in the country in use for a considerable period with a close service of electric cars which are entirely free from this trouble. With regard to the wear of the rails themselves, as apart from curves and special work, a portion of the single line in Park-road, which carried traffic in both directions for five years, on being removed in consequence of street improvements appeared not to be worn to the extent of half its useful life, and judging from the condition of the rails such a line well maintained should have a life on double track much in excess of the original estimate of 10 years. The life obtained from portions of the heaviest traffic lines has already exceeded the city engineer's original estimate, and it is probable that from such lines a life of 7½ to 10 years will be obtained. With regard to the points, intersections and special work on the earlier extensions most of the special work had to constructed by scarfing the rails, but in many of the later lines it has been possible to introduce manganese steel intersections. Originally these were of American make, but latterly English manufacturers have competed with intersections of equal quality, and the manganese or hardened centre specials are now generally used for intersections taking heavy traffic in Liverpool. The durability both of the permanent way and of the car-wheels depends on the relative suitability of the materials used and the care taken to maintain accurate adjustment, not only of the rails but of the rolling stock. The cost of maintenance also depends very largely on the care taken by the drivers in approaching curves and crossings and in the judicious use of brakes. The above matters receive the closest attention of the city engineer and the general manager.

Wheels.—The wheels of the German cars, which were the first to be used in Liverpool in 1898, were steel tyred, and the wheels of the American cars which followed were chilled cast iron. The steel tyres "spread" in running, became loose, and out of gauge, and were ultimately abandoned in favour of the chilled wheel, which was giving much better results on the American cars. The British manufacturers commenced the production of special steel tyres for tramcars about 1900, when their experimental use in competition with chilled wheels began. These experiments were carefully watched, and in May, 1902, a number of selected tyres were placed in service in Liverpool, and later it was considered desirable to try tyres of all the representative makers. Fifty-two of the cars are now fitted with steel-tyred wheels, none of which have yet worn out and, therefore, final figures cannot be quoted. Very divergent results have, however, been obtained, the mileage per unit of wear varying to the extent of 50 per cent., indicating the importance of selecting tyres of suitable composition. As a result of the experiments carried out for the last two years, a steel-tyred wheel is now being assembled and finished at Lambeth-road works, which will cost 50 per cent. less than the price at which such wheels can at present be bought, and which it is believed will afford a life considerably in advance of the average of these wheels, which may be estimated at 60,000 miles, the average mileage of chilled wheels in Liverpool being 35,000. It is hoped that on trial this new wheel will be found suitable for general adoption.

Electrical Equipment.—When it was decided by the Corporation to equip the tramways for electric traction the engineers recommended an overhead system of construction, the special points of which were a larger gauge of conductor than was then in general use, and a method of suspension by cross wires by which the rigidity of the ordinary bracket suspension was avoided. The system adopted has proved satisfactory in work, the only alterations which it has been found advantageous to make have been in small matters of detail in some of the overhead fittings by which the durability of these parts has been increased and replacement facilitated with consequent reduction in the cost of maintenance. Under a carefully organised system of periodic inspection and test of the overhead wire, failures of every character are largely anticipated, and emergency calls reduced to a minimum. It is impossible to entirely prevent an occasional breakage of the overhead conductor, but numerous tests have been made which demonstrate satisfactorily that beyond ordinary wear no general deterioration has taken place in the copper wire. The electrical equipment of the cars consists of two 25 H.P. single reduction motors regulated by a special pattern of controller by means of which the driver has at his disposal a powerful electric brake, without removing his hand from the controller handle. Some of the controllers first supplied by the contractors were not entirely satisfactory, but these were quickly replaced without any cost to the Corporation. The cars were at first fitted with safety fuses through which the current passed from the line to the motors. In starting heavily-loaded cars on steep gradients, necessitating a momentary excess of current, these fuses were frequently brought into action, causing inconvenience and delays. The fuses have been strengthened and supplemented by magnetic circuit-breakers under each canopy with very satisfactory results. Some smaller improvements have been made in minor details as the result of experience in working.

POWER SUPPLY TO TRAMWAYS IN NORTH LONDON.

(*Continued from p. 666.*)

The engine room is on the same level as the boiler house It is airy and light, the walls being for the most part plain brick with a green glazed brick dado. The floor is covered with red tiles, and the condenser pits, the depth of which is but a few feet, are of concrete with white glazed tiles on sides and red tile floor. The low-tension switchboard is on the ground floor, while the high-tension switchboard is on a gallery, access to which is obtained by two staircases, one at each end. Three 1,000kw. turbo-generator sets have been installed, and there is room for a fourth. Fig. 2 is a general view of a set, while Fig. 3 illustrates the interior of the engine room.

The steam turbines are of Messrs. C. A. Parsons & Co's. standard design, and run at 1,500 revs. per min. All bearings are fitted with forced lubrication, the oil being circulated by a pump operated through gearing from the engine shaft. The oil is cooled in a tank supplied with cold water, and is used over and over again. In addition to the ordinary governor there is also a safety governor, which cuts off the steam entirely when the speed exceeds a pre-determinable value. The ordinary governor is fitted with hand adjustment gear, which allows the turbine speed to be regulated within 5 per cent. of the normal. Before entering the turbine, the steam passes through a steam separator, where the last traces of water, if any, are extracted. Directly coupled to each turbine, and resting on the same bed-plate, is one 1,000kw three-phase generator, built by Messrs. Brown, Boveri & Co. for generating current at a voltage of from 10,000 to 11,000 volts between any two stator windings. It is noteworthy that the generator is of the revolving field type, as at the high speed in question, considerations with regard to balancing and mechanical strength of the magnet poles are very important. Since the frequency of the supply is 50 $\sim$ per second, it follows that the dynamo has four poles. These consist of laminated iron sheets of special quality, and the magnet windings of copper wire of 100 per cent. conductivity (Matthiessens' standard) are embedded in slots milled in the core, metal wedges being employed to prevent the windings from flying outwards owing to centrifugal forces. Those parts of the winding which overhang the core are protected by heavy metal caps. The rotating part is provided with two ventilators, one at each end of the magnet core, which force a strong current of cooling air through the ventilating ducts in the armature core and out into the engine room through a funnel-shaped aperture at the top of the casing of the alternator. Exciting current is taken

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from the 110-volt circuit of the station, and is led to the rotating magnets by way of two steel slip-rings and suitable brass brushes. At full load and with a power-factor of 0·85, the exciting current is specified not to exceed 115 amperes. The stationary armature comprises a casting in one piece, to which the laminated core is suitably fixed on the inside. Each armature coil may be removed separately, and consists of insulated cable placed in micanite tubes. The parts of the winding overhanging the armature core are supported by insulators fixed to the casing. Fig. 4 represents the calculated characteristic curves of the generator, no complete actual tests having yet been made at Brimsdown. After a 10 hours' run at full-load and with a power-factor of 0·85, the rise in temperature of any part of the alternator does not exceed 40°C., and if, immediately after this test, the load is increased by 25 per cent., and kept on for one hour, the ultimate temperature rise is still less than 50°C. The insulation of the field winding and of the stator

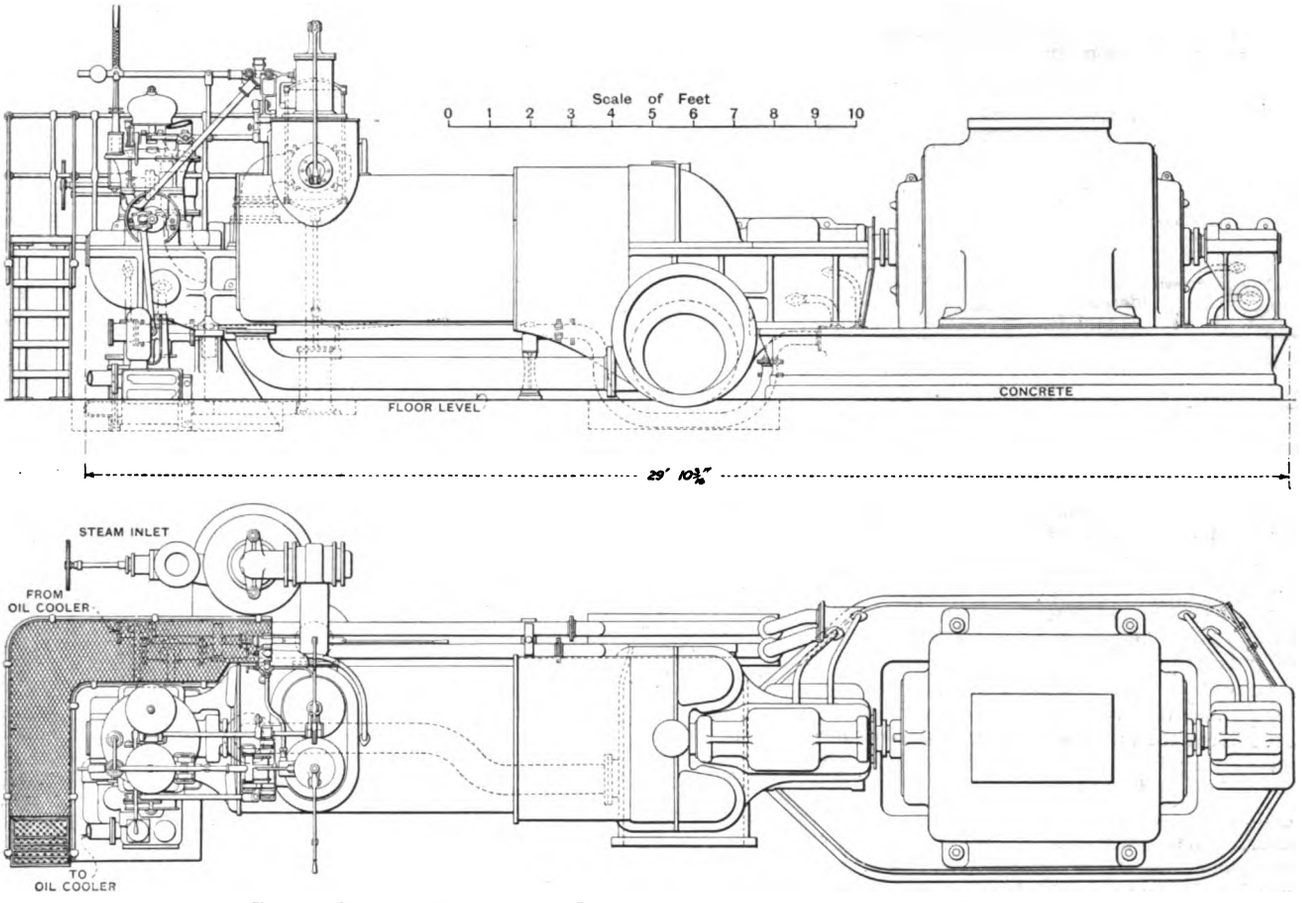

FIG. 2.—PLAN AND ELEVATION OF TURBO-GENERATOR AT BRIMSDOWN POWER STATION.

winding were tested by alternating pressures of 500 volts and 20,000 volts respectively, the trial lasting in each case half an hour. The rise in pressure from full load to no-load was specified not to exceed the following figures:—(1) With three phases fully and equally loaded and a power-factor unity, 8 per cent. of the normal. (2) With two phases equally and fully loaded and a power-factor unity, the third phase being on open circuit, 7 per cent. The difference in voltage between one of the loaded phases and the phase on open circuit was not to exceed 4 per cent. (3) With one phase loaded, the power-factor being unity and the other phases on open circuit, 6 per cent. The difference between the loaded phase and the phases on open circuit was not to exceed 5 per cent. With a power-factor of 0·85, the regulation from no-load to full load was not to exceed 18 per cent. The alternator windings are star-connected and the neutral point is not earthed. The guaranteed figures for the steam consumption per kilowatt-hour for full load and half load are 19lb. and 22lb. respectively. When the set is working non-condensing the corresponding guarantee figures are 32lb. and 39lb. It has also been guaranteed that the above-mentioned consumption figures will not be exceeded after one year's service.

Each turbine has its own surface condenser, which is connected through a valve to the low-pressure side of the steam turbine by a short length of corrugated brass pipe of large diameter. The condenser is placed in a pit immediately below the turbine. It was supplied by Messrs. Mirrless, Watson & Co., and has a cooling surface of about 2,500 sq. ft. The outer shell consists of a cast-iron cylinder, placed horizontally, and the tubes, of solid drawn brass, have an external diameter of ¾in. and are 18 S.W.G. thick. These tubes are set up and packed with cotton wick in the tube plates, which are fixed at either end of the shell, and are of rolled brass. In order to support the tubes in the centre, an intermediate plate of rolled brass, ⅜in. thick, is provided. Both the end boxes and the covers are, like the outer shell, of cast iron. The division plate in the water head is so arranged that the cooling water has to pass twice through the condenser before being discharged. Suitable baffle plates are fixed for effectively distributing the steam over the tubes. The outside of the condenser tubes are cleaned by a jet of water from a water hose-pipe, which may be inserted through the manhole at the top of the condenser, while, in order to clean the inside of the tubes, the cast-iron end covers have to be removed. This, however, does not disturb the condensing pipe-work in any way. Each condenser is equipped with an Edwards three-throw air pump, with cylinders 12½in. in diameter and a stroke of 6in., the speed being 200 revs. per min. Each pump is driven through gearing by a 9½ H.P. totally enclosed Brush motor, running at 600 revs. at a voltage of 110 volts across the terminals. There is also a circulating pump for each condenser, capable of driving some 1,700 gallons of water per minute against a combined suction and delivery head of 15ft. The set consists of a 10in. circulating pump directly driven by a 22 H.P. totally enclosed motor, running at 660 revs. per min. when fed with current at 110 volts. While the body of the pump is of cast iron, the disc and the

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bearings are of gunmetal, the shaft being of manganese bronze. The bearings, formed in the stuffing box of the pump, are lubricated by the flowing water. For safety's sake, however, a grease cup is fixed on the outside of the casting, to be used when necessary. It is specified that with the condensing plant as described above the vacuum at full load shall not be lower than 3in. below barometric pressure and that the air pumps, when properly started, shall not consume more than 5kw. and the circulating pump not more than 18·5kw. These figures are based on a temperature of the cooling water of 65°F., and the quantity of water required is guaranteed not to exceed 1,700 gallons per minute. There are also two sets of auxiliary surface condensers, complete with air pumps, circulating-water pumps, &c., also supplied by Messrs. Mirrlees, Watson & Co. Each set is capable of maintaining a vacuum of 26in. when dealing with 6,000lb. of steam per hour. In general construction and arrangement these auxiliary sets closely resemble the larger ones. The cooling surface is, of course, smaller, being only 500 sq. ft. As is the case with the larger sets, these auxiliary condensers are fitted with Edwards air pumps, which have a cylinder diameter of 12in., a stroke of 6in., and are driven at a speed of 155 revs. per min. through single reduction gear by a 9 H.P. compound-wound completely enclosed B.T.-H. motor running at about 700 revs. per min. when supplied with current at 110 volts. The same motor also drives the circulating pumps. A maximum temperature rise of 75°F. is specified after a six hours' run at full load. The rheostats for these motors are fitted within cast-iron water-tight cases, the switch handles, &c., projecting through stuffed glands; both over-load and no-voltage releases are fitted. The circulating pumps, of the 5in. type, are capable of circulating 350 gallons of water per minute against a total suction and delivery head of 15ft. In all other respects these pumps are identical in design to the larger ones. In the conditions as outlined above, the energy consumed by each motor does not exceed 6·5kw. Arrangements have been made for conducting the exhaust steam from the turbines directly to atmosphere in case of need. To this end, an auxiliary pipe of large diameter runs the whole length of the engine house, from pit to pit, and the turbine is connected to this pipe by an automatic valve. In case the condenser breaks down, or has been put out of use for any reason, this valve automatically connects the low-pressure end of the turbine with the exhaust pipe, at the same time cutting out the condenser.

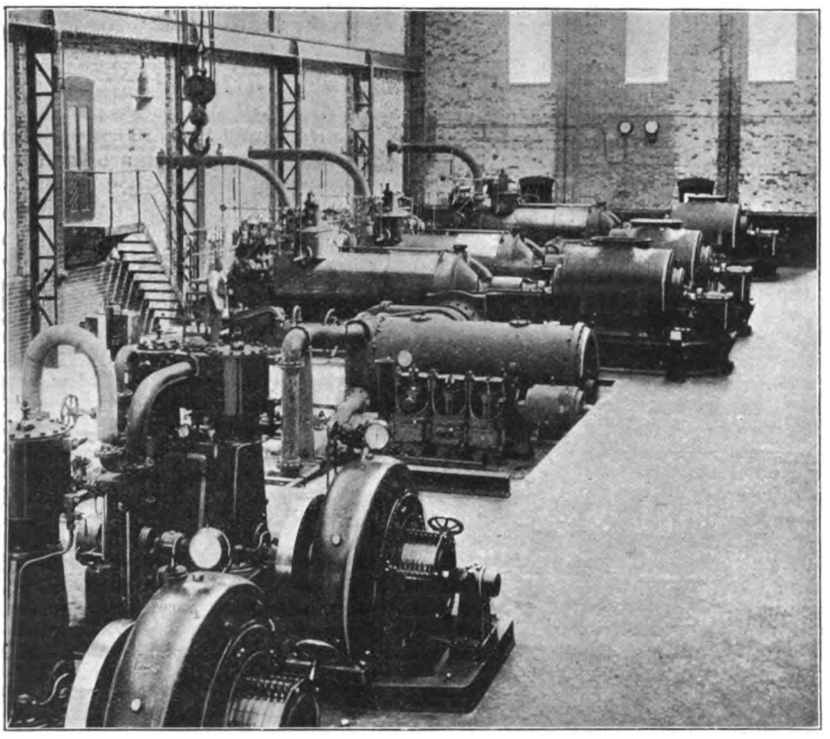

FIG. 3.—THE ENGINE ROOM IN THE BRIMSDOWN STATION.

The plant in the engine room comprises, in addition to the turbo-generators four steam exciter sets, two of 50kw. each and two of 100kw. each. In these sets Belliss-Morcom two crank compound engines are directly coupled to B.T.-H. shunt-wound dynamos, capable of supplying continuous current at a pressure of from 110 to 125 volts. Steam of the same pressure and temperature as used for the steam turbines is employed for these reciprocating engines, which are of the manufacturers' standard design. The speed of the 50kw. sets is 575 revs. per min., and that of the larger sets 435 revs. per min. A centrifugal regulator keeps the speed within 3 per cent. of the normal, and arrangements are provided for adjusting the speed within 5 per cent. while the engine is in motion. When the load is thrown off the engine, the momentary increase in speed for the 150 B.H.P. engine, does not exceed 10 per cent., the corresponding figure for the 75 B.H.P. engines being 12 per cent. The dynamos present no special features, but follow standard practice. After a 24 hours' run at full load the temperature rise of the armature does not exceed 72°F., and the commutator not more than 81°F. above the surrounding air. When running condensing, the 150 B.H.P. engines are guaranteed not to consume more than 16lb. of steam per brake horse-power-hour at full load and 17·75lb. at half load, the corresponding figures for the 75 H.P. engines being 17·75lb. and 19·25lb. As regards the dynamos, their efficiencies are:—For the 100kw. type, 91 per cent. at full load and 87 per cent. at half load, and for the 50kw. size, 90·5 per cent. at full and 87 per cent. at half load. In addition to supplying the exciting current for the alternators, these four continuous-current generating sets produce the necessary energy for running the auxiliary motors in the station and for operating the lighting system of the building. A B.T.-H. booster for the accumulators is also installed in the engine room. It consists of two shunt-wound dynamos mounted

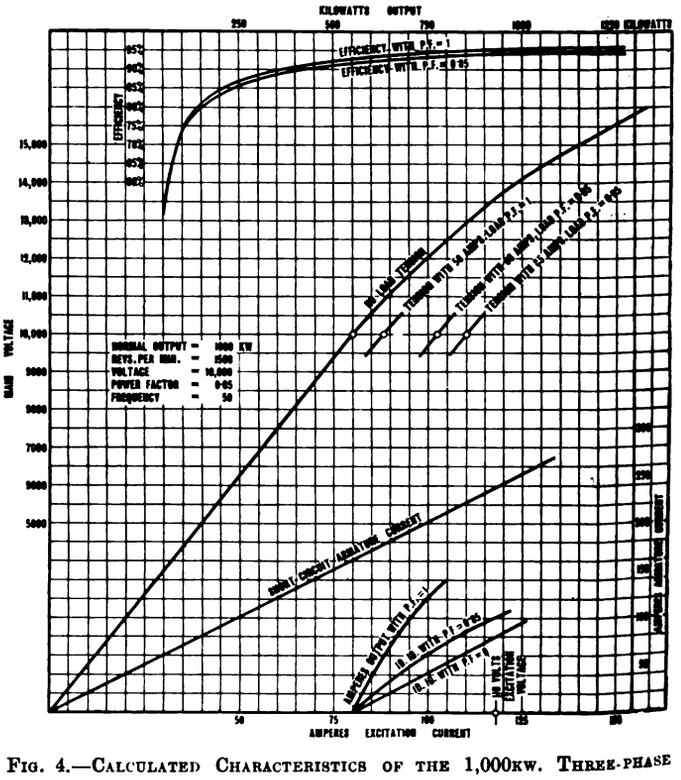

FIG. 4.—CALCULATED CHARACTERISTICS OF THE 1,000KW. THREE-PHASE BROWN-BOVERI ALTERNATORS AT THE BRIMSDOWN POWER STATION.

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on a common bed-plate, one acting as a motor and driving the other as a generator. The latter is capable of raising a current of 350 amperes anything from 10 to 70 volts. When the motor is fed with current at 110 volts, the speed of the set is 510 revs. per min. The voltage of the generator is varied solely by means of a rheostat connected up to its shunt winding. At full load the efficiency of the set is guaranteed to be not less than 79 per cent.

(*To be continued.*)

ON A NEW STANDARD OF WAVE-LENGTH.*

BY DR. JAMES E. IVES.

In a recent number of the *Electrical World and Engineer* (February 6, 1904), I have given the results of some measurements of the wave-length of free vibrations in antennæ and closed oscillating circuits. I now propose to describe the *standard of wave-length* with which these measurements were made.

This instrument was designed for the American De Forest Wireless Telegraph Co., conjointly by Dr. Lee de Forest and the author. Its general appearance is shown in Fig. 1. It stands 22in. high, is 30in. wide and 14½in. deep. It is symmetrical in form, consisting of two variable condensers and two variable inductances similarly placed on each side of the spark-gap. The condensers are made of sheets of glass covered with tinfoil and placed in the base of the instrument. Each of the inductances consists of two concentric

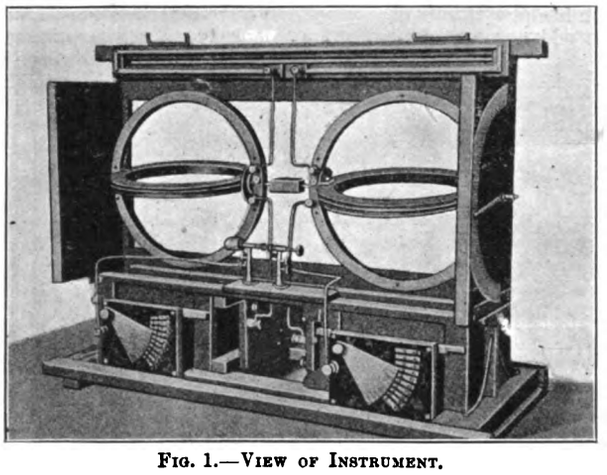

FIG. 1.—VIEW OF INSTRUMENT.

circles of wire supported by hard rubber rings, the outer rings being fixed in a common vertical plane, and the inner rotating together about a horizontal diameter. The circles and all connecting wires are made of No. 10 bare copper (0·102in. in diameter).

Starting at the spark-gap and tracing the connections on the right-hand side, we see that a wire leads to the right-hand condenser; from the condenser a wire passes to the outer circle of the right-hand inductance; from the outer circle we pass by means of a sliding contact to the inner circle, and from the inner circle by means of another sliding contact to a wire that goes to the *contact bar* at the top of the instrument. The contact bar is a brass rod of rectangular cross-section, which, as will be seen from Fig. 1, is bent upon itself. The dimensions of its cross-section are ¼in. by ⅛in. The outer circles of wire are 11¼in. in diameter, and the inner circles 9⅝in. The sliding contacts are made by means of two small concentric flat brass rings, which are attached to the inner hard-rubber ring, making contact with two small brushes fastened to the outer ring. The inner hard-rubber rings are rigidly connected so that they must always rotate together. Pointers attached to these rings indicate the angle moved through upon semicircular dials on the sides of the instrument. Each of the condensers consists of 48 glass plates, 8in. square, coated with tinfoil 7in. square. The plates vary in thickness from $\frac{1}{32}$in. to ¼in. The thicker plates, are of course, used for the smaller capacities. The plates are divided into groups of suitable capacity, 10 leads being taken off from the front of the condenser and nine leads from its inner side. As will be seen from Fig. 1, the number of sections used can be varied at will by means of a fan-shaped contact. There are similar contacts on the inner sides of the condensers, directly under the spark-gap, which cannot be seen in the photograph. The electrical circuit of the instrument is shown diagramatically in Fig. 2. r_1, r_1', r_2 and r_2' are the outer and inner circles of the variable inductances; c_1 and c_2 are the variable condensers; s is the spark-gap used to excite the system and b the *contact bar*, to which the circuit whose wave-length is to be measured is attached. Both parameters of the circuit—viz., its inductance and its capacity, are variable. Its resistance can be neglected.

* From the *Electrical World* of New York.

The calibration was made by means of Lecher wires. Two No. 10 bare copper wires were stretched parallel to each other at a distance of 6in. apart, and about 4ft. above the floor, between the end walls of a loft 122ft. long. The loft was about 50ft. wide and divided by three rows of wooden pillars into four alleys. The parallel wires were stretched in the middle of each alley, and connected by cross wires at alternate ends, making the total length of parallel wires about 500ft. (see Fig. 3). They were subdivided into lengths of 12ft. or less by cutting the wires, making loops at the ends, and tying these ends together with short pieces of heavy cord. When desired, the cuts could be bridged with short pieces of the same wire fitting snugly into the loops. In this manner the parallel wires could be made of any desired length. To perform the calibration the parallel wires were attached at one end to the points p_1 and p_2 on the "contact bar" of the standard (see Fig. 3). The standard was then excited with a small induction coil, causing a spark to pass between the balls of the spark-gap s. This sparking produced electrical oscillations in the standard, and also in the Lecher wires, since they were attached to it. A Geissler tube was then placed across the free ends of the parallel wires, and the capacity of the condensers of the standard varied until the tube began to glow. The final adjustment was made by rotating the movable coils until the glow became a maximum. The standard

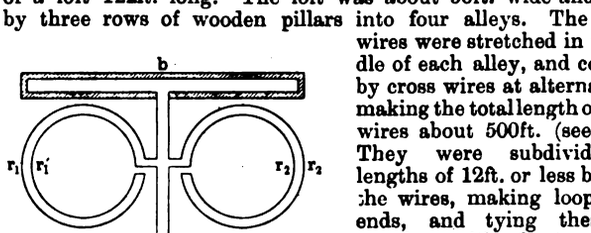

FIG. 2.—SCHEMATIC DRAWING OF THE CIRCUIT OF THE STANDARD.

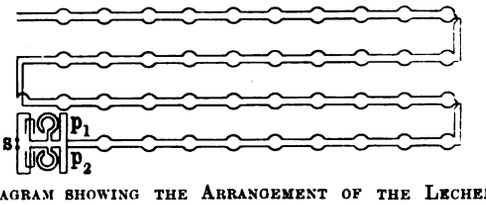

FIG. 3.—DIAGRAM SHOWING THE ARRANGEMENT OF THE LECHER WIRES BY MEANS OF WHICH THE STANDARD WAS CALIBRATED.

and the Lecher wires were then in resonance, and the *quarter wave-length* of the standard was equal to the length of the parallel wires. This process was repeated some 50 times, starting with the wires 40ft. long and increasing their length a few feet at a time up to 500ft. The results are shown in the *calibration curve*, Fig. 4. It will be seen that the curve is made up of 12 sections, each section corresponding to a certain number of condenser leads. For the first section of the curve, we have *one* front lead, and *one* side lead; for the second section *one* front lead and *two* side leads; for the

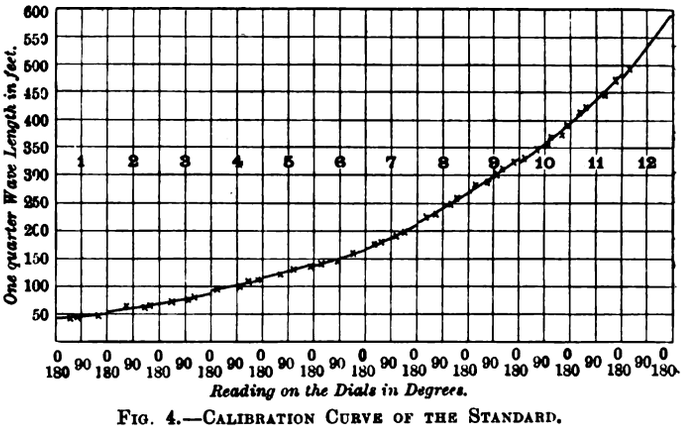

FIG. 4.—CALIBRATION CURVE OF THE STANDARD.

third section *two* front leads and *two* side leads, and so forth. Both condensers must, of course, have the same number of front and side leads. The readings in degrees on the dials are plotted as abscissæ, and the quarter wave-lengths as ordinates. The curve is broken, as it was difficult to adjust the capacities of the successive sections of the condensers so that the different sections of the curve would fit on to each other. To test the accuracy of this experimental calibration, the quarter wave-length of the standard was *calculated* for each section, for the movable coils in the position of maximum induc-

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tance. This necessitated the measurement of the capacities of the sections of the condensers, and the calculation of the maximum inductance of the concentric circles. The results are given in Table I., and show that the observed and calculated values differ from each other only by a few per cent.

Table I.

No. of section of curve.	Capacity in microfarads of the two condensers in series.	Maximum quarter-wave length in feet.	
		Calculated.	Observed.
1	0·0248	586	587
2	0·0174	490	478
3	0·0116	409	390
4	0·00815	336	328
5	0·00525	269	267
6	0·00325	212	208
7	0·00204	167	163
8	0·00149	144	138
9	0·00091	112	110
10	0·00054	86	85
11	0·00037	63	67
12	0·00022	54	50

The maximum quarter-wave length was calculated from the formula

$$\lambda = 2\pi v \sqrt{LC}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where λ is the wave-length; v the velocity of propagation of electric waves, taken in this case as 3×10^{10}cm. per second, L the maximum inductance of the standard, C the capacity of the number of sections of condenser used. The inductance of the standard is, of course, equal to the sum of the two inductances, and its capacity equal to half that of either condenser. The total maximum inductance of the standard was found to be equal to 5,830 absolute units or abhenrys. This is made up of two parts—viz., the inductance of the concentric circles, amounting to 4,910 abhenrys, and the inductance of the rest of the circuit, amounting to 920 abhenrys. The minimum inductance of the concentric circles was found by calculation to be equal to 2,670 abhenrys. The total inductance of the standard, therefore, when the circles are in the position of minimum inductance, is relatively large, and equal to 3,590 abhenrys. This accounts for the large initial ordinate of each section of the calibration curve.

The inductance L of formula (1) is made up of six parts, as follows:—

$$L = L_1 + L_2 + 2M_{12} + L_3 + L_4 + 2M_{34}, \quad . \quad . \quad . \quad . \quad (2)$$

where L_1 is the inductance of the left-hand outer circle, L_2 the inductance of the left-hand inner circle, M_{12} their mutual inductance, L_3 the inductance of the right-hand outer circle, L_4 the inductance of the right-hand inner circle, M_{34} their mutual inductance. But since $L_1 = L_3$; $L_2 = L_4$; and $M_{12} = M_{34}$, formula (2) reduces to

$$L = 2L_1 + 2L_2 + 4M_{12}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

It was found by calculation that $L_1 = 1{,}088$ abhenrys, $L_2 = 855$ abhenrys, and $M_{12} = 280$ abhenrys. To calculate L_1 and L_2 the following formula was used:—

$$L = 4\pi R \log_e \frac{R}{g} + 0{\cdot}08, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where R is the radius of the circle and g the radius of the wire, both in centimetres. To calculate M_{12}, the formula for two concentric circles was used—viz.,

$$M = 4\pi R\left(\log_e \frac{R}{d} + 0{\cdot}08\right), \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where R is the radius of the inner circle, and d the distance between the two circles, both in centimetres.

The standard may be used to determine the wave-length of a closed circuit or of an open circuit, e, f, of a tuning coil, or of an antenna. To determine the wave-length of the closed circuit ASC, shown in Fig. 5, we open it at some convenient point and attach it to the "contact bar" of the standard at the points p_1 and p_2. It is now linked to the circuit of the standard, and when electrical oscillations are set up in the standard by a spark at S, oscillations both of current and potential will be produced in it, if its resistance be not too great. The amount of the current oscillations will be shown by the reading of the hot-wire ammeter A placed in the neighbourhood of a current loop. When the two circuits have the same period of oscillation, the disturbance in each, by the principle of resonance, will have a maximum value. The inductance and capacity of the standard are, therefore, varied until a *maximum* deflection is obtained on the ammeter. The wave-length of the standard is then equal to that of the unknown circuit. The amount of the electrical disturbance of the unknown circuit can be regulated by varying the distance apart of the points of attachment p_1 and p_2 on the contact bar. By bringing these points together, the reading on the ammeter may be made as small as desired. The connecting wires from the unknown circuit to the contact bar should be heavy, and as near to each other as possible, so as to reduce the inductance of this part of the circuit to a minimum. If insulated, they may advantageously be twisted together. The "contact bar" is relatively heavy, and the inductance introduced by it into the unknown circuit can usually be neglected. To measure the wave-length of an open circuit, such as an earthed antenna, we cut the wire at some convenient point, near to the earth plate, and link it to the standard, as shown in Fig. 6. In the figure p_1 and p_2 are the points of attachment to the contact bar; a is the aerial wire, E the earth-plate, and A the hot-wire ammeter.

This form of standard is compact and covers a large range of wave-lengths. One advantage of the symmetrical form is that it can be calibrated by Lecher wires, these affording a simple and accurate means of calibration. In its present form the inner circles of wire rotate about a common horizontal axis, and, since they are rigidly connected together, are always in the same plane. Their mutual induction, therefore, remains constant as they rotate. In an earlier form the inner circles were made to rotate about *vertical* axis, and consequently were not always in the same plane. This introduced a variable mutual inductance which disturbed the calibration curve in a peculiar manner, especially for the longer wave-lengths. In these sections the curve became steeper and steeper up to about 120deg., and at this point became so indefinite that it was impossible to plot it farther. This trouble disappeared at once when the present arrangement was adopted.

To determine the condition of resonance, both a spark-gap and a Geissler tube were used across the ends of the parallel wires and were found to give the same results. Neither the Geissler tube nor the spark-gap appeared to have any appreciable effect upon the wave-length of the wires.

Lecher wires are in resonance with any given circuit, if their length is equal to one-quarter of the wave-length of the circuit, or to an odd number of quarter wave-lengths. In determining the wave-length of a circuit by measuring the length of the parallel wires, most accurate values are obtained by making the wires three or more quarter wave-lengths long and measuring the distances between the nodes. Some values for the standard obtained in this way I found to be greater by 2 or 3 per cent. than those obtained by using a single quarter wave-length. Since in calibrating the standard I used a single quarter-wave-length in each case, the values given in the calibration curve are probably too small by 2 or 3 per cent. This supposition is borne out by the difference between the observed and calculated values given in Table I. In making these measurements no trouble was experienced from the presence of overtones; in fact, I did not observe any. I wish to express my thanks to Mr. James B. Gottsberger for his assistance in this work.

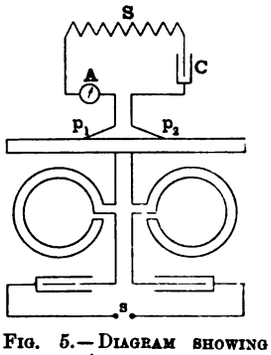

FIG. 5.—DIAGRAM SHOWING MANNER OF ATTACHING A CLOSED OSCILLATING CIRCUIT TO THE STANDARD.

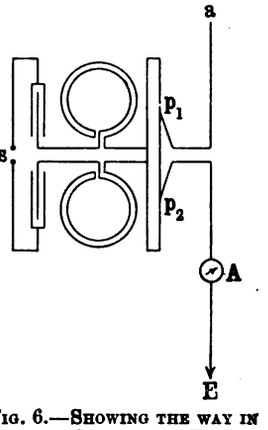

FIG. 6.—SHOWING THE WAY IN WHICH THE STANDARD IS LINKED TO AN ANTENNA IN ORDER TO MEASURE ITS WAVE LENGTH.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Calender of the Glasgow and West of Scotland Technical College" for 1904-5 session. (Glasgow: The College.)

"Report (by Labour Department of the Board of Trade) on Changes in Rates of Wages and Hours of Labour in the United Kingdom in 1903." (London: Eyre & Spottiswoode. Edinburgh: Oliver & Boyd. Dublin: E. Ponsonby.) 7d.

"Journal of the Institution of Electrical Engineers." July. Vol. XXXIII. Part 4. No. 167. (London: E. and F. N. Spon). 5s.

"Proceedings of the Royal Society." Vol. LXXIV. No. 498. (London: Harrison & Sons.) 2s.

"Obituary Notices of Fellows of the Royal Society." Part II. (London: Harrison & Sons.) 3s.

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A METHOD OF LAYING BARE UNDERGROUND MAINS.

Of the various systems of underground mains now available, it is rapidly becoming recognised that the solid system is the only one which efficiently protects the cable from outside influences, whether mechanical, chemical or electrical; it also entails the least subsequent expenditure on maintenance. Hitherto, the greatest objection to its general adoption has been its first cost, which is decidedly higher than that of others.

The "Simplified" solid system was protected and brought out about two years ago and embodies in its present form the result of many experiments and of some 16 years' practical experience of the older systems in many parts of the world and under various conditions of soil and climate. The inventors were led by considerations of the existing excessive costs to attack the problem of laying bare metal

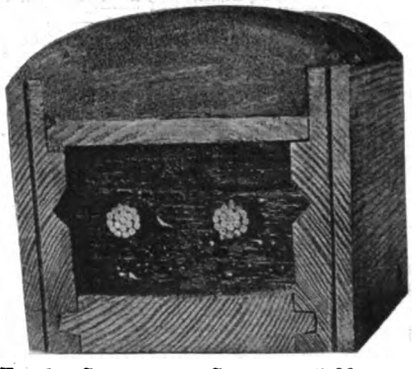

FIG. 1.—SECTION OF "SIMPLIFIED" MAIN.

conductors underground, and after extensive experiments were able to produce their "Carbolite" insulating compound for use as a trough filling. It was fully realised that such a compound, in order to ensure success, would have to be of such a nature as to surround thoroughly the bare metal conductor so that the whole mass should be homogeneous. It would also have to be entirely free from air bubbles or cavities and thoroughly impervious to gas and water. Other necessary properties are: Absolutely neutral chemical composition, so that there may be no chemical or electro-chemical action on the bare metal embedded therein; indifference to chemical impurities in the surrounding soil; absence of liability to crack; high specific insulation resistance; capability of withstanding considerable differences of potential; electric capacity approaching that of dry air; cheap, simple in composition, and easily obtainable and

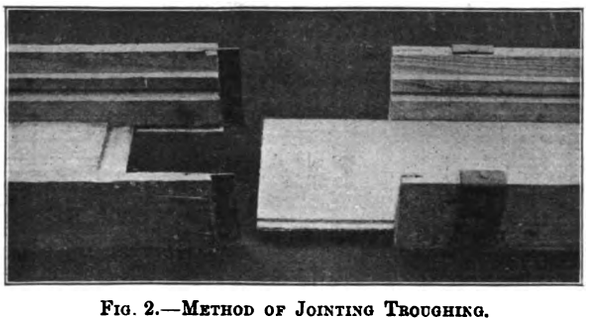

FIG. 2.—METHOD OF JOINTING TROUGHING.

workable. It is claimed by the Simplified Underground Conductor Co., that the compound employed in their system fully complies with every one of these conditions and possesses all the essential characteristics appertaining to the ideal compound.

The troughs, which may be of any suitable material, are laid in the trench, porcelain bearers or bridges are spaced at short intervals therein and bare-stranded conductors are placed on and securely wedged into them. Carbolite is then run into the trough so as to cover entirely the conductors, an inner lid of wood is placed in position and the whole is finished off with a continuous cover of carbolitic asphalte. It will be observed that the above system depends for its efficiency on a minimum of details, and it may be of interest to describe rather more fully the various component parts.

The material for the troughs which is usually adopted by the Simplified Company is sound red pitch pine, machined to certain standard shapes and sizes and rapidly put together by metal bands, which are sprung on. Special attention has been devoted to the provision of an efficient method of jointing individual lengths of troughing together, and the accompanying illustration (Fig. 2) clearly shows how this is done. No loose sockets are used, but a far stronger and more mechanical joint is obtained by staggering the sides and the bottoms. Where two planks (whether forming sides or bottoms) butt against one another, each is provided with a saw cut, into which a small tongue of metal is inserted. By this means an absolutely tight joint is obtained between the butting ends of the troughing, besides increased mechanical strength.

Considerable difficulty was experienced in obtaining exactly the right material for the insulating bridges, and it was only after a large number of experiments that a particular mixture of clays was adopted as the standard. These clays, when properly mixed in the required proportions and moulded to shape, are dried and burnt in the kilns at an extremely high temperature, the result being a porcelain bridge possessing a highly vitrified body which is unglazed and absolutely non-hygroscopic, and forms a reliable and efficient insulating support for the bare metal conductors. On reference to Fig. 3, it will be noticed that the projections on the edges of the bridges engage with the grooves machined in the sides of the troughing, the bridges being thus prevented from rising and are kept securely in position. The latter being fixed in position, the conductors are paid out and securely wedged into them. By this means the conductors are clamped up as tightly as possible, and are prevented from moving in any direction relatively to each other or to the trough, except in a longitudinal direction. Expansion and contraction have been in the past some of the most fruitful sources of trouble during the laying down of mains on the solid system, and it was with a view of obviating this and of transmitting its effects in such a direction as should not affect the efficiency of the main that the wedging process has been adopted. Fig. 3 shows that the bridges are made of such a form as to ensure their being thoroughly surrounded by the carbolite. The V-shaped slots at the bottom and

FIG. 3.—CURVED PIECE OF MAIN SHOWING INSULATING BRIDGES.

the chamfer at the sides admit of the free and uninterrupted flow of the molten compound without the risk of imprisoning air, which experience has proved frequently happens with the older square form of wooden bridge. In the latter form, the bridge usually fits more or less tightly into the trough, and thus converts the conduit into a number of compartments, which, if not very carefully filled with compound, will tend to produce air cavities. Those who have had experience with the solid systems have, in the course of chipping out the filling compound, often observed large pockets of water embedded in the mass, which water has doubtless replaced the air originally imprisoned by the too rapid filling up of the particular space enclosed between two bridges. On several occasions there can be little doubt that serious trouble, especially with lead-covered cables, has arisen from this cause.

Little need be said regarding the conductors themselves, but it may be noted that the invention lends itself admirably to the use of metals other than copper The relative conductivity of aluminium and copper for instance, and the slightly increased sectional area of the former metal for given current capacity makes little or no difference to standard sizes of troughing, in most cases the size of the trough to contain copper conductors being the same for aluminium. For small mains too, it is quite possible to use iron for the conductor, although for larger sizes its relative sectional area and weight is prohibitive. Whatever metal is adopted the company advise the use of soft-drawn wire in stranded conductors, the lay to be kept as short as possible, not only so as to ensure the maximum sectional area but to obviate the tendency of the outer strands to open when the conductor is being laid around curves and bends.

The insulating compound, which is composed of refined carbolite, is said to be a material with high insulating properties, is absolutely waterproof and non-hygroscopic, and at the temperature of the surrounding soil sets to a very tough and slightly plastic consistency, such that it is capable of being bent to almost any extent without

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cracking. It does not break down under high pressures, a length of low-tension main having recently been subjected, we are informed, to an alternating difference of potential between conductors of 20,300 volts for 10 minutes, without showing any signs of breaking down. It contracts very slightly on cooling, but as an additional precaution against any possible trouble in this direction, the compound is usually poured into the troughs in thin layers over a considerable length of main at a time, the final "topping up" process being done when the bulk of the filling has almost cooled. As an illustration of the extremely flexible nature of the "Simplified" system as a whole, the following instance may be quoted. Whilst carrying out an extension some little time ago, it was found necessary, owing to the re-levelling of one of the roads, to lower the main some 18in. below the level at which it had been originally laid. Some 200yds. of three-wire distributor were successfully lowered in this way, and that whilst the main was alive and without removing any of the filling or in any other way disturbing the completed main. Of course, great care had to be taken in performing this operation, but the possibility of thus altering the position of the "Simplified" main will doubtless appeal to practical men.

FIG. 4.—"SIMPLIFIED" CONNECTING PILLAR

The primary object of the inner lids is to provide a support for the asphalte cover referred to below, but they also materially increase the mechanical strength of the main, and tend to prevent accidental displacement after being laid. They are generally composed of wood, are put on in short lengths of about 8ft. to 4ft. each, and are easily removed for purposes of service connections and so forth.

The outside cover is composed of carbolitic asphalte, which is made and supplied by the Simplified Company in compact ½ cwt. blocks ready for use. The blocks are readily melted in a boiler, and the molten asphalte is then poured on to the main from end to end and is tooled off with a hot iron and quickly sets hard and tough.

Amongst the many advantages claimed for the "Simplified" system, it is asserted that it is quite practicable to overload considerably the conductor. It is impossible for the conductors to become decentralised due to heating, as they are permanently clamped into their bridges, which are composed of indestructible porcelain, and all that happens is that the carbolite compound in the immediate vicinity of the conductor becomes slightly softened. This has no deleterious effect upon it whatever, and the compound returns to its original state upon the load becoming normal. This distinctive feature of the "Simplified" main is of especial value in connection with feeders for electric tramways, and, indeed, we are informed that a tramway feeder laid on this system by the Simplified Underground Conductor Co. in the spring of 1908 has been working with an overload of nearly 50 per cent. without giving the smallest trouble since it was put down. Contracts for mains laid on this system have been carried out during the last three years for the Corporations of Blackpool, Salford, Bootle, St. Anne's, &c., and at Ledsham, Blundellsands, Witley, Eastham, Knowsley and other places. Several corporations are now installing the "Simplified" system, utilising their own labour and working under licence from the Simplified Company, and this plan will no doubt commend itself to many engineers who make a practice of laying their own mains.

Among the many appliances incidental to the distribution of electrical energy, none are more important than the means by which the jointing up and inter-connection of the feeder and distributor mains are effected. For many years the only method adopted was by means of underground boxes, either entirely buried in the soil, or surrounded by an air chamber, supporting a surface cover. The disadvantages attaching to underground boxes and the heavy cost of maintaining them in even approximately efficient condition has frequently been brought before the notice of electrical engineers, and it was to obviate many of these undoubted objections that pillar boxes were first introduced some few years ago. In low-lying districts, and many waterside towns, the only possible and practicable method of ensuring access to the mains during floods is by the adoption of pillars.

The two objections hitherto most frequently urged against pillars were, first, that their initial cost was high as compared with underground boxes, and, secondly, that they were unsightly. Till recently the method of inter-connecting the cables in a pillar was an adaptation of the old flatback switchboard, with the cable ends at the back of a central panel and the switches, fuses, links, &c., on the front. Some little time ago, however, a novel form of pillar and method of inter-connection was placed on the market by the Simplified Underground Conductor Co., which possesses certain advantages over the older pattern. One of the chief merits possessed by this pillar is that no inflammable substance of any description is exposed in the upper or disconnecting portion, the only materials being metal and white glazed porcelain, whilst great attention has been devoted to providing plenty of air space and ventilation, so that in the event of a fuse blowing or an arc being formed in breaking a circuit under load, the suddenly heated air may be able to escape rapidly. The most important feature of the pillar is the means adopted for sealing and inter-connecting the cables. Each cable, whether it be single-core, triple-concentric, concentric or multiple-core, is led up intact into the disconnecting chamber at the top of the pillar, and each cable finishes at one and the same

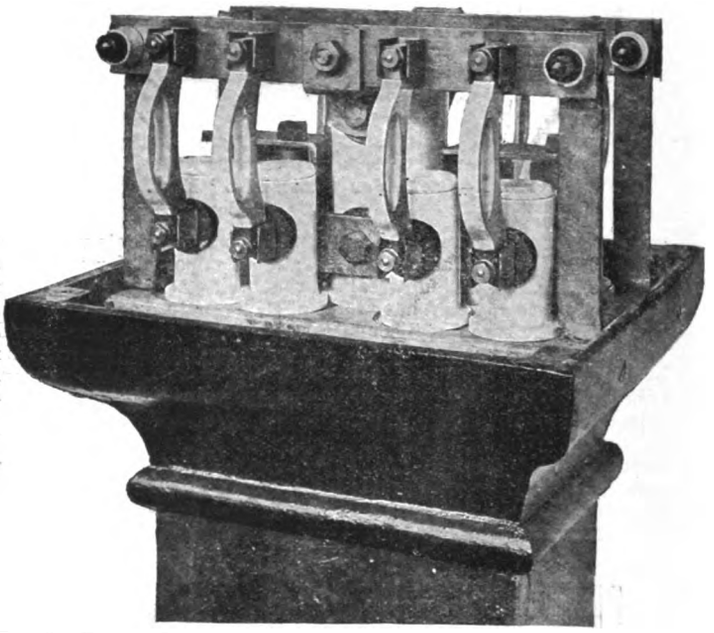

FIG. 5.—FEEDER PILLAR FOR CONNECTING TRIPLE CONCENTRIC TO FOUR 3-WIRE SINGLE-CORE DISTRIBUTORS.

level in its own sealing tube, which not only provides an effective sealing arrangement for the dielectric, but also forms the support for the terminal and keeps it rigidly in position 'Bus bars, either bare or enclosed in porcelain, are provided, to which each cable terminal is attached either by switch, plug, link or fuse. It will be obvious that this arrangement, being composed of small units—viz., the cable ends themselves—adapts itself with great facility to a variety of combinations either during erection or subsequently, and moreover, whilst no space is wasted, plenty of ventilation is provided round the terminals.

If it is desired to provide additional security from the effects of an arc, the whole disconnecting chamber may be at once converted into a multicellular arrangement of compartments, each compartment containing only one tube and terminal, by inserting between the tubes loose porcelain dividing plates. In the design of the "Simplified" pillars and their fittings attention has been devoted to the details necessary to ensure efficiency, whilst not detracting from the general appearance of the pillar. Care has been taken to provide ample contact area for links, plugs or switches, and, generally speaking, in designing these a current density of not more than 500 amperes per square inch has been assumed. The pillars can be erected quickly, and are bolted down securely to a base piece set in concrete, ensuring great stability. The absence of all rubber tape, solution and lapping effects considerable economy in labour and material, the cable ends being simply trimmed, the terminal attached and the whole inserted in its own sealing tube, which is then run in with "Carbolite" sealing compound. Conductors are attached to the terminals by hydraulic power, the use of solder and sweating being entirely done away with.

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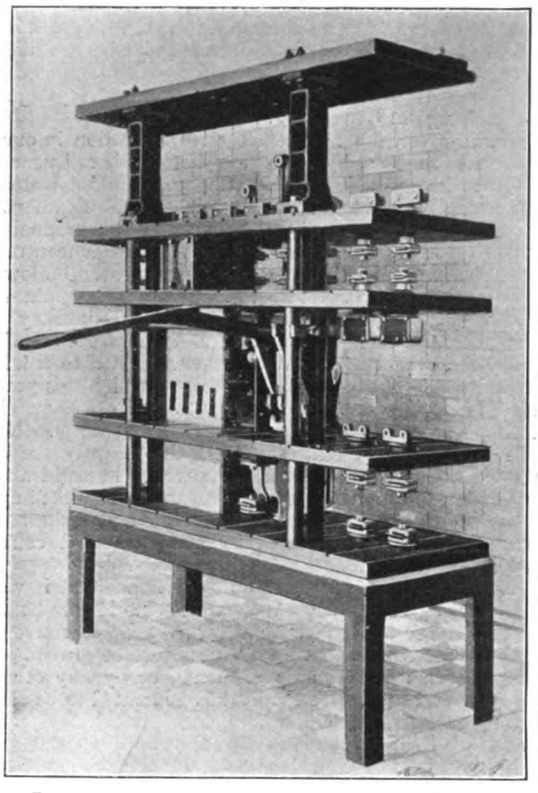
NEW CELLULAR SWITCH GEAR.

Messrs. Walker & Hodgetts, Salford, have sent us the following description of a modification of the cellular pattern of switch gear which they are about to place on the market. It is particularly designed for single-phase systems at 2,000 to 3,000 volts. We understand that the improvements consist of some simple detail alterations to the fuses, with several objects in view, among which may be mentioned the avoidance of the use of springs, the provision of a new type of flexible conductor inside the pots, and also a mechanical method of fixing the fuse wire in order to replace the existing soldered connections.

In the modification of the general construction of the gear, the heavy horizontal slates are taken out of the wall, and the switch gear is re-constructed in the reverse position, so that what has been the back now becomes the front and vice versa. This is illustrated in the photograph which has been taken from a trial board. It will be noted that there are four sets of bolts and distance pieces holding the slates together, and it is found that a very rigid self-contained switchboard can be obtained in this way, although in actual practice, on a board of the size illustrated, six or eight bolts are used;



View of Board Constructed for Test, only Four Bolts being used.

For the purpose of showing the construction clearly all division slates, partitions, all but two back slates, and the guard slates completely covering the switches from the front have been removed.

the bolts are cemented into the distance pieces, and it is claimed that the construction is as solid as if the board were mounted into the wall. By this means the switches and fuses are removed from the operator. He is shielded from any possible arcing from these by two thicknesses of slate slabs. The makers point out that, although this method introduces a back, which has hitherto been absent from the type of gear in question, it is possible to see any person at the back through certain portions of the gear; moreover, the fittings at the back are now shielded in identically the same way as those visible at the front in the original design.

Breakdown at the Islington Electricity Works.—An unfortunate incident occurred at the Islington electricity works on Wednesday night, resulting in the complete shut-down of the supply for a short time. An armature coil on one of the alternator coils burnt out, and, in consequence, it was necessary to switch off the entire plant and to parallel the machines again. Considerable inconvenience was, of course, caused, as the time of the occurrence was 9 p.m.

MR. BALFOUR'S PRESIDENTIAL ADDRESS TO THE BRITISH ASSOCIATION.*

Reflections Suggested by the New Theory of Matter.

The meetings of this great Society have for the most part been held in crowded centres of population, where our surroundings never permit us to forget, were such forgetfulness in any case possible, how close is the tie that binds modern science to modern industry, the abstract researches of the student to the labours of the inventor and the mechanic. This, no doubt, is as it should be. The interdependence of theory and practice cannot be ignored without inflicting injury on both; and he is but a poor friend to either who undervalues their mutual co-operation.

Yet, after all, since the British Association exists for the advancement of science, it is well that now and again we should choose our place of gathering in some spot where science rather than its applications, knowledge, not utility, are the ends to which research is primarily directed.

If this be so, surely no happier selection could have been made than the quiet courts of this ancient university. For here, if anywhere, we tread the classic ground of physical discovery. Here, if anywhere, those who hold that physics is the true *Scientia Scientiarum*, the root of all the sciences which deal with inanimate nature, should feel themselves at home. For, unless I am led astray by too partial an affection for my own university, there is nowhere to be found in any corner of the world, a spot with which have been connected, either by their training in youth or by the labours of their maturer years, so many men eminent as the originators of new and fruitful physical conceptions. I say nothing of Bacon, the eloquent prophet of a new era; nor of Darwin, the Corpernicus of Biology; for my subject to-day is not the contributions of Cambridge to the general growth of scientific knowledge. I am concerned rather with the illustrious line of physicists who have learned or taught within a few hundred yards of this building—a line stretching from Newton in the 17th century, through Cavendish in the 18th, through Young, Stokes, Maxwell in the 19th, through Kelvin, who embodies an epoch in himself, down to Rayleigh, Larmer, J. J. Thomson, and the scientific school centred in the Cavendish laboratory, whose physical speculations bid fair to render the closing years of the old century and the opening years of the new as notable as the greatest which have preceded them.

Now what is the task which these men, and their illustrious fellow-labourers out of all lands, have set themselves to accomplish? To what end led these "new and fruitful physical conceptions" to which I have just referred? It is often described as a discovery of the "laws connecting phenomena." But this is certainly a misleading, and in my opinion a very inadequate, account of the subject. To begin with, it is not only inconvenient, but confusing, to describe as "phenomena" things which do not appear, which never have appeared, and which never can appear, to beings so poorly provided as ourselves with the apparatus of sense perception. But apart from this, which is a linguistic error too deeply rooted to be easily exterminated, is it not most inaccurate in substance to say that a knowledge of Nature's law is all we seek when investigating Nature? The physicist looks for something more than what, by any stretch of language, can be described as "co existences" and "sequences" between so-called "phenomena." He seeks for something deeper than the laws connecting possible objects of experience. His object is physical reality; a reality which may or may not be capable of direct perception; a reality which is any case independent of it; a reality which constitutes the permanent mechanism of that physical universe with which our immediate empirical connection is so slight and so deceptive That such a reality exists, though philosophers have doubted, is the unalterable faith of science; and were that faith *per impossibile* to perish under the assaults of critical speculation, science, as men of science usually conceive it, would perish likewise.

If this be so, if one of the tasks of science, and more particularly of physics, is to frame a conception of the physical universe in its inner reality, then any attempt to compare the different modes in which, at different epochs of scientific development, this intellectual picture has been drawn, cannot fail to suggest questions of the deepest interest. True, I am precluded from dealing with such of these questions as are purely philosophical by the character of this occasion, and with such of them as are purely scientific by my own incompetence. But some there may be sufficiently near the dividing line to induce the specialists who rule by right on either side of it to view with forgiving eyes any trespasses into their legitimate domain which I may be tempted, during the next few minutes, to commit.

Let me, then, endeavour to compare the outlines of two such pictures, of which the first may be taken to represent the views prevalent towards the end of the 18th century; a little more

* Delivered by the Right Hon. A. J. Balfour, D.C.L., L.L.D., M.P., F.R.S., Chancellor of the University of Edinburgh, on Wednesday.

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than 100 years from the publication of Newton's "Principia," and, roughly speaking, about midway between that epoch-making date and the present moment. I suppose that if at that period the average man of science had been asked to sketch his general conception of the physical universe, he would probably have said that it essentially consisted of various sorts of ponderable matter, scattered in different combinations through space, exhibiting most varied aspects under the influence of chemical affinity and temperature, but through every metamorphosis obedient to the laws of motion, always retaining its mass unchanged, and exercising at all distances a force of attraction on other material masses, according to a simple law. To this ponderable matter he would (in spite of Rumford) have probably added the so-called "imponderable" heat, then often ranked among the elements, together with the two "electrical fluids" and the corpuscular emanations supposed to constitute light. In the universe as thus conceived, the most important forms of action between its constituents was action at a distance; the principle of the conservation of energy was, in any general form, undreamed of; electricity and magnetism, though already the subjects of important investigation, played no great part in the whole of things; nor was a diffused ether required to complete the machinery of the universe.

Within a few months, however, of the date assigned for these deliverances of our hypothetical physicist, came an addition to this general conception of the world, destined profoundly to modify it. About 100 years ago Young opened, or re-opened, the great controversy which finally established the undulatory theory of light, and with it a belief in an interstellar medium by which undulations could be conveyed. But this discovery involved much more than the substitution of a theory of light which was consistent with the facts for one which was not; since here was the first authentic introduction* into the scientific world-picture of a new and prodigious constituent—a constituent which has altered, and is still altering, the whole balance (so to speak) of the composition. Unending space, thinly strewn with suns and satellites, made or in the making, supplied sufficient material for the mechanism of the heavens as conceived by Laplace. Unending space filled with a continuous medium was a very different affair, and gave promise of strange developments. It could not be supposed that the ether, if its reality were once admitted, existed only to convey through interstellar regions the vibrations which happen to stimulate the optic nerve of man. Invented originally to fulfil this function, to this it could never be confined. And accordingly, as everyone now knows, things which, from the point of view of sense perception, are as distinct as light and radiant heat, and things to which sense perception makes no response, like the electric waves of wireless telegraphy,† intrinsically differ, not in kind, but in magnitude alone.

This, however, is not all, nor nearly all. If we jump over the century which separates 1804 from 1904, and attempt to give in outline the world-picture as it now presents itself to some leaders of contemporary speculation, we shall find that in the interval it has been modified, not merely by such far-reaching discoveries as the atomic and molecular composition of ordinary matter, the kinetic theory of gases, and the laws of the conservation and dissipation of energy, but by the more and more important part which electricity and the ether occupy in any representation of ultimate physical reality.

Electricity was no more to the natural philosophers in the year 1700 than the hidden cause of an insignificant phenomenon.‡ It was known, and had long been known, that such things as amber and glass could be made to attract light objects brought into their neighbourhood; yet it was about 50 years before the effects of electricity were perceived in the thunderstorm. It was about 100 years before it was detected in the form of a current. It was about 120 years before it was connected with magnetism; about 170 years before it was connected with light and ethereal radiation.

But to-day there are those who regard gross matter, the matter of everyday experience, as the mere appearance of which electricity is the physical basis; who think that the elementary atom of the chemist, itself far beyond the limits of direct perception, is but a connected system of monads or sub-atoms which are not electrified matter, but are electricity itself; that these systems differ in the number of monads which they contain in their arrangement and in their motion relative to each other and to the ether; that on these differences, and on these differences alone, depend the various qualities of what have hitherto been regarded as indivisible and elementary atoms; and that while in most cases these atomic systems may maintain their equilibrium for periods which, compared with such astronomical processes as the cooling of a sun, may seem almost eternal, they are not less obedient to the law of change than the everlasting heavens themselves.

But if gross matter be a grouping of atoms, and if atoms be systems of electrical monads, what are these electrical monads? It may be that, as Prof. Larmor has suggested, they are but a modification of the universal ether, a modification roughly comparable to a knot in a medium which is inextensible, incompresible and continuous. But whether this final unification be accepted or not, it is certain that these monads cannot be considered apart from the ether. It is on their interaction with the ether that their qualities depend; and without the ether an electric theory of matter is impossible.

Surely we have here a very extraordinary revolution. Two centuries ago electricity seemed but a scientific toy. It is now thought by many to constitute the reality of which matter is but the sensible expression. It is but a century ago that the title of an ether to a place among the constituents of the universe was authentically established. It seems possible now that it may be the stuff out of which that universe is wholly built. Nor are the collateral inferences associated with this view of the physical world less surprising. It used, for example, to be thought that mass was an original property of matter, neither capable of explanation nor requiring it; in its nature essentially unchangeable, suffering neither augmentation nor diminution under the stress of any forces to which it could be subjected; unalterably attached to, or identified with, each material fragment, howsoever much that fragment might vary in its appearance, its bulk, its chemical or its physical condition.

But if the new theories be accepted, these views must be revised. Mass is not only explicable, it is actually explained. So far from being an attribute of matter considered in itself, it is due, as I have said, to the relation between the electrical monads of which matter is composed and the ether in which they are bathed. So far from being unchangeable, it changes, when moving at very high speeds, with every change in its velocity.

Perhaps, however, the most impressive alteration in our picture of the universe required by these new theories is to be sought in a different direction. We have all, I suppose, been interested in the generally accepted views as to the origin and development of suns with their dependent planetary systems; and the gradual dissipation of the energy which during this process of concentration has largely taken the form of light and radiant heat. Follow out the theory to its obvious conclusions, and it becomes plain that the stars now visibly incandescent are those in mid-journey between the nebulæ from which they sprang and the frozen darkness to which they are predestined. What, then, are we to think of the invisible multitude of the heavenly bodies in which this process has been already completed? According to the ordinary view, we should suppose them to be in a state where all possibilities of internal movement were exhausted. At the temperature of interstellar space their constituent elements would be solid and inert; chemical action and molecular movement would be alike impossible, and their exhausted energy could obtain no replenishment unless they were suddenly rejuvenated by some celestial collision, or travelled into other regions warmed by newer suns.

This view must, however, be profoundly modified if we accept the electric theory of matter. We can then no longer hold that if the internal energy of a sun were as far as possible converted into heat either by its contraction under the stress of gravitation or by chemical reactions between its elements, or by any other interatomic force; and that, were the heat so generated to be dissipated, as in time it must be, through infinite space, its whole energy would be exhausted. On the contrary, the amount thus lost would be absolutely insignificant compared with what remained stored up within the separate atoms. The system in its corporate capacity would become bankrupt—the wealth of its individual constituents would be scarcely diminished. They would lie side by side, without movement, without chemical affinity; yet each one, howsoever inert in its external relations, the theatre of violent motions and of powerful internal forces.

Or, put the same thought in another form. When the sudden appearance of some new star in the telescopic field gives notice to the astronomer that he, and, perhaps, in the whole universe, he alone, is witnessing the conflagration of a world, the tremendous force by which this far-off tragedy is being accomplished must surely move his awe. Yet not only would the members of each separate atomic system pursue their relative course unchanged, while the atoms themselves were thus riven violently apart in flaming vapour, but the forces by which a world is shattered are really negligible compared with those by which each atom of it is held together.

In common, therefore, with all other living things, we seem to be practically concerned chiefly with the feebler forces of Nature, and with energy in its least powerful manifestations. Chemical affinity and cohesion are on this theory no more than the slight residual effects of the internal electrical forces which keep the atom in being. Gravitation, though it be the shaping force which concentrates nebulæ into organised systems of suns and satellites, is trifling compared with the attractions and repulsions with which we are familiar between electrically-charged bodies; while these, again, sink into insignificance beside the attractions and repulsions between the electric monads themselves. The irregular molecular movements which constitute heat, on which the very possibility of organic life

* The hypothesis of an ether was, of course, not new. But before Young and Fresnel it cannot be said to have been established.

† First known through the theoretical work of Maxwell and the experiments of Hertz.

‡ The modern history of electricity begins wiih Gilbert, but I have throughout confined my observations to the post-Newtonian period.

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seems absolutely to hang, and in whose transformations applied science is at present so largely concerned, cannot rival the kinetic energy stored within the molecules themselves. This prodigious mechanism seems outside the range of our immediate interests. We live, so to speak, merely on its fringe. It has for us no promise of utilitarian value. It will not drive our mills; we cannot harness it to our trains. Yet not less on that account does it stir the intellectual imagination. The starry heavens have from time immemorial moved the worship or the wonder of mankind. But if the dust beneath our feet be indeed compounded of innumerable systems, whose elements are ever in the most rapid motion, yet retain through uncounted ages their equilibrium unshaken, we can hardly deny that the marvels we directly see are not more worthy of admiration than those which recent discoveries have enabled us dimly to surmise.

Now, whether the main outlines of the world-picture which I have just imperfectly presented to you be destined to survive, or whether in their turn they are to be obliterated by some new drawing on the scientific palimpsest, all will, I think, admit that so bold an attempt to unify physical nature excites feelings of the most acute intellectual gratification. The satisfaction it gives is almost æsthetic in its intensity and quality. We feel the same sort of pleasurable shock as when from the crest of some melancholy pass we first see far below us the sudden glories of plain, river and mountain. Whether this vehement sentiment in favour of a simple universe has any theoretical justification I will not venture to pronounce. There is no *à priori* reason that I know of for expecting that the material world should be a modification of a single medium, rather than a composite structure built out of 60 or 70 elementary substances, eternal and eternally different. Why, then, should we feel content with the first hypothesis and not with the second? Yet so it is. Men of science have always been restive under the multiplication of entities. They have eagerly noted any sign that the chemical atom was composite, and that the different chemical elements had a common origin. Nor, for my part, do I think such instincts should be ignored. John Mill, if I rightly remember, was contemptuous of those who saw any difficulty in accepting the doctrine of "action at a distance." So far as observation and experiment can tell us, bodies *do* actually influence each other at a distance. And why should they not? Why seek to go behind experience in obedience to some *a priori* sentiment for which no argument can be adduced? So reasoned Mill, and to his reasoning I have no reply. Nevertheless, we cannot forget that it was to Faraday's obstinate disbelief in "action at a distance" that we owe some of the crucial discoveries on which both our electric industries and the electric theory of matter are ultimately founded; while at this very moment physicists, however baffled in the quest for an explanation of gravity, refuse altogether to content themselves with the belief, so satisfying to Mill, that it is a simple and inexplicable property of masses acting on each other across space.

These obscure intimations about the nature of reality deserve, I think, more attention than has yet been given to them. That they exist is certain, that they modify the indifferent impartiality of pure empiricism can hardly be denied. The common notion that he who would search out the secrets of Nature must humbly wait on experience, obedient to its slightest hint, is but partly true. This may be his ordinary attitude; but now and again it happens that observation and experiment are not treated as guides to be meekly followed, but as witnesses to be broken down in cross-examination. Their plain message is disbelieved, and the investigating judge does not pause until a confession in harmony with his preconceived ideas has, if possible, been wrung from their reluctant evidence.

This proceeding needs neither explanation nor defence in those cases where there is an apparent contradiction between the utterances of experience in different connections. Such contradictions must, of course, be reconciled, and science cannot rest until the reconciliation is effected. The difficulty really arises when experience apparently says one thing and scientific instinct persists in saying another. Two such cases I have already mentioned; others will easily be found by those who care to seek. What is the origin of this instinct, and what its value; whether it be a mere prejudice to be brushed aside, or a clue which no wise man would disdain to follow, I cannot now discuss. For other questions there are, not new, yet raised in an acute form by these most modern views of matter, on which I would ask your indulgent attention for yet a few moments.

That these new views diverge violently from those suggested by ordinary observation is plain enough. No scientific education is likely to make us, in our unreflective moments, regard the solid earth on which we stand, or the organised bodies with which our terrestrial fate is so intimately bound up, as consisting wholly of electric monads very sparsely scattered through the spaces which these fragments of matter are, by a violent metaphor, described as "occupying." Not less plain is it that an almost equal divergence is to be found between these new theories and that modification of the common sense view of matter with which science has in the main been content to work.

What was this modification of common sense? It is roughly indicated by an old philosophic distinction drawn between what were called the "primary" and the "secondary" qualities of matter. The primary qualities, such as shape and mass, were supposed to possess an existence quite independent of the observer; and so far the theory agreed with common sense. The secondary qualities, on the other hand, such as warmth and colour, were thought to have no such independent existence, being, indeed, no more than the resultants due to the action of the primary qualities on our organs of sense-perception; and here, no doubt, common sense and theory parted company.

You need not fear that I am going to drag you into the controversies with which this theory is historically connected. They have left abiding traces on more than one system of philosophy. They are not yet solved. In the course of them the very possibility of an independent physical universe has seemed to melt away under the solvent powers of critical analysis. But with all this I am not now concerned. I do not propose to ask what proof we have that an external world exists, or how, if it does exist, we are able to obtain cognisance of it. These may be questions very proper to be asked by philosophy; but they are not proper questions to be asked by science. For, logically, they are antecedent to science, and we must reject the sceptical answers to both of them before physical science becomes possible at all. My present purpose requires me to do no more than observe that, be this theory of the primary and secondary qualities of matter good or bad, it is the one on which science has in the main proceeded. It was with matter thus conceived that Newton experimented. To it he applied his laws of motion, of it he predicted universal gravitation. Nor was the case greatly altered when science became as much preoccupied with the movements of molecules as it was with those of planets. For molecules and atoms, whatever else might be said of them, were at least pieces of matter, and, like other pieces of matter, possessed those "primary" qualities supposed to be characteristic of all matter, whether found in large masses or in small.

But the electric theory which we have been considering carries us into a new region altogether. It does not confine itself to accounting for the secondary qualities by the primary, or the behaviour of matter in bulk by the behaviour of matter in atoms; it analyses matter, whether molor or molecular, into something which is not matter at all. The atom is now no more than the relatively vast theatre of operations in which minute monads perform their orderly evolutions; while the monads themselves are not regarded as units of matter, but as units of electricity; so that matter is not merely explained, but is explained away.

Now the point to which I desire to call attention is not to be sought in the great divergence between matter as thus conceived by the physicist and matter as the ordinary man supposes himself to know it, between matter as it is perceived and matter as it really is, but to the fact that the first of these two quite inconsistent views is wholly based on the second.

This is surely something of a paradox. We claim to found all our scientific opinions on experience; and the experience on which we found our theories of the physical universe is our *sense-perception* of that universe. That *is* experience; and in this region of belief there is no other. Yet the conclusions which thus profess to be entirely founded upon experience are to all appearance fundamentally opposed to it; our knowledge of reality is based upon illusion, and the very conceptions we use in describing it to others, or in thinking of it ourselves, are abstracted from anthropomorphic fancies, which science forbids us to believe and nature compels us to employ.

We here touch the fringe of a series of problems with which inductive logic ought to deal, but which that most unsatisfactory branch of philosophy has systematically ignored. This is no fault of men of science. They are occupied in the task of making discoveries, not in that of analysing the fundamental presuppositions which the very possibility of making discoveries implies. Neither is it the fault of transcendental metaphysicians. Their speculations flourish on a different level of thought; their interest in a philosophy of nature is lukewarm; and howsoever the questions in which they are chiefly concerned be answered, it is by no means certain that the answers will leave the humbler difficulties at which I have hinted either nearer to or further from a solution. But though men of science and idealists stand acquitted, the same can hardly be said of empirical philosophers. So far from solving the problem, they seem scarcely to have understood that there was a problem to be solved. Led astray by a misconception to which I have already referred; believing that science was concerned only with (so-called) "phenomena," that it had done all that it could be asked to do if it accounted for the sequence of our individual sensations, that it was concerned only with the "laws of Nature," and not with the inner character of physical reality; disbelieving, indeed that any such physical reality does in truth exist; it has never felt called upon seriously to consider what are the actual methods by which science attains its results, and how those methods are to be justified. If anyone, for example, will take up Mill's logic, with its "sequences and co-

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existences between phenomena," its "method of difference," its "method of agreement," and the rest; if he will then compare the actual doctrines of science with this version of the mode in which those doctrines have been arrived at, he will soon be convinced of the exceedingly thin intellectual fare which has been hitherto served out to us under the imposing title of Inductive Theory.

There is an added emphasis given to these reflections by a train of thought which has long interested me, though I acknowledge that it never seems to have interested anyone else. Observe, then, that in order of logic sense-perceptions supply the premises from which we draw all our knowledge of the physical world. It is they which tell us there *is* a physical world; it is on their authority that we learn its character. But in order of causation they are effects due (in part) to the constitution of our organs of sense. What we see depends not merely on what there is to be seen, but on our eyes. What we hear depends not merely on what there is to hear, but on our ears. Now, eyes and ears, and all the mechanism of perception, have, as we know, been evolved in us and our brute progenitors by the slow operation of natural selection. And what is true of sense-perception is, of course, also true of the intellectual powers which enable us to erect upon the frail and narrow platform which sense-perception provides, the proud fabric of the sciences.

Now, natural selection only works through utility. It encourages aptitudes useful to their possessor or his species in the struggle for existence, and, for a similar reason, it is apt to discourage useless aptitudes, however interesting they may be from other points of view, because, being useless, they are probably burdensome.

But it is certain that our powers of sense-perception and of calculation were fully developed ages before they were effectively employed in searching out the secrets of physical reality—for our discoveries in this field are the triumphs but of yesterday. The blind forces of natural selection, which so admirably simulate design when they are providing for a present need, possess no power of prevision, and could never, except by accident, have endowed mankind, while in the making, with a physiological or mental outfit adapted to the higher physical investigations. So far as natural science can tell us, every quality of sense or intellect which does not help us to fight, to eat, and to bring up children, is but a by-product of the qualities which do. Our organs of sense-perception were not given us for purposes of research: nor was it to aid us in meting out the heavens or dividing the atom that our powers of calculation and analysis were evolved from the rudimentary instincts of the animal.

It is presumably due to these circumstances that the beliefs of all mankind about the material surroundings in which it dwells are not only imperfect, but fundamentally wrong. It may seem singular that down to, say, five years ago, our race has, without exception, lived and died in a world of illusions; and that its illusions, or those with which we are here alone concerned, have not been about things remote or abstract, things transcendental or divine, but about what men see and handle, about those "plain matters of fact" among which common sense daily moves with its most confident step and most self-satisfied smile. Presumably, however, this is either because too direct a vision of physical reality was a hindrance, not a help, in the struggle for existence; because falsehood was more useful than truth; or else because, with so imperfect a material as living tissue, no better results could be attained. But, if this conclusion be accepted, its consequences extend to other organs of knowledge besides those of perception. Not merely the senses, but the intellect, must be judged by it; and it is hard to see why evolution, which has so lamentably failed to produce trustworthy instruments for obtaining the raw material of experience, should be credited with a larger measure of success in its provision of the physiological arrangements which condition reason in its endeavours to turn experience to account.

Considerations like these, unless I have compressed them beyond the limits of intelligibility, do undoubtedly suggest a certain inevitable incoherence in any general scheme of thought which is built out of materials provided by natural science alone. Extend the boundaries of knowledge as you may; draw how you will the picture of the universe; reduce its infinite variety to the modes of a single space-filling ether; retrace its history to the birth of existing atoms; show how under the pressure of gravitation they became concentrated into nebulæ, into suns and all the host of heaven; how, at least in one small planet, they combined to form organic compounds; how organic compounds became living things; how living things, developing along many different lines, gave birth at last to one superior race; how from this race arose, after many ages, a learned handful, who looked round on the world which thus blindly brought them into being, and judged it, and knew it for what it was: perform, I say, all this, and, though you may indeed have attained to science, in nowise will you have attained to a self-sufficing system of beliefs. One thing at least will remain, of which this long-drawn sequence of causes and effects gives no satisfying explanation, and that is knowledge itself. Natural science must ever regard knowledge as the product of irrational conditions, for in the last resort it knows no others. It must always regard knowledge as rational, or else science itself disappears. In addition, therefore, to the difficulty of extracting from experience beliefs which experience contradicts, we are confronted with the difficulty of harmonising the pedigree of our beliefs with their title to authority. The more successful we are in explaining their origin the more doubt we cast on their validity. The more imposing seems the scheme of what we know the more difficult it is to discover by what ultimate criteria we claim to know it.

Here, however, we touch the frontier beyond which physical science possesses no jurisdiction. If the obscure and difficult region which lies beyond is to be surveyed and made accessible, philosophy, not science, must undertake the task. It is no business of this Society. We meet here to promote the cause of knowledge in one of its great divisions; we shall not help it by confusing the limits which usefully separate one division from another. It may perhaps be thought that I have disregarded my own precept—that I have wilfully overstepped the ample bounds within which the searchers into Nature carry on their labours. If it be so, I can only beg your forgiveness. My first desire has been to rouse in those who, like myself, are no specialists in physics the same absorbing interest which I feel in what is surely the most far-reaching speculation about the physical universe which has ever claimed experimental support, and if in so doing I have been tempted to hint my own personal opinion that as natural science grows it leans more, not less, upon an idealistic interpretation of the universe, even those who least agree may perhaps be prepared to pardon.

INSPECTION AND INSURANCE OF ELECTRICAL MACHINERY.

In his report for 1903, the chief engineer of the Engine, Boiler and Employers' Liability Insurance Co. makes some interesting remarks regarding electrical machinery. He says that considerable additions have had to be made to the premiums charged for motors driving coal cutters owing to the excessive rate of breakdown of these machines. The annual rate of breakdown among them has been about one in two. Motors driving underground hauling machines, motors out of doors driving shears, saws and portable tools in ironworks, foundries and shipyards are also subject to frequent breakdown. Then come crane motors and so on, till we come to the minimum of risk with the lighting dynamos in a dry and well-appointed room, kept clean and tended by a careful man. The breakdowns in 1903 may be classified as under. First as to parts which apparently broke first:—

	Dynamos.	Motors.
Armatures or rotors	62·0 per cent.	50·5 per cent.
Magnets or stators	12·5 ,,	11·5 ,,
Commutators or brush gear	17·0 ,,	14·5 ,,
Miscellaneous	8·5 ,,	8·5 ,,
Switch gear	— ,,	15·0 ,,
	100	100

Second, as to causes of damage:—

Accident	14·0 per cent.	12·0 per cent.
Dirt and oil	10·0 ,,	15·5 ,,
Age and deterioration	24·0 ,,	19·5 ,,
Bad workmanship or design	17·5 ,,	18·0 ,,
Overloading	3·5 ,,	5·5 ,,
Not ascertained	31·0 ,,	29·5 ,,
	100	100

A general idea of the nature of these breakdowns, and of the services rendered by the company's inspectors, may be gathered from the following examples selected from the experiences of the year:—

Four-pole shunt-wound 60 B.H.P. enclosed motor, supplied with current at 500 volts, and intended to run at 600 revs. per min. When proposed for insurance the motor could not be seen at work, but as it was new from the works of a well-known maker the insurance was accepted. As soon as it was put to work the owner asked the company to send an inspector, as the magnet coils were very hot and the brushes sparking badly. The inspector found the owner's report correct. The magnet coils after two or three hours' run were too hot to keep the hand upon, and with the brushes in the marked position the sparking was very bad. By moving the brushes back about 1in. on the commutator, the sparking was reduced, but the speed was increased by 50 revolutions. As the machine was a new one, the inspector suggested that the attention of the makers should be drawn to its unsatisfactory working. They sent a man to examine it, who found one of the magnet coils "earthed" to the frame. The coil was taken off and re-wound, but the heating still continued, the temperature rising quickly to 217° F. The inspector, who was then present, tested the current passing through the shunt, and found it to be 7·5 amperes. This led to the discovery that by some unaccountable mistake a set of coils wound for 250

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instead of 500 volts had been put on. They were replaced, and the motor at once ran sparklessly with the field coils at a temperature of 80°F. at the end of an eight hours' run.

Continuous-current transformer with double-wound armature, in a sub-station on an electric lighting circuit receiving 46 amperes at 1,000 volts from high-tension mains in connection with the generators at the central station, and supplying 360 amperes at 110 volts to the low-tension network. The inspector found the armature was completely wrecked, all the steel bands upon it stripped off, and the conductors wedged tightly in between the core and the pole pieces. The armature had to be entirely rewound. The accident seems to have occurred in this way:—Two of the generators at the central station were running in parallel supplying the low-tension systems through this and other transformers. The network fed by this particular transformer was also in connection with the battery through the main battery fuse and single-pole battery switch. One of the generators at the central station began to spark so viciously that it had to be shut down. The excessive load thus thrown upon the second generator caused it to spark so much that it had to be stopped also. Thus the whole load of the low-tension network fed by the sub-station was thrown upon the battery, The battery fuse being insufficient to carry the current, was blown, leaving the whole network "dead." The shunt circuit, however, still remained excited by the battery, as the connection to the shunt coil was taken off the battery side of the fuse. After a short stoppage the generators at the central station were got to work again, and the transformer was restarted. Having started the transformer the attendant thought about replacing the battery fuse, and either forgetting or not knowing the peculiar way in which the shunt circuit was connected, opened the battery switch for the purpose of cutting the battery out of circuit, but with the effect of breaking the shunt circuit. Before he fully realised the effect of his action, the armature, deprived of its field, had attained sufficient speed to burst the wire bands and throw out the conductors. There may have been some special reason for connecting up the shunt coil on the battery side of the fuse, otherwise it surely would have been better to have connected it across the 'bus bars.

Two-pole continuous-current motor, shunt-wound with independent excited field, used for driving a machine for bending rolled joists. To maintain the motion of the machine and reduce the strain upon the motor when the beams were being bent, the driving shaft, whose normal speed was 225 revs. per min., carried three flywheels, two of 55in. diameter, each weighing 10 cwt. 3qrs., and one 36in. diameter, weighing 8 cwt. Several complaints having been received of severe sparking and trouble with fuses, an inspector was sent to see what was wrong. He found that the motor required about 30 seconds to attain its full speed of 1,250 revs. per min., and that during this time the current increased to 46 amperes and the sparking was very vivid. When full speed was reached the current fell to 13 amperes and did not exceed 15 when joists were under pressure. Thus the flywheels, which were put on to relieve the motor, and did relieve it when the machine was bending the joists, caused heavy overloading at starting, because the starting resistance was cut out too quickly. Assuming the weight of the rims of the three wheels to have been 600lb., 600lb. and 450lb. respectively, and the radii of gyration to be equal to the radii of the wheels (to compensate for neglecting the arms), then the work done in imparting the velocities of 54ft., 54ft. and 35·3ft. per second (the equivalents of 225 revs. per min.) being equal to half the increase of vis viva is

$$=\frac{1}{2g}(600\times 54^2+600\times 54^2+450\times 35{\cdot}3^2)=126{,}000 \text{ foot-pounds},$$

and as this work was done in half-a-minute it was done at the rate of 252,000 foot-pounds per minute, and was therefore equivalent to 7½ H.P. With a motor of 80 per cent. efficiency this would require a current of 32 amperes at 220 volts. Further, this current could only do the work if it remained constant during the whole period of 30 seconds which, of course, was impossible, since the back E.M.F. generated by the armature when it attained full speed was sufficient to prevent the current exceeding 15 amperes when the whole of the starting resistance was cut out. During part of the 30 seconds, therefore, the current must have considerably exceeded 32 amperes. The inspector says he saw it reach 45 amperes, and there is little doubt it often exceeded this, for it is probable that in his presence the starting resistance would be cut out more slowly than on many other occasions. But it was not only at starting that the flywheels threw a heavy strain upon the motor. They endangered it whenever the armature current was cut off by running the armature for about 200 seconds in the field (which, as has been mentioned, was permanently maintained by excitation from an independent source). Now, the machine was so designed that when running as a motor the neutral part of the commutator was close to the trailing horns of the pole-pieces. The moment the supply of current to the armature was cut off the machine became a dynamo generating voltage but sending no current through the outer circuit. The field then became horizontal, or nearly so, and the neutral part of the commutator moved from under the trailing horns of the pole-pieces to a point half-way between the horns. The brushes, therefore, were no longer at the neutral point, but at a point where there was considerable difference of potential between adjoining sections of the commutator, and accordingly very heavy currents, causing vicious sparking, were set up in the armature coils connected to these sections every time they passed under the brushes. Assuming the energy stored in the wheel when the current was cut off to have been 126,000 foot-pounds as before, then, since the machinery came to rest in 200 seconds, this energy must have been absorbed at the rate of $126{,}000\times\frac{60}{200}=38{,}000$ foot-pounds per minute, which is equivalent to 1·15 H.P. This was the power required to drive the armature of the motor, and to overcome the friction of the machinery, at a mean speed of 112·5 revs. per min. Assuming as before an efficiency of 80 per cent. for the motor, the current required to overcome the friction of the machinery when driven by the motor would be about 5 amperes, which should be added to the 32 amperes required to give the flywheels their velocity. There are many other kinds of machines possessing great inertia when at rest and endowed with a large amount of kinetic energy when in motion. This example explains a special risk to which motors driving such machines are subject.

On receipt of a letter from the owner of an insured motor stating that "electricity was escaping from the motor," and that he had sent for the makers to repair it, an inspector was sent to inquire and report. On arrival at the works he learnt that sparks had been seen to pass between the driving belt from the motor and an iron guard, and was informed that the maker's man had attributed the sparking to a fault on one of the mains. He tested the motor and the mains and found the insulation satisfactory. He then examined the belt. He found it very dry and standing within ¾in. of the iron guard. When running it would doubtless approach the guard more closely and might even touch it. Evidently the sparks were due to discharges of frictional electricity. The origin of the sparks was explained to the owner and his fears of loss and damage removed.

An Inverse Time-limit Relay.—The ordinary time-limit relay, as generally employed in connection with the tripping coil of a circuit breaker, insures the line from interruption until an overload shall have been maintained for a predetermined period which is long enough to threaten the safety of the apparatus. The action of the Westinghouse inverse time-limit relay, a description of which appears in the *Street Railway Journal*, is similar, except that the speed with which the movable contact travels is regulated by the amount of the overload, and it thus differentiates between a short circuit which requires an immediate action of the circuit breaker and a slight overload, which will cause no damage unless sustained until the thermal effect is dangerous. The device consists essentially of a solenoid in which a core slides, this being in mechanical connection with the trip gear. When an overload occurs the core is drawn into the coils, raising the moving contact until connection is made with the stationary contact and the tripping circuit is closed. The variable time element is supplied by an air check which is connected with the magnet core by a vertical rod. As the core and moving contact rise the air in the checking chamber is compressed and acts in the same manner as a dash-pot in retarding the closure of the circuit. An intake valve allows the checking chamber to fill quickly when the overload is removed and the relay is thus automatically reset. The outlet valve furnishes the inverse time-limit feature, as the ball which closes the valve is held lightly under the compresssion of a coiled spring, the amount of the pressure upon the valve from within regulating the size of the opening. When a slight overload occurs the pressure upon the check is light and the air escapes slowly through a small opening. In the event of a short circuit the magnet core would be drawn rapidly upward, the air being expelled quickly from the valve, which the pressure would force wide open, and the tripping circuit would be closed. Should the overload cease before the contacts touch, the magnet core drops to its original position and the relay is reset. Adjustments are provided covering a wide range in time and current. The stationary contacts can be raised or lowered, thus varying the distance traversed by the moving contacts. Both the intake and the outlet valve of the air check are adjustable, thus controlling the speed with which it is emptied and filled. The leverage of the counterpoises attached to the check is also subject to adjustment, and by means of weights placed upon the scale pan beneath the magnet the weight of the moving element is increased.

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THE PARLIAMENTARY SESSION OF 1904.

At the beginning of the year there was every indication that the Parliamentary Session of 1904 would be an unproductive one so far as new schemes were concerned, and although this indication was not altogether falsified, there can be no doubt that, from the point of view of the electrical industry, a number of important matters have been discussed and decided. As is usual in every Session, municipal trading has again intruded itself, perhaps not quite so violently as last year; but there has been a general feeling within the Committee rooms of both Houses that trading by a local authority outside its area is to a large extent an illegitimate speculation with the ratepayers' money; and this will tend to minimise the strife between municipalities and companies trading in the vicinity of their districts.

Probably the most important feature of the Session has been the effort made by the Board of Trade to improve electrical legislation, for by the introduction of the Supply of Electricity Bill and the Light Railways Bill the Board has endeavoured to meet many objections which have been made during the past few years to the existing condition of the law relating to electric lighting and tramways. It is to be regretted, however, that these efforts of the Board of Trade are so continually nullified by the belated introduction of the Bills. Neither the Supply of Electricity Bill nor the Light Railways Bill has been passed; and in the case of the last mentioned this is inexcusable, for the Bill was practically "non-contentious." With regard to the former, it can only be hoped that the good work accomplished when the Bill was before the House of Lords Committee presided over by Lord Wolverton will not be thrown away, and that next year the Bill in its amended form will be re-introduced. Unfortunately, the Standing Orders do not allow a Bill to proceed from the point at which it was left in the previous Session, so that all those opponents of the measure who failed to secure what they petitioned for this year will be able to oppose again when the Bill is next introduced. Therefore there is every reason why these Bills should be reintroduced at an early date in the 1905 Session. We have already

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expressed our views concerning the Government's well-conceived Wireless Telegraph Act which has been rushed through at the last moment, and there is no need to recapitulate them here. Apart from this useful item the Session has not been one to excite enthusiasm as regards legislative reform affecting the electrical industry.

Dealing with the private legislation of the Session, attention is at once directed to the now familiar "Bermondsey" clause, and it may be claimed that the gas companies have received a well-merited check. Their persistency in bringing the matter before the Committees of both Houses of Parliament had at length the effect of forcing Local Authorities to demand a definite expression of opinion as to the equity of the "Bermondsey" clause in its original form, and a Committee of the House of Lords, presided over by the Duke of NORTHUMBERLAND, propounded what has now become known in Parliamentary Committee rooms as the "Northumberland" clause. An analysis of the terms of the clause, however, which gives a new undertaking five years and an existing undertaking applying for fresh powers three years before any equalisation of charges with expenditure becomes necessary, reveals the position adopted by the Committee which drafted it—viz., that a local authority authorised by statute to carry on certain works should not be compelled by a competitor to raise its prices because a loss may be incurred in the early stages of the undertaking. Many gas companies even do very little more than make both ends meet for the first year or two, but we venture to think that the shareholders of any such company would not acquiesce silently if the directors were to increase the selling price of gas if an increase of turnover were all that was required to convert a loss into a profit. We do not advocate that municipal trading should be carried on in an absolutely unrestricted manner, but it would tend to greater uniformity in legislation if the proper regulations and safeguards were laid down once for all, instead of each Parliamentary Committee (consisting of a few members only) being left to settle each case in accordance with their opinion of its merits. This does not apply only to the "Bermondsey" clause, but also to the disputes arising every Session between power companies and Local Authorities as to the allocation of areas and on the question of competition.

Another matter in which the gas companies have again keenly interested themselves is the question of alleged electrolytic damage to their pipes by leakage current from electric tramways. Now, it is already known that the Board of Trade has formulated a set of regulations for the protection of gas and water companies, but in spite of these regulations and the oft-repeated assurances of the Board of Trade that it sees no need for modifying or extending them in this respect, application is constantly made for more protection. One of the boldest—and we are pleased to say unsuccessful—attempts in this direction ever made was at the instigation of the Barnet Gas and Water Co. this Session. It was sought to include an "electrolysis clause" in a Bill of this company's own promotion, applicable, not to any specific works, but in the widest possible sense to any electrical undertaking, past, present or future, within the company's area of supply. Later, the same point was raised in connection with the Torquay Tramways Bill, promoted by the Dolter Electric Traction Co. This particular case, moreover, emphasises the ever-growing necessity for the abolition of the local veto under the Tramways Act of 1870. As a condition of consent, the Torquay Corporation insisted on having protection under a special electrolysis clause so far as its gas and water mains were concerned. To this the promoters perforce agreed, and, as a consequence, a House of Commons Committee felt bound, merely as a matter of consistency and not of principle, to give similar protection to the Torquay Gas Co. Fortunately for the electrical industry, however, great vigilance is now being displayed by the Chairman of Committees in the House of Lords, aided by his counsel, and both sections of the clause were struck out, even after a Committee of the House of Lords had agreed to their insertion. Really, the Dolter Company deserve thanks for having introduced their Bill, for, as a result of the discussion which took place upon the third reading of the Bill in the House of Lords in respect of electrolysis, the gas companies are inclined to drop this question, at any rate for the present. An indication of this tendency was presented only a few days ago in connection with the Caerphilly electric lighting order, the reason given being that it was quite evident Parliament had made up its mind that the Board of Trade regulations were sufficient.

In connection with the "Power" bills, only three of which involved new schemes, an important question arises as to the tendency of Parliamentary Committees on the question of finance. Both the East London and Lower Thames Electric Power Bill and the Cheshire Electric Power Bill were rejected practically because the promoters failed to produce an absolute guarantee that the capital would be forthcoming. Without suggesting for one moment that a scheme lacking substantial financial support should be passed, there is a possibility of the principle above referred to being applied too rigidly. We should not be far wrong in saying that it is a legacy handed down from the year 1902, when several rival schemes for tube railways in London were defeated by the YERKES and MORGAN groups solely because these gentlemen, figuratively speaking, produced the necessary capital in the Committee-room. Except in such exceptional circumstances, however, no promoter could expect to be in a position to follow this precedent, because in the ordinary course an investor will not pledge himself to subscribe to a scheme which has not even obtained Parliamentary sanction. Had this policy on the part of Parliament been pursued in the early days of electric power Bills, we should still have been waiting for the first of our "bulk" supply undertakings. While we are not finding fault with the decisions in regard to the East London and Lower Thames Bill and the Cheshire Bill, it is from a fear that such a precedent in the hands of a clever counsel may be employed to the disadvantage of the electrical industry in the future that we draw attention to it. The one satisfactory feature of the Session as regards "Power" schemes has been the passing of the North Wales Electric Power Bill; and this for two reasons: the scheme involves the employment of water power for generating electrical energy, and also the use of overhead wires for transmission and distribution.

Regarding municipal trading, it has been shown on more than one occasion during the Session that Parliamentary Committees view with disfavour any municipal trading operations outside the trading authority's own boundaries. Doncaster is a case in point so far as a general supply of electricity is concerned. The Belfast Corporation, also, in its Bill providing for the purchase of the Belfast Street Tramways Co., sought to be authorised to enter into working agreements with tramway companies outside the city; but this, again, was refused at the instance of the Belfast and County Down Railway Co., the argument being that it would be possible for rate aided competition to exist over many miles of line, while rates were levied only in Belfast, the railway company contributing largely.

The Tyneside Tramways and Tramroads Bill created considerable stir in municipal and tramway circles owing to an almost successful attempt to compel the Newcastle

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Corporation, against its will, to give running powers to the Tyneside Company. The intention of those who opposed the Bill on third reading was to secure the rejection of the running power clauses, but the Bill was re committed to the former Committee without any instruction, and, mainly owing to the firmness of the Committee in insisting that through-running would be to the public advantage, an agreement was arrived at between the parties and scheduled to the Bill. The introduction of the Dolter surface contact system at Torquay will be watched with interest, especially in the light of events at Wolverhampton. In London, the County Council again met with its annual rebuff before the Embankment tramway even reached the Committee stage of the House of Commons, and, later on, by a process of gradual elimination—first at the hands of the Committee and then at the instance of the House itself—the proposed line down Tottenham Court-road disappeared. An interesting point in connection with municipal tramway schemes in the provinces has been the granting, in a few instances, of power to run omnibuses over routes which are being reconstructed for electric traction, but only during the period of reconstruction, or in order to test the capacity of any particular route with the view of constructing a new tramway. In one case an effort was made to obtain powers to run the omnibuses beyond the tramway termini and in competition with the local omnibus companies, but the application was refused by the Police and Sanitary Committee of the House of Commons.

A word may be said here as to a welcome improvement in Parliamentary procedure which has manifested itself, probably in a greater degree this Session than hitherto. It has been a standing complaint for several years that in many unopposed Bills, and especially municipal omnibus Bills, clauses of a very far-reaching character have been inserted without sufficient inquiry as to their reasonableness or equity. This state of affairs, however, is fast being broken down. For instance, all municipal Bills of an omnibus character, whether opposed or unopposed, are now sent to the Police and Sanitary Committee of the House of Commons, which goes through the clauses seriatim with the assistance of a representative of the Local Government Board, and we may warn promoters that they have now to produce good evidence in support of any uncommon or unprecedented proposal. Other unopposed private Bills, also, are not now treated in an informal manner by the Unopposed Committees of both Houses, as we have had occasion recently to point out.

A number of matters of more or less importance may also be referred to in conclusion. A small difficulty in the matter of the transfer, by local authorities, of their electric lighting provisional order to "Power" companies has been cleared away, a clause being inserted in several power Bills giving power companies the right to acquire such powers without having to come to Parliament again. This clause was introduced owing to a doubt having existed on the point. Local authorities have, of course, only to obtain the consent of the Board of Trade to the transfer. The electric lighting difficulty in Marylebone has been smoothed out—at any rate for the present—by the passing of the Marylebone Borough Council Act, authorising the borrowing of the necessary sums to complete the purchase of that part of the Metropolitan Company's undertaking which lies in the borough of St. Marylebone, and also by the passing of the London County Council (Money) Act, which included powers to lend the Marylebone Council the requisite amounts. "Zone" fares, which will be adopted on the District Railway when it is electrified, are an innovation so far as a system of such magnitude is concerned. The rejection of the Bill proposing the construction of a tube railway between North and South Woolwich on the opposition of the London County Council is, in a measure, to be regretted, as, although a more or less definite promise was given by the Council to promote such a scheme itself, it must be many years before it can be put into effect owing to the large capital expenditure to which the Council already stands committed. The Metric Bill, too, has been dropped, it not having survived the Committee stage of the House of Lords, but the Electric Lighting (London) Bill, providing for slight readjustments in the Metropolitan electric lighting areas, has at last been passed.

We trust that next Session of Parliament will be more beneficial to the electrical industry, and, we hope, by more direct methods. An equivalent of this year's abortive Electricity Supply Bill must certainly be passed, and legislation must be introduced to continue and amend the Light Railways Act, 1896, and to amend the 1870 Tramways Act particularly by removing the burdens of the local veto and the 21 years purchase clause from the electric traction industry.

OBITUARY.

JOSEPH DAVID EVERETT.

We regret to announce the death of Prof. Joseph David Everett, M.A., D.C.L., F.R.S., who retired from the chair of Natural Philosophy at Queen's College, Belfast, in 1897, after having held it for 30 years. Prof. Everett was born near Ipswich in 1831 and received his preliminary education there, subsequently occupying the post of mathematical master at a school in Hertfordshire. In 1854 he entered the University of Glasgow and studied under Lord Kelvin (then Prof. Wm. Thomson), graduating M.A. in 1857 with honours in mathematics, natural philosophy, classics and mental philosophy. For a short time he was secretary to the Meteorological Society of Scotland, and was afterwards professor of mathematics at Kings' College, Nova Scotia, which post he resigned in 1864. His next move was to Glasgow, where he was appointed assistant professor of mathematics, and on leaving this position he was appointed to the chair of Natural Philosophy at Queen's College, Belfast, in 1867.

One of Prof. Everett's favourite studies was in connection with thermometric measurements, and for many years he was secretary to the Underground Temperature Committee of the British Association. As secretary to the committee appointed by the B.A. in 1871, "for the Selection and Nomenclature of Dynamical and Electrical Units," he suggested the names "dyne," "erg" and "C.G.S.," and drafted the Report issued in 1873. To facilitate the adoption of its recommendations, he drew up a small volume of "Illustrations of the C.G.S. System," published by the Physical Society in 1875. Part III. of Prof. Everett's version of Deschanel's "Traité de Physique" was published in 1900 and consisted almost entirely of new work. It dealt with the fundamental principles of modern electrical theory, as represented by Maxwell and Heaviside. His interest in physics did not abate during recent years, and he was a prominent figure at the meetings of the Physical Society, and only a few weeks ago joined in the discussion in our Correspondence columns on the rationalisation of electrical units.

Prof. Everett was elected F.R.S. in 1879, and it may truly be said that he dedicated his life to the advancement of science. A hard thinker and great worker, he was always ready to impart his views and suggestions to others.

HENRY PALIN GURNEY.

The death of Dr. Henry Palin Gurney, by a mountaineering accident in Switzerland, removes from the educational world a man of strong personality and wide sympathies. In his public career he was Deputy Professor of Mineralogy at Cambridge, partner in the well-known firm of Wren and Gurney, and Principal of the Durham College of Science. In all these

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positions his skill in tuition and knowledge of affairs gained him a wide reputation. He took Orders in 1871, and to the end his intimate friends knew of the active interest he took in philanthropic work, though absorbed in the duties of administration. His loss to the North will be great. By his tactful efforts he had succeeded in drawing together many scattered interests, and their co-ordination is just beginning to be felt. He will be remembered as one who held on his way steadily, with wide public views and a sincere desire to leave the world better than he found it.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

Rayons "N." By R. Blondlot. (Paris: Gauthiers-Villars.) 1904. fr.2.

This is a reprint of all the communications made by the author to the Academy of Sciences on the subject of N-rays, together with a number of supplementary notes and directions for making N-ray screens and observing N-rays. It is suitably prefaced with Dumas' words concerning Faraday: "What makes the Sciences advance is mostly an almost insensible detail, observed with delicate instruments, measured with precision, controlled and pursued through its consequences with a patient logic. . . . The germ of an idea, as that of living beings, remains invisible until it finds its abode, and emerges like them, weak, feeble and hidden." The first Paper was published on February 2, 1903, and bears the title "On the Polarisation of X-Rays." The title was, of course, composed in error, as the author found out in the course of the following month, when he succeeded, not only in polarising the new rays, but also in reflecting and refracting them. Since that time the plot has been thickening, until to-day there is a vast amount of experimental material accumulated in France alone, and vouched for by some of the most distinguished of French savants, but almost entirely confined to that country. The situation is extraordinary and probably unique in recent scientific history. The development of the discovery may be followed up by looking through our Contemporary Science columns under the names of Blondlot, Macé de Lépinay, Charpentier, Meyer and Becquerel, and care has been taken not to overlook any Paper on the subject. For any intending student of N-rays the present volume will be a valuable guide, especially as it contains practical instructions, and, best of all, an actual sulphide screen ready for work. The reviewer must confess to not having succeeded in obtaining any decisive effect with the use of the screen, which consists of 32 patches of phosphorescent calcium sulphide deposited with a brush on black paper from an emulsion of the salt in collodion diluted with ether. A point not mentioned in the book is that some of the rows of patches should be less illuminated than others in order to allow for the different sensitiveness of different eyes.—E.E.F.

Refuse Disposal and Power Production. By W. F. Goodrich (Westminster: Archibald Constable & Co., Ltd.) 1904. 16s. net.

This volume, which is very fully illustrated, deals in a comprehensive manner with existing methods of refuse destruction, and describes in some detail the construction of the various types of destructors in actual use. In the chapter on "Refuse Destructors Combined with Electricity Works" the author puts forward opinions which cannot be passed without comment. He says, "Those who have constantly asserted that the combination is worthless have in the course of time found themselves faced with actual statistics from various towns, clearly proving the combination to be of value, and so the critics have gradually decreased in number, and the situation to-day, as compared with that of five years ago, has entirely changed." On the contrary, instead of decreasing, the number of critics has increased, the apparent decrease being due to the fact that interest in the subject has diminished, and therefore the critics are not heard so frequently.

Mr. Goodrich accuses station engineers of reluctance to admit the value of a combined destructor, because they consider that it would be an unpleasant adjunct, but the fact of the matter is that some station engineers know by experience the characteristics of the destructor, and other station engineers wisely benefit by their brethren's trials. The author strongly recommends that one engineer should have control of both the destructor and the generating plant, and in this contention he is undoubtedly correct, although many engineers would prefer to leave the former severely alone. An apology is made for the steam curves, given in the book, being "not altogether satisfactory, but," the author continues, "in studying the same it must be remembered that they are diagrams taken under normal working conditions. . . . ." He does not seem to recognise that such curves are the only ones of any value, and that it is just under normal working conditions that steady steaming is required.

The remainder of the book deals with tests that have been carried out on separate and combined destructors, and there is a great deal of information of considerable value to those engaged in this particular work.

The Phase Rule and its Applications. By A. Findlay. (London: Longmans, Green & Co.) 5s.

This book is reminiscent of certain treatises on logic. These define with precision things which are common knowledge, continue them with care, and evolve an obvious result. Labouring through a vast quantity of semi-syllogisms, we have elicited that tin when persistently cooled, may disintegrate, that ice has a vapour pressure, and that the compounds of ammonia with silver chloride have a greater vapour tension and are more readily decomposed when the percentage of ammonia is greater. Praiseworthy efforts are made to express in a quasi-mathematical manner the very complex relations which occur when a change of state takes place, and for this purpose a nomenclature is coined worthy of a metaphysician in his most aggravated form. The humble student would be right in accepting all this if he could be assured of its correctness, but when he finds, as he will if he is sufficiently persevering, on p. 79 a statement thus: "From this table we see that it is only at a temperature of about 812deg. that the pressure of the carbon dioxide becomes equal to atmospheric pressure. In a vessel open to the air, therefore, the complete decomposition of the calcium carbonate would not take place below this temperature by the mere heating of the carbonate," he suspects that on the physical side the methods of ratiocination of his teacher are inexact. There is an introduction by Prof. Sir William Ramsay, which is less scholastic and better worth reading.

Le Radium et la Radioactivité. By Paul Besson. With a Preface by Dr. A. d'Arsonval, Membre de l'Institut. (Paris: Gauthiers-Villars.) 1904. fr.2·75.

The author, who is directing engineer to the Société Centrale de Produits Chimiques, aims, with considerable success, at giving a connected account of the work hitherto done on Becquerel rays and radium rays, including their physiological actions and medical applications, with references to the original Papers. It is a pity that he should have marred the excellence of his work by some rather crude theorising, culminating in the sentence (p. 162): "In demonstrating the identity of light, electricity and magnetism, we have established the unity of Force; if we admit the unity of Matter, we shall have taken another step in advance." The "practician" got rather out of his depth there.

Contrôle des Installations Électriques. By A. Monmerqué. (Paris: Ch. Béranger.) 2nd edition, 1904.

The first part of this book contains an elementary treatise on the theory of electricity, and deals with the principal practical applications of electric energy. All the usual technical information, formulæ and definitions are given, and the matter is rendered clear by numerous diagrams and illustrations. In the latter part of the book are to be found reproductions, partly in full, partly in abstract, of regulations and recommendations drawn up by various authorities, and having regard to the efficient and safe generation and distribution of electricity. Several German and English regulations are included, being set side by side with the corresponding French ones. Sample specifications, agreement forms, &c., are appended.

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THE POSTMASTER-GENERAL'S ANNUAL REPORT.

The fiftieth annual report of the Postmaster-General has just been issued and, as usual, contains a large amount of statistical and other information relating to telegraphs, in addition to that regarding the ordinary Post Office business.

During the year ended March 31, 1904, no fewer than 89,997,000 telegrams passed over the Post Office wires, but even this enormous number shows a falling off to the extent of 2,474,000 or 2·7 per cent. of those transmitted during the previous year. This decrease is attributed to the bad state of trade and especially Stock Exchange depression; but probably the principal cause is the growth of the telephone system. This, the Postmaster-General remarks, is to be expected when it is remembered that a single telephone conversation often takes the place of two or more telegrams. Of course, it must be borne in mind, too, that Coronation year involved a large amount of telegraphic traffic, and this has naturally been missed during the year under review. It is comforting to observe that, if the telegraph business may be taken as a criterion, there appear to be signs of a revival of business activity. One curious paragraph in the report is to the effect that on December 17th nearly 90,000 telegrams relating to the "Encyclopædia Britannica" were handed in, and it says much for the organisation of the department that these were dispatched without delay and without interference with the ordinary traffic.

The telegraph has been extended during the year to 199 post offices in country districts and in the growing suburban areas of the larger towns. Guarantees have been given for 137 of the new telegraph offices—49 by local authorities and 88 by private persons. There are now in the United Kingdom 9,976 telegraph offices at post offices, and 2,357 at railway stations and other public places. The metropolitan intercommunication system installed last year, under which, by means of an arrangement analogous to a telephone switchboard, telegrams are sent direct from one office to another without re-transmission to the Central telegraph office, continues to give satisfaction, and arrangements are being made for a considerable extension of the system. From 3,000 to 4,000 telegrams have passed daily between the offices connected in this manner, and a considerable saving in time has resulted.

Progress is being made with the underground cable from London to the North: the line of pipes is now completed as far as Carlisle: further north a section 19 miles in length has been laid across the Beattock incline, and a spur line of two pipes has been laid from Manchester to Leeds. A temporary cable has been provided over 25 miles of this latter section, the permanent cable has been carried northwards for a long distance on the main route, and provision has been made this year for carrying it as far as Carlisle. The laying of pipes as far as Glasgow is also contemplated. In order that the various sections of the underground system may be more readily available in case of damage to overhead lines, it has been decided to modify the scheme outlined in the Postmaster-General's report of July 29, 1902, and to carry the line direct to Glasgow, extending it thence to Edinburgh, instead of laying branches from Lanark to Glasgow and Edinburgh. This arrangement will also afford additional means of direct communication between Edinburgh and Glasgow; and the means of communication between Dundee and Aberdeen will be reinforced by the underground wires as far as Larbert.

Regarding the magnetic storm which occurred on October 31st, the Postmaster-General has very little to say except that the traffic happened to be abnormally heavy on that day. The protection of the telegraphs against the powerful currents used for lighting and traction purposes continues to demand careful attention, and the precautions taken have so far prevented any serious damage to Post Office property or interference with the telegraph and telephone services.

He views with alarm the growing tendency of local authorities to attach onerous conditions to the consents granted by them for the erection of overhead lines, and in three instances during the past year it has been necessary to appeal to the Courts. The report next deals with the International Telegraph Conference and the International Wireless Telegraph Conference which took place last year; the results of these have already been reported in our columns.

Turning now to the statement of accounts showing the revenue and expenditure on telegraphs, it appears that in spite of the decrease of traffic the total receipts have increased from £3,723,866 in the previous year to £3,736,115 in 1903-4. These figures include respectively £92,121 and £61,957, representing the estimated value of services to other departments. Under "Expenditure" are the following items:—Purchase and erection of buildings and sites £140,643, telegraph extension £541,948, superannuations and other non-effective charges £111,665, salaries, wages, &c., £2,562,290, percentage of salaries to total revenue 68·58, maintenance of the telegraph system £1,001,205, percentage of maintenance to total revenue 26·8; under Telegraph vote £250,873; under other votes £111,172; total expenditure £4,719,796. This last figure is no less than 126·33 per cent. of the total revenue, as compared with the corresponding figure of 116·16 per cent. of the previous year, and there is thus a deficit of nearly £1,000,000. The interest on stock created for the purchase of the telegraphs remains as before—viz., £298,860. On the whole, therefore, it appears that the outlook is by no means bright, but it is as well to point out that the extra deficit is due almost entirely to the sum which has been expended on maintenance, this being £127,000 in excess of last year's figure, and to that on extensions which exceeds the previous year's figure by £145,000.

Dealing with telephones, the Postmaster-General states that

On March 31st last the number of Post Office trunk wire centres was 396, an increase of 41 in the year. The total number of trunk circuits in use was 1,418, as compared with 1,309 in the preceding year. The number of new circuits opened for traffic during the year was therefore 109. The total length of the trunk circuits in use was 51,400 miles, containing about 102,800 miles of wire. The capital expenditure on the purchase and development of the trunk wire system up to March 31st last was £2,200,024, including an expenditure during the year of £108,607. The Telegraph (Money) Act of this session authorised the raising of a further sum of £3,000,000 on the development of the telephone system of the country. Of this sum about £1,300,000 will be required for the extension of the trunk wire system and about £1,700,000 for the development of the exchange system in London and the provinces.

The total number of trunk-line conversations during the year was 13,467,975. The corresponding number for the preceding year was 11,574,229; and the increase in the year was thus 1,893,746, which is at the rate of 16·3 per cent. The gross revenue from this service was £325,525, as compared with £274,835, the increase being at the rate of 18·4 per cent. The average value of each conversation was 5·8d. Seven years ago the average value was 5·02d. This increase corresponds with a greater use of the trunk lines between more distant towns.

An arrangement has been made whereby conversations over the Anglo-French and Anglo-Belgian circuits can be obtained between the hours of 9 p.m. and 7 a.m. for double periods of six minutes, at the same rates as for conversations of three minutes during the day, by callers who contract for one or more calls each night for a period of at least one month. Experiments have been conducted during the year with a view to the establishment of telephonic communication between London and Holland. The results were such as to show that it is not at present practicable to construct a cable at reasonable cost which will enable direct telephonic communication to be established and maintained satisfactorily.

The sum received as rentals of Post Office provincial telephone exchange circuits and of private wires was £206,786, as compared with £194,429 for the previous year, and the total number of subscribers on March 31st was 5,253; the number of telephones rented increased in the year from 5,218 to 6,874. The experiment has been tried of establishing a telephone call office system in rural districts with the aid of the public telegraph circuits, with a view to ascertain what demand there is for telephonic facilities between market towns and the surrounding villages. But the system has been little used by the public up to the present, and the receipts have not covered the cost of attendance and maintenance.

The number of telephones in connection with the Post Office London telephone system increased during the year from 9,122 to 15,632, and additional subscribers are being connected at the rate of from 100 to 200 a week. Three new exchanges have been opened during the year. The accommodation at the Central Exchange will be nearly exhausted in the course of the financial year 1904-5, and the construction of a second exchange with a maximum capacity of 18,000 lines is in progress. The length of the underground pipes which had been laid in the London area on March 31st last was 1,146 miles, and cables containing 125,717 miles of wire have been provided, including 32,248 miles provided for the use of the National Telephone Co. on rental terms pending the transfer of the company's system to the Post Office. The lines of the present subscribers and the junction lines between exchanges have absorbed 43,335 miles, and 50,134 miles of wire remain available for the further development of the London service. On an average each circuit directly connected with an exchange has involved the provision of 1½ miles of double wire, if allowance be made for the junction lines between exchanges. This in an increase

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on the average length given in my predecessor's report (1·35 miles), the greater length being due to the greater average distance of subscribers' premises from exchanges as well as to the increasing number of junction lines required for calls between subscribers of different exchanges. Owing to the great extent of the London exchange area and the number of its local exchanges, the proportion of junction lines required is probably greater than in any other local exchange system in the world, and this fact will always make the cost of the service comparatively high. The average cost of construction has increased since the last report from £18. 11s. 4d. per mile of double wire to £18. 16s. 10d. Including the cost of installation of telephone instruments and of exchange apparatus, the total cost of each subscriber's line has increased from £38. 6s. 3d. to £41 9s. 8d. This does not include the cost of the spare wires which are necessary for the maintenance of an exchange system in an efficient state, or of the ducts, cables and exchange plant intended to provide for the future development of the system and not yet brought into use.

An account of the receipts and expenditure relating to the London service for the year ending March 31st shows a balance of £33,515 available for meeting the charge for interest on capital and for making provision for depreciation of plant. The capital expenditure to March 31st last was £1,514,300. The Postmaster-General points out, however, that a large part of the plant which has been constructed has not yet been brought into use and is earning no revenue. This must happen in all cases where large underground systems are provided to meet future requirements, and the great extent of the London system makes it more noticeable in London than elsewhere. The proportion of revenue available, after paying working expenses, for the payment of interest on capital and as a sinking fund ought, however, to increase each year. No licences have been granted during the year for the establishment of municipal exchange systems. The amount of royalty received during the year from the National Telephone Co. was £169,853, and the amount from other licensees was £6,206.

Post Office Telephone Service—London Area

An Account of the above Service for the year ended March 31, 1904.

RECEIPTS.

Subscribers' rentals:—		
Proportion of subscriptions paid in 1902-3 but proper to 1903-4		£31,934
Paid in the year 1903-4:		
At flat rates	£20,615	
At toll rates	79,695	
	100,340	
Less proportion proper to 1904-5	53,522	
		46,818
Message fees, in addition to fixed minimum of £1. 10s. per subscriber		5,117
Call office fees		1,580
Rentals of wires leased to National Telephone Co.		3,132
Miscellaneous receipts		421
Value of services rendered to Government departments without payment		1,820
		£90,822

EXPENDITURE.

Maintenance of system	£26,216
Salaries, wages, &c., of staff, including provision for pensions of established staff	22,495
Rent, rates, fuel and light, including estimated rental value of premises already belonging to the department	6,546
Miscellaneous expenses (stationery, travelling, &c.)	2,050
Balance available towards meeting depreciation, interest, &c.	33,515
	£90,822

NOTES.—1. The estimated amount required to provide for depreciation of plant, inclusive of spare wires, is £39,921, and interest at 3 per cent. on the capital expenditure of £1,514,300 is £45,429, making together £85,350.

2. Terminable annuities have been created, payable from the vote for the telegraph service, to provide for the repayment, with interest at 3 per cent., of capital raised for telephone purposes under the Telegraph Act of 1899. The proportions proper to the London telephone service of the annuity payments already made are as follows:—Payment on April 1, 1901, £24,406. 2s. 6d.; payment on April 1, 1902, £57,772. 14s.; payment on April 1, 1903, £95,001. 15s. 2d.

3. The annuities provide for the repayment of the capital in 12-15 years, while the estimated life of the plant averages 36 years. The annuity required for interest and sinking fund on a capital expenditure of £1,514,300, repayable in 30 years with interest at 3 per cent., would be £77,259.

Poole and District Electric Traction Co. v. Bournemouth Corporation.—The resumption of the arbitration proceedings, which have been reported at length in our legal colums, will not take place until after the long vacation.

THE HON. CHARLES A. PARSONS' PRESIDENTIAL ADDRESS TO SECTION G (ENGINEERING) OF THE BRITISH ASSOCIATION.*

On this occasion I propose to devote my remarks to the subject of invention. It is a subject of considerable importance, not only to engineers but also to men of science and the public generally. I also propose to treat invention in its wider sense, and to include under the word discoveries in physics, mechanics, chemistry and geology. Invention throughout the Middle Ages was held in little esteem. In most dictionaries it receives scant reference except as applied to poetry, painting and sculpture. Shakespeare and Dryden describe invention as a kind of muse or inspiration in relation to the arts, and when taken in its general sense to be associated with deceit, as "Return with an invention, and clap upon you two or three plausible lies." As to the opposition and hostility to scientific research, discovery and mechanical invention in the past, and until comparatively recent times, there can be no question, in some cases the opposition actually amounting to persecution and cruelty. The change in public opinion has been gradual. The great inventions of the last century in science and the arts have resulted in a large increase of knowledge and the powers of man to harness the forces of Nature. These great inventions have proved without question that the inventors in the past have, in the widest sense, been among the greatest benefactors of the human race. Yet the lot of the inventor until recent years has been exceptionally trying, and even in our time I scarcely think that anyone would venture to describe it as altogether a happy one. The hostility and opposition which the inventor suffered in the Middle Ages have certainly been removed, but he still labours under serious disability in many respects under law as compared with other sections of the community. The change of public feeling in favour of discovery and invention has progressed with rapidity during the last century. Not only have private individuals devoted more time and money to the work, but societies, institutions, colleges, municipalities and Governments have founded many research laboratories, and in some instances have provided large endowments. These measures have increased the number of persons trained to scientific methods, and also provided greatly improved facilities for research; but perhaps one of the most important results to engineers has been the direct and indirect influence of the more general application of scientific methods to engineering.

Sir Frederick Bramwell, in his Presidential Address to this Association in 1888, emphasised the interdependence of the scientist and the civil engineer, and described how the work of the latter has been largely based on the discoveries of the former; while the work of the engineer often provides data and adds a stimulus to the researches of the scientist. And I think his remarks might be further appropriately extended by adding that since the scientist, the engineer, the chemist, the metallurgist, the geologist all seek to unravel and to compass the secrets of Nature, they are all to a great extent interdependent on each other. But though research laboratories are the chief centres of scientific invention, and colleges, institutions and schools train the mind to scientific methods of attack, yet in mechanical, civil and electrical engineering the chief work of practical investigation has been carried on by individual engineers or by firms, syndicates and companies. These not only have adapted discoveries made by scientists to commercial uses, but also in many instances have themselves made such discoveries or inventions.

To return to the subject, let us for a moment consider in what invention really consists, and let us dismiss from our minds the very common conception which is given in dictionaries and encyclopædias that invention is a happy thought occurring to an inventive mind. Such a conception would give us an entirely erroneous idea of the formation of the great steps in advance in science and engineering that have been made during the last century; and, further, it would lead us to forget the fact that almost all important inventions have been the result of long training and laborious research and long-continued labour. Generally, what is usually called an invention is the work of many individuals, each one adding something to the work of his predecessors, each one suggesting something to overcome some difficulty, trying many things, testing them when possible, rejecting the failures, retaining the best, and by a process of gradual selection arriving at the most perfect method of accomplishing the end in view. This is the usual process by which inventions are made. Then after the invention, which we will suppose is the successful attempt to unravel some secret of Nature, or some mechanical or other problem, there follows in many cases the perfecting of the invention for general use, the realisation of the advance or its introduction commercially; this after-work often involves as great difficulties and requires for its accomplishment as great a measure of skill as the invention itself, of which it may be considered in many cases as forming a part. If the invention, as is

* Delivered yesterday.

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often the case, competes with or is intended to supersede some older method, then there is a struggle for existence between the two. This state of things has been well described by Mr. Fletcher Moulton. The new invention, like a young sapling in a dense forest, struggles to grow up to maturity, but the dense shade of the older and higher trees robs it of the necessary light. If it could only once grow as tall as the rest all would be easy, it would then get its fair share of light and sunshine. Thus it often occurs in the history of inventions that the surroundings are not favourable when the first attack is made, and that subsequently it is repeated by different persons, and finally under different circumstances it may eventually succeed and become established.

We may take in illustration almost any of the great inventions of undoubted utility of which we happen to have the full history—for instance, some of the great scientific discoveries, or some of the great mechanical inventions, such as the steam engine, the gas engine, the steamship, the locomotive, the motor car, or some of the great chemical or metallurgical discoveries. Are not most, if not all, of these the result of the long-continued labour of many persons, and has not the financial side been, in most cases, a very important factor in securing success? The history of the steam engine might be selected, but I prefer on this occasion to take the internal combustion engine, for two reasons—firstly, because its history is a typical one; and secondly, because we are to hear a Paper by that able exponent and great inventor in the domain of the gas engine, Mr. Dugald Clerk, describing not only the history, but the engine in its present state of development and perfection, an engine which is able to convert the greatest percentage of heat units in the fuel into mechanical work, excepting only, as far as we at present know, the voltaic battery and living organisms.

The first true internal combustion engine was undoubtedly the cannon, and the use in it of combustible powder for giving energy to the shot is strictly analogous to the use of the explosive mixture of gas or oil and air as at present in use in all internal combustion engines; thus the first internal combustion engine depended on the combination of a chemical discovery and a mechanical invention, the invention of gunpowder and the invention of the cannon. In 1680, Huygens proposed to use gunpowder for obtaining motive power in an engine. Papin, in 1690, continued Huygens' experiments, but without success. These two inventors, instead of following the method of burning the powder under pressure, as in the cannon, adopted, in ignorance of thermodynamic laws, an erroneous course. They exploded a small quantity of gunpowder in a large vessel with escape valves, which after the explosion caused a partial vacuum to remain in the vessel. This partial vacuum was then used to actuate a piston or engine and perform useful work. Subsequently, several other inventors worked on the same lines, but all of these failed on account of two causes which now are very evident to us. Firstly, gunpowder was then, as it still is, a very expensive form of fuel, in proportion to the energy liberated on explosion: secondly, the method of burning the powder to cause a vacuum involves the waste of nearly the whole of the available energy, whereas had it been burned under pressure, as in the cannon, a comparatively large percentage of the energy would have been converted into useful work. But even with this alteration, and however perfect the engine had been, the cost of explosives would have debarred its coming into use, except far very special purposes. We come a century later to the first real gas engine. Street, in 1794, proposed the use of vapour of turpentine in an engine on methods closely analogous to those successfully adopted in the Lenoir gas engine of 80 years later, or 30 years ago. But Street's engine failed from crude and faulty construction. Brown, in 1823, tried Huygens' vacuum method, using fuel to expand air instead of gunpowder, but he also failed, probably on account of the wastefulness of the method. Wright, in 1833, made a really good gas engine, having many of the essential features of some of the gas engines of the present day, such as separate gas and water pumps and water-jacketed cylinder and piston. Barnett, in 1839, further improved on Wright's design, and made the greatest advance of any worker in gas engines. He added the fundamental improvements of compression of the explosive mixture before combustion, and he devised means of lighting the mixture under pressure, and his engine conformed closely to the present-day practice as regards fundamental details. No doubt Barnett's engine, so perfect in principle, deserved commercial success, but either his mechanical skill or his financial resources were inadequate to the task, and the character of the patents would seem to favour this conclusion, both as regards Barnett and other workers at this period. Up to 1850 the workers were few, but as time went on they gradually increased in numbers; attention had been attracted to the subject, and men with greater powers and resources appear to have taken the problem in hand. Among these numerous workers came Lenoir, in 1860, who, adopting the inferior type of non-compression engine, made it a commercial success by his superior mechanical skill and resources. Mr. Dugald Clerk tells us: "The proposals of Brown (1823), Wright (1833), Barnett (1838), Bansanti and Matteucci (1857) show gradually increasing knowledge of detail and the difficulties to be overcome, all leading to the first practicable engine in 1866, the Lenoir." This stage of the development being reached, the names of Siemens, Beaude Roches, Otto Simon, Dugald Clerk, Priestman, Daimler, Dowson, Mond and others appear as inventors who have worked at and added something to perfect the internal combustion engine and its fuel, and who have helped to bring it to its present state of perfection.

In the history of great mechanical inventions there is perhaps no better example of the interdependence of the engineer, the physicist, and the chemist than is evinced in the perfecting of the gas engine. The physicist and the chemist together determine the behaviour of the gaseous fuel, basing their theory on data obtained from the experimental engines constructed by the mechanical engineer, who, guided by their theories, makes his designs and improvements; then, again, from the results of the improvements, fresh data are collected and the theory further advanced, and so on till success is reached. But though I have spoken of the physicist, the chemist and the engineer as separate persons, it more generally occurs that they are rolled into one, or at most two, individuals, and that it is indispensable that each worker should have some considerable knowledge of all the sciences involved to be able to act his part successfully. Now let us ask, Could not this very valuable invention, the internal cumbustion engine, have been introduced in a much shorter time by more favouring circumstances, by some more favourable arrangement of the patent laws, or by legislation to assist the worker attacking so difficult a problem? I think the answer is that a great deal might be done, and I will endeavour to indicate some changes and possible improvements. The history of this invention brings before our minds two important considerations. Firstly, let us consider the patentable matter involved in the invention of the gas engine, the utilisation for motive power purposes of the then well-known properties of the explosive energy of gunpowder or of mixtures of gas and oil with air. Are not these obvious inferences to persons of a mechanical turn of mind and who had seen guns fired, or explosions in bottles containing spirits of turpentine when slightly heated and a light applied to the neck? Surely, no fundamental patent could have been granted under the existing patent laws for so obvious an application of known forces. Consequently, patent protection was sought in comparative details, details in some cases essential to success which were evolved or invented in the process of working out the invention. In this extended field of operations a slight protection was in some instances obtained. But, in answer to the question whether such protection was commensurate with the benefits received by the community at large, there can, I think, be only one reply. Generally, those who did most got nothing, some few received insufficient returns, and in very few cases, indeed, can the return be said to have been adequate. The second important consideration is that of the methods of procedure of the patentees, for it appears that very few of them had studied what had been suggested or done before by others before taking out their own patent. We are also struck by the number of really important advances that have been suggested and have failed to fructify, either from want of funds or other causes, to be forgotten for the time and to be re-invented later on by subsequent workers. What a waste of time, expense and disappointment would be avoided if we in England helped the patentee to find out easily what had been done previously, on the lines adopted by the United States and German Patent Offices, who advise the patentee after the receipt of his provisional specification of the chief anticipatory patents, dead or alive! And ought we in England to rest content to see our patentees awaiting the report of the United States and German Patent Offices on their foreign equivalent specifications before filing their English patent claims? Ought not our Patent Office to give more facilities and assistance to the patentee?

Before proceeding further to discuss some of the possible improvements for the encouragement and protection of research and invention, I ask you to further consider the position of the inventor—the man anxious to achieve success where others have hitherto failed. To be successful he must be something of an enthusiast; and usually he is a poor man, or a man of moderate means, and dependent on others for financial assistance. Generally the problem to be attacked involves a considerable expenditure of money; some problems require great expenditure before any return can thereby accrue, even under the most favourable circumstances. In the very few cases where the inventor has some means of his own they are generally insufficient to carry him through, and there have unfortunately been many who have lost everything in the attempt. In nearly all cases the inventor has to co-operate with capital; the capitalist may be a sleeping partner, or the capital may be held by a firm or syndicate, the inventor in such cases being a partner—a junior partner—or a member of the staff. The combination may be successful and lasting, but unfortunately the best inventors are often bad men of business. The elements of the combination are often unstable, and the disturbing forces are many and active; especially is this so when the problem to be attacked is one of difficulty, necessitating various and successive schemes involving considerable expenditure, generally many times greater than that foreshadowed at the com-

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mencement of the undertaking. Under such circumstances, unless the capitalist or the senior partner or board be in entire sympathy with the inventor or exercise great forbearance, s imulated by the hope of ultimate success and adequate returns, the case becomes hopeless, disruption takes place, and the situation is abandoned. Further, in the majority of cases, after some substantial progress has been made, it is found that under the existing patent laws insufficient protection can be secured, and the prospect of a reasonable return for the expenditure becomes doubtful. Under such circumstances the capitalist will generally refuse to proceed further unless the prospect of being first in the field may tempt him to continue. Very many inventors, as I have said, avoid the expense of searching the patent records to see how far their problem has been attacked by others. In some cases the cost of a thorough search is very great indeed; sometimes it is greater than the cost of a trial attack on the problem. In the case of young and inexperienced inventors there sometimes exists a disinclination to enter on an expensive search; they prefer to spend their money on the attack itself. There are some, it is true, who have a foolish aversion to take steps to ascertain if others have been before them, and who prefer to remain in ignorance and trust to chance. It will, however, be said that the United States and German Patent Office reports ought to suffice to warn or protect the English patentee, but my own experience has been that such protection is not entirely satisfactory. There is, firstly, a considerable interval before such reports are received, and the life of a patent is short. Then, if a patent is upon an important subject, attracting general attention, the search is vigorous and sometimes overwrought, and the patent unjustly damaged or refused altogether. If, however, the patent is on some subject not attracting general attention, it receives too little notice, and is granted without comment.

In some few instances it may be said that ignorance has been a positive advantage, and that if the patentee had realised how much of his patentable work was honeycombed by previous publications and patents, he would have lost heart and given up the task. It is, I think, a case of the exception proving the rule; and the patentee ought, as far as possible, in all cases to know his true position, and make his choice accordingly. The present patent law has some curious anomalies. Let us suppose some inventor has the good fortune to place the keystone in the arch of an invention, to add some finishing touch which makes the whole invention a complete success, and valuable. Then, success having been proved possible, others try to reap the results of his labour and good fortune, and, as often happens, it is discovered after laborious search that someone else first suggested the same keystone in some long-forgotten patent or obscure publication, but for some reason or other the public were none the better for his having done so. What does the law do? It says this is an anticipation, and instead of apportioning to all parties reasonable and equitable shares in the perfected invention, to which no one could object, it says that the patent is injured or perhaps rendered useless by the anticipation, and that its value to everyone concerned is thereby diminished or destroyed, as the case may be, and thrown open to the public. Up till a few years ago, any anticipations, however old, might be cited; but recently the law has been amended, and at present none rank as anticipations which are more than 50 years old.

The perfecting of inventions and their introduction into general use requires capital, as we have seen - sometimes a considerable amount, as in the introduction of the Bessemer process for steel, or the linotype system of printing—before any commercial success can be realised. Capital having been found, the next difficulty is in the conservatism of persons and communities who are the buyers of the invention. There is always present in their minds the risk of failure and its consequent loss and worry to themselves, and in the event of success the advantage, in their estimation, may not be sufficient to counterbalance the risk. In large departments and companies whose management is conducted by officials receiving fixed salaries, acting under non-technical supervision, there is a strong tendency among the officials to leave well alone, the organisation being such that the risk of failure, even though it be remote, more than counterbalances, in their estimation, the advantages that would result in the event of success. Next is the opposition of those who are financially interested in competing trades or older inventions; and if the invention is a labour-saving appliance, then the active opposition of the displaced labour is a serious, though generally only a temporary, barrier. Fortunately, however, for the community, for research and for invention, there is always to be found a considerable percentage of persons who, apart from the inventor, are able and willing to risk, and indeed to sacrifice, their personal interests in the cause of progress for the benefit of the community at large, and were it not for such persons the task of the introduction of most inventions would be an impossible one. There are many problems of the highest importance in physics, engineering, chemistry, geology and the arts, of which the investigation might probably prove of great benefit to the human race, and of which the probable monetary cost of the attack would be considerable, and of some very great indeed. Let us, then, inquire how the necessary funds could be raised. It is possible in the case of some of the more attractive problems that a group of rich philanthropists might be found, but in most cases it would be impossible to form a company on business lines, under the existing laws of this and other countries, as I shall endeavour to show. In the case of many of the problems, no patents will give adequate protection; in some cases there is no subject matter of novelty and importance involved. In other cases the probable duration of the investigation is so long that any initial patents would have expired before a commercial result was reached, and under either of these circumstances there would be no inducement to business men or financiers to undertake the risk.

As an illustration of my meaning, I will take two investigations that have doubtless occurred to the minds of most of those present, though many others of greater or less importance might be cited. One is the thorough investigation of the problem of aerial navigation, with or without the assistance of flotation by gas. This problem could undoubtedly be successfully solved by an organised attack of skilled and properly trained engineers and the expenditure of a large sum of money. Assuming the problem solved and commercially successful, it appears to be impossible, under the existing patent laws, to secure any adequate monopoly, so as to justify the expectation of a reasonable return on the capital expended on the invention. For in view of the multitude of suggestions that have been made and the experiments that have been carried out, the practical solution of the problem would appear to rest on a judicious selection of old ideas by means of exhaustive experiments. Another, and perhaps more important, investigation which has not, as yet, been attacked to any material extent is the exploration of the lower depths of the earth. To succeed in the undertaking a great expenditure of money must be incurred, and to raise this sum the pioneers have practically no security to offer. For if they succeed in finding rich deposits of precious minerals in greater abundance, or succeed in making some geological discovery associated with deep borings, they gain no exclusive title to these under existing laws. The shaft would be sunk in a locality to avoid as far as possible water-bearing strata and the necessity of pumping. It would be of a size usual in ordinary mines or coal pits. The exact position of such shaft would require some consideration as to whether it should commence in the primary or secondary strata. It would be sunk in stages, each of about half a mile in depth, and at each stage there would be placed the hauling and other machinery, to be worked electrically, for dealing with each stage. At each second or third mile in depth there would be air-locks to prevent the air-pressure from becoming excessive owing to the weight of the superincumbent air, which at from 2 to 3 miles would reach about double the atmospheric pressure at the surface. In order to carry on the transfer of air through the air-locks for ventilating purposes pumps coupled to air-engines would be provided, the energy to work the pumps being obtained from electromotors. To maintain the shaft at a reasonable temperature at the greater depth powerful means of carrying the heat to the surface would be provided.

As to the cost, rate of boring, and normal temperature of the rock, an approximate estimate has been made, based on the experience gained on the Rand, but including extra costs for air-locks and cooling:—

	Cost.	Time in years.	Temperature of rock.
For 2 miles depth from the surface	£500,000	10	122°F.
,, 4 ,, ,,	1,100,000	25	152°F.
,, 6 ,, ,,	1,800,000	40	182°F.
,, 8 ,, ,,	2,700,000	55	212°F.
,, 10 ,, ,,	3,700,000	70	242°F.
,, 12 ,, ,,	5,000,000	85	272°F.

My main object in discussing the enterprise has been to show that a pioneer company would not acquire any subsequent monopoly of similar works under the existing patent laws or the laws of any country. In the scheme as I have described it, there appears to be nothing that could be patented; but let us suppose that some good patent could have been found that was absolutely essential to the success of the undertaking, it would certainly have expired before the pioneer company could have reaped any substantial return, and probably before the first enterprise had been completed. It follows, therefore, that at the present time there is no adequate protection, or indeed any protection at all, for the promoters of many great and important pioneer enterprises, some of which might prove of immense benefit to mankind. Let us ask what change in the laws would place great pioneer research works on a sound financial basis. A Government grant, except for very special purposes, seems to be out of the question, seeing that the benefits to be derived are generally not confined to any one country. An extension of the life of patents, which is now from 14 to 16 years in different countries, would be undoubtedly a step in the right direction. It would be of great benefit generally if some scale of duration of patents could be fixed internationally, the scale being fixed according to the subject-matter, the difficulty of the attack, and the past history of the subject, but more especially in view of the utility

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of the invention. One of the chief objections raised by the Privy Council against the extension of patents in this country has rightly been that undue prolongation is unfair to the British public, seeing that abroad no prolongations are granted. Therefore, if the duration of patents for important matters is to be extended at home, it must also be extended abroad. In other words, such prolongations, to be effective, should necessarily extend to other countries. They should be international, and concurrent in all countries interested.

One possible solution of this difficult question would be to place such matters under the jurisdiction of a central international committee, who would have the apportionment of the life and privileges of patents and of the extension or curtailment of their duration, according to their handling by the owners. I would ask, Why has a patent a life of only 14 to 16 years, while copyright is for 42 years? Why has a pioneer company making a railway under act of Parliament generally rights for ever unless it abuses its privileges, or the requirements of the district necessitate the construction of competing lines, while a patent has in comparison a life of infinite shortness? I might also cite gas companies, electrical supply companies, under act of Parliament or provisional orders of 42 years' duration; and this reminds us of the fact that until the term of life for electric supply companies had been extended from 21 years to 42 years by the bill of 1884, it was impossible to find capital for such undertakings. Now, it may be urged that the grant of a patent is a different thing from the grant of power to a railway company, a gas or electric supply company. But the object of this address has been to show that a patent, to be fair to the patentee, ought in many cases to be analogous to an act of Parliament or a provisional order. Would it not place matters in a fairer position, especially in the case of expensive and lengthy researches, to grant to those who pledge themselves to spend a suitable and minimum sum within a stated period on the research a reasonable and fair monopoly, so that such person or syndicate might, in the event of success, be in the position to reap a reasonable return for their expenditure and risk? Some such measure would unquestionably give an immense stimulus to research and invention by enabling capital to be raised and works started on commercial lines in fields of great promise at present almost untouched. I pass over the disadvantages to the British inventor of the hostile patent tariffs of Continental nations and of the protective patent laws of some of the British dependencies, disadvantages greater than those imposed by protective tariffs on the ordinary British manufacturer. There is, however, another aspect of the question to which I would briefly allude: it is the great benefits that the world at large has derived from the work of inventors in the past. Think of the multitude and power of the great steam engines and gas engines that drive our factories, and pump the water out of our mines, and supply our cities with water, light and power; of the great steamships scattered over the ocean and the locomotives on the railways. Think of the billions of tons of steel that have been made by the Bessemer, Siemens-Martin and Thomas Gilchrist processes, and of the great superiority and less cost of the material over the puddled iron which it superseded. Think of the vast work performed by the electric telegraphs and telephones, and we must not fail to include the great chemical and metallurgical processes carried on all over the world, besides the countless other inventions and labour-saving appliances. Can we form any idea of the commercial value of all these gigantic tools that past inventors have left as a heritage to the human race, and can we venture to place any order of magnitude on so vast a sum? If we take as our unit of value the whole of the money spent on all inventions, both successful and unsuccessful, I think we shall be much below the mark if we assume that the value of the benefits have on the average exceeded by ten-thousandfold the money spent on making and introducing the inventions. If this is so, let us see what it means. It means that for every unit of capital spent by the inventors and their friends on invention they have in some cases received nothing back. In some cases they have just got their capital back, in some cases two or threefold, occasionally tenfold, very rarely a hundredfold. Whereas the world at large has received a present of ten-thousandfold greater value than all the money spent and misspent by the small band of past inventors.

In conclusion, let us hope that the inventor will in the future receive more encouragement and support, that the patent laws will be further modified and extended, that the people at large will consider these matters more closely and recognise that they are of first importance to their progress and welfare, and that in the future it may be easier, nay, in some cases, possible, to carry on many great researches into the secrets of Nature.

Water Power in Russia.—At the third Russian Electrical Congress, recently held in St. Petersburg, a report on the available water power of that country was presented. The total power is estimated to approximate 11,000,000 H.P., of which 3,000,000 relate to Finland. 24 rivers represent considerable sources of energy, ranging from the Dnieper (240,000 H P.) downwards.

PROF. HORACE LAMB'S PRESIDENTIAL ADDRESS TO SECTION A (MATHEMATICS AND PHYSICS) OF THE BRITISH ASSOCIATION.*

Of the various subjects which fall within the scope of this section there is no difficulty in naming that which at the present time excites the widest interest. The phenomena of radio-activity, ionisation of gases and so on are not only startling and sensational in themselves, they have suggested most wonderful and far-reaching speculations, and, whatever be the future of these particular theories, they are bound in any case deeply to influence our views on fundamental points of chemistry and physics. It will be felt as a matter of legitimate pride by many present that the University of Cambridge has been so conspicuously associated with this work. It would, therefore, have been natural and appropriate that this chair should have been occupied, this year above others, by one who could have given us a survey of the facts as they at present stand, and of their bearing, so far as can be discerned, on other and older branches of physics. But it has been otherwise ordered, and you and I must make the best of it. If the subject cannot be further dealt with for the moment, we have the satisfaction of knowing that it will in due course engage the attention of the section, and that we may look forward to interesting and stimulating discussions, in which we trust the many distinguished foreign physicists who honour us by their presence will take an active part.

It is, I believe, not an unknown thing for your president to look up the records of previous meetings in search of inspiration, and possibly of an example. I have myself not had to look very far, for I found that when the British Association last met in Cambridge, in the year 1862, this section was presided over by Stokes, and, moreover, that the address which he gave was probably the shortest ever made on such an occasion, for it occupies only half a page of the report, and took, I should say, some three or four minutes to deliver. It would be to the advantage of the business of the meeting, and to my own great relief, if I had the courage to follow so attractive a precedent; but I fear that the tradition which has since established itself is too strong for me to break without presumption.

The practical character of the mathematical work of Stokes and his followers is shown especially in the constant effort to reduce the solution of a physical problem to a quantitative form. It is now generally accepted that an analytical solution of a physical question, however elegant it may be made to appear by means of a judicious notation, is not complete so long as the results are given merely in terms of functions defined by infinite series or definite integrals, and cannot be exhibited in a numerical or graphical form. This view did not originate, of course, with Stokes; it is clearly indicated, for instance, in the works of Fourier and Poinsot, but no previous writer had, I think, acted upon it so consistently and thoroughly.

We have had so many striking examples of the fruitfulness of the combination of great mathematical and experimental powers that the question may well be raised, whether there is any longer a reason for maintaining in our minds a dististinction between mathematical and experimental physics, or at all events whether these should be looked upon as separate provinces which may conveniently be assigned to different sets of labourers. It may be held that the highest physical research will demand in the future the possession of both kinds of faculty. We must be careful, however, how we erect barriers which would exclude a Lagrange on the one side or a Faraday on the other. There are many mansions in the palace of physical science, and work for various types of mind. A zealous, or over-zealous, mathematician might indeed make out something of a case if he were to contend that, after all, the greatest work of such men as Stokes, Kirchhoff and Maxwell was mathematical rather than experimental in its complexion. An argument which asks us to leave out of account such things as the investigation of fluorescence, the discovery of spectrum analysis, and the measurement of the viscosity of gases may seem audacious; but a survey of the collected works of these writers will show how much, of the very highest quality and import, would remain. However this may be, the essential point, which cannot I think, be contested, is this, that if these men had been condemned and restricted to a mere book knowledge of the subjects which they have treated with such marvellous analytical ability, the very soul of their work would have been taken away. I have ventured to dwell upon this point because, although I am myself disposed to plead for the continued recognition of mathematical physics as a fairly separate field, I feel strongly that the traditional kind of education given to our professed mathematical students does not tend to its most effectual cultivation. This education is apt to be one-sided and too much divorced from the study of tangible things. Even the student whose tastes lie mainly in the direction of pure mathematics would profit, I think, by a wider scientific training. A long list of instances might be given to show that the most fruit-

* Delivered yesterday. Abstract.

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ful ideas in pure mathematics have been suggested by the study of physical problems.

Another characteristic of the applied mathematics of the past century is that it was, on the whole, the age of linear equations. The analytical armoury fashioned by Lagrange, Poisson, Fourier, and others, though subject, of course, to continual improvement and development, has served the turn of a long line of successors. The predominance of linear equations, in most of the physical subjects referred to, rests on the fact that the changes are treated as infinitely small. The electric theory of light forms at present an exception; but even here the linear character of the fundamental electrical relations is itself remarkable, and possibly significant. The theory of small oscillations, in particular, runs as a thread through a great part of the literature of the period in question. It has suggested many important analytical results, and it still gives the best and simplest intuitive foundation for a whole class of theorems which are otherwise hard to comprehend in their various relations, such as Fourier's theorem, Laplace's expansion, Bessel's functions and the like. Moreover, the interest of the subject, whether mathematical or physical, is not yet exhausted; many important problems in optics and acoustics, for example, still await solution. The general theory has in comparatively recent times received an unexpected extension (to the case of "latent motions") at the hands of Lord Kelvin; and Lord Rayleigh, by his continual additions to it, shows that, in his view, it is still incomplete.

When the restriction to infinitely small motions is abandoned, the problems become, of course, much more arduous. The whole theory, for instance, of the normal modes of vibration which is so important in acoustics, and even in music, disappears. The researches hitherto made in this direction have, moreover, encountered difficulties of a less patent character. It is conceivable that the modern analytical methods which have been developed in astronomy may have an application to these questions. It would appear that there is an opening here for the mathematician; at all events, the numerical or graphical solution of any one of the various problems that could be suggested would be of the highest interest. One problem of the kind is already classical—the theory of steep water-waves discussed by Stokes; but even here the point of view has perhaps been rather artificially restricted. The question proposed by him, the determination of the possible form of waves of permanent type, like the problem of periodic orbits in astronomy, is very interesting mathematically, and forms a natural starting-point for investigation; but it does not exhaust what is most important for us to know in the matter. Observation may suggest the existence of such waves as a fact; but no reason has been given, so far as I know, why free water-waves should tend to assume a form consistent with permanence, or be influenced in their progress by considerations of geometrical simplicity.

I have tried to indicate the kind of continuity of subject matter, method and spirit which runs through the work of the whole school of mathematical physicists of which Stokes may be taken as the representative. It is no less interesting, I think, to examine the points of contrast with more recent tendencies. Mathematical and physical science have become markedly introspective. The investigators of the classical school, as it may perhaps be styled, were animated by a simple and vigorous faith; they sought as a matter of course for a mechanical explanation of phenomena, and had no misgivings as to the trustiness of the analytical weapons which they wielded. But now the physicist and the mahematician alike are in trouble about their souls. We have discussions on the principles of mechanics, on the foundations of geometry, on the logic of the most rudimentary arithmetical process as well as of the more artificial operations of the Calculus. Those discussions are legitimate and inevitable, and have led to some results which are now widely accepted. Although they were carried on to a great extent independently, the questions involved will, I think, be found to be ultimately very closely connected. Their common nexus is, perhaps, to be traced in the physiological ideas of which Helmholtz was the most conspicuous exponent. To many minds such discussions are repellent, in that they seem to venture on the uncertain ground of philosophy. But, as a matter of fact, the current views on these subjects have been arrived at by men who have gone to work in their own way, often in entire ignorance of what philosophers have thought on such subjects. It may be maintained chiefly, indeed, that the mathematician or the physicist, as such, has no special concern with philosophy. Nor, although this is a matter for their own judgment, have philosophers very much to gain by a special study of the methods of mathematical or physical reasoning, since the problems with which they are concerned are presented to them in a much less artificial form in the circumstances of ordinary life. As regards the present topic I would put the matter in this way: that between mathematics and physics on the one hand and philosophy on the other there lies an undefined borderland, and that the mathematician has been engaged in setting things in order, as he is entitled to do, on his own side of the boundary.

(To be concluded.)

PARLIAMENTARY RECORD FOR 1904.

According to custom, we present our readers with a brief résumé of the legislation of the past session so far as it affects electricity supply, electric traction, telegraphy, &c. We give also a complete list of the various acts (public and private) which were passed and received Royal assent. Some of the special features of the principal acts are commented upon in our leading article:—

Public Acts.

Electric Lighting (London) Act.

Expiring Laws (Continuance) Act (including the Light Railways Act 1896).

Wireless Telegraphy Act.

Provisional Order Confirmation Acts.

Electric Lighting.

Electric Lighting Provisional Orders (No. 1): Barry, Clitheroe, Gainsborough, Glastonbury, Heysham, Kirkby-in-Ashfield, Saffron Walden, Walmer, Whickham and Yardley.

Electric Lighting Provisional Orders (No. 2): Bath Rural District, Brynmawr, Chippenham, Eastleigh and Bishopstoke, Hanwell, Southgate Urban District, Tamworth, Walton-le-Dale, Watford and Widnes (Amendment).

Electric Lighting Provisional Orders (No. 3): Birkenhead (Extension), Bishop Auckland (Amendment), Huddersfield (Extension to Golcar), Maidenhead (Extension), Milford-on-Sea, Newquay, Penzance, Ramsgate, Sunderland Districts and Tavistock.

Electric Lighting Provisional Orders (No. 4): Ashford (Kent), Ely, Ham, Hexham, Horley, Keynsham (Somerset), Kingswood, Newton Abbot (Extension), Teignmouth (Amendment) and Walton-upon-Thames.

Electric Lighting Provisional Orders (No. 5): Musselburgh, Portpatrick and Wishaw.

Electric Lighting Provisional Orders (No. 6): Clevedon, Portishead and Long Ashton, Crediton, Devizes, Hampton Wick and District, Houghton-le-Spring and District, the Maldens and Coombe, Northampton and District, Stroud, Nailsworth and Dursley and Trowbridge (Urban), Bradford-on-Avon (Urban) and Bradford-on-Avon (Rural).

Electric Lighting Provisional Orders (No. 8): Caerphilly, Epsom Rural District (Cheam), Mansfield Woodhouse, North Worcestershire (Bromsgrove Urban), and Sutton-in Ashfield.

Tramways.

Tramways Orders Confirmation (No. 1): Altrincham, Calverley, Crompton, Plymouth, Rochdale, Royton and Wardle.

Tramway Orders Confirmation (No. 2): Bishop Auckland, Shildon and Spennymoor, Dewsbury Corporation, East Ham Urban District Council, Ossett Corporation, Sunderland Corporation and West Ham Corporation.

Confirmatory Acts under Private Legislation Procedure (Scotland) Act, 1899.

Ayr Corporation.
Dumbarton Tramways.
Dundee, Broughty Ferry & District.
Glasgow Corp. (Tramways, &c.).
Govan Corporation.
Kirkcaldy Corporation.
Leith Corporation.
Paisley District Tramways.

Private Bill Legislation.

Baker Street and Waterloo Railway.
Barrow-in-Furness Corporation.
Belfast and North-East Ireland Electricity and Power Gas.
Belfast Corporation (Tramways).
Bournemouth Corp. (Tramways).
Bridlington Corporation.
Bristol Corporation.
Bristol Tramways (Extension).
Carlisle Corporation.
Charing Cross, Euston and Hampstead Railway.
Chesterfield Corporation (Tramways and Improvements).
Clyde Valley Electrical Power (*substituted bill*).
Derbyshire and Nottinghamshire Electric Power.
Doncaster Corporation.
Govan Burgh (Electricity) (*substituted bill*).
Great Northern and City Railway (Extension of Time).
Great Yarmouth Corporation.
Harrow Road & Paddington Tramways.
Holyrood Tramways. [Powers.
Ilford District Council.
Lancashire Electric Power.
Leeds Corp. (Waterworks) Railway.
Leicestershire and Warwickshire Electric Power.
Leyton District Council.
Loch Leven Water Power (*substituted bill*).
London County Council (Money).
London County Council (Tramways and Improvements).
London United Tramways.
Lothians Electric Power (*substituted bill*). [Powers.
Manchester Corporation (General
Manchester Corporation (Tramways)
Metropolitan District Railway.
Metropolitan Railway.
Middlesbrough, Stockton-on-Tees and Thornaby Tramways.
Newcastle-upon-Tyne Corporation.
North Staffordshire Railway.
North Wales Electric Power.
North Western Electricity & Power
Plymouth Corporation. [Gas.
Portmadoc, Beddgelert and South Snowdon Railway.
Preston, Chorley and Horwich Tramways.
Radcliffe Tramways & Improvement.
Rotherham Corporation.
Saddleworth and Springhead Tramways (Abandonment).
St. Marylebone Electric Lighting.
Shipley District Council.
Soothill Nether Urban District Tramways.
Southport and Lytham Tramroad (Extension of Time).
Strabane, Raphoe and Convoy Rly.
Stretford District Council.
Swindon Corporation.
Torquay Tramways.
Trafford Park.
Tynemouth Corporation.
Tyneside Tramways and Tramroads.
West Metropolitan Rly. (Abandonment)
West Riding Tramways.
Wolverhampton Corporation.

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We gave some particulars of the various projected bills and provisional orders in our issues in January last. A list of the principal schemes dropped, withdrawn or rejected is set out below: -

Public Bills.

Light Railways (*withdrawn*).
Supply of Electricity (*withdrawn*).

Provisional Orders.

Electrical Lighting Provisional Orders (No. 7): Barrhead, Bothwell, Eastwood and Cathcart, Johnstone, Kilpatrick, Lanark, Renfrew and Shettlestone (*dropped*).

Private Bills.

Barnet District Gas and Water (*electrolysis clauses rejected*).
Cheshire Electricity and Power Gas (*rejected*).
East London and Lower Thames Electric Power (*rejected*).
Leeds Corporation (Consolidation) (*suspended in House of Lords*).
Lincolnshire and Yorkshire Electric Power (*withdrawn*).
London, Camberwell and Dulwich Tramways (*rejected*).
North and South Woolwich Electric Railway (*abandoned*).
Preston and Blackburn Tramways (*rejected*).

PARLIAMENTARY INTELLIGENCE.

WIRELESS TELEGRAPHY BILL.

On Thursday last week a Committee of the House of Commons considered this bill, Mr. J. W. Lowther occupying the chair.

Mr. W. RUTHERFORD moved the following addition to clause 1:—"Provided that nothing in this act shall prevent any person from making or using electrical apparatus for actuating machinery or for any purpose other than the transmission of messages."

This amendment, together with those set forth in our Parliamentary columns last week, having been agreed to, the bill was ordered to be reported as amended.

The bill was read for the third time in the House of Commons, and for the first time in the House of Lords on Friday last.

On Saturday, Lord SELBORNE, in moving the second reading of the bill in the House of Lords, said it was only intended to apply for two years, and it did not, therefore, involve the final settlement of the great questions which the introduction of wireless telegraphy had raised. These questions related to the country's defence and its trade and internal communications, as well as to the progress of the invention. The absence of State control over wireless telegraphy was a standing danger to the defence of the country by land and by sea, as it was quite possible for anyone to communicate by means of wireless telegraphy with other persons at sea or across the Channel. Unless it was controlled the utility of wireless telegraphy might be negatived, and nothing but chaos would result. Also, it was only proper that vested rights should not be allowed to grow up which the State would have to purchase at immense cost. The bill was read a second time, and Committee stage dispensed with.

The bill was read a third time in the House of Lords on Monday.

Lord SELBORNE moved an amendment to clause 5 (that portion of the act which applies to the Channel Islands and the Isle of Man) having for its object the deletion of words which excepted the substitution of the authorities in the islands for the Board of Trade regarding the grant of licences as provided by the act. As they stood the words meant nothing, and the amendment necessarily followed a previous one which had been agreed to.

The amendment was carried and the bill passed. Subsequently the Lords amendments were considered and agreed to by the House of Commons. Royal Assent was announced later.

SUPPLY OF ELECTRICITY BILL.

In the House of Lords on Thursday last week this bill was read the third time.

Lord WOLVERTON moved to amend clause 4 (provisions as to right of local authorities to purchase) by leaving out the following proviso to sub-section (3):—"Provided always that any local authority having power to purchase any part of an undertaking being wholly or partly within the administrative county of London may, subject to the provisions of this section and to the like consents, transfer such rights to the London County Council."

The amendment was agreed to, and the bill, as amended, was passed.

THE TELEPHONE PURCHASE.

In a printed reply to Mr. HAY, who asked the Postmaster-General whether, in the event of his coming to an arrangement during the autumn with the National Telephone Co. as to the purchase of their undertaking, he would give the House an opportunity of discussing the terms of purchase previous to a definite settlement being made, and whether he would refer such an agreement, if any, to a Select Committee; also whether, in the event of purchase being postponed until 1911, he would reduce the rates of the Post Office service with special reference to the charge for unlimited service,

Lord STANLEY said: With regard to the first part of the hon. member's question, he had already pledged himself that no agreement between the Post Office and the National Telephone Co. for purchase of their undertaking would be considered binding until the House of Commons had had an opportunity of expressing its opinion thereon. He had nothing to add to that assurance, except that he was unable to accept the suggestion which the hon. member's question appeared to convey, that the Government was not likely to protect the interests of the users of the telephone and the taxpayer. The question of the rates charged for the Post Office service was one that would have to be considered on its merits apart from any question of purchase.

ROYAL ASSENT.

Royal assent has been given by commission to the Newcastle-upon-Tyne Corporation Tyneside Tramways and Tramroads and the Middlesbrough, Stockton-on-Tees and Thornaby Tramways Bills. Measures introduced for the purpose of confirming provisional orders have also received the Royal assent, including those granted to Hexham and Houghton-le-Spring (electric lighting) and Bishop Auckland, Shildon and Spennymoor, and Sunderland Corporation Tramways.

CORRESPONDENCE.

A NEW SINGLE-PHASE MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of July 15th, on p. 528, Mr. Rudolf Goldschmidt attempts to indicate differences between what has been called "A New Single-phase Motor" and original forms of my repulsion motor, first brought out in 1887. He evidently has not taken the trouble to look up the early literature on the subject. In the very earliest forms of repulsion motor, to use Mr. Goldschmidt's own words, "each rotor coil is short-circuited independently of all others, whilst it moves from the neutral position to the middle of the pole—that is, in a two-polar motor, over 90deg. *This angle is not affected by the number of rotor coils.*"

I will close my connection with the discussion by simply stating that a mere casual examination of my United States patents 363,185 and 363,186 of May 17, 1887, and 516,849 of March 20, 1894, will convince any reader of the actual state of the case. It will be noticed, too, that there is no substantial difference between Fig. 1 of my U.S. patent 516,849 and the Fig. 1 accompanying Mr. Goldschmidt's letter in your issue of July 15th, above mentioned; and it will be seen from the arrangement of the circuit connections of Fig 3 of my patent that the three coils are individually short-circuited, each for 90deg. Any minor points of construction or working are outside of the discussion, as they were not referred to in the original description of "A New Single-phase Motor," to which I took exception in my former letter. -Yours, &c.,

West Lynn, Mass., Aug. 4. ELIHU THOMSON.

"GREATER LONDON RAILWAYS."

The *Standard* of last Wednesday contains a communicated article under this title in which some interesting figures are collected with the object of demonstrating the recuperative power of the much-maligned Metropolitan and Metropolitan District Railways. Taking the Metropolitan District Railway first, it is stated that the number of passengers, exclusive of season-ticket holders, carried by this line was 25,572,539, as compared with 24,022,866 during the first half of 1902. It is assumed that the same number of passengers would be carried during the second half of the year, and the following table is given. This assumption, however, is obviously incorrect if the 1902 figures are taken as a criterion, for it will be seen that during the year in question there were less than twice the number of passengers in the first part of the year:—

Year.	Passengers.	Year.	Passengers.
1895	40,046,583	1900	39,475,254
1896	40,193,049	1901	38,175,618
1897	41,658,403	1902	43,203,584
1898	40,143,837	1903	48,413,832
1899	40,512,104	1904	51,145,078

The corresponding figures for the Metropolitan Railway were:—

Year.	Passengers.	Year.	Passengers.
1895	88,271,486	1900	93,333,025
1896	90,938,256	1901	87,821,904
1897	95,022,581	1902	89,874,833
1898	94,449,490	1903	94,000,150
1899	96,050,502	1904	95,144,886

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The drop in 1900 and 1901 is due to the opening of the Central London Railway, but in 1902 there was an increase again, which has been continued. Nothing is said, however, as to what increase there has been in the train-mileage; it is just conceivable that this has not been increased, but it must not be forgotten that the opening of the Whitechapel–Bow line has increased the route mileage. A statement as to the reduction in the number of season ticket-holders, and as to the amount of the gross earnings is also necessary to make these figures of real value, for there has recently been a considerable reduction of fares, and, moreover, the "twopenny tube" may have taken away more long-distance than short-distance passengers. In fact, the directors of the Metropolitan District Company complain that, although the company is carrying a much larger number of passengers, there has been no corresponding increase in receipts. If there is any cure for these troubles it can only be "electrification," and we are happy to learn that the work in connection with this is in an advanced state. The article continues—

Thirteen trains of new corridor cars have been constructed for the Metropolitan, and are being electrically equipped at Neasden. The remainder of the rolling stock required for the new system of working is now in course of construction at Manchester and Birmingham. The expenditure made by the Metropolitan during the past six months for the installation of electric traction was £230,911. The Metropolitan District Company's power station at Lot's-road, Chelsea, and the sub-stations upon the company's lines are also approaching completion, 420 new corridor cars providing trains have been ordered, and many miles of cables have also been drawn into the ducts. The Metropolitan District will have interchange stations at various points with the Great Northern, Piccadilly and Brompton, the Baker Street and Waterloo and the Charing Cross, Euston and Hampstead.

Arrangements are being made with these companies for the user of ducts through the Metropolitan District Company's tunnels, and also for the joint user of certain sub-stations. Satisfactory progress is being made with the widening of the Metropolitan District between West Kensington and Hammersmith, the erection of new car sheds and depots at Mill Hill Park, the erection of a new station at High-street, Kensington, and the lengthening of the company's stations.

The following table with regard to the first two "tube" electric railways has also considerable interest. It gives the number of passengers carried (in the case of the City and South London) exclusive of season-ticket holders. The 1904 figures are estimated from the first half-year's receipts:—

Year.	City & South London.	Central London.	Total.
1895	6,285,637	—	6,285,637
1896	6,561,152	—	6,561,152
1897	6,775,671	—	6,775,671
1898	6,941,791	—	6,941,791
1899	6,983,040	—	6,983,040
1900	9,188,559	14,916,922	24,105,481
1901	12,896,628	41,188,389	54,085,017
1902	19,069,319	45,305,110	64,374,429
1903	18,222,512	44,953,988	63,176,500
1904	18,453,974	45,938,794	64,392,768

The article concludes:—

The locomotive stock of the four companies stood as follows at the close of June, 1904:—Metropolitan, 89 tank (steam) engines; Metropolitan District, 54 tank (steam) engines and six motor cars; Central London, 28 electric engines, two steam engines and 68 motor cars; City and South London, 52 electric engines. The cost of locomotive power in the first half of this year upon the Metropolitan was £57,818; upon the Metropolitan District, £26,828; upon the Central London, £27,992; and upon the City and South London, £11,268. The distance run by trains were: Metropolitan, 1,715,543 miles; Metropolitan District, 770,229; Central London, 652,048; City and South London, 589,401.

LEGAL INTELLIGENCE.

Briggs v. Partington.

At the Salford Hundred Court last week plaintiff, a glass cutter and polisher, sued defendant for recovery of damages for misrepresentation and breach of contract.

Mr. WHARTON, for plaintiff, said that defendant induced him to replace steam as motive power in his works by electricity. He agreed to take two motors (13 H.P. and 5 H.P. respectively) from a company recommended by defendant. When the motors had been fixed it was found that the one of 13 H.P. was incapable of doing the work which, it was alleged, defendant had represented it would do. In the meantime plaintiff had agreed to sell his steam engine and boiler. It was also claimed that plaintiff had suffered loss by reason of failure of defendant to do the wiring necessary to connect the motor with the Corporation's electric cables within the stipulated time.

Defendant admitted that he received a commission on the sale of the motors, but denied that he had made any representation as to the amount of work the motors would do. The agreement to take the motors was made by plaintiff with a representative of the makers. Defendant considered that his contract was completed when he had done the wiring and seen the motor running connected to the gearing which worked the machinery. In that condition defendant said the motor ran satisfactorily. As to the allegation that there had been a breach of contract in respect of the time taken to complete the work, defendant pleaded that plaintiff had, by negligence, obstructed the progress of the work. Defendant further pleaded that the motor would have been capable of doing the work had the shafting been in good condition.

Ultimately the jury found for plaintiff for amount claimed (£43), and for defendant on a counterclaim (£12. 18s. 11d.). The counterclaim was for work done by defendant.

Kraus and Others v. South Lancashire Electric Traction & Power Co.

In the Chancery Court of Lancashire on Tuesday, Mr. Registrar Taylor, in a debenture-holders' application, made an order for the appointment of a receiver, and for inquiries and accounts.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Applications are invited for the position of lecturer in electrical engineering in the University of Sydney. Salary £500 per annum, with permission to carry on a certain amount of consulting practice subject to approval of Senate. Further particulars from the Acting Agent General for New South Wales (the Earl of Jersey), 9, Victoria-street, London, S.W., to whom applications by Sept. 10. See also an advertisement.

A lecturer in physics is required at the Municipal Technical School, Birmingham, in September. Commencing salary £140 per annum. Particulars from the secretary (Mr. Geo. Mellor), Suffolk-street, Birmingham. Applications by Aug. 27. See advertisement.

The Council of the County Borough of West Ham require a lecturer in electrical engineering at the Municipal Technical Institute. Salary £200 per annum. Application to principal by noon Sept. 1. See also advertisement.

An instructor in electric wiring is also wanted at West Ham Municipal Technical Institute for one evening per week for the ensuing session. Particulars from the principal until Sept. 1. See advertisement.

Glasgow Corporation invite applications for the position of chief electrician of the telephone department. Applicants must be well acquainted with the construction and maintenance of telephone switchboards and instruments. Salary not to exceed £225. Applications to the town clerk (Mr. James G. Monro) by 22nd inst. See also advertisement.

The governing body of the Battersea Polytechnic, London, S.W., require the services from September of an assistant lecturer in the department of mechanical engineering. Commencing salary £170. Particulars from secretary. See also advertisement.

Willesden District Council are prepared to receive applications for the position of resident electrical engineer, to take charge of the distribution of electricity within the district. Salary £250 per annum. Particulars and forms of application from the consulting engineer (Mr. E. T. Ruthven-Murray), electricity office, Salusbury-road, Kilburn, London, N.W., to whom applications by Sept. 17. See also advertisement.

A mains assistant is wanted with experience in laying, jointing, and testing single and concentric paper-insulated cables. Applications to the engineer and manager of Stepney Borough Council electricity department, 27, Osborn-street, Whitechapel, London, E. See advertisement.

Kirkcaldy Corporation require a switchboard attendant, preferably with experience in combined station for supplying power for tramways and lighting on the three-wire system. Applications to burgh electrical engineer (Mr. O. F. Francis), electricity works, Kirkcaldy, N.B., by 27th inst. See also advertisement.

Hereford Electric Lighting committee require a resident electrical engineer. Salary £200, in addition to half pupil's premium. Applications by 26th inst. to the committee clerk (Mr. Thos. Lewis), Town Hall, Hereford. See advertisement.

Richardsons, Westgarth & Co. (Ltd.), Hartlepool Engine Works, Hartlepool, require a young man with good technical experience and ability for estimating and sales departments. See advertisement.

Southport Electricity committee require an engineer-in-charge. Salary £2. 5s. per week. Applications to borough electrical engineer (Mr. Reginald S. Downe) by Aug. 22.

The Electric Supply committee of St. Marylebone (London) Borough Council invite applications for the position of resident

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engineer and manager of their electricity undertaking. Salary £600 per annum. Applications to the town clerk (Mr. James Wilson), Town Hall, Marylebone-lane, London, W., by Sept. 5.

The committee of the City and Guilds of London Institute are about to appoint a professor of Mechanical Engineering and Applied Mathematics at Finsbury Technical College. Salary £600 per annum. Applications to the hon. sec., Gresham College, London, E.C., by Sept. 15.

The Governing Body of the Northampton Institute, St. John Street-road, London, E.C., require a chief instructor in mathematics (day and evening, part time only). Salary £150 per session. Particulars from the principal (Dr. R. Mullineux Walmsley) and applications by Aug. 31.

Mr. C. Waldrop has been appointed sub-manager of the River Plate Electricity Co.'s La Plata station. Mr. E. G. Clark, who has been in charge of this station for several years, is resigning.

Mr. G. H. Carter, resident electrical engineer at Heckmondwike, has been appointed to a similar position at Acton.

EDUCATIONAL NOTICES.

City and Guilds of London Institute.—Particulars of the courses of instruction for the session 1904-5 at the Institute's Central Technical College, Exhibition-road, London, S.W., and at the Technical College, Leonard-street, Finsbury, in the engineering and chemistry departments, are set out in an advertisement on another page. The entrance examinations to both colleges are held in September, and particulars can be obtained at either of the colleges or from the head office of the Institute, Gresham College, Basinghall-street, London, E.C.

Durham College of Science (Newcastle-on-Tyne).—Courses are provided at this college for students proceeding to the degrees in Science or Letters or the diploma in the Theory and Practice of Teaching, and special facilities are offered for the study of agriculture, chemistry, mining, engineering and naval architecture. Matriculation and exhibition examinations begin Sept. 26, and lectures Oct. 4. Prospectuses from the secretary. An advertisement gives some additional particulars.

Engineering Apprenticeships.—Mr. W. H. Allen, of W. H. Allen, Son & Co. (Ltd.), Queen's Engineering Works, Bedford, has offered to the Bedford County Council to apprentice two boys yearly at the works to the electrical andmechanical engineering, and the offer has been accepted in connection with the technical education scheme of scholarships.

Glasgow and West of Scotland Technical College—The next session begins on Sept. 27. The diploma of the college is granted in civil, mechanical and electrical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics, and architecture. The courses of study usually extend over three sessions, and special courses for individual students are arranged as required. The laboratories in the departments of physics, chemistry, metallurgy, mechanical and electrical engineering are equipped with the most approved apparatus. The preliminary examination of candi dates for the diploma begins on Sept. 19. Prospectuses from the secretary, 38, Bath-street, Glasgow.

Northampton Institute.—Full day courses in the theory and practice of mechanical, electrical and horological engineering will commence on Monday, Oct. 3. Entrance examination, Wednesday and Thursday, Sept. 28 and 29. The courses for mechanical and electrical engineering include periods spent in commercial workshops and extend over four years. Students also prepare for the degree of B Sc. in engineering at the University of London. Particulars as to fees, &c., can be obtained at the Institute, St. John Street-road, London, or on application to the principal (Dr. R. Mullineux Walmsley). See also advertisement

University of Birmingham.—The session 1904-5 commences on Monday, Oct. 3. The full courses in the department of engineering extend over four years, and students who enter at matriculation and who pass successfully the examinations at the end of each year will be entitled to the degree of B.Sc. in the branch of engineering to which they devote themselves. There are lectures and demonstrations in all branches of electrical engineering, and the electrical laboratory work includes testing of continuous and alternate-current machinery, electrical instruments, meters, lamps and batteries, and insulation and magnetic testing. Further particulars are given in an advertisement, and detailed syllabuses, &c., can be obtained from the secretary.

Victoria University of Manchester.—The engineering drawing room and Whitworth engineering laboratory will open on Tuesday, Oct 4, and lectures will commence on Oct. 5. Particulars of the course of instruction may be obtained from the registrar.

Argentina.—"The Review of the River Plate" states that electricity works are to be at once erected at Tres Arroyas.

Buenos Ayres Council refuse to modify their new regulations as to the w'ring of theatres, and insist upon compliance with their requirements within 12 months. The revised regulations make the use of steel conduits compulsory and forbid the use of wood casing. The theatre proprietors urge that, as their buildings were originally wired in accordance with municipal requirements, it is now unreasonable to call upon them to carry out the work of re-wiring at their own expense.

A London syndicate has been negotiating for the acquisition of the tramways in Rosario, with a view to their conversion to electric traction, but no definite arrangement has yet been arrived at.

Belfast.—The electric lighting mains are to be extended to the new Jewish synagogue.

Boston (Lincs)—The Council have now adopted the recommendation of the Paving and Lighting committee to establish electricity supply works and to apply for sanction to a loan of £20,000. It is proposed to erect the generating station near the dock. The scheme has been prepared by the surveyor and electrical engineer, Mr. Clarke.

Bradford—The revenue of the tramways department for the year ended March was £197,138 and the expenditure £184,037 (including £46,000 for interest and sinking fund), leaving £13,101 net profit. Of this, £10,482. 13s. 8d. goes to the Bradford & Shelf Tramway Co. and the Bradford Tramway & Omnibus Co., whoses leases were acquired by the Corporation in 1902, and the balance to depreciation and renewal fund. The capital expenditure is £744,430.

Bury (Lancs.).—The Tramways committee have decided to perform the work of re-constructing the tramway track for electric traction by direct labour.

Cambridge.—A report prepared by the consulting tramway engineers (Messrs. Kincaid, Waller, Manville & Dawson) on the proposed conversion of the tramways to electric traction will come before the next meeting of the Council.

Cannock.—An inquiry was recently held into the application of the Council for permission to borrow £10,000 for electricity supply.

The clerk (Mr. Loxton) said in 1901 a provisional order was obtained. It was proposed to lease the works after construction to Messrs. Whittaker Bros., who would put £2,500 into the undertaking as a guarantee and would pay the annual capital charges.

Mr. T. Evans (chairman of the Council) and Mr. J. H. Whittaker gave evidence in support of the application, which was opposed by the local gas company and several colliery companies.

The inquiry was adjourned until Tuesday, when further evidence was taken, and at the termination of the inquiry the inspector (Mr. H. Ross Hooper) inspected the district.

Chingford.—The Council will oppose the application of the Mutual Electric Supply Co. for a provisional electric lighting order.

Conway.—The Council have resolved to apply for a provisional electric lighting order.

Cottage Lighting.—Leeds electricity department have secured about 500 new customers during the current year, the majority of the houses concerned being let at rents of less than £25 per annum, and in some cases as low as £16 or £18. On some new estates builders now put in electric light wires as well as gas pipes.

Datchet.—Electric lighting is to be adopted in this village.

Dewsbury.—On the recommendation of the Tramways sub-committee the Council decided on Tuesday to purchase the Yorkshire (Woollen District) Tramways Co.'s electric tramways at £52,500, and to lease the lines to the company for 30 years. Application is to be made for sanction to borrow the money.

Dublin.—At a specially-convened meeting of the Corporation on Wednesday the report of the Lighting committee in reference to the extension of the generating plant at the Pigeon House electricity works was confirmed.

The chairman of the committee (Mr. Irwin) said that the main principle underlying the report had been approved in May last. Tenders for new generating plant had been obtained, and that of the General Electric Co. at £19,227. 10s. was duly accepted. The contractors thereupon set to work to manufacture the plant, which was to be delivered by Oct. 31, in order to be in time to cope with the demand of the coming year. The remaining items in the amount were made up of engineer's fees, printing, inspection, and testing, &c. While Mr. R. Hammond remained in the position of consulting engineer he was entitled to 5 per cent. on all extensions of his original scheme, and the present being an extension, he was entitled to get it. The Corporation had power to determine Mr. Hammond's agreement by three months' notice, but the committee did not think that was a wise thing to do in view of the special circumstances surrounding this matter.

Dunfermline.—Mr. J. Alex. Bell, city electrical engineer of Aberdeen, has presented his report on the relative advantages of establishing municipal electricity works and of taking supply in bulk from the Fife Electric Power Co. Mr. Bell favours the latter proposal.

Electric Coal Cutting in New South Wales.—Sullivan electric coal-cutting machines are being successfully used in the Northern Extended colliery, Teralba, and the A. A. Co.'s colliery, Hebburn, while contracts have been entered into for their supply to the Pacific and Rhondda collieries.

Electric Traction in Spain.—The Sarria-Barcelona Railway Co. have applied for a concession for the construction of an electric

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railway from Sarria to the mountainous district of Vallvidrera. The "Gaceta" of 9th inst. invites applications within one month from companies desirous of competing for the concession.

Exeter.—The work of constructing the permanent way of the electric tramways was commenced on Tuesday.

Exhibition.—The "Diario de Barcelona" states that the time for receiving applications for space at the Barcelona exhibition of mineral products and hydraulic machinery to be held in September is extended to Aug. 31, and that foreign exhibits will be admitted even after the exhibition is open.

Felixstowe.—Some time ago the Council decided to acquire the electricity works of the Suffolk Electricity Co.

The Lighting committee now report that there is a clause in the company's lease which prohibits the use of steam engines within 50ft. of the northern boundary of the station site while the whole length of the land is only 105ft. The committee suggest that the company might use gas engines, which should remain the company's property and be outside the agreement with the Council, but the Council's consulting engineer (Mr. Reginald P. Wilson) advises that gas engines would be more prejudicial to adjoining property than steam engines. The Council have decided to meet in committee to discuss the subject with Mr. Wilson.

Fire.—The car shop of the British Columbia Electric Railway Co. was destroyed by fire on Friday. Damage is estimated at £30,000, and is covered by insurance.

Fremantle (W. Australia).—In respect of the Fremantle and East Fremantle electricity supply and tramways scheme, Messrs. Noyes Bros. are to carry out the construction and equipment at a commission of 10 per cent. on total outlay. The agreement contains a clause that if the outlay exceeds £84,000 (exclusive of legal and clerical charges), the contractors are to refund the excess to the Tramway Board.

Gowerton (Wales).—The Parish Council last week referred back a recommendation to add to the number of oil lamps for public lighting, as there was a desire to adopt electric or some other form of lighting.

Grimsby.—The Electric Lighting committee have approved recommendations of the borough electrical engineer (Mr. W. A. Vignoles) to carry out certain extensions of the electric lighting mains, purchase of meters, &c., during 1904-5, and also to purchase a water purifier for the electricity works. The estimated cost of the extensions is £3,000.

Halifax.—In future tramway extensions outside the borough are only to be carried out by the Corporation if they are free from local rates for five years.

Hampton Wick.—The Council have invited the Twickenham & Teddington Electric Supply Co. and the local gas company to tender for public lighting.

Hastings-Ramsgate Railway.—A syndicate has submitted to the various local authorities proposals for the construction of an electric railway from Hastings to Ramsgate, which would pass through Winchelsea, Hythe, Shorncliffe Camp, Folkestone, Dover, Walmer, Deal and Sandwich.

Hereford.—The electrical engineer has tendered his resignation.

Heywood.—The Town Council have expressed their willingness to again meet the neighbouring corporations (Rochdale and Bury) to discuss the subject of the reconstruction of the local tramways, the arrangement of through running facilities, &c. An extension of six months has been granted by the Board of Trade for carrying out the terms of the Heywood provisional tramway order.

Hotel Lighting.—The Imperial Hotel, Torquay, has been wired for the electric light by a local firm, Messrs. Harding & Son, to the specification of Mr. P. Storey, borough electrical engineer. There are 680 lights and the fittings are of artistic design, chiefly in oxidised silver and fired copper.

Huddersfield.—The Traffic sub-committee have selected the following seven out of the 87 applicants for the position of manager of the Corporation tramways. From these the final choice will be made:—

Mr. A. G. Livesay, assistant tramways engineer, Leeds; Mr. R. H. Wilkinson, general manager Oldham Corporation tramways; Mr. James McF. Smith, borough electrical engineer, Keighley; Mr. John R. Williams, chief engineer in charge and station superintendent Sheffield Corporation tramways; Mr. G. R. Blackburn, tramways electrical engineer and works manager Bradford Corporation; Mr. T. R. Whitehead, general manager and engineer Coventry electric tramways; and Mr. E. H. Edwards, resident engineer and manager of the South Lancashire Tramways Co.

The tramway employés of the Corporation have passed a resolution protesting against a proposal of the Tramways committee to compel each man to undergo a medical examination annually, and at the meeting of the Corporation on Wednesday this portion of the Tramway committee's minutes was withdrawn. The recommendations as to reconstructing certain portions of the track, &c., were adopted.

Ince.—The Board of Trade recently inquired whether any notice of intention to apply for a provisional electric lighting order had been served upon the Council before July 1, and also asking for further information as to the prospects of the Council being able to obtain a supply of electrical energy in bulk. The clerk has been instructed to reply that no notices have been served, and that negotiations are proceeding with Wigan Corporation and the Lancashire Electric Power Co. as to obtaining a supply of electricity. An appointment has been arranged with representatives of the Wigan Corporation to discuss the agreement as to the purchase of the Lower Ince tramways and to arrange the purchase price of the Lower and Higher Ince tramlines.

Import Duties.—Sparking plugs, fitted with or without porcelain, and being part of a spark coil, have been declared liable to 12½ per cent. ad val. under the Australian Commonwealth tariff.

Inquests.—An inquest was held on Tuesday on the body of a man named James Harris, killed on the North-Eastern Railway at the Tynemouth end of the North Shields tunnel by contact with the live rail.

Deceased attempted to cross the railway and had climbed a fence when he fell forward on the rails. The place where the accident happened was between the tunnel and the bridge. A witness who gave evidence said he knew nothing about the live rail until he received the shock, and, at first, he thought deceased (his cousin) had simply received a shock. He had heard about the electric railway, but had no idea where it was.

A platelayer named Cowling said that when called to deceased he was lying across the rail. Witness put on his rubber gloves and pulled deceased off the line. The railway was enclosed at the place, and deceased would have to drop 7ft. after climbing the wall.

The Coroner said the question of the live rail was a serious one. He believed there was an inquiry being made by the Board of Trade, to see what could be done to prevent those accidents. Deceased was trespassing on the line.

The jury returned a verdict that deceased was accidentally electrocuted while trespassing on the North-Eastern Railway.

An inquest was held on Wednesday into the circumstances attending the death of a girl named Reeves, who was killed by an iron telephone bracket falling from the top of a house and striking her on the head.

Mr. J. Leslie Brown, district engineer to the National Telephone Co. said the wire had given way from the stays, which had been attached to a chimney stack.

International Telegraph Land-lines.—A new line from Mendoza to La Cumbre has been opened, joining the Chilian and Argentine land-line telegraph systems.

Inverness.—The Corporation have entered into an arrangement with Edmundson's Electricity Corp. for the erection and maintenance of electricity works in the district. As announced in our issue of the 5th inst., the Council have granted an extension of six months to the company to commence the erection of the works.

It appears that Messrs. Claud Hamilton (Aberdeen), Ltd., are supplying current from a small station in the town, and have declined the offer of Edmundson's Corp. of £700 for their plant as they estimate its value at £1,310, and to obviate loss they have issued a circular asking their consumers to make up the difference of £610 by paying 2d. per unit more than Edmundson's Corp. proposed to charge (4½d. per unit) for four years, and intimating that unless this undertaking is given the supply of current will be withdrawn.

King's Lynn.—The Council have conditionally agreed to supply electric current to Messrs. Savage Bros. at 1¼d. per unit for the first 50,000 units per annum and 1d. per unit for any quantity in excess of this figure, instead of the present rate of 3d. per unit for the first hour's average use per day and 1⅛d. after.

Kingstown (Ireland).—Messrs. Kincaid, Waller, Manville & Dawson have agreed to accept £500 in discharge of their claim for services rendered as consulting engineers in connection with the Council's proposed electricity supply scheme. As announced in our issue of the 5th inst., the Kingstown provisional order (obtained in 1896) has been revoked.

Kirkintilloch (N.B.).—The Council have decided to equip a small temporary generating station to supply current in the centre of the town for a time. If the experiment is a financial success it is proposed to eventually extend the area and to erect a permanent station.

Leith.—The capital expended on the electricity department at May 16 was £95,650. 12s. 9d., an increase of £13,570. 7s. 3d. for the year.

The total receipts for 1903-4 were £16,188. 13s. 8d., including £7,612. 18s. 2d. from sale of current for private lighting, £2,854. 0s. 7d. for motor power and £5,344. 11s. 2d. for public lighting. Cost of generation was £4,427. 17s. 3d., distribution £264. 6s. 8d., repair and maintenance of public lamps £998. 12s. 8d., rent, rates and taxes £1,087. 14s. 6d., management expenses £790. 12s. 6d., and special charges £170. 11s. 11d. After setting aside £100 for bad debts, £8,348. 18s. 2d. was carried to net revenue account, to meet interest £2,376. 17s. 3d., income tax on interest on loans £154. 15s. 7d., instalments of loans repaid £1,878. 9s. 4d., amount set aside for repayment of loans £1,029. 10s. 8d., amount transferred to burgh general assessment account (sums advanced in former years) £1,894. 4s. 10d., leaving a credit balance of £1,764. 9s. 2d. 1,551,819 units of electric energy were generated, 514,131 were supplied to public lamps, 921,950 to private consumers. The maximum supply demanded 992kw.

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A deputation is at present inspecting English electric tramway systems in order to obtain information as to the most suitable form of electric traction to be adopted on the local lines.

Litherland.—The Council have resolved to apply for a provisional electric lighting order. The Liverpool District Lighting Co. also intend to apply for an order.

Lowestoft.—The income of the Corporation electric tramways department for the year ended July 21 (the first year's working) included £10,377. 15s. traffic receipts and £349. 13s. 7d. for advertisements. Working expenses were £7,392, 18s., of which £2,534. 17s. were for electrical energy. The gross profit was £3,334. 10s. 7d. Sinking fund required £875. 3s. 9d. and interest £2,684. 18s. 10d. After taking into account a balance in hand of £80. 12s., £145 had to be taken from the borough fund to meet the deficiency. 2,309,857 passengers were carried and 286,730 car-miles run. The revenue per car-mile was 8·97d. and the total costs (including capital charges) 9·16d., the working expenses being 6·18d.

Macclesfield.—The Electricity committee have declined to entertain proposals from several companies for erecting electricity works.

The chairman (Councillor Cameron) recently put an amended scheme before the committee estimated to cost £11,600. A sub-committee has been appointed to report whether it would not be advisable to extend the area of supply in Councillor Cameron's scheme.

Middlesex Light Railways.—The first portion of the County of Middlesex Light Railways, running between Tottenham and Wood Green, via Bruce-grove and Lordship-lane, will be formally opened for traffic to-morrow (Saturday) by the chairman of the Tramways and Light Railways committee (Sir Francis C. Cory-Wright).

Municipal Telephony.—It is stated that requests for connection to the Hull municipal system are coming in at the rate of from 30 to 40 per week. The official opening of the central exchange will take place in a few weeks, although some subscribers are already connected.

Mynyddislwyn.—The Council have engaged Messrs. Lewis & Fletcher as consulting electrical engineers.

Newcastle-on-Tyne.—The revenue of the tramways department for the year ended March was £185,027. 12s. 9d., including traffic receipts £180,630. 12s. 2d. and street lighting £2,980.

Working expenses were £121,557. 14s. 9d., leaving gross profit £63,469. 18s. (against £64,508. 19s. 6d. in the previous year). Interest absorbed £28,896. 0s. 4d., and redemption of loans £22,638. 3s. 8d., leaving £11,935. 14s. Capital expenditure is £1,054,681. 11s., against £903,594. 0s. 6d. at March, 1903. 39,715,120 passengers were carried at an average fare of 1·1d. and 4,059,907 car-miles run, the revenue per car-mile being 10·68d. and the net working cost per car-mile 7d. There are 45 miles of single track and 165 cars in use, and 12 further cars are in course of construction.

In his report the manager and engineer (Mr. A. E. Le Rossignol) remarks that the charges for interest and redemption on capital spent on construction work and not yet productive (£37,463. 11s. 11d.) have been met out of revenue, having been paid in this way during the 2½ years of working. An extension of the boiler house has been completed during the year, four new boilers have been put in, and a new 3,000 H.P. engine is nearing completion. All the cars were originally ordered with chilled cast-iron wheels, but it was found that the traffic conditions in Newcastle were very severe on the wheels, the flanges chipped away so that the cars easily came off the rails, and flats were formed on the tread of the wheels when the rails were slippery. 311 cars have had other wheels fitted during the year, each car requiring new wheels every 6½ months on an average. Steel-tyred wheels are now being used and 92 cars have been fitted with the steel wheels during the year, the whole of the cost being charged to revenue. The spare open single-deck bogie bodies have all been altered into complete double-deck cars. In regard to permanent way, the report states that when the contracts for the construction of the track were let in 1899 no anchors were included in the specification for holding down the rails to the concrete bed, but experience has shown that with the heavy cars necessitated by electric traction, the rolling of the wheels tends to bow up the rails in the centre of their length, and leads to the loosening of the paving round about. As soon as this effect manifested itself at Newcastle, anchors were arranged for and are being inserted whenever the paving along a rail requires replacing. Up till the end of the financial year 4,000 anchors had been fitted. The undertaking gives employment to 1,420 persons.

The question of making an extension of the street arc lighting system is being considered by the Lighting committee, who have requested the Tramways committee to quote terms for current.

Ormskirk.—The Council have adopted the scheme for electricity supply prepared by the National Electric Construction Co.

The Council have secured an extension of the period of their electric lighting order until December. The capital is to be provided by the Council, the company paying the annual capital charges. Profits in excess of 3 per cent. over the sum required for interest and sinking fund instalments are to go to the Council for the first 10 years, and subsequently are to be divided equally between the Council and the company. The company pays the expenditure incurred by the Council in obtaining the order, &c. The Council will have the right to acquire the undertaking after seven years by payment of capital expenditure plus 10 per cent., after 10 years on payment of 7½ per cent., and after 15 or 20 years without premium on 12 months' notice, or without notice on the completion of the redemption of capital.

Penang (Straits Settlements).—Supply of electricity was commenced on 14th ult.

The consulting engineers for the scheme (Messrs. Preece & Cardew) were represented locally by Mr. Orlo V. Thomas, who was assisted by Messrs. E. S. Haslam and Roberts, the latter being the engineer for Callender's Co., contractors for the cables. The three-wire system of distribution has been adopted, the voltage at consumers' terminals being 220. The plant and material is all British. Current is supplied to private consumers for lighting and for operating fans, and also for public lighting, and as the demand is already nearly equal to the capacity of the plant, extensions have been decided upon. The contractors for plant, &c., were: Callender's Co. for cables, W. H. Allen, Son & Co. for steam dynamos, Penang Foundry Co. for boilers and chimney, General Electric Co. for switchboards, Carrick & Ritchie for travelling crane, Electrical Power Storage Co. for accumulators, and Crompton & Co. for street lamps.

Penmaenmawr.—The Council will apply for a provisional electric lighting order.

Personal.—We are informed that Mr. G. A. Hughes and Mr. Adolph Wunderlich are retiring from Messrs. Johnson & Phillips, Victoria Works, Old Charlton, after 15 and seven years' service respectively, having held the positions of works secretary and departmental managers. We understand these gentlemen will shortly commence business on their own account as electrical manufacturers.

Presentation.—On Friday last the Mayor of Huddersfield (Ald. R. H. Inman), on behalf of the chief officials of the Corporation, presented a dressing case, with ebony and silver fittings, to Mr. H. N. Thomas, who has resigned his position as tramways manager in order to take up a similar appointment at Durban, South Africa.

The chair was occupied by the town clerk (Mr. J. H. Field), and all the chief officials of the Corporation were present.

In making the presentation, the MAYOR said Mr. Thomas had always displayed kindness and courtesy in his business relationships with his colleagues. At the same time they were not unmindful of the great energy he had displayed in the administration of the large and important department of which he had been the head. He hoped the same success would follow him in the country beyond the seas to which he was going.

The borough engineer (Mr. K. F. CAMPBELL) testified to the esteem in which Mr. Thomas was held by his brother officials and the members of the Tramways committee. There had been a marked improvement in the tramways under Mr. Thomas's managership, not only in the method of locomotion but financially, which spoke very highly of the energy he had put into his work.

Mr. THOMAS replied in suitable terms in returning thanks for the present.

Railway Station Lighting.—The gas lighting of the Dundee West station has this week been superseded by electric light. Arcs are in use on the platforms.

Rawmarsh.—The Council have decided to take legal proceedings against the promotors of the local tramways act and provisional electric lighting order for the recovery of costs (£2,000) incurred by the Council in connection therewith.

Saffron Walden.—The Council decided on Thursday last to proceed with their application for sanction to a loan for electricity works.

Sheffield.—The criticisms of the accountant-auditor (Mr. S. Seager) on the accounts of the electric light department were considered at the last meeting of the Corporation.

It appeared that the Electric Light committee has been supplying itself with brickwork and factory products and charging these goods to capital account at a profit on the cost of manufacture, and this policy is condemned by Mr. Seager.

Councillor KELLEY alleged that the accounts of the electric light department had not been kept in a way which a business man would require in the case of his own accounts.

Councillor HUGHES asked the chairman (Ald. Styring) how he intended to deal with Mr. Seager's report, and what steps he would take to arrive at the truth. He also complained of the charging of £2,860, officials' salaries, to the accumulated surplus instead of to revenue, and said that was only done to keep up the appearance of profit. He suggested an appeal to an outside authority.

Ald. Sir CHARLES SKELTON said the committee's method would make no actual difference, but he agreed that it was desirable to have a state of finance that left no room for dispute. He congratulated the committee on their revised scale of charges for current for power.

Ald. STYRING, in reply, said the claim for a reduction of the charge for current for lighting would have the consideration of the committee. As to the auditor's report, the real question at issue was what was the true cost of those articles charged to capital account. He was prepared to contend that no profit had been charged, and that the debit to capital account was, therefore, correct.

On the presentation of the Tramways committee's minutes last week, Ald. Chambers proposed the rejection of a recommendation to accept the tender of the Works Construction department for paving the approach to Kelham Island power station at £882, and urged that tenders should be invited from outside firms. After discussion, Ald. Chambers' proposal was adopted.

The Board of Trade inspection of the Angel-street, Snighill and Bridge-street tramways was made on Wednesday.

South Australian Railway Electrification.—A deputation recently waited upon the Premier of South Australia to urge that the

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Port Adelaide railway should be converted to electric traction, and that, in the event of the conversion of the suburban railways and tramways to electric working, the power house should be situate at Port Adelaide. The Premier said that preliminary reports had been obtained from Mr. Roberts, of the railway department, while Mr. F. E. Bradford, electrical engineer, had been asked to report on the question of the conversion of the suburban railways, which would cost several hundred thousand pounds. The Government would not, however, restrict him in his recommendation as to a site for the power station.

Surbiton.—The District Council have decided to put down a third boiler and engine at the electricity works at a cost of £4,400.

Swansea.—From an analysis of the accounts of the electricity department for the year ended March, we find that the total capital expenditure at that date was £102,051. 15s. 5d., an increase of £12,455. 16s. 5d. during the year.

The revenue was £10,988. 15s. 1d., against £8,300. 8s. 3d. in the preceding year. Working expenses were £5,111. 19s. 11d. (against £3,649. 12s. 3d.), leaving a gross profit of £5,876. 15s. 2d. After adding £1,810. 6s. 11d. from previous year and deducting bad debts, £81. 15s. 8d., interest on loans £3,901. 15s. 4d., and sinking fund from 1901, £2,959. 0s. 1d., there was a net profit of £744. 11s. 521,977 units were sold for private lighting at an average of 4·30d. per unit (against 424,752 in the previous year), 210,984 for power at 1·71d. (against 63,190), and 138,594 for public lighting at 2·42d. (against 90,240). There is the equivalent of 54,929 8 c.p. lamps connected (against 42,112 at March, 1903). The capacity of the plant is 1,725kw. The maximum load was 625kw. (against 547kw.) and the load-factor 15·91 (against 12·06).

The Anglo-French Telephone Service.—The following circular has been issued by the Post Office authorities:—

A heavy-gauge telephone circuit having been erected between Calais and Lille, some further experiments have been made in telephonic communication between England and the north of France, and it has been found that it will be possible to extend the service. From Sept. 1 communication will be practicable between any Post Office call office or between the telephone of any subscriber to the Post Office telephone system in the London area and telephone subscribers or persons using call offices in the following places in France:—Abbeville, Amiens, Aniche, Anor, Armentières, Arras, Béthune, Boulogne-sur-Mer, Calais, Cambrai, Denain, Douay, Dunkirk, Fourmise, Lens, Lille, Masnières, Montreuil, Péronne, Roubaix, St. Omer, St. Quentin, Tourcoing and Valenciennes. The charge for each period of three minutes' communication will be 8s.

Tramway Bye-Laws.—Last week a Board of Trade inquiry was held as to three new bye-laws proposed to be made by Manchester Corporation with reference to their tramway traffic in certain thoroughfares in the business portion of the city. Sir Herbert Jekyll presided. One bye-law was as follows:—

1. The driver of every carriage using any tramway within the city shall so drive the same that it shall not follow a preceding carriage using the same tramway at a less distance than 15yds., except as hereinafter mentioned, viz.:

(*a*) In case of a stopping place, one-third of the above distance shall be observed, but the speed of the carriage shall be slackened.

(*b*) In any portion of the city situate within the area hereinafter described . . . ; or,

(*c*) Within 50yds. of any terminus (not being within the area defined in the preceding paragraph) on any of the tramway routes of the Corporation, the city boundary being considered the terminus as regards any tramway route extending beyond the city.

In the excepted cases (*b*) and (*c*) the driver of every carriage shall so drive the same that it shall not follow a preceding carriage at a less distance than 2yds., and he shall proceed slowly while a less distance than 15yds. is maintained, but it shall not be deemed an offence for cars to stand nearer to each other than 2yds. in case of accident or emergency, or where cars are standing upon any siding in any street.

Every person who shall offend against this bye-law shall be liable for every such offence to a penalty not exceeding 40s.

The extent of the user by the Corporation of the tramways in certain streets was defined by the second bye-law, and the third bye-law provided that the foregoing bye-law might be from time to time revoked or altered by the Corporation.

For property owners who opposed the making of the new bye-laws, Mr. Forbes Lankester explained that when the bill to authorise the Corporation purchase of the tramways was being promoted the property owners claimed that certain streets named in the bye-laws were totally unsuitable for tramways, and that if tramways were allowed they ought to be subjected to restrictions. It was because of that opposition that the Corporation agreed to a clause in the Act of 1900, under which they were to define the user of the streets for tramway purposes. The objection to the use of the streets for tramcars was that they were already so crowded with heavy traffic that tramcars passing along would probably make them unfit for the extensive use of the buildings abutting for business purposes.

Sir Herbert Jekyll said so far as he could see an inspector would have to go down to make a local inquiry, but no local evidence would be taken.

Mr. Coward, K.C., said that the Corporation had described the user, which he admitted was rather wide, but urged that there was no reason why those streets should be subject to restrictions which were not imposed in respect of other business streets.

Evidence was then taken as to the traffic in certain streets.

Mr. Forbes Lankester pointed out that the statute provided that bye-laws should be made within six months, and now 2½ years had passed without bye-laws being made.

Sir Herbert Jekyll said that the question of distance between two cars had already been settled in the case of the London United Tramways, and the Board had arrived at what was now considered a model regulation. It read as follows:—

The driver of every car shall so drive the same that it shall not follow a preceding car at a less distance than 50yds., except in cases of emergency, when the driver shall comply with the directions given by the authority controlling traffic on the spot. No car shall be stopped within 15yds. of another car on a parallel line of rails, nor within 15yds. of the intersection or junction of two or more streets or roads.

Mr. Forbes Lankester said his clients would accept that.

On Friday, when the inquiry was resumed, Sir Herbert Jekyll asked what the Corporation thought was the meaning of the words in the statute which said that the Corporation were to define the user of John Dalton, Portland and Peter-streets.

Mr. Coward replied he had advised his clients that the expression "unrestricted" which the Corporation had employed to define the user of the streets was not a compliance with what Parliament had imposed upon them, and that they should bring forward a bye-law to the effect that there must be a substantial interval between the tramcars using the streets. He was prepared to submit evidence as to the three lines upon which he should ask the Board to fix an interval of 100yds. They were providing for relief lines, and the lines in question were intended to be used partially for that purpose.

The general manager of the Corporation tramways department (Mr. J. M. McElroy) said that the Corporation tramcars served a population of 750,000, whom they carried 3½ times over each week. At the busiest times of the day 240 cars passed through Piccadilly in an hour, or about four per minute. Piccadilly was the place where all the routes in the city converged. For relieving traffic the Tramways committee had agreed to become responsible for £100,000 in respect of a widening of Portland-street opposite the Infirmary. When the widening was completed it would be used to relieve the traffic by sending the cars round the Infirmary, and they proposed that the tramcars should run in that thoroughfare at intervals of not less than 100yds. except in emergencies. Portland-street was 35ft. wide, and to close it during the busiest hours of the day would be to render it absolutely useless for relief of traffic. He thought that a 15yds. interval was the right figure in general. With such an interval as 50yds. between cars they would be under the necessity of taking cars off a number of routes and inconveniencing the traffic. There was an immense difference between the traffic in Manchester and at Shepherd's Bush. As to the question of stoppages on parallel lines, the committee had not considered that, as they were under no statutory obligation to make bye-laws on the point. Before long they would have cars from 20 additional miles of tramways in the south coming into the city and they had to accommodate that traffic. When the loop round the infirmary was completed it would be hard if they were not able to use the remainder of Portland-street to bring some of those cars over.

Sir Herbert Jekyll said he never intended the London United case to be followed slavishly, but merely to be used as a basis to work upon.

Replying to Sir Herbert Jekyll, Witness said he could not draw much distinction between Portland and the other two streets and the rest of the Manchester streets. If they were closed to tramway traffic, then the rest of the streets would become more congested.

The Chief Constable of Manchester (Mr. Robert Peacock) agreed that the congestion had been greatly relieved by the through tramway routes established by the Corporation. If some such bye-laws as the Corporation proposed were not passed it would be impossible for the tramways to be worked at all. There was no place comparable to Manchester in the United Kingdom, except the City of London, for in no place was the heaviest traffic confined in such a small area. Besides the Manchester cars there were 73 Salford cars an hour at some periods of the day to be accommodated.

After counsel had replied on the evidence, Sir Herbert Jekyll said what was necessary to be done was that the Corporation should submit revised bye laws, and then an inspector should go down to Manchester and inspect the streets and the condition of traffic.

Victoria (Australia).—The Victorian Premier (Mr. Bent) recently announced his intention of appointing an expert to report upon the advisability of at once commencing the conversion of the suburban railways and tramways to electric traction.

Waipori Falls (N.Z.).—The Waipori Falls Electric Power Co., which proposes to spend about £100,000 on their works, have asked Taieri County Council to support the company's bill in Parliament authorising the erection of overhead distributing cables.

Ware.—The Council have sealed the agreement with the North Metropolitan Electric Power Supply Co. for a transfer of the Council's electric lighting order, the company paying £186 and the cost of obtaining the order. The Council reserve the right to acquire the undertaking in 14 years.

Wednesbury.—The Council have resolved not to charge meter rents to customers whose accounts for electric current amount to or exceed £1 per quarter.

Westhoughton (Lancs.).—The Council are negotiating with the Lancashire Electric Co., J. Musgrave & Sons, and the Hulton Colliery Co. as to the supply of electricity in the district.

Wigan.—Last week the chairman of the Electric Light and Tramways committee (Ald. Johnson) opened a club which has been established for the employés of the electric lighting and tramways departments of the Corporation. Already there are about 180 members.

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TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Council of the County Borough of *West Ham* invite tenders for the reconstruction of certain existing horse tramways of a route length of about 3 miles 3 fur. double track. Plans, &c., may be inspected at the office of the consulting engineer, Mr. J. E. Waller, M.Inst.C.E. (Messrs. Kincaid, Waller, Manville & Dawson), 29, Great George-street, Westminster, from whom copies of specification may be obtained. Tenders to the town clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, by 4 p.m. Sept. 7. An advertisement contains further particulars.

Worksop District Council invite tenders for underground cables. Specifications from the consulting engineer (Mr. A. B. Mountain, M.I.E.E.), St. Andrew's-road, Huddersfield. Tenders to the clerk (Mr. George H. Featherston) by Aug. 29. See also advertisement.

Hove Corporation invite tenders for the supply, delivery and laying in the parish of Aldrington of low-tension vulcanised bitumen, dialite or leadless paper cables, conduits, boxes, meters, &c. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Handcock & Dykes), 1, Victoria-street, Westminster, and can be obtained from the town clerk (Mr. H. Endacott), Town Hall, Hove, to whom tenders by 6 p.m. of 30th inst. See also advertisement.

Tenders are invited by the *Postmaster-General* until noon of Sept. 26 for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles, to be delivered at one or more of the ports set out in an advertisement in another column. Forms of tender from the controller of stores (Mr. S. C. Hooley), Stores Department, G.P.O., 17-19, Bedford-street, London, W.C.

Torquay Town Council invite tenders for the erection of a chimney shaft (260ft. high) at their new proposed electric light and power station, in accordance with plans and specifications prepared by the borough engineer (Mr. Henry A. Garrett), from whom copies of specifications and conditions may be obtained. Tenders to town clerk, Town Hall, Torquay, before noon Sept. 12. See also advertisement.

Stoke-upon-Trent Guardians invite tenders for two 13 H.P. and one 2 H.P. electric motors, electric cable, piping and tubing, junction boxes and frames. Tenders to the clerk (Mr. C. Daniel) by 24th inst.

Tenders are wanted by 22nd inst. for wiring the *Batley* working men's club premises.

Bristol Electrical committee require tenders by Sept. 1 for foundations, culverts, subways, &c., at Avonbank electricity works.

Tenders are required by Sept. 1 for the supply of 70 tons 4mm. galvanised iron wire at the upset price of 570 pesetas (£16) per ton and 10 tons 2mm. bronze wire at the upset price of 3,300 pesetas (£94) per ton for the Telegraph Section of Posts and Telegraphs, *Madrid*. Local representation is necessary.

TENDERS RECEIVED AND ACCEPTED.

Bristol Corporation have accepted the following tenders :—

For E.H.T. switch gear, Siemens Brothers & Co. The other tenderers were :—Johnson & Phillips, Ferranti Limited, Cowans Limited, Dick, Kerr & Co., British Thomson-Houston Co., British Westinghouse Co., and Kelvin & James White.

For H.T. switchgear, Siemens Brothers & Co. Also tendered :—British Thomson-Houston Co., Dick, Kerr & Co., Ferranti Limited, Johnson & Phillips, Cowans Limited, British Westinghouse Co, and Kelvin & James White.

For water-tube boilers, Babcock & Wilcox. Tenders were also submitted by Stirling Boiler Co., B. R. Rowlands & Co. and E. Danks & Co.

For motor-generators, Bruce Peebles & Co. Tenders were also submitted by Vickers, Sons & Maxim, International Electric Co., Electric Construction Co., Siemens Brothers & Co., Richardsons, Westgarth & Co., General Electric Co, Crompton & Co., Electrical Co., Dick, Kerr & Co., Brush Co., British Thomson-Houston Co., Mather & Platt, British Westinghouse Co., and Phœnix Dynamo Co.

For turbo-alternators, Willans & Robinson and Dick, Kerr & Co. Tenders were also received from Siemens Brothers & Co., British Thomson-Houston Co., Richardsons, Westgarth & Co., British Westinghouse Co., Brush Co., C. A. Parsons & Co., Bruce Peebles & Co., and Mather & Platt.

For E.H.T. transformers, British Electric Transformer Co. Also tendered :—British Thomson-Houston Co., International Electric Co., Johnson & Phillips, Ferranti Limited, Electric Construction Co., British Westinghouse Co., Crompton & Co., John Fowler & Co., Burnand Transformer Co, Dick, Kerr & Co., Brush Co., and the Electrical Co.

For E.H.T. cables, Siemens Brothers & Co. Also tendered :—British Insulated & Helsby Cables (Ltd.), Western Electric Co., W. F. Dennis & Co., Callender's Co., W. T. Henley's Co., St. Helens Cable Co., and W. T. Glover & Co.

Messrs. W. T. Glover & Co., Trafford Park, Manchester, have secured from the Johannesburg Municipality the contract for supplying and laying their Diatrine paper lead-covered, Diatrine paper leadless, and vulcanised rubber cables. The total value of the contract will be considerably over £100,000.

The Admiralty have placed orders with Edward C. Herbert (Ltd.) for a number of eccentric sawing machines, and the company have in hand machines for the dockyards at Chatham, Devonport, Sheerness, Portsmouth, Pembroke, Haulbowline, Gibraltar and Malta.

The Lancashire Dynamo & Motor Co. have received (through the Hart Accumulator Co.) an order for a large automatic reversible booster for the Bradford tramway service.

The Howard Conduit Co. have secured an order for all the troughing required in connection with the contract for cables for the Acton electricity scheme recently secured by the St. Helens Cable Co (Ltd.).

Aberdeen Corporation have accepted the tenders of J. & A. Davidson, the Aberdeen Coal Co., W. M. Brechin and Geo. Elsmie & Son for the supply of 12,000 tons of coal for the electricity department.

The following tenders have been received for the supply of electric fans and electric light fittings for Surbiton Council offices :—

Surbiton Electricity Supply Works (*accepted*), £95; Guilford & Co., £147; Donnison, Sillem & Co., £123; and Roger Dawson (Ltd.), £93. 16s. 8d.

Mexborough Council have accepted the tender of Babcock & Wilcox for pipe work at £118, that of Holden & Brooke for a steam dryer at £18. 1s., and that of Taylor & Sons for a Lancashire boiler at £530.

Warrington Corporation have accepted the tender of Babcock & Wilcox for four mechanical stokers at £957 and that of Bell Bros. for water-softening plant at £450.

Loughborough Corporation have accepted the tender of Ed. Bennis & Co., Bolton, for two mechanical stokers, with driving shaft and 2½ H.P. motor, for the electricity works at £320. 7s. 10d.

Hackney (London) Guardians have accepted the tender of W. Wallace & Co. for fitting up electric fire alarm bells at their Homerton establishments.

Hants County Council have accepted the tender of Dicks & Son for wiring the Assize Courts, magistrates' room, library and cells at £280, and for altering the fittings at the judge's lodgings at £24.

Bermondsey (London) Council have accepted the tender of Sunderland & Co. for wiring the staircase and courtyards of Fulford-street dwellings at £138.

Ossett Council have placed an order with Meldrum Bros. for an engine, boiler, &c., for their destructor works.

Warrington Council have accepted the tender of the National Telephone Co. for telephonic installation at the fever hospital at £42.

BUSINESS NOTICES.

The National Fan & Motor Co. (Ltd.) have started in business at East Bog, Bo'ness, N.B., as manufacturers of dynamos, electric motors, ventilating fans and blowers.

Messrs. A. V. Swaebe and David Hertzberg, electrical engineers, Cape Town, have dissolved partnership. Mr. Hertzberg continues.

Messrs. J. Hall and A. Hackblock, electrical engineers, Ipswich and Lowestoft, have dissolved partnership.

Messrs. J. M. Hewitt and W. G. Rhodes, consulting electrical and mechanical engineers, Tower Chambers, Brown-street, Manchester, have dissolved partnership.

Messrs. Roberts & Co., parliamentary agents, have removed to 11, Carteret-street, Queen Anne's Gate, London, S.W.

BANKRUPTCIES, LIQUIDATIONS, &c.

In Leeds Bankruptcy Court on Monday a receiving order was made, on the creditors' petition against James William Hunter, trading as the Yorkshire Motor Car & Electrical Engineering Co., at 101 and 103, Kirkstall-road.

W. C. Mower, electrical agent, 101, Unthank-road, Norwich, has been adjudicated bankrupt. First meeting of creditors 24th inst. at 8, King-street, Norwich, public examination, same date, at Shire Hall, Norwich.

At Liverpool Bankruptcy Court on Wednesday, last week, John James de Lacy and Howard Ryan de Lacy, trading as De Lacy Bros., electrical engineers, Liverpool, appeared for their adjourned examination.

The Johnson Electro-Germicide Synd. (Ltd.) is to be wound up voluntarily, and Mr. S. L. Jones, 25, Ladbroke-grove, London, W., is liquidator.

A meeting of the British Electromobile Co. (Ltd.) will be held on Sept. 21, at 25, Abchurch-lane, London, E.C., to receive an account of the winding-up.

An order has been made appointing Messrs. W. E. Clark, W. B. Law and C. H. Lea as a committee of inspection to act with the official receiver and liquidator in the winding-up of the Electro-Voelker Synd. (Ltd.).

On Friday, Max Margowski, managing director of the Automatic Telephone Co. (Ltd.) (in liquidation) and a director of public companies, applied for his discharge. Including proofs for £8,163. 10s. 3d. admitted, the claims, it was said, would probably amount to £8,800. 10s. 3d., while the assets (estimated at £651) had realised only £1. 0s. 1d.! An adjournment was asked for on

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behalf of the trustee, as there were matters under inquiry with reference to transactions between the bankrupt and his wife. The hearing stands over until Oct. 28.

Water Power for Disposal.—Valuable water power (about 400 H.P.), adjacent to important seaport town, is advertised for disposal by Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C. There are numerous buildings, which may be converted for almost any trade, together with cottages and managers' residences.

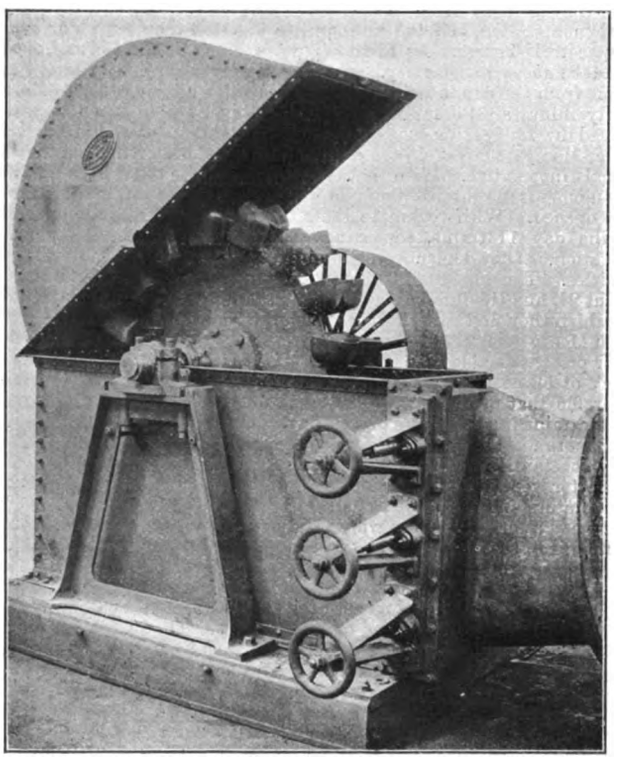
Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 80, Birley-street, Blackpool.

Mr. Thomas Johnson, Prescott-street, Wigan, has for sale some electrical generating plant, further particulars of which are set out in an advertisement.

Lawrence's Stores (Ltd)., Bracknell, Berks, have some electric lighting plant for sale. See advertisement.

Bristol Corporation have for immediate disposal two Lancashire boilers, four 210kw. and two 88kw. Siemens alternators and one 52kw. Siemens-Willans direct-current generator, a quantity of steam and water valves, piping, &c. Offers to the city electrical engineer, Mr. H. Faraday Proctor, by Aug. 30.

Pelton Water Wheels.—Mr. Percy Pitman, of Ledbury, sends us some pamphlets on Pelton water wheels of his manufacture. He makes a speciality of high-pressure wheels to work off hydraulic



The Pitman Pelton Water Wheel.

power mains and low-pressure motors for use in connection with the ordinary town water supply. Mr. Pitman guarantees a minimum drop of speed of 3 per cent. from full load to no-load when the wheels are fitted with governors, and an efficiency of not less than 75 per cent. The accompanying figure represents a 50 H.P. Pelton wheel running at 135 revs. when consuming 700 cubic ft. of water per minute at a head of 50ft. After entering the inlet pipe, shown at the right-hand side, the water is divided into three streams by three nozzles playing on the wheel. The quantity of water flowing through any of the nozzles is governed by three valves operated by hand. In the motor illustrated, no speed governor is shown, but where this is fitted it is based on the following principle:—Hinged to the end of one of the nozzles is a plate of metal, which deflects more or less the stream of water emanating from this nozzle, thus governing the speed to a nicety. The governor itself is of the centrifugal type, and actuates this device by means of a pair of bevel wheels and worm gearing, the action being such that if the speed is, say, too high, one of the bevel wheels comes into play; but if the speed is too low the other bevel wheel is actuated. Arrangements are made for operating the deflecting plate by hand also. It is not necessary to add that electric generators may easily be directly coupled to such water motors.

Nernst Electric Lamps.—We have received from the Electrical Co., 121-125, Charing Cross-road, London, W.C., a copy of their latest pamphlet on the Nernst lamp, giving illustrated particulars and prices of the various types of these lamps. The company ask us to announce that they have made arrangements with the patentees such that all their customers are fully protected against actions for infringement. By an agreement with the holders of the patents and the different licencees special discounts have been fixed which came into force on 1st inst. The company claim that they keep the largest stock of Nernst lamps accessories and materials in the United Kingdom.

Flame Prevention.—Mr. F. Seaton-Snowdon sends us particulars of flame-preventing compositions supplied in three forms—in powder, starch, and liquid. It is claimed for these compositions that they are cheap, easily and rapidly applied, and that they do not injure the colour, texture, &c., of any material to which they are applied, that they are strongly antiseptic and disinfectant, and that they may be applied to thin woods while *in situ*. It is said that almost any substance can be successfully flame-proofed with these compositions, which are somewhat water repellent. An order has recently been placed with the manufacturers (Snowdon's Flame Preventers Co., 10, Tudor-street, London, E.C.) by Messrs. F. Matcham & Co. for treating the woodwork of the stage of the new Empire at Ardwick! The annual loss caused by fire in the United Kingdom is about £15,000,000 and a large percentage of this could be saved by means of fire-proof structures and materials; consequently, there should be an opening for genuine fire prevention compositions, &c.

Liquid Fuel.—We have received from the Lucal Light & Heating Co., West Regent-street, Glasgow, a copy of the report by Prof. Watkinson on the Lucal liquid fuel burner.

Electric Coal Cutters.—Messrs. John Davis & Son (Derby), Ltd., have forwarded us a copy of a pamphlet giving illustrated particulars of the various coal cutters supplied by them.

Patent Amendment.—The Thomson-Davis Telephone System (Ltd.), 66, Victoria-street, Westminster, S.W., seek leave to amend specification of letters patent No. 12,249 of 1899 granted to Messrs. A. T. M. Thomson and P. Warnford-Davis for "Improvements in Telephone Systems and Apparatus therefor." Particulars of the proposed amendment are set out in the "Illustrated Official Journal" (Patents) of Aug. 10, and notice of opposition must be given within one calendar month of that date.

Catalogues, &c.—Messrs Monté Callow & Co., have issued their 1904 amended price list of "Perfecta" resistance apparatus.

Ernest F. Moy (Ltd.) send us sheets containing particulars and prices of their radial battery regulators.

The International Acheson Graphite Co., of Niagara Falls, N.Y., send us their Bulletin, No. 6, containing suggestions regarding the machining and assembling of Acheson Graphite electrodes for electrolytic and electro metallurgical processes, and also for use as stirring rods, bushings, circuit-breaker contacts, moulds, &c.

Mr. H. R. Worthington, New York, forwards a pamphlet containing a description of the Worthington steam-hydraulic accumulator.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Aug. 10 to 16, with the ports of destination:—

***Africa*—Alexandria, £92; Cape Town, £1,651; Durban, £20; East London, £1,121 (including £137 telegraph material); Port Elizabeth, £133. *Argentina*—Buenos Ayres, £554 (including £400 telegraph cable); Rosario, £106.—*Australasia*—Adelaide, £42; Auckland, £22; Brisbane, £28; Melbourne, £44; Otago, £173; Perth, £16 (telegraph material); Rockhampton £151; Sydney, £357; Wellington, £69. *Belgium*—Ostend, £30. *Brazil*—Rio Janeiro, £230. *British Guiana*.—Demerara, £22. *Ceylon*—Colombo, £29. *China*—Canton, £292. *Germany*—Hamburg, £44. *Holland*—Amsterdam, £72; Flushing, £25; Rotterdam, £40. *Hong Kong*, £45. *India*—Bombay, £52; Calcutta, £2,472 (including £100 telegraph material). *Japan*.—Yokohama, £3,897. *Norway*.—Christiana, £14. *Peru*.—Callao £3.680 (submarine cable). *Portugal*.—Lisbon, £22. *Siam*.—Bangkok, £507. Total £16,052 against £17,823 in the corresponding week last year (Aug. 12 to 18).**

KALGOORLIE ELECTRIC POWER AND LIGHTING CORP. (LTD.)—The directors' report for 1903 states that, although there has been a steady and increasing demand for power, most of the small mines in existence when the supply from a central station was in contemplation had either closed down entirely or suspended operations. For that reason the mines now working were nearly all large undertakings, and negotiations were going on with some of those for the sale of the power remaining at the disposal of the company. A profit of £9,336 was earned after charging all costs of production, maintenance, &c. Since the date of the last report 8,000ft. of new pole lines have been constructed and some 190,250ft. of transmission wire erected, making a total at April 30 of about 35,000ft. of pole lines and 286,850ft. of overhead cable erected.

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PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

June 6, 1904.

12,725 G. D. A. PARR. Leeds. Electro-mechanically operating rail and conductor points on electric tramways and railways from the tram or train.
12,729 R. C. SAYER. Bristol. Electric railways.*
12,737 J. BENTLEY. Manchester. Electric motor for variable speeds.
12,741 H. DU CROS (Société Anonyme des Anciens Etablissements Panhard and Levassor, France). Electric ignition for internal combustion motors.
12,755 J. CARTER and S. H. LEHEUP. Coin-freed apparatus for supplying electricity and for indicating strength of current supplied.*
12,766 J. SAZÉRAT. Apparatus for gripping and cutting submarine cables.*
12,801 W. B. SAYERS. Dynamo-electric machines.

June 7, 1904.

12,821 A. J. WARE. Birmingham. Adjustable standard for holding a glow lamp.
12,822 A. J. WARE. Birmingham. Chain for suspending electroliers.
12,840 D. WELLS. Edinburgh. Electrical train describer or indicator.
12,841 N. A. LYLE. Burglar alarm device.*
12,844 G. FRANKLIN and T. F. FURNIVAL. Bunsen semi-dry battery.
12,860 E. A. CAROLAN (G.E. Co., U.S.) Incandescent lamps and the manufacture thereof.
12,861 B.T.-H. Co. (G.E. Co., U.S.). Electric contact devices.

June 8, 1904.

12,947 S. M. G. TEAL. Current collectors for use in electric traction.
12,949 F. BURKS (C. Roblfs, U.S.). Manchester. Electric apparatus for exercising and therapeutic purposes.
12,966 V. W. DELVES-BROUGHTON. Internal combustion engines (commutators).
12,967 A. E. DEAN. Electrical ignition for explosion engines.
12,970 A. J. WRIGHT. Small dynamos and motors.
12,973 E. I. EVERETT and K. EDGCUMBE. Electrical measuring instruments.
12,974 K. EDGCUMBE and E. I. EVERETT. Recording devices.
12,975 C. HENSHAW. Manchester. Life-guard attachment for electric cars.
12,977 J. J. NYE and M. PECK. Kingston-on-Thames. Telephones.*
13,015 S. G. BROWN. Telegraphy.
13,016 FRANÇOIS LOPPÉ and LA COMPAGNIE GÉNÉRALE D'ELECTRICITÉ DE CREIL. Obtaining a constant potential current from a variable speed dynamo. (Date applied for, Nov. 10, 1903, date of application in France.)* Also No. 13,017 Ditto. (Date applied for, Feb. 20, 1904.)*

June 9, 1904.

13,019 P. J. PRINGLE. Burton-on-Trent. Electrical tramway and railway overhead crossings.
13,040 S. RUSSELL. Walsall. Motor lamps burning electricity.
13,051 M. WALKER. Manchester. Dynamo-electric machines.
13,061 F. O. VAN DE KASTEELE. Voltmeter.
13,072 B.T.-H. Co. (G.E. Co., U.S.). Condensers.
13,073 B.T.-H. Co. (G.E. Co., U.S.). Collector rings for dynamo-electric machines.
13,083 H. J. J. HUMMEL (J. Pintsch, Germany). Electro-magnetic couplings.
13,084 J. B. BUTLER-BURKE. Electric incandescent vapour lamps.

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1903.

6,899 WALKER. Automatic fire alarms and the like.
7,531 ARMSTRONG and ORLING. Signalling through the natural media.
7,773 EKSTROMER and LLOYD. Secondary batteries.
10,236 LAKE (Andriano). Telephone systems.
13,965 ELPHICK. Burglar and fire alarms.
14,062 GUESS. Electrical cash-checking machines.
14,175 LE TALL (Cooper-Hewitt Electric Co.) Mercury vapour lamps and converters for lighting or other purposes.
14,190 BROWN. Wireless telegraphy.
14,247 VON KRAMER. Electrical resistances.
14,363 LAKE (Automatic Telephone Meter Co.). Telephone call recording systems.
14,721 PETER LEONARD and C. H. JONES. Holders for incandescent lamps.
14,770 BURNAND. Electric motors or dynamos.
14,913 MURPHY and TOWNSEND. Arc lamps.
15,199 MARCONI'S WIRELESS TELEGRAPH CO., ASHLEY and HINDE. Induction coils for the ignition apparatus for motors.
15,243 WATKINS (Consolidated Railway Electric Lighting & Equipment Co.). Automatically regulating currents generated by dynamos.
15,247 DARRAH and HACKETT. Incandescent lampholders.
15,514 MEYER. Electric device for indicating fall in level of liquids in closed vessels.
17,229 LUBY and HARRIS. Appliance for gripping and supporting wires of overhead wire systems of electric traction.
18,252 CAROLAN (G.E. Co., U.S.). Speed-regulating governors.
18,731 CROWE. Switches.
18,860 CASSELLA. Switches.
19,015 MARCONI'S WIRELESS TELEGRAPH Co. and PRIDDLE. Contacts especially suitable for induction coils.
19,092 SYKES. Electrical locking apparatus for railway signals.
19,491 FOSTER, GROTE and ELEY. Arc lamps.
19,522 CHITTY. Rotary electric machines.
19,583 DEUTGEN. Flexible conduit for electric conductors.
20,633 and 20,634 CHAMBERS. Attaching insulators to brackets and poles.
21,363 MÉRAN. Accumulators.
21,984 WEAVER. Starting switches for electric motors.
22,674 HARDEGEN. Telephone systems.

COMPANIES' MEETINGS AND REPORTS.

BELFAST STREET TRAMWAYS CO.—At the meeting yesterday (Thursday) the chairman (Mr. Geo. Richardson) said that the bill promoted by the Corporation for the purchase of the company's undertakings had received the Royal assent. He refused to discuss the amount to be paid by the Corporation, as that would have to be determined by arbitration. The best experts available had been retained, and everything possible would be done in the shareholders' interest.

CITY OF YORK TRAMWAYS CO.—At the meeting on Wednesday the chairman (Mr. Joseph Kincaid) stated that the Corporation had approached them with the view of acquiring the lines and he intimated that the directors were willing to meet the Council on fair terms.

GREAT NORTHERN AND CITY RAILWAY CO.—At the meeting on Monday, the chairman (Sir Charles Scotter) said the line was opened the day after they received the Board of Trade authority. There was, therefore, no demonstration, and the consequence was that the opening of the line was scarcely known. As to the actual working of the railway, nothing could be more satisfactory. There has only been one interruption of traffic from the day it was opened. That interruption caused a delay of thirty minutes. So far as they could judge, the failure was entirely caused by rats eating away the rubber insulation of the signal cables under Moorgate-street station cabin, causing a short circuit, rendering the signals inoperative. With that exception, and one other little delay of a few moments, no interruption had taken place in the traffic since the line was opened. With regard to their train service, during the busy times of the day 11 trains, consisting of three and four coaches, were in operation. They had not yet found it necessary to run more than four vehicles. The number of trains in and out of the termini in an hour was about 24, and the interval between the trains was 2½ minutes. The date on which they first ran 11 trains was July 25. The time of the journey from Moorgate-street to Finsbury-park was 13 minutes. For operating their present service they used about 41 coaches; but they had a total in stock of 58 coaches; so that they were amply provided for any increase of traffic that might arise. They had made arrangements to run two-coach trains in the middle of the day. Two were now in operation, and four more would be put into service in September. That would effect a very substantial reduction in working costs. Their tunnels gave ample space for ventilation, and during the late abnormally hot weather the temperature in the tunnels and stations had never risen above 60deg. They had a medical officer whose duty it was to take constant samples of the air in the tunnels, and experiments he had made gave eminently satisfactory results. Their power house had never yet been worked up to its fullest capacity. During the busiest periods only two of their large engines were run at about 60 per cent. of their output, and one engine at 75 per cent. during the period of light service. They were generating a unit of electricity for slightly under 4lb. of coal per hour, which was a very satisfactory figure indeed. The cost of generation at present, including all charges except depreciation, but including maintenance, was slightly under ½d. per unit. He thought, therefore, that a word of praise was due to the electrical engineer and traffic manager (Mr. Brousson) and his staff for that most satisfactory result. The traffic receipts were disappointing, but the traffic was growing. They opened the Highbury station before the lifts were finished, and notwithstanding the public was put to the inconvenience of walking up 70 or 80 steps, they carried from that station between 3,000 and 4,000 passengers a day. He believed the lifts would be in use within the next month. He had just heard that all their difficulties with the Great Northern Co. were settled, and arrangements had been made which would materially affect the prosperity of their line.

MATHER & PLATT (LTD.)—The directors' report for the year ended June 30 states that the net profit, after charging depreciation and directors' remuneration, was £115,178. 19s. 9d., and after adding balance from 1903 (£10,209. 16s. 6d.) the available total was £125,388. 16s. 3d. The preference dividend (paid March 1) for half-year to Dec. 31, 1903, absorbed £9,687. 14s. 2d., leaving £115,701. 2s. 1d. for disposal. The directors recommend payment of dividends of 5 per cent. per annum on preference shares for half-year to June 30 (£10,000) and 7 per cent. per annum on the ordinary shares for the year to June 30 (£28,000) and also a bonus of 3 per cent. on the ordinary shares (£12,000). £50,000 has been transferred to reserve and £15,701. 2s. 1d. forward.

NORTH METROPOLITAN TRAMWAYS CO.—At the meeting on Wednesday the chairman (Mr. Geo. Richardson) said that the major portion of the decrease in traffic receipts was due to a reduction in the average number of cars run, and a reduction of 4 miles in the number of miles open. There was a reduction in the number of miles run of 374,044, and of passengers carried of 6,409,150: the loss in receipts, about £8,000, being accounted for by the bad weather in the first three months of the

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half-year, and increasing competition. The reduction in the rents was accounted for by the disappearance of the 12½ per cent. hitherto paid to the London County Council. That was due to sale of the lines to the Metropolitan Electric Tramways (Ltd.) and to West Ham Corporation. A dividend at the rate of 3½ per cent. per annum was declared.

YORKSHIRE ELECTRIC POWER CO.—The directors' report states that the power station at Thornhill has made rapid progress. The main buildings are roofed, and the chimneys completed. The boilers, with auxiliary machinery, &c., are erected, and will shortly be in working order. Delivery of the electric plant and the laying of mains have begun. Current will be ready for supply to consumers this year. An agreement has been sealed with Mirfield District Council for the supply of electric energy in bulk, and under the agreement large power users will receive a supply direct from the company. The accounts of the Yorkshire Electric Power Synd. (Ltd.) have been closed, and a balance of £223. 16s. 2d. has been repaid to the company.

NEW COMPANIES, STATUTORY RETURNS, LIENS, REGISTERED, &c.

NEW COMPANIES.

GENERATORS LIMITED. (81,816.)—Reg. Aug. 12, capital £5,000 in £1 shares, to acquire business carried on in Manchester by J. M. Wallwin, and to carry on the business of electrical and mechanical engineers, electricians, manufacturers of and dealers in electricity, generator manufacturers, &c. First directors, T. W. Sheffield and J. M. Wallwin (managing). Reg. office, 77 and 78, Trevelyan-buildings, 52, Corporation-st., Manchester.

POLLAK-VIRAG TELEGRAPH SYND. (LTD.) (81,819.)—Reg. Aug. 12, capital £2,500 in £1 shares (300 founders'), to establish, work, control and regulate telegraph and telephone exchanges, &c., to carry on the business of a telegraph, telephone and electric light, heat and power supply company, and to adopt an agreement with H. Strakosch. Reg. office, 120, Bishopsgate-street Within, London, E.C.

MORTGAGES AND CHARGES.

DAVIES, KENT & STEWART (LTD.)—Issue on Aug. 4 of £1,050 debentures, part of series created July 26, 1904, to secure £1,350, charged on company's undertaking and property, present and future, including uncalled capital, if any. No trustees. No previous issue of same series.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—Re-issue on July 6 of £1,600 debentures, part of series created Nov. 19, 1900, to secure £15,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £15,000.

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—Issue on Aug. 4 of a mortgage debenture for £500, part of series created Feb. 18, 1904, to secure £100,000, charged on company's undertaking and property, present and future, except uncalled and unpaid capital. Holder, Admiral H. J. Carr. No trustees. Previously issued of same series, £25,600.

SOUTH LANCASHIRE ELECTRIC TRACTION & POWER CO. (LTD.)—An agreement dated Dec. 23, 1903, and a letter of demand dated July 1, 1904, relating to an exchange of prior mortgage debenture stock for first mortgage debenture stock, securing £47,000 (amount originally represented by first mortgage debenture stock under trust deed dated Jan 28, 1901), have been registered. Property charged, shares in South Lancashire Tramways Co. and Lancashire Light Railway Co., certain lands and hereditaments afterwards acquired by company, and company's other assets, present and future, including uncalled capital. The charge contained herein will be the same (but ranking in priority thereto) as that raised in respect of the first mortgage debenture stock which was secured by trust deed. Trustees, Electric Conversion Synd.

WOKING ELECTRIC SUPPLY CO. (LTD.)—Issue on July 16 of £500 debentures, part of series created Nov. 2, 1899, to secure £25,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £24,150.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26½d. per oz. (Aug. 18). Consols $88\frac{1}{16}$—$88\frac{3}{16}$ for money, 88–88¼ for account; 2½ per cent. annuities 87–87½. Consols Pay Day, Sept. 1; Stocks and Shares Continuation Days, Aug. 29 and Sept. 13; Ticket Days, Aug. 30 and Sept. 14; Pay Days, Aug. 31 and Sept. 15; Mining Share Carry-over Days, Aug. 26 and Sept. 12.

BROWN, BOVERI & CO. AKTIENGESELLSCHAFT (BADEN)—A dividend at the rate of 9 per cent. has been declared for the past year, compared with 7 per cent. for the year 1902-3.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.)—The preference share register will be closed from Aug. 17 to 31 inclusive preparatory to payment of interim dividend for half-year ended June 30 on 50,000 7 per cent. cumulative preference shares.

TYNEMOUTH & DISTRICT ELECTRIC TRACTION CO. (LTD.)—An interim dividend at the rate of 5 per cent. has been declared for the half-year ended June 30.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 13	1,664	+ 292	11	16,420	+ 3,402
Airdrie	,, 5	196	...	26	5,137	...
Ayr Corporation	,, 13	469	+ 90	13	5,480	+ 174
Barnsley	,, 6	185	- 11	31	5,184	- 375
Barrow	,, 5	374	...	26	4,797	...
Bath Electric Trams, Ltd.	,, 10	883	...	33	19,903	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 14	1,058	...	...	...	...
Birmingham Corporation	...	...	...	...	...	...
Birmingham Tramways Co.	,, 13	5,082	+ 259	6	33,861	+ 2,793
Blackburn Corporation	,, 12	1,141	+ 88	20	19,687	+ 1,841
Blackpool Corporation	,, 11	2,588	+ 81	19	28,339	+ 2,606
Blackpool and Fleetwood	,, 13	1,910	+ 161	6	9,124	- 202
Blackp'l, St. Anne's & Lytham	,, 11	1,050	- 45	41	13,782	+ 6,157
Bolton Corporation	,, 14	1,885	+ 76	20	37,719	+ 277
Bournemouth Corporation	,, 10	1,604	+ 166	‡19	22,175	+ 1,468
Bradford Corporation	,, 13	5,116	+ 1,170	19	91,912	+ 16,118
Brighton Corporation	,, 14	1,369	+ 135	19	21,140	+ 1,767
Brisbane Tramways	June 22	2,061	- 24	26	59,267	+ 503
	,, 29	2,096	- 166			
Bristol Trams & Carriage	Aug. 12	5,212	+ 235	12	66,261	+ 209
Buenos Ayres & Belgrano	July 17	3,295	+ 190	13	43,133	+ 2,103
Burnley Corporation	Aug. 13	1,225	+ 311	20	21,318	+ 4,954
Burton Corporation	,, 14	418	- 25	¶19	7,162	...
Calcutta Tramways Co.	,, 13	a86,959	+ a5,054	7	a211,270	+ a25,469
Camborne-Redruth	,, 15	183	+ 9	15	1,772	- 92
Cardiff Corporation	,, 13	2,172	+ 95	19	41,257	+ 1,257
Carlisle Tramways Co.	,, 13	219	- 8	32	6,414	+ 801
Central London Railway	,, 13	5,386	- 152	6	35,680	- 2,022
Chatham & Dist. Lt. Rys.	,, 11	656	+ 10	32	18,842	+ 2,240
City & South London Rly.	,, 14	2,214	- 118	7	16,275	- 928
Colchester Corporation	,, 11	334	...	2	997	...
Cork Electric Trams Co.	,, 11	571	- 75	32	14,854	- 1,806
Darwen Corporation	,, 12	248	- 11	19	4,700	- 108
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 5	773	+ 169	31	16,468	+ 2,648
Dover Corporation	,, 13	317	+ 18	20	4,769	- 142
Dublin & Lucan Railway	,, 12	141	- 50	6	924	+ 59
Dublin Southern District	...	...	...	...	...	...
Dublin United	..	...	...	...	...	...
Dudley—Stourbridge	,, 5	1,606	+ 70	31	26,895	+ 1,064
Dundee Corporation	...	...	...	...	...	...
East Ham Council	,, 13	790	+ 75	19	15,181	+ 1,870
Gateshead & Dist. Trams	,, 5	1,086	+ 53	31	28,047	+ 1,815
Glasgow Corporation	,, 13	14,218	+ 1,421	†11	152,651	+ 6,317
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 5	461	- 9	31	8,011	+ 805
Gt. Northern & City Rly.	,, 13	984	- 7	26	24,818	...
Greenock & Port Glasgow	,, 5	748	+ 92	31	17,650	+ 688
Halifax Corporation	,, 3	2,069	+ 259	19	30 297	+ 2,287
	,, 10	1,977	+ 157			
Hartlepool Tramways	,, 5	498	+ 55	31	9,153	+ 921
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 16	2,190	+ 345	19	42,083	+ 5,504
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	,, 10	151	- 43	19	2,882	+ 112
Ipswich Corporation	,, 13	605	...	19	10,307	...
Isle of Thanet Co.	,, 13	2,072	+ 367	¶46	25,146	+ 201
Kidderminster & District	,, 5	389	+ 26	31	4,048	- 40
Kirkcaldy Corporation	...	...	...	...	...	...
Lanarkshire Trams Co.	,, 11	696	+ 27	32	20,232	...
Leeds Corporation	,, 13	5,834	+ 105	21	119,737	+ 7,112
Leicester Corporation	,, 13	1,727	...	...	...	...
Liverpool Corporation	,, 6	11,764	+ 2	32	330,110	+ 11,082
Liverpool Overhead Rly.	,, 14	1,703	- 56	†7	12,090	- 88
*London County Council	,, 6	15 919	+ 3 711	§19	229 505	+ 44,966
Lowestoft	...	...	...	...	...	...
Manchester Corporation	,, 13	12,594	+ 879	19	238,705	+ 9,002
Mersey Railway	,, 13	1,353	+ 74	6	8,685	+ 502
Merthyr	,, 5	271	- 5	31	6 203	+ 142
Metropolitan Elec. Trams	,, 4	2,495	...	...	...	...
Middleton	,, 5	407	+ 34	31	10,709	+ 178
Nelson Corporation	,, 13	195	+ 31	20	2,383	+ 918
Newcastle-on-Tyne Corp.	,, 13	3,763	+ 132	6	22,649	+ 1,936
Newport (Mon.)	,, 13	546	+ 60	19	10 309	+ 2,016
Oldham, Ashton & Hyde	.. 5	615	- 7	31	16,927	- 778
Oldham Corporation	July 31	1,209	...	32	25,676	...
	Aug. 7	1,279	...			
Perth (W. A.) Elec. Trams.	,, 12	1,293	+ 141	32	42,389	+ 5,518
Peterborough	,, 5	291	+ 18	31	4,709	- 104
Poole and District	,, 5	558	- 19	31	9,128	- 13
Portsmouth Corporation	,, 14	2,774	+ 201	†19	41,974	+ 3,822
Potteries	,, 5	1,582	- 165	31	52,849	+ 4,288
Reading Corporation	,, 11	772	+ 80	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 5	850	+ 3	31	4 596	- 91
Salford Corporation	,, 15	4,021	+ 204	24	81,852	+ 6 239
Sheerness	,, 3	122	- 19	31	1,885	- 436
Sheffield Corporation	,, 14	4,638	+ 308	§20	95,969	+ 2,547
Southampton Corporation	,, 4	1,488	+ 91	11	1,145	- 125
Southend Corporation	...	...	...	...	...	...
Southport Tramways	,, 5	617	+ 84	31	10,054	+ 626
S. Staffordshire Trams.	,, 5	1,117	- 360	31	24,182	- 2,913
Stockport Corporation	,, 12	590	+ 79	19	11,905	+ 5,055
Sunderland Corporation	,, 14	1,424	+ 19	18	25,103	+ 661
Swansea Trams	,, 5	915	+ 13	31	16,956	+ 986
Taunton Trams	,, 5	96	- 54	31	1,741	- 160
Tynemouth and District	,, 5	664	- 46	31	9,136	- 528
Tyneside Trams Co.	,, 10	399	- 10	33	12,290	+ 9,085
Wallasey District Council	,, 13	928	+ 109	§19	15,535	+ 976
Walsall	,, 13	487	...	32	15,590	...
Warrington Corporation	,, 11	334	+ 19	19	6,254	+ 190
West Ham Corporation	,, 11	1,178	...	24	20,357	...
Weston-super-Mare	,, 3	535	+ 93	31	3,489	+ 215
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 5	705	+ 77	31	12,161	- 117
Worcester	,, 5	579	+ 295	26	8,255	+ 3,769
Wrexham	,, 5	153	- 57	31	3,472	- 476
Yorkshire Woollen District	,, 5	751	+ 194	31	18,574	+ 7,794

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 8 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Aug. 17.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS, WEEK TO AUG. 17. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	..	Anglo-Argentine Ordinary Shares	6⅜–6⅝	..	April, Oct	6 5/16	6 1/16
5	2/6	Do. 5% Cum. Pref.	5¼–5⅜	4 10 11	..	5⅜	5⅛
St.	6%	Do. Permanent 6% Deb. Stock	137 –141	4 5 0	..	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	98 –100	5 0 0	..	99¼	..
10	6%	Barcelona Tramways Ord.	9 –10	3 0 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 –10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 –96	4 14 0	..	..	..
100	6%	Do. 5 per Cent. Debs.	96 –99	5 1 0	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	11/16–13/16	..	..	..	..
1	..	Do. 5% Cum. Pref.	7/8–1	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½–2¼	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾–4¼	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96 –101	4 9 3	..	..	..
10	8%	†Bristol Tramways and Carriage Ord.	19 –20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 –10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107 –109	3 13 4	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	97 –100	6 2 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	99 –102	4 18 6	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10½	4 15 3	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝–105⅞	4 6 2	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 –100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	8¾–9¼	6 9 9	..	9 1/16	8 7/8
10	6/0	† Do. 6 per Cent. Cum. Pref.	10¾–11	5 9 1	Feb, Aug	11 1/16	10 15/16
St.	5/0	Do. 5 per Cent. Perpetual Debs	116 –119	4 5 1	..	118½	117⅜
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	95 –98	..	..	97	96½
5	3/0	Buenos Ayres and Belgrano Ord.	2¾–3⅛	4 16 0	..	3 1/16	3
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼–5⅝	5 4 4	..	5 3/16	..
5	3/0	Do. "B"	5 –5⅛	5 9 1	..	5 1/16	..
St.	5%	Do. 5 per Cent. Debs.	105 –108	4 12 8	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	101 –104	4 16 6	..	..	..
5	3/6	Calcutta Tramways	7¼–7⅜	3 17 6	..	7⅜	7⅜
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 –108	4 3 3	..	105	..
1	1/0	Cape Electric Tram Shares	1⅜–2	5 0 0	..	..	..
St.	4%	†Central London Ordinary Stock	87 –89	4 9 11	June, Dec	87½	..
St.	4%	† Do. 4 per Cent. Pref. Stock	100 –102	3 18 3	..	..	..
St.	4%	Do. Deferred Stock	80 –82	4 17 7	..	81	..
100	4%	Do. 4 per Cent. Debs.	106 –109	3 13 5	..	108	107¼
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½–5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 –101	3 19 2	..	42¾	41½
St.	2½%	†City and South London Rly. Con. Ord.	40 –42	5 7 2	Feb, Aug	..	..
St.	5%	† Do. 5 per Cent. Perp. Pref. (1891)	121 –124	4 0 8	Feb, Aug	..	..
St.	5%	† Do. (1896)	118 –121	4 2 8	..	120	..
St.	5%	† Do. (1901)	117 –120	4 3 4	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	105 –108	3 14 9	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 –103	4 17 10	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½–13½	4 8 11	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	..	..
10	1/8⅓	Gt. Northern & City Rly. Prf. Ord. (4%)	4 –4½	..	..	..	..
10	4/0	†Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 –10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19½–20½	4 17 7	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 –14½	4 2 9	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 –110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 –91	4 7 11	..	..	..
10	1½%	†Liverpool Overhead Railway Ord	3⅛–3⅜	3 9 9	Feb, Aug	..	..
10	5%	† Do. 5 per Cent. Pref.	9⅜–10½	4 17 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10⅛–10⅜	4 13 0	..	10⅛	10 1/16
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 –105	3 16 4	..	104	103
St.	..	Mersey Con. Ord. Stock	6 –9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 –15	..	..	..	..
1	..	Metropolitan Electric Trams Def	13/16–15/16	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	¾–1	5 0 0	..	..	..
St.	13/7	Do. 4½% Deb. Stock	97 –100	..	..	19	98½
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1968)	102 –105	4 16 0	..	103	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 –105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 –2	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 –102	4 18 1	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 –9	5 11 2	..	..	..
10	5/0	† Do. 5 per Cent. Cum. Pref.	8⅛–9⅛	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 –104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	†Waterloo and City Ord.	87 –90	3 6 8	June, Dec	87	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	†Alliance E ec. Co. 5% Cum. Pref.	⅝–¾	8 0 0	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	¼–⅜	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾–6¼	6 8 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¼–6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 –104	4 6 7	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 –103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	2¾–3¼	9 4 6	..	3	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	85 –88	4 10 11	..	..	..
2	..	Brush Electrical Engineering	½–1	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1 –1⅛	8 0 0	Mar, Sept	1 3/32	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 –99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	71 –76	5 18 4	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½–10½	5 14 3	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	101 –105	4 5 8	Nov, May	..	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	⅝–¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 –93	4 16 10	..	..	..
1	1/2⅔	Chadburn's (Ship) Telegraph Ord.	⅞–1⅛	8 0 0	..	..	..
3	1/6	†Crompton and Co. (Nos. 1 to 54,000)	1½–2	3 15 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	94 –97	5 3 6	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7½–8	..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5¼–5⅝	5 4 4	..	..	..
St.	4½%	Do. 4½% Deb. Stock	102–105	4 6 0	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½–¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 –2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 –82	4 18 1	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 –83	6 3 8	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6 –6½	5 12 0	Half-yearly	6⅛	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅜–6	5 0 0	..	6	5⅞
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 –107	4 4 0	..	..	..
2	1/7½	Electric Construction Co.	1 –1½	6 8 0	July	..	..
2	2/9⅓	Do. 7 per Cent. Cum. Pref.	2 –2½	5 12 0	July	2½	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	96 –99	4 0 9	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 –9½	5 5 3	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 –98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	11 –12	6 5 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 –5½	4 1 10	Feb, Aug	5 3/32	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 –111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½–19½	5 2 6	Feb, Aug	..	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 –103	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½–11	4 10 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	35 –38	6 6 2	Mar, July	38	35
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 –103	3 18 0	Jan, July	103	100
5	..	Willans and Robinson Ord.	2 –3	..	..	..	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Aug. 17.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS, WEEK TO AUG. 17. Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d.			
1	..	Blackheath & Gr'nwich. Dist. Ord. (f.p.)	⅛–¼	..	..	..	..
1	0/8⅓	Do. 7% Cum. Pref.	1⅛–1⅜	5 1 9	..	..	..
St.	..	Do. 4½ 1st Db. Stk. Prv. Cts. (rd.&con.)	102 –106	4 5 3	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½–12½	6 8 0	..	..	..
10	4/6	† Do. 4½ per Cent. Cum. Pref	9½–10½	4 5 9	..	..	..
10	6/0	† Do. 6% Cum. Second Pref.	10½–11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 –105	4 6 3	..	..	..
5		Bromley (Kent) El. Lt. & Power Shares	5½–6	..	..	..	..
St.	4½%	Do. 1st Debs	100 –103	4 7 5	..	..	..
5	4/6	†Brompton & Kensington Elec. Sup. Ord.	10⅜–11½	4 8 11	..	11	..
5	3/6	† Do. 7 per Cent. Pref.	10¼–10⅜	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7¼–7⅜	4 10 5	..	7⅜	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 –109	3 13 11	..	106⅛	..
5	4/0	†Charing Cross & Strand Electric Sup.	7⅛–8	5 0 0	Feb, Aug	7⅛	7 1/16
5	2/3	Do. 4½ per Cent. Pref.	5⅛–5⅜	4 3 7	Feb, Aug	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅜–5	4 10 0	..	..	..
5	2/3	Do. Do. (1903)	4⅜–5	..	..	4 1/16	..
St.	4%	Do. 4% Deb. Stock (red.)	102 –104	3 17 0	..	..	..
5	3/6	Chelsea Electric Supply Ord.	6¾–7	4 2 2	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –109	4 2 6	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10¼–10⅜	4 13 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	120 –125	4 0 0	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 –105	4 5 9	..	102½	..
10	4/0	†County of London Elec. Supply Ord.	7⅛–8⅛	4 14 3	..	..	..
10	6/0	† Do. 6 per Cent. Cum. Pref.	11 –12	5 0 0	Mar, Sept	11 1/16	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	105 –108	4 3 6	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 7 10	..	102½	102
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 –93	5 7 6	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅜–6½	4 8 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 9	..	..	..
10	..	Havana Electricity Co. Shares	9½–10½	..	..	..	..
5	5.0	Hove Electric Lighting Ord.	7½–8½	5 0 0	..	..	..
St.	4½%	I of W. Elec Lt. & Power 4½% Db St (red.)	101 –103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅜–7/16	..	..	..	..
5	5/0	Kensingtn & Knghtsbdge Ord.	12 –13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 –105	3 16 6	..	..	..
3	..	London Electric Supply Ord.	1¼–1⅜	..	..	..	..
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 9 1	..	5¼	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 –99	4 1 6	Mr, Jn, S, D	97	96⅛
10	9/0	†Metropolitan Electric Sup. Ord.	15½–16½	5 9 0	April, Oct	16⅜	15⅝
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅛–5⅜	4 1 10	Jan. July	5 1/16	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	4 0 0	Jn, Dec ..	113	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	86 –99	3 10 6	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93 –96	4 13 9	..	..	..
10	6.0	Notting Hill Electric Ord.	14 –15	4 0 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	100 –103	3 18 3	..	..	..
5	4.0	Oxford Electric Ord.	5⅜–6½	5 4 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	97 –100	4 0 0	..	..	..
1	..	Rand Electric	1 –1⅛	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 –103	4 7 9	April, Oct	..	..
5	5.0	St. James' & Pall Mall Elec. Ord.	14 –15	4 16 8	Feb, Aug	..	..
5	3.6	Do. 7 per Cent. Pref.	8 –9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 –100	3 10 2	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¾–3¼	6 3 1	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 –88	4 10 11	..	..	..
5	3/0	South London Electric Supply Ord.	3⅜–4¼	3 10 7	..	3⅜	..
5	2/6	Urban Electric Supply Ord.	4½ 5	5 0 0	..	4 3/32	..
5	2/6	Do. 5% Cum. Pref.	4⅜–5¼	4 15 3	..	..	..
5	6/6	Westminster Electric Supply Ord.	12½–13½	5 0 0	Mar, Sept	13	1 3/8
5	2/6	Do. 5 per Cent. Cum. Pref.	6 –6½	3 16 11	..	..	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	97 –101	3 19 2	Jan, July	..	..
10	..	Amazon Telegraph	2½–3½	..	Jn. Dec ..	..	..
St.	12/6	Anglo-American	46 –49	5 18 9	F, My, Ag, N	..	..
St.	25/0	Do. Preferred	90 –92	6 0 8	F, My, Ag, N	90½	90
St.	2/0	Do. Deferred	7 –7⅛	1 6 8	F, My Ag, N	7⅛	6⅞
100	£2	Commercial Cable Capital Stock	170 –180	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 –96	4 3 6	Jn Ap, Jy, O	95½	95⅛
10	5/0	Cuba Submarine Ord.	7 –8	7 10 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15 –16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½–3⅛	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 –8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅝–101⅝	4 9 2	Jan, July	..	..
20	3/0	Direct United States Cable	10 –10½	5 14 3	Ja, Ap, Jy, O	10½	10⅜
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 –101	4 9 2	Jn, Dec ..	127	125
St.	65/0	Eastern Ordinary	124 –129	5 8 6	Ja, Ap, Jy, O	88⅜	..
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 –90	3 18 6	Ja Ap, Jy, O	106¼	105⅛
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 –108	3 14 6	May, Nov	12⅛	12 1/16
10	2/6	Eastern Extension	11⅜–12⅛	5 14 3	Ja, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	103 –106	3 15 6	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	99 –102	3 18 9	Feb, Aug	101⅛	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100⅝–103⅝	3 18 6	May, Nov	..	..
10	5.0	Gt. Nrthn. (of Copenhagen)	25½–26½	5 13 2	Jan, July	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 –101	4 9 2	June, Dec	..	..
25	37/6	Indo-European	43 –46	5 8 9	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 –100	4 0 0	June, Dec	..	..
10	6/0	West African Telegraph Shares	6 –7	5 14 3	..	..	..
2½	..	West Coast of America	13/16–15/16	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	16 –99	4 1 3	Jan, July	..	..
10		West India and Panama	⅜–½	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½–6¾	8 17 9	May, Nov	..	..
10		Do. 6 per Cent. 2nd Pref.	5 –6	..	May, Nov	..	..
*	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 1	Jan, July	..	..
10	3/C	Western Telegraph	12 –12½	5 12 0	Mr, Jn, O, D	..	..
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 –104	4 16 3	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99 –102	3 18 5	..	99½	..
		TELEPHONES.					
5	4 0	Chili Telephone (fully paid)	5 –5½	6 7 3	August ..	..	..
1	7½	Monte Video Telephone Ord.	7/8–15/16	..	..	..	..
St.	6%	National Co. Pref. Stock	104 –106	5 13 9	..	105½	104½
St.	5%	Do. Def. Stock	88 –91	5 10 0	..	89	86½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 –14	4 5 8	Feb, Aug	12	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 –13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅛–5⅜	4 13 0	Feb, Aug	5⅜	5⅛
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 –99	3 10 8	June, Dec	98⅜	98⅛
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 –105	3 16 2	..	104⅛	104
..	5/9	Do. Do. Prov. Certs. 35% to be pd.	65 –67	..	..	66¼	65½
1	0/8⅔	Oriental	1/16–1 1/16	6 6 3	April, Oct	1	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 –1⅛	6 4 6	..	..	..
5	5/0	United River Plate	6 –6½	6 3 3	July.....	6¼	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅜–5⅛	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 –106	4 14 4	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5¼–5½	6 14 4	..	5⅜	5⅛
10	2/0	Globe Telegraph and Trust	8¼–9¼	5 19 0	Ja Ap Jy O	8⅜	8⅛
10	6 per Cent. Pref.	13½–13⅝	4 7 2	Ja Ap Jy O	13⅜	13⅛

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THE ELECTRICIAN:

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NOTES.

We publish this week a draft of the revised Board of Trade Regulations under the Electric Lighting Acts. In accordance with the recent custom with regard to regulations directly affecting the electrical industry, a draft has been issued before the Regulations are finally "made" by the Board of Trade. This draft is being circulated among those who are interested in the matter, so as to give them an opportunity of suggesting any improvements or pointing out any ambiguities. We are confident that suggestions of this nature, if made by those who are in a position to speak authoritatively on the subject, will be received with every consideration by the broad-minded electrical adviser to the Board of Trade (who, by the way, desires to receive them by October 21st). The new Regulations, however, show evidence of such extreme care and thought in their production, and their publication has been made only after such prolonged deliberation, that we think there will be little general desire for their further amendment except perhaps in the way of mere verbal alterations.

The main change in the Regulations consists in the embodiment of a number of the supplementary rules and memoranda, either issued by the Board of Trade or included in the officially "approved descriptions" of the schemes that have obtained sanction during the past few years. Thus the rules as to the use of motors on consumers' premises at pressures between 250 and 650 volts are embodied with but little alteration from the form already familiar to central station engineers, and the conditions under which earthing is allowed are also included. The same "medium" pressure permitted for consumers' motors may also be employed for arc lamps and incandescent lamps in series; and in all three cases the joint application to the Board of Trade by consumer and undertaker for permission to utilise it is to be dispensed with. An important innovation is Regulation 3, by which it will be permitted, subject to special regulations to be prescribed by the Board of Trade and the Home Office, to deliver supply at extra high pressure to a factory, mine or electric traction works. It is not quite clear, however, whether the amended regulations for high pressures apply generally to extra high pressures also, or whether supplementary rules with regard to mains, sub-stations, &c., used with voltages above 3,000, are to be issued as hitherto. The specification as to thickness of insulation for high-pressure cables is omitted, a pressure test being deemed sufficient precaution, coupled with the warning that no high-pressure line is to be brought into use until it has been formally handed over by the contractors, and that if high and low-pressure lines pass through the same street-box they shall be readily distinguishable from each other. The maximum power that may be transmitted by each high-pressure cable without special sanction has been increased from 300kw. to 500kw., and consent of the Board of Trade must also be obtained before street-box transformers of over 30kw. in size may be employed, or underground sub-stations of a greater capacity than 75kw.; but "sub-stations shall be erected above ground wherever possible."

In the rules as to earthing the middle wire of a three wire system, it is made clear that this is to be done at one point only, and that the current flowing from the middle wire to earth at this point is not to exceed one-thousandth part of the maximum supply current. On such systems it is laid down that if the districts of the network are interconnected, this is to be done only through fuses or circuit-breakers—a wise rule, but one that we fear will give rise to some opposition

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Trouble, we know, has occasionally been experienced with fuses in network boxes, but this can always be overcome by a suitable design of box. No fuse is to be allowed on the middle wire in service boxes, however.

It will be seen that the B Regulations, "For ensuring a Proper and Sufficient Supply of Electrical Energy," have been almost re-written, but their effect is in the main the same as before. A fault in the old Regulations was that nothing had been said to prevent the electrical engineer from changing the polarity of his mains or the frequency without consulting the consumer or the Local Authority which looks after his interest. Now, the same formalities will have to be gone through in the case of change of frequency or polarity as in the similar case of change of "declared" pressure. A 2½ per cent. variation in the "declared frequency" will be allowed. In the course of these notes, we have naturally not been able to refer to all the alterations which are proposed, and we recommend a careful perusal of the Regulations themselves.

The strange fatality on the mains of the Metropolitan Electric Supply Co., of which particulars are given on another page in our report of the inquest, should receive the attention of mains engineers. Some portions of the Company's network are still run at 1,000 volts alternating, the current from Willesden being transformed down to this pressure by transformers the middle point of whose secondary is earthed. Thus both conductors are charged at 500 volts, and a man standing on the ground and making good contact with one of them would receive a severe shock, as the current is alternating. It is only in exceptional circumstances, however, that such a shock would be attended with fatal results. In this particular case two men were engaged in cutting through an iron pipe containing a live cable, the chisel was allowed to penetrate to the conductor, and the man holding the chisel received a fatal shock. Although the man must have been shunted by a circuit of low resistance, it is evident that this short-circuit was not bad enough to actuate instantaneously the fuse or cut-out at the sub-station, with the result that a sufficiently high pressure was maintained between the cable and earth to kill him. Possibly the man had a weak heart or was abnormally sensitive to electric shock, but there is no evidence on this point. Although there has been a 1,000-volt alternating-current fatality before in connection with the Company's system, a case similar to this one has not occurred before. We believe that the network in question is gradually being replaced by one more consistent with modern practice, and, in the meantime, the Company's main superintendent has issued an order that in future all pipe-cutting on live circuits is to be carried out with rubber-gloved hands.

The public has been able to glean no new facts, and the daily Press no fresh sensation from the Board of Trade reports upon the recent live rail fatalities. Still, it is none the less evident that the matter is one with regard to which energetic and immediate action is necessary. Although in two cases the persons who met their death were trespassing, it is evident that those who commit such a trivial offence have not sinned so grievously as to deserve summary extinction Doubtless there may be some engineering and financial objections to a guard plank being fixed all the way along the third rail, but we think that too much importance was attached to these in the evidence given by Mr. C. H. Merz at one of the inquiries. There is evidently no valid reason why guard planks should not be fixed at points where there is a large amount of pedestrian traffic, such as in shunting yards and places where people are in the habit of trespassing. Of course, this precaution has already been taken near level crossings and stations, and its employment should be more extended. It must be admitted, on the other hand, that the railway companies are in no sense, either legally or morally, bound to protect the live rail over the whole length of their line, nor is there any necessity for them to go to great expense in providing extra-high fencing. Persons who walk along or across a steam railway have now become educated up to looking out for expresses, and in the course of time they will, doubtless, learn to regard the third-rail as being equally dangerous.

The annual report of Mr. G. Scott Ram, electrical inspector of factories, contains several interesting points which are well worthy the consideration of electrical engineers engaged in active practice. Mr. Ram calls attention to the common practice of cleaning and carrying out repairs on switchboards and apparatus which are supposed to be dead, but are in reality very much alive. He, together with many others, is of the opinion that the "negative" methods of finding out whether a conductor is alive or dead are by no means perfect, and that some more reliable way ought to be employed. Mr. Ram suggests the reasonable precaution that sub-station 'bus bars should always be definitely connected to earth before work is commenced on them. He is also strongly in favour of "remote control" switchboards, and in this respect will probably receive almost unanimous support, as the remote control board for extra high-tension working is much to be desired, provided too many complications are not introduced. With regard to overhead electric cranes Mr. Ram advocates earthing the entire framework, and there is apparently no reason why this suggestion should not be carried into effect. Certainly, the crane-driver's occupation is not an enviable one, and his lot should, therefore, be made as easy as possible. We fear, however, that some difficulty will be experienced in persuading those who are responsible for the design of central stations to leave sufficient room between the roof and the crane for trolley wires to be fixed out of reach of a man standing upright. If they are not fixed out of reach then their best place is at the side, as usual, because, in walking about on the top of a crane some 30ft. or 40ft. above ground, a man does not keep his eyes fixed on the roof, and he is, therefore, more liable to make accidental contact with bare wires overhead than if they are safely out of the way at the side. The idea that the door of the crane cage should operate the motor switch is an excellent one, and will effectually prevent the recurrence of such an accident as is described by Mr. Ram; but a no-voltage release attachment to the ordinary switch will answer the same purpose, and should, in fact, be applied to all electrical hoisting or hauling gear worked by three-phase motors, just as it must be when continuous-current shunt motors are employed.

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LOCAL authorities are apt to view with alarm anything that may tend to obstruct traffic in their principal streets, and it is, therefore, no matter for surprise that the Westminster City Council should have sought to impose restrictions as to the hours during which the electricity supply companies should be permitted to open the street boxes on their networks. The regulations which the Council sought to impose, however, were unreasonable on the face of them, as they left very few hours of daylight during which work could be done in the boxes. At a conference at the Board of Trade, Mr. BONAR LAW, who presided, suggested a compromise; but as is shown in the report of the subsequent correspondence on p. 739 of this issue, the Westminster authorities adopted such an immovable position that no agreement could be arrived at. The Board of Trade, therefore, has simply refused to sanction the regulations which the Westminster City Council had drafted. A similar conference is shortly to take place with regard to the City of London, the parties being the City Corporation on the one hand, and the City of London Electric Lighting Co. and the Charing Cross & Strand Electricity Supply Corporation on the other. We trust that the City Corporation will be more amenable to reason than their neighbours in Westminster. Some regulations are doubtless advisable to prevent the too frequent opening of surface boxes and the consequent disorganisation of pedestrian and vehicular traffic, but it must not be forgotten that the continuity of a city's electric light and power supply is still more important, and nothing should be done which would hamper the companies in carrying out their statutory obligations.

IT appears that American railways, as well as English, feel tramway competition to a considerable extent, but they are endeavouring to meet it in quite an original way. Instead of "electrifying" their own lines, they are buying up the electric lines which run parallel to their own steam routes. This is doubtless excellent for the railways, but it is by no means clear that it will be equally beneficial to the public. Moreover, it appears that such procedure would not be possible, or at any rate feasible, in England, owing to a large number of the tramway undertakings being worked and owned by municipalities. By means of an Act of Parliament, however, a municipal tramway could be leased to a railway company, and an arrangement could be arrived at similar to that existing between the Middlesex County Council and the Metropolitan Electric Tramways (Ltd.) But local authorities have learned too well the value of electric tramways to allow them to pass out of their hands so easily, and to hand them over to competing railway companies would certainly not tend to increase travelling facilities. The only remedy for the railways, therefore, is "electricification," and this fact is receiving greater recognition every day.

An Electrically-propelled Dining Car.—According to the *Electrical Review* of New York, a trolley dining car is to be established by the Aurora, Elgin and Chicago Railway Co. This car will be at first available only for special parties, but eventually it will be placed in general service, making four runs daily between Chicago and the Aurora and Elgin terminals. The car was built at an expense of $12,000, and is named the "Carolyn." 28 persons can be accommodated.

Automobile Trials.—Trials of small motor cars are to be held at Hereford from Monday next to the following Saturday, under the auspices of the Automobile Club. There will be 12 non stop runs of 50 miles each. As, however, the cars which compete have to be of a value of £200 or less, no electric or petrol electric vehicles are taking part in the competition.

Cable Interruptions and Repairs.

	Date of Interruption	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Cayenne—Paramaribo	July 13, 1904 ..	—
Marseilles—Barcelona	Aug. 16, 1904 ..	Aug. 22, 1904
Cap Haitien—Mole St. Nicholas	Aug. 20, 1904 ..	—

Opening of the Dorking Electricity Works.—The Dorking electricity works, an undertaking of Edmundson's Electricity Corp., was opened on Aug. 9. It supplies electricity for lighting purposes, the distribution being on the three-wire system, with 500 volts between the outers. Some 4 miles of conductors, supplied by Callender's, have been laid so far, all on the solid system. The principal items of the power plant in the station are:—Two B. & W. boilers capable of evaporating together 8,400lb. of water per hour; two Belliss steam engines of an aggregate power of 290 H.P., working non-condensing; two Parker 90kw. dynamos, generating continuous current at 500 volts; and a battery of 400 ampere-hours capacity, consisting of 260 D.P. cells. Mr. L. Smith is the resident engineer.

Visit of Belgian Engineers to London.—On Monday and Tuesday, September 12th and 13th, a visit is to be paid to London by a large party of Belgian engineers, members of the Association des Ingénieurs Sortis de l'Ecole de Liège. The party, which will number about 200, will be the guests of the Iron and Steel Institute, which was hospitably received by the Belgian association as far back as the year 1873 and again in 1894. During their stay in London the Belgian engineers will visit the National Physical Laboratory, the Royal Mint, the works of Messrs. Fraser and Chalmers at Erith, those of the Temperley Transporter Co. (Ltd.) and other establishments. On the evening of the 12th they will visit the Earl's Court Exhibition, by invitation of the management, and on the following evening they will be entertained at dinner at the Hotel Cecil by the members of the Iron and Steel Institute, upon which occasion about 400 persons will be present.

Long-distance Run on an Electric Car.—On July 22nd a remarkable ride was made in which, on one charge, an electric car ran from Providence to Boston (U.S.A.) and returned—a distance of probably 105 miles. It is stated by the *Electrical Review* of New York that the distance from Providence to Boston was covered in 3½ hours, at about the rate of 15 miles an hour; the trip was made without accident and the hill-climbing done easily. Three consecutive hills, a distance of 1¼ to 1½ miles, were covered in 10½ minutes. The current rose to 65 amperes, and on the heaviest part of the incline to 76 for about half a minute on each hill. For the hills the average demand was from 50 to 55 amperes, the average on the level being from 22 to 25. 2 volts per cell were recorded at the end of the trip, so that it would have been possible for the vehicle to run another 15 or 20 miles. The weight of the battery of 42 cells was 1,219lb., and of the battery and carriage together a trifle less than 2,000lb.

Telegraphic Cable to Iceland.—The *Times* announces that it has learnt from "a most trustworthy source" that the telegraphic connection with Iceland and the Faroe Islands which has been desired during so many years and may be said to be a necessity from several points of view, but first of all in the interests of commerce, will be established next year. The cable will be laid from Iceland, via the Faroe Islands to the Shetland Islands, where it will be connected with the British system. The Great Northern Telegraph Co. has taken the matter in hand, but no details are given as the authorities are reported to be most reticent on the subject, because the final negotiations between the interested parties are still pending. It has been thought inadvisable to have a direct cable to Denmark on account of the increased cost, and because it is feared that,

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as it is, the cable will not be a paying concern. We are unable to obtain either a confirmation or a contradiction of this report.

International Tramways and Light Railways Union.—The official circular of the Tramways and Light Railways Association publishes the following programme for the Congress of this Union in Vienna from September 4th to 9th :—

Sunday 4th, 8 p.m.—Reception in the Stadt Park Hall.

Monday 5th, 10 to 1.—Opening of Congress by the Minister for Railways and the Mayor of Vienna in the hall of the Austrian Association of Engineers and Architects.

Drive round to the Hotel de Ville, the Imperial Theatre, and the Siemens-Schuckert works. 6 p.m.—Performance at Imperial Opera House.

Tuesday 6th.—Congress meeting. Visit to car and repair sheds of the Municipal tramways and to the Imperial Park, Schrönbrunn. In the evening, banquet at Heitsing, given by the Minister of Railways.

Wednesday 7th.—Congress meeting. Visit to the new harbours on the Danube, to the Municipal electric power station, and run by the cable railway to Kahlenberg, where the Austrian Tramways and Light Railways Association will hold a reception.

Thursday 8th.—Final meeting. Visit to the Electro-Technical Institution. 5 p.m.—Banquet given by the Municipality at the Hotel de Ville.

Friday 9th, Saturday 10th and Sunday 11th.—Excursions either two days to the Schneeberg and Semmering Pass and on to Trieste, or three days to Linz, the Postlinberg, Innsbruck and the Stubai Valley (monophase current) Railway.

Mont Blanc Railway.—The Paris correspondent of the *Standard* states that the project for a mountain railway up Mont Blanc, which has been submitted to the French authorities by a financial syndicate, has, by a decree now published, received the Government's official sanction, and is declared to be of public utility. The syndicate is accorded a concession for an electric tramway up the mountain for a period of 75 years. Le Fayet (near Saint Gervais) is to be the starting point of the line, and there will be stations at Saint Gervais-les-Bains, Motivon, the Col de Voza, the Pavillon de Bellevue, Mount Lachat, Les Rognes, Tête Rousse and the summit of the Aiguille du Gouter. The final plans are to be presented within a year of the signing of the decree, and the construction of the railway must be commenced within another year and prosecuted in such a way that it is completed within a period of six years from the commencement of the work. Metre gauge has been selected, and at least two daily journeys are to be made each way from June 15th to September 15th. The trains will be composed of two carriages, and the maximum speed is to be 8 kilometres an hour. The fares will be calculated upon a scale of 1f. 50c. per head per kilometre, and goods or luggage at the rate of 3f. per ton per kilometre.

Wireless Telegraph Notes.—The following order relating to the Wireless Telegraphy Act, 1904, has been issued by the Postmaster-General :—

Notice is hereby given that it is provided by the above-named Act that a person shall not establish any wireless telegraphy station, or instal or work any apparatus for wireless telegraphy, in any place in the British Isles, or on board any British ship in the territorial waters abutting on the coast of the British Isles, except under and in accordance with a licence granted in that behalf by the Postmaster-General. Wireless telegraphy is defined by the Act to mean any system of communication by telegraph as defined in the Telegraph Acts, 1868 to 1904, without the aid of any wire connecting the points from and at which the messages or other communications are sent or received. Companies or persons requiring a license for any wireless telegraph station should make application to the Postmaster-General on or before October 1, 1904. Forms of application may be obtained from the Secretary to the Post Office, General Post Office, E.C.

In the annual report of the New Zealand Post and Telegraph Department, it is stated that no progress has been made in the direction of introducing wireless telegraphy into this colony, negotiations which were commenced with the Marconi Company having fallen through. Inquiries are now being made as to the desirability of testing another system.

Marconi's Wireless Telegraph Co. informs us that the statements quoted from *l'Elettricista*, in last week's *Electrician*, are not correct. No convention between Mr. Marconi and the Italian Government has been rejected by the Board of Audit. The route between Bari and Antivari comes under the Government monopoly, but the Government has power to grant concessions to private individuals, and has granted a concession in this case to Mr. Marconi. It has never been proposed by Mr. Marconi to erect the station at Coltano, Pisa. at his own expense. On the contrary, the Government has voted a sum of money for this purpose.

We announced a few weeks ago that the International Conference on Wireless Telegraphy would take place in Berlin in the beginning of October. We are now able to state the exact date, which is October 6th.

Standards for Tubular Tramway Poles.—The Engineering Standards Committee has published a standard specification for tubular tramway poles which has been drawn up by the following sub-committee on electric tramways :—

A. P. Trotter (chairman), Philip Dawson, F. Forbes Higginson, E. R. Hill, J. H. Rider, W. Rutherford, H. M. Sayers, R. H. Scotter, A. M. Sillar, J. J. Steinitz, A. H. Walton, Leslie S. Robertson (secretary), C. Le Maistre (electrical assistant secretary).

The specifications given are for three classes of poles—light, medium and heavy—and for both sectional and taper poles. The overall length of all classes is to be 31ft., and in the case of the sectional poles the top and middle sections are each to be 8ft. 6in. long and the bottom section 17ft. The outside diameters for the sectional poles are as follows :—*Light*, top 5½in., middle 6½in., bottom 7½in. ; *medium*, top 6½in., middle 7½in., bottom 8½in. ; *heavy*, top 7½in., middle 8½in., bottom 9½in. The light, medium and heavy taper poles are to be 4¾in., 5¾in. and 6¾in. diameter respectively at the top, and the outside diameters 9ft. 6in. from the base are to be 7½in., 8½in. and 9½in. respectively. In all cases the thickness of metal is not to be less than ¼in. Drop tests and bending tests are also specified. The report may be obtained from the Secretary of the Engineering Standards Committee (28, Victoria-street, London, S.W.) at 5s. net. We are asked to state that, although the report is styled "Interim," it is final so far as the specification is concerned, all the sub-committee reports being considered as "interim" until the final report of the Committee combining all the reports and specifications is issued.

St. Louis International Electrical Congress.—We are informed by the general secretary, Dr. E. A. Kennelly, that the International Electrical Congress will convene at the Music Hall of the Coliseum, St. Louis, at 9:30 a.m. on Monday, September 12th. It is intended that after the opening ceremonies, the Convention will immediately divide into sections, the section halls being on the second floor of the same building. On Tuesday, Thursday and Friday, the sections will meet on the second floor of the Coliseum from 9 a.m. to 1 p.m. The Committee of Organisation of the Congress was appointed by the President of the St. Louis Exposition in June, 1903. The committee held its first meeting in August, 1903. In response to invitations to join the Congress, 1,915 acceptances have been received, of which 1,542 are from North America and 373 from other countries. Over 1,300 certificates of membership have been issued to persons who have already become members by forwarding their subscriptions. The preliminary programmes of Sections A, B, C, D, E, F and G have appeared from time to time in *The Electrician*, that of Section H (Electro-therapeutics) being as follows :—

Prof. Dr. M. Benedikt, "A Contribution to the Radiodiagnostics of Diseases of the Head and of the Brain"; Dr. J. Bergonié (subject to be announced) ; M. le Docteur G. O'Farrill, "Some Improvements in Generator Apparatus of High-frequency Currents" ; Dr. J. Rivière, Physicotherapy of Neurasthenia" ; Prof. S. Schatzky, "The Ionic Theory as Biological Basis for the Therapeutic Action of Electricity" ; Prof. S. Schatzky, "Experimental Researches on the Treatment of Tuberculosis by Constant Current" ; Dr. Carl Beck, "Recent Advances in Röntgen-ray Science ; Dr. Gordon G. Burdick, "Radiations in Therapeutics ;" Dr. Margaret A. Cleaves, "The Nature of the Changes Established in Living Tissue by the Action of Oxidizable Metals at the Anode" ; Dr. Charles R. Dickson, "Some Observations upon the Treatment of Lupus Vulgaris by Phototherapy, Radiotherapy and otherwise" (A.E.-T.A. Paper) ; Dr. Emil H. Grubbé, "X-Rays and Radio-active Substances as Therapeutic Agents" ; Dr. T. Proctor Hall, "The Principles of Electro-therapeutics" ; Dr. J. H. Kellogg, "Electro-therapeutics" ; Dr. John Williams Langley, "The Purification of Water for Drinking by Electricity" ; Prof. Jacques Loeb, "The Control of Life Phenomena by Electrolytes" ; Dr. G. Betton Massey, "The Cataphoric Diffusion of Metallic Ions in the Destructive Sterilisation of Cancer and Tuberculous Deposits" ; Dr. W. J. Morton, "Artificial Fluorescence of the Human Organism as a means of Treating Disease" ; Dr. C. S. Neiswanger, "Static Electricity in Chronic Nephritis" ; Dr. Clarence E. Skinner, "A Large Fibro-Sarcoma treated by X-Radiance" ; Dr. Wm. Benham Snow, "The Therapeutic Uses of Static Electricity."

The chairman of the section is Dr. W. J. Morton, and the secretary Mr. W. J. Jenks. The Government of the United

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States, at the petition of the Committee of Organisation, has issued invitations to the various foreign Governments to send official representatives to the Chamber of Delegates of the Congress. Up to the present time the following appointments have been announced :—Austro-Hungary, Prof. Charles Zipernovzky; Italy, Prof. Moise Ascoli, Prof. L. Lombardi, Ing. A. Maffezzini; Switzerland, Prof. Ferdinand Weber, Prof. François Louise Schüle; Norway and Sweden, Prof. Svante August Arrhenius; Australian Colonies, John Hesketh, Esq.; Brazil, Señor Jorge Newbery; India, J. C. Shields, Esq.; Mexico, Señor Rafael R. Arizpe; United States, Prof. H. S. Carhart, Dr. A. E. Kennelly, Prof. H. J. Ryan, Prof. S. W. Stratton, Prof. Elihu Thomson.

Standards for Electric Wires and Cables.—The Engineering Standards committee has issued its standards for copper conductors and thicknesses of dielectric. The sub-committee on cables consisted of the following gentlemen :—

Robert Kaye Gray (chairman), C. H. Wordingham and L. J. Steele (representing the Admiralty), Capt. A. H. Dumaresq (representing the War Office), Llewellyn Preece (representing the Crown Agents for the Colonies), Martin F. Roberts (representing the General Post Office), T. O. Callender, W. E. Gray and A. H. Howard (nominated by the Cable Makers' Association), H. A. C. Saunders (nominated by Eastern Telegraph Co.), Alexander Siemens, H. A. Taylor, A. P. Trotter, Leslie S. Robertson (secretary), and C. le Maistre (electrical assistant secretary). The sub-committee also acknowledges its indebtedness to Mr. John Gavey, C.B. and the sub-committee on telegraphs and telephones for their co-operation, and also to the Cable Makers' Association, the members of which have given it considerable assistance.

The standards for copper conductors are practically the same as those adopted by the Cable Makers' Association, the chief difference being that the increase in resistance and weight due to the loss in lay on stranded cables is taken as 2 per cent. in all wires except the centre wire instead of 1·01226 per cent., as adopted by the Association. Moreover, the allowance of 1 per cent. increased resistance, as calculated from the diameter, allowed on all tinned copper conductors now applies between Nos. 12 and 28 S.W.G. instead of 12 and 22 S.W.G., as formerly. In addition to tables similar to those already published by the Cable Makers' Association, tables of sizes of conductors smaller than 0·025 sq. in. are given, the standards chosen here being 3-strand and 7-strand conductors of S.W.G. size. Tables of 7, 19 and 37 strand conductors of larger size are also given in cases where the S.W.G. sizes do not work out to even sectional areas. The nominal section areas from 0·025 to 1 sq. in. are the same as those adopted by the Cable Makers' Association, with the addition, however, of standards for 0·45, 0·55 and 0·65 sq. in. In concentric cables there may be a variation of 4 per cent. between the resistances of the two conductors instead of 5 per cent. given in the Cable Makers' Association's standards. The standard limits of working pressures chosen are 660, 2,200, 3,800, 6,600 and 11,000 volts instead of 500, 2,000, 3,000, 6,000 and 10,000 given in the Association's tables; but the same thicknesses of dielectric and lead are adopted, the only alteration made being in the specified tests for working pressure. For working pressures up to 660 volts the test at the works for paper cables is to be 2,500 volts for half-an-hour, and for jute cables 1,500 volts for half-an-hour; when laid and jointed the pressure test is to be 1,000 volts in both cases. The tests for high-pressure and extra high-pressure cables have also been altered to a slight extent, half an-hour in most cases being the time adopted during which the voltage is applied, instead of 15 minutes and one hour as in the British Cable Makers' Association's rules. Standards for rubber-insulated lead-covered cables are also given, the dielectric thicknesses being slightly less in the case of the smaller cables, but greater in the case of the larger cables, than with paper cables with corresponding size of conductor; and the lead in some cases is slightly thicker. There is also a table for rubber-insulated lead-covered cables for internal wiring, the dielectric thicknesses in this case corresponding to those in the wiring rules of the Institution of Electrical Engineers. For further information we refer our readers to the report itself which is obtainable either from the secretary of the Engineering Standards committee, or from Messrs. Crosby Lockwood & Sons, the price being 2s. 6d. net.

The Opening of Street Boxes.—In our issue of November 13th last we published the report of a conference of the Board of Trade, at which Mr. Bonar Law, Parliamentary Secretary to the Board of Trade, heard an application by the Westminster City Council that certain regulations should be sanctioned restricting the time during which the street boxes belonging to the electric supply companies should be opened. The following supply companies were affected :—St. James' and Pall Mall Electric Light Co., London Electric Supply Corporation, Kensington and Knightsbridge Electric Lighting Co., Westminster Electric Supply Corporation, Charing Cross and Strand Electricity Supply Corporation, Metropolitan Electric Supply Co., Chelsea Electric Light Co. The Westminster City Council divided the streets into three classes, of which No. 1 took in 39 of the busiest streets, No. 2 31 streets of medium importance, and No. 3 the remainder. They desired that the companies should only be allowed to open street boxes between midnight and 9 a.m. in the streets of the first class, between 8 p.m. and 10 a.m. in streets of the second class, while in streets of the third class they would allow the boxes to be opened at any time. The imposing of these restrictions was naturally opposed by the companies concerned. After the matter had been discussed, an adjournment was made, at the suggestion of Mr. Bonar Law, in order that the parties might be given an opportunity to come to some compromise. We understand that the Kensington and Knightsbridge Company subsequently agreed to the Westminster City Council's proposals, on the understanding, of course, that the company should be allowed to open street boxes at any time in cases of emergency. This power, it might be mentioned, however, is already possessed by electricity undertakings under the Electric Lighting Acts. Dr. A. B. W. Kennedy, on behalf of the remaining companies, wrote to the Westminster City Council on December 17th, referring to Mr. Law's suggestion that a compromise should be arrived at, and offering to agree to the following regulations for 12 months as a trial: In summer the time for opening the street boxes was to be between 6 a.m. and 10 a.m., and in the winter from 5 p.m. to 12 noon, in order to give more hours of daylight in the winter months. Mr. Bonar Law, at the conference, had given his opinion that it was the duty of the Board of Trade to sanction reasonable restrictions, but he thought it would be perfectly unreasonable to make the hours such that the bulk of the work would not be done in the daylight, and he had himself suggested that in the winter months a slightly longer time should be allowed. Dr. Kennedy proposed, therefore, that the above time should be fixed for the bulk of the streets of classes 1 and 2. He also pointed out that boxes at feeder points, which contained fuses or switches, must be exempt from these regulations, and also that the rules should not apply to new work, of which notice should be given, or to repairs to mains and services, or to boxes in which the presence of gas was suspected. We may point out, however, that it is the practice to place the "districting" boxes referred to above in the side or back streets, and that, with regard to new work and repairs to mains, undertakers have already power under the Electric Lighting Acts to execute any such work when necessary after having given proper notice. The act also covers the question of emergency work, but the point with regard to the opening of boxes when gas is suspected is most important. It was added that these regulations should only apply to week days, so that a thorough inspection of boxes could always be made on Sundays. The Westminster City Council took until May 20th to consider these suggestions, and then their committee wrote to say that they were unable to advise the Council to accept the companies' proposals as to the hours on week days on account of the heavy pedestrian and vehicular traffic in the streets. They should, therefore, adhere to their original proposals, only they would transfer 17 of the streets mentioned from class 1 to class 2. They would also allow any boxes to be opened between 2 p.m. on Saturday and 10 a.m. on Monday. On June 24th it was pointed out on behalf of the companies that this reply of the committee practically disregarded the proposals of the companies. In consequence, the entire correspondence was sent to the Board of Trade, and a letter was received from the Board last Monday conveying the Board's refusal to sanction the regulations desired by the Westminster City Council.

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REVISION OF THE BOARD OF TRADE REGULATIONS UNDER THE ELECTRIC LIGHTING ACTS.

The Board of Trade have had under consideration the question of the revision of the regulations and conditions for securing the safety of the public and for ensuring a proper and sufficient supply of electrical energy which were settled by the Board, after consultation with the various parties interested, in 1896. The experience which has been since gained has, in the opinion of the department, rendered a revision of these regulations desirable, and the Board of Trade have accordingly prepared for consideration a fresh draft set of regulations.

Four codes of regulations have been prepared:—(1) For Local Authority undertakings in the provinces. (2) For Company undertakings in the provinces. (3) For Company undertakings in London. (4) For Local Authority undertakings in London. The various codes differ according to circumstances in regard to the notices, &c., specified in the regulations as to supply, and the regulations as to overhead wires are omitted in the codes relating to London.

We print below the code for Local Authority undertakings in the provinces, indicating in footnotes what are the differences in the other three cases.

BOARD OF TRADE REGULATIONS.

(A), for securing the Safety of the Public, and
(B), for ensuring a proper and sufficient Supply of Electrical Energy.

Definitions.

In the following regulations—

The expression "the order" means the . . . . .

The expression "the undertakers" means the undertakers for the purpose of the Order.

The expression "consumer's wires" means any electric lines on a consumer's premises which are connected with the service lines of the undertakers at the consumer's terminals.

The expression "overhead line" means any electric line which is placed above ground and in the open air.

The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and the earth; and, subject to the variations allowed by these Regulations,

(*a*) Where the conditions of the supply are such that the pressure at the consumer's terminals does not exceed 250 volts, the supply shall be deemed a low-pressure supply;

(*b*) Where the conditions of the supply are such that the pressure between any two conductors, or between one conductor and earth, may at any time exceed 250 volts but does not exceed 650 volts, the supply shall be deemed a medium pressure supply;

(*c*) Where the conditions of the supply are such that the pressure may exceed 650 volts but does not exceed 3,000 volts, the supply shall be deemed a high-pressure supply; and

(*d*) Where the conditions of the supply are such that the pressure may exceed 3,000 volts, the supply shall be deemed an extra high-pressure supply.

Where these regulations require any metallic body to be "efficiently connected with earth," it shall be connected with the general mass of earth in such manner as will ensure at all times an immediate and safe discharge of electrical energy.

Other expressions to which meanings are assigned in the Order or in the above-mentioned Acts have the same respective meanings in these regulations.

A.—Regulations for Securing the Safety of the Public.

General.

1. *Pressure of Supply to Consumers.*—The pressure of a supply delivered to any consumer shall not exceed the limit of low-pressure, except for special purposes; but for those purposes it may exceed the limit of low-pressure but not the limit of medium pressure on the consumer undertaking to comply with the following conditions:—

(*a*) Where the supply is for power purposes—

(1.) The frame of every electric motor shall be efficiently connected with earth.

(2.) The consumer's wires forming the connections to motors, or otherwise in connection with this supply, shall be, as far as practicable, completely enclosed in strong metal casing efficiently connected with earth, or they shall be fixed at such a distance apart, or in such a manner that there shall be no danger of any shock.

(3.) The supply to every motor shall be controlled by means of an efficient cut-off switch, placed in such a position as to be easily handled by the person in charge of the motor, and connected so that by its means all pressure can be cut off from the motor itself, and from any regulating switch resistance or other device in connection therewith.

(4.) Switches, efficient fuses or other automatic cut-outs, shall also be provided, so as to protect the circuits from excess of current, and all switches and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

(5.) A notice shall be fixed in a conspicuous position at every motor and switchboard in connection with the supply forbidding unauthorised persons to touch the motors or apparatus.

(*b*) Where the supply is for arc lamps in series—

(1.) The consumer's wires forming the connections to the arc lamps, or otherwise in connection with the supply, shall be, as far as practicable, completely enclosed in strong metal casing efficiently connected with earth, or they shall be fixed at such a distance apart or in such a manner that there shall be no danger of any shock.

(2.) The supply to every arc lamp shall be controlled by means of an efficient cut-off switch, placed in such a position as to be easily handled by the person in charge of the arc lighting, and connected so that by its means all pressure can be cut off from the arc lamp itself, and from any regulating switch resistance or other device in connection therewith.

(3.) Switches, efficient fuses or other automatic cut-outs shall also be provided, so as to protect the circuits from excess of current, and all switches and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

(*c*) Where the supply is for incandescent lamps in series—

(1.) The consumer's wires forming the connections to the incandescent lamps, or otherwise in connection with this supply, shall be completely enclosed in strong metal casing, and this casing, together with the switches and lamp-holders, if metallic, shall be efficiently connected with earth.

(2.) Switches, efficient fuses or other automatic cut-outs shall also be provided, so as to protect the circuits from excess of current, and all switches and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

Where the supply is for any special purpose other than those above-mentioned, or where the pressure of the supply exceeds the limits of medium pressure it shall be subject to such other regulations as the Board of Trade may from time to time prescribe.

2. *Introduction of Three-wire System into Consumer's Premises.*—When the pressure between the outer conductors of a three-wire system exceeds 250 volts and the three wires of the system or two pairs of wires are brought into a consumer's premises, the supply must be given to two pairs of terminals arranged in such a manner that there shall be no danger of any shock, and the wiring from those terminals must be kept distinct.

3. *Extra High-pressure Supply to Consumer's Premises.*—The pressure of a supply delivered to any consumer's premises shall not exceed the limit of high-pressure, except with the consent of the Board of Trade and subject to such regulations as the Board may prescribe, and to the following conditions:—

(1.) The premises must be a factory, a mine, or electric traction works

(2.) Where the premises are a factory, or a mine, the supply shall only be given on condition that the provisions of the Factory Acts and the Mines Regulation Acts, respectively, and any regulations which may be made thereunder are complied with.

4. *Minimum Size of Conductors.*—The sectional area of any conductor in any electric line laid or erected in any street after the date of these regulations shall not be less than the area of a circle of one-tenth of an inch diameter, and where the conductor is formed of a strand of wires, each separate wire shall be at least as large as No. 20 standard wire gauge.

This regulation shall not apply in the case of an electric line placed in a lamp-post.

5. *Insulation Test of Low-pressure and Medium-pressure Electric Lines.*—Every low-pressure and medium-pressure main shall be tested for insulation after having been placed in position and before it is used for the purposes of supply, the testing pressure being 50 per cent. greater than the maximum pressure to which it is intended to be subjected in use, and in any case at least 200 volts, and the undertakers shall duly record the results of the tests of each main, or section of a main.

6. *Maintenance of Insulation.*—The insulation of every complete circuit used for the supply of energy, including all machinery, apparatus, and devices forming part of, or in connection with, such circuit, shall be so maintained that the leakage current shall not under any conditions exceed one-thousandth part of the maximum supply current; and suitable means shall be provided for the immediate indication and localisation of leakage. Every leakage shall be remedied without delay. Every such circuit shall be tested for insulation at least once in every week, and the undertakers shall duly record the results of the testings. Provided that where the Board of Trade have approved of any part of any electric circuit being connected with earth, the provisions of this regulation shall not apply to that circuit so long as the connection with earth exists.

7. *Testing of Insulation of all Parts of any High-pressure Circuit.*—A high-pressure circuit shall not be brought into use unless the insulation of every part thereof has withstood the continuous application, during half-an-hour, of pressure exceeding the maximum pressure to which it is intended to be subjected in use, in the following manner: In the case of every electric line a pressure twice the said maximum pressure, and in the case of every machine, device, or apparatus, a pressure 50 per cent. greater than the said maximum pressure. The undertakers shall duly record the results of each test.

8. *Circuit-breaker for High-pressure Lines, &c.*—Every high-pressure electric line, conductor, or other apparatus shall be protected by a suitable automatic fuse or circuit-breaker. Provided that it shall not be incumbent upon the undertakers to provide such a fuse or circuit-breaker for the outer conductor of a concentric main which is, with the approval of the Board of Trade, efficiently connected with earth.

9. *Transformers.*—In every case where a high-pressure supply is transformed for the purpose of supply to one or more consumers, some suitable automatic and quick-acting means shall be provided to protect the consumer's wires from any accidental contact with or leakage from the high-pressure system, either within or without the transforming apparatus.

10. *Earthing of Transformers.*—The metallic portion, other than the conductors of every transformer, shall be efficiently connected with earth.

11. *Limit of Power in High-pressure Electric Line.*—An electric line used for a high-pressure supply shall not be used for the transmission of more than 500kw., or in the case of an overhead line 50kw.* except with the consent of the Board of Trade, and efficient means shall be provided to prevent this limit being at any time exceeded.

12. *Protection from Lightning.*—Where any portion of any electric line or any support for an electric line is exposed in such a position as to be liable

* In the Code of Regulations applying to London, the regulations as to overhead lines are omitted.

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to cause injury from lightning, it shall be efficiently protected against such liability.

13. *Accidents to be Reported.*—Where any accident by explosion or fire, or any other accident of such kind as to have caused or to be likely to have caused loss of life or personal injury, has occurred at any part of any electric line or work, the undertakers shall give immediate notice thereof to the Board of Trade.

Overhead Lines.*

14. *Maximum Intervals between Supports.*—Every overhead line shall be attached to supports at intervals not exceeding 200ft. where the direction of the line is straight, or 150ft. where the line makes a horizontal angle at the point of support.

15. *Factors of Safety.*—Every support for an overhead line shall be of a durable material, and properly stayed against forces due to wind pressure, change of direction of the line or unequal lengths of span. The factor of safety shall be for overhead lines at least 6, and for all other parts of the structure at least 12, taking the maximum possible wind pressure at 50lb. per square foot. No addition need be made for a possible accumulation of snow.

16. *Attachment of Overhead Lines.*—All overhead lines shall be attached to insulators, and shall be so guarded that they cannot fall away from the support.

17. *Height from Ground, &c.*—An overhead line placed after the date of these regulations shall not in any part thereof be at a less height from the ground than 22ft., or accessible to any person without the use of a ladder or other special appliance. A high-pressure overhead line placed after the date of these regulations shall not in any part thereof be at a less height from the ground than 28ft. where it crosses a street.

18. *Three-wire System.*—Where a supply is given by overhead wires on the three-wire system, the positive and negative conductors shall be placed above the intermediate conductor. The intermediate conductor shall consist of two wires placed at a greater distance apart than the positive and negative conductors, and these two wires shall be connected by cross wires, two for each span, fixed at a distance not less than 6ft. from the insulators.

19. *Supply from Traction System.*—Where a supply is given by overhead wires from a traction system, the positive conductor shall be placed above the negative conductor in such a manner that in the event of breakage it must fall on the negative conductor.

20. *Service Lines from Overhead Lines.*—Service lines from overhead lines shall be led as directly as possible to insulators firmly attached to some portion of the consumer's premises which is not accessible to any person without the use of a ladder or other special appliance, and from this point of attachment they shall be enclosed and protected in accordance with the subsequent regulations as to electric lines on the consumer's premises. Every portion of any service line which is outside a building but is within 7ft. from the building shall be efficiently protected by insulating material.

21. *Angle of Crossing Thoroughfares.*—Where an overhead line crosses a street, the angle between the line and the direction of the street at the place of crossing shall not be less than 60deg., and the spans shall be as short as possible.

22. *Lines Crossing Metallic Substances.*—Where an overhead line crosses, or is in proximity to, any metallic substance, precautions shall be taken by the undertakers against the possibility of the line coming into contact with the metallic substance, or of the metallic substance coming into contact with the line by breakage or otherwise.

23. *Discharge of Pressure in Case of Fire.*—In the case of any high-pressure overhead line exceeding one-half mile in total length, means shall be provided whereby the pressure may be discharged from any portion of the line erected over or alongside of any building or buildings without loss of time in case of fire or other emergency.

24. *Maintenance.*—Every overhead line, including its supports and all the structural parts and electrical appliances and devices belonging to or connected with the line, shall be duly and efficiently supervised and maintained as regards both electrical and mechanical conditions.

25. *Disused Overhead Lines to be Removed.*—An overhead line shall not be permitted to remain erected after it has ceased to be used for the supply of energy, unless the undertakers intend within a reasonable time again to take it into use.

Electric Lines other than Overhead Lines.*

26. *Construction of Receptacles for Electric Lines.*—All conduits, pipes, casings, and street boxes used as receptacles for electric lines shall be constructed of durable material, and where laid under carriageways shall be of ample strength to prevent damage from heavy traffic; and reasonable means shall be taken by the undertakers to prevent accumulation of gas in such receptacles.

27. *Crossing Pipes, &c.*—Where any electric line crosses, or is in proximity to, any metallic substance, special precautions shall be taken by the undertakers against the possibility of any electrical charging of the metallic substance from the line or from any metal conduit, pipe or casing enclosing the line.

28. *Electric Continuity of Metal Conduits, Pipes and Casings.*—All metal conduits, pipes or casings containing any high-pressure electric line shall be efficiently connected with earth; and shall be so jointed and connected across all street boxes and other openings so as to make good electrical connection throughout their whole length.

29. *Precautions to be taken when Bare Conductors are Used.*—Where the conductors of electric lines placed in any conduit are not continuously covered with insulating material, they shall be secured in position, and no unfixed uninsulated material of a conducting nature shall be contained in the conduit. No such conductor shall be at a higher potential than 300 volts from earth. Adequate precautions shall also be taken to ensure that no accumulation of water shall take place in any part of the conduit, and to prevent any dangerous access of moisture to the conductors or the insulators. In the case of any such electric lines laid in conduits after the date of these regulations, the insulators shall be so disposed that they can be readily inspected.

30. *High-Pressure Lines Laid above Ground.*—Every portion of any high-pressure electric line placed above the surface of the ground, or in any subway not in the sole occupation of the undertakers, shall be completely enclosed either in a tube of highly insulating material embedded in brickwork, masonry or cement concrete, or in strong metal casing efficiently connected with earth.

31. *High-Pressure Lines Laid near other Electric Lines or to the Surface of the Ground.*—Where any high-pressure electric line is laid beneath the surface of the ground efficient means shall be taken to render it impossible that the surface of the ground or any neighbouring electric line or conductor shall become charged by leakage from the high-pressure electric line.

32. *Completion of High-Pressure Mains.*—A high-pressure electric line shall not be brought into use for the supply of energy before it has been completely laid, properly jointed, examined and tested, or while it is still in charge of other parties than the undertakers.

Street Boxes.

33. *Street Boxes.*—In addition to the provisions contained in Regulation 26 as to the construction of receptacles for electric lines, the following conditions shall be observed with respect to the construction of street boxes:—

(*a.*) The covers of all street boxes shall be so secured that they cannot be opened except by means of a special appliance.

(*b.*) The covers of all street boxes containing high-pressure apparatus other than cables shall be connected to strips of metal laid immediately underneath the adjacent roadway, and efficient means shall be taken to render it impossible that the covers or other exposed parts of these boxes, or any adjacent material forming the surface of the street, shall become electrically charged, whether by reason of leakage, defect, or otherwise.

(*c.*) Where street boxes are used as transformer chambers, reasonable means shall be taken to prevent as far as possible any influx of water, either from the adjacent soil or by means of pipes; and in the case of any such street box exceeding 1 cubic yd. in capacity, ample provision shall be made, by ventilation or otherwise, for the immediate escape of any gas which may by accident have obtained access to the box, and for the prevention of danger from sparking.

(*d.*) All street boxes shall be regularly inspected for the presence of gas, and if any influx or accumulation is discovered, the undertakers shall give immediate notice to the authority or company whose gas mains are laid in the neighbourhood of the street box.

(*e.*) Where high-pressure and low-pressure mains pass through the same street box, they shall be readily distinguishable from each other,

(*f*) The maximum power supplied to any transformer placed singly in a street box shall not exceed 30kw. without the consent of the Board of Trade.

Sub-stations.

34. *Sub-stations.*—Sub-stations or points in a system of distribution, at which a high-pressure supply is transformed for the purpose of supply to consumers, and which are not on the consumer's premises, shall be established in suitable places and shall be in the sole occupation and charge of the undertakers.

35. *Plans to be Approved.*—Sub-stations shall be erected above ground wherever possible, but where necessarily underground, they shall be constructed in accordance with plans approved by the Board of Trade, and the maximum power supplied to any underground sub-station shall not exceed 75kw. without the consent of the Board of Trade.

Consumer's Premises.

36. *Responsibility of Undertakers for their Lines, &c., on Consumer's Premises.*—The undertakers shall be responsible for all electric lines, fittings and apparatus belonging to them, or under their control, which may be upon a consumer's premises, being maintained in a safe condition and in all respects fit for supplying energy.

37. *Fire Risks.*—In delivering the energy to a consumer's terminals the undertakers shall exercise all due precautions so as to avoid risk of causing fire on the premises.

38. *Supply to Public Buildings.*—Where a supply is given to a building for public purposes, the undertakers shall periodically satisfy themselves that the wires and fittings within the building are maintained in a safe condition.

39. *Main Fuses or Circuit-breakers.*—A suitable safety fuse or other automatic circuit-breaker shall be inserted in each service line within a consumer's premises as close as possible to the point of entry, and contained within a suitable locked or sealed receptacle of fireproof construction, except in cases where the service line is protected by fuses in a street box; no fuse or automatic circuit-breaker may be inserted in the intermediate conductor of a three-wire system.

40. *Treatment of Electric Lines and Apparatus on Consumer's Premises.*—All service lines and apparatus placed on a consumer's premises shall be highly insulated and thoroughly protected against injury to the insulation or access of moisture, and any metal forming part of the electric circuit shall not, unless efficiently connected with earth, be exposed so that it can be touched. All electric lines shall be so fixed and protected as to prevent the possibility of electrical discharge to any adjacent metallic substance.

41. *Transformers and High-pressure Apparatus to be Enclosed in Metal.*—Where the general supply of energy is a high-pressure supply, and transforming apparatus is installed on a consumer's premises, the whole of the high-pressure service lines, conductors and apparatus, including the transforming apparatus itself, so far as they are on the consumer's premises, shall be completely enclosed in solid walls, or in strong metal casing efficiently connected with earth and securely fastened throughout.

42. *Undertakers Responsible for Transformers, &c.*—Transformers and all high-pressure apparatus used for the supply of energy to a consumer's premises, unless the premises are a factory, mine or electric traction works, shall be the property of, and under the charge of the undertakers.

43. *Connection to Consumer's Premises not to be made where Leakage would Result.*—The undertakers shall not connect a consumer's wires with their mains unless they are reasonably satisfied that the connection would not cause a leakage from those wires or fittings exceeding one ten-thousandth part of the maximum supply current to the premises; and where the undertakers decline to make such connection they shall serve upon the consumer a notice stating their reasons for so declining.

* In the Code of Regulations applying to London, the regulations as to overhead lines are omitted, and the heading "Electric Lines other than Overhead Lines" becomes simply "Electric Lines," Regulation 26 becoming No. 14, Regulation 27 No. 15, &c.

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44. *Discontinuance of Supply on Discovery of Leakage on Consumer's Premises.*—If the undertakers are reasonably satisfied, after making all proper examination by testing or otherwise, that a leakage exists at some part of a consumer's wires or fittings of such extent as to be a source of danger, then and in such case any officer of the undertakers, duly authorised by them in writing, or, if the undertakers so require, an electric inspector, may, for the purpose of discovering whether the leakage exists at any part of a circuit within or upon any consumer's premises, by notice require the consumer at some reasonable time after the service of the notice to permit him to inspect and test the wires and fittings belonging to the consumer and forming part of the circuit.

In any case where the undertakers require the services of an electric inspector under this regulation they shall pay him the prescribed fee.

If on such testing the officer or the electric inspector discovers a leakage from the consumer's wires exceeding one ten-thousandth part of the maximum supply current to the premises, or if the consumer does not give all due facilities for inspection and testing, the undertakers shall forthwith discontinue the supply of energy to the premises in question, giving immediate notice of discontinuance to the consumer, and shall not recommence the supply until they are reasonably satisfied that the leakage has been removed. This regulation shall not affect any power contained in the order or otherwise enabling the undertakers to discontinue the supply.

45. *Appeal to Electric Inspector.*—If any consumer is dissatisfied with the action of the undertakers in refusing to give, or in discontinuing or in not recommencing the supply of energy to his premises, the wires and fittings of that consumer shall, on his application and on payment of the prescribed fee, be tested for the existence of leakage by an electric inspector.

This regulation shall be endorsed on every notice given under the provisions of either of the two last preceding regulations.

Arc Lighting.

46. *Arc Lamps to be Guarded.*—All arc lamps shall be so guarded as to prevent pieces of ignited carbon or broken glass falling from them, and shall not be used in situations where there is any danger of the presence of explosive dust or gas.

47. *Height from Ground.*—Arc lamps used in any street for public lighting shall be so fixed as not to be in any part at a less height than 10ft. from the ground.

Connection of Circuits with Earth.

48. *Earthing of a Three-wire System.*—Where the pressure of a supply between the adjacent conductors of a three-wire system of mains exceeds 125 volts, the intermediate conductor must be connected with earth, with the concurrence of the Postmaster-General, and in accordance with the following conditions:—

(*a*) The connection with earth of the intermediate conductor must be made at one point only on each distinct circuit—namely, at the generating station, sub-station or transformer, and the insulation of the circuit must be efficiently maintained at all other parts.

(*b*) The system of distributing mains must be separated into sections corresponding approximately to the different feeders, and these sections may be inter-connected only through suitable circuit-breakers or fuses, arranged so as to be easily inspected.

(*c*) The current from the intermediate conductor to earth must be continuously recorded, and if it at any time exceed one-thousandth part of the maximum supply current, steps must be immediately taken to improve the insulation of the system.

Penalties.

49. *Penalties for Default.*—If the undertakers make default in complying with any of the preceding regulations, they shall on conviction be liable to a penalty not exceeding £10 for every such default, and to a daily penalty not exceeding £10.

The recovery of a penalty under these regulations shall not affect the liability of the undertakers to make compensation in respect of any damage or injury which may be caused by reason of the default.

B.—Regulations for Ensuring a Proper and Sufficient Supply of Electrical Energy.

1. *Notice of Intention to Supply through Mains.*—Forty-eight hours at least before the undertakers are ready to commence to supply energy through any main, they shall give public notice of their intention to commence such supply.*

2. *Undertakers to Provide Constant Supply.*—From and after the time when the undertakers commence to supply energy through any distributing main, they shall maintain a supply sufficient for the use of all the consumers for the time being entitled to be supplied from such main; and such supply shall, except so far as the Board of Trade may otherwise from time to time permit,† be constantly maintained, and in the case of continuous currents, without change of polarity. Provided that, for the purposes of testing, or for any other purposes connected with the efficient working of the undertaking, the authority by whom the electric inspector is appointed may give permission to the undertakers to discontinue the supply at such intervals of time and for such periods as that authority may think expedient. When the supply is so discontinued, or the polarity is changed, notice to all persons likely to be affected shall be given of such discontinuance or change and of the probable duration thereof.

3. *Provision as Regards Stoppage.*—The system of distributing mains shall be so arranged that in case it becomes necessary to stop the supply through any portion of a main for more than one hour, for the purposes of repairs or for any other reason, the stoppage of supply will in no case exceed in amount a total power of 200kw. or extend to the premises of more than 80 consumers, and in the case of every stoppage for more than one hour reasonable notice shall be previously given by the undertakers to every consumer affected thereby except in cases of emergency.

4. *Fixing of Declared Pressure at Consumer's Terminals.*—Before commencing to give a supply of energy to any consumer, the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of a consumer's terminals shall not at any time be altered or departed from except by the consent of the Board of Trade,* and upon such terms and conditions as the Board of Trade* may impose, and after public notice has been given during a period of one month, in such manner as the Board of Trade* may require, of the intention of the undertakers to apply for consent to alter the same.

Provided that the undertakers shall be deemed to have complied with the requirements of this regulation so long as (except with the consent of the Board of Trade) the variation of pressure at any consumer's terminals does not under any conditions of the supply which the consumer is entitled to receive exceed 4 per cent. from the declared constant pressure.

5. *Fixing of Declared Frequency.*—Before commencing to give a supply of energy by alternating current to any consumer, the undertakers shall declare to such consumer the number of complete periods per second at which they propose to supply energy. The frequency so declared shall not at any time be altered or departed from except by consent of the Board of Trade*, and upon such terms and conditions as the Board of Trade* may impose, and after public notice has been given during a period of one month, in such manner as the Board of Trade* may require, of the intention of the undertakers to apply for consent to alter the same.

Provided that the undertakers shall be deemed to have complied with the requirements of this regulation so long as the frequency does not vary more than 2½ per cent. from the declared frequency.

6. *Penalty for Default.*—If the undertakers make default in complying with any of these regulations as to supply, they shall, subject to the provisions of the order, be liable on conviction to a penalty not exceeding £5 for every such default and to a daily penalty not exceeding £5.

These regulations are made subject to the power of the Board of Trade to make such further or other regulations as they may think expedient; and nothing in these regulations shall be construed to authorise the undertakers to lay any electric line or work their undertaking otherwise than in accordance with the order and the principal act, or to supply energy otherwise than by a system for the time approved of by the Board of Trade under the order.

These are the regulations and conditions for securing the safety of the public and for ensuring a proper and sufficient supply of electrical energy, made by the Board of Trade under the provisions of the Electric Lighting Acts, 1882 and 1888, and of the , referred to in the letter from the Board of Trade to the , of the day of one thousand nine hundred and , and that date shall be deemed to be the date of these regulations.

Assistant Secretary, Board of Trade.

* If a Company is the undertakers, instead of "public notice," notice is to be served on the Local Authority; in London upon the County Council and the Local Authority.

† In the case of Companies in the provinces, the agreement of the Local Authority has to be obtained, and the permission of the Board of Trade is dispensed with. In London this permission is also dispensed with; a Local Authority has to obtain the agreement of the County Council, and a Company has to obtain the agreement both of the County Council and of the Local Authority.

* In the case of Companies in the provinces, "Local Authority" is substituted for "Board of Trade" here, and in the following sentence is added: "If the Local Authority refuse to consent to an alteration or impose any terms or conditions with which the undertakers are dissatisfied, the undertakers may appeal to the Board of Trade, whose decision shall be final."

In the case of London, whether a Local Authority or a Company are the undertakers, "London County Council" is substituted for Board of Trade at the places marked *, and the same appeal to the Board of Trade is provided for in case of disagreement.

POWER SUPPLY TO TRAMWAYS IN NORTH LONDON.

(*Continued from p. 705.*)

Fig. 5 is the diagram of connections of the station, the only connections left out being those for the lighting circuits and the auxiliary motor equipment. Taking the high-tension system first, it will be noticed by reference to the general plan of the station (Fig. 1, p. 665) that the cables from the dynamos are led through a tunnel into the switch chamber situated on the level of the engine room and below the high-tension switchboard. A section through this chamber and the high-tension and low-tension switchboards is given in Fig. 6. It must be mentioned, however, that the potential transformers shown in the tunnel have actually been placed on the ground floor within the chamber, it being desired to place them in as accessible a place as possible. The high-tension cables from the alternators first of all pass through the high-tension oil switch, shown on the right-hand side of Fig. 6, and then go on to the high-tension 'bus bars, which are fixed in cells in the brick wall shown on the left. The feeders, leading from the 'bus bars, pass through the high-tension switches shown on the left-hand side, and then are led downwards and out of the station. Connection between the high-tension cables of the station and the high-tension feeder cables of the distributing network is made by means of suitable terminal boxes. The high-tension oil switches, both in the alternator and feeder circuits, are of the British Thomson-Houston Co.'s type. They are similar in construction and working to the oil switches used at the Carville power station, and were fully described and illustrated in *The Electrician* of July 8th, p. 471. The operation of closing and opening is performed by a small continuous-current motor, the switch of which is mounted on the high-tension switch-

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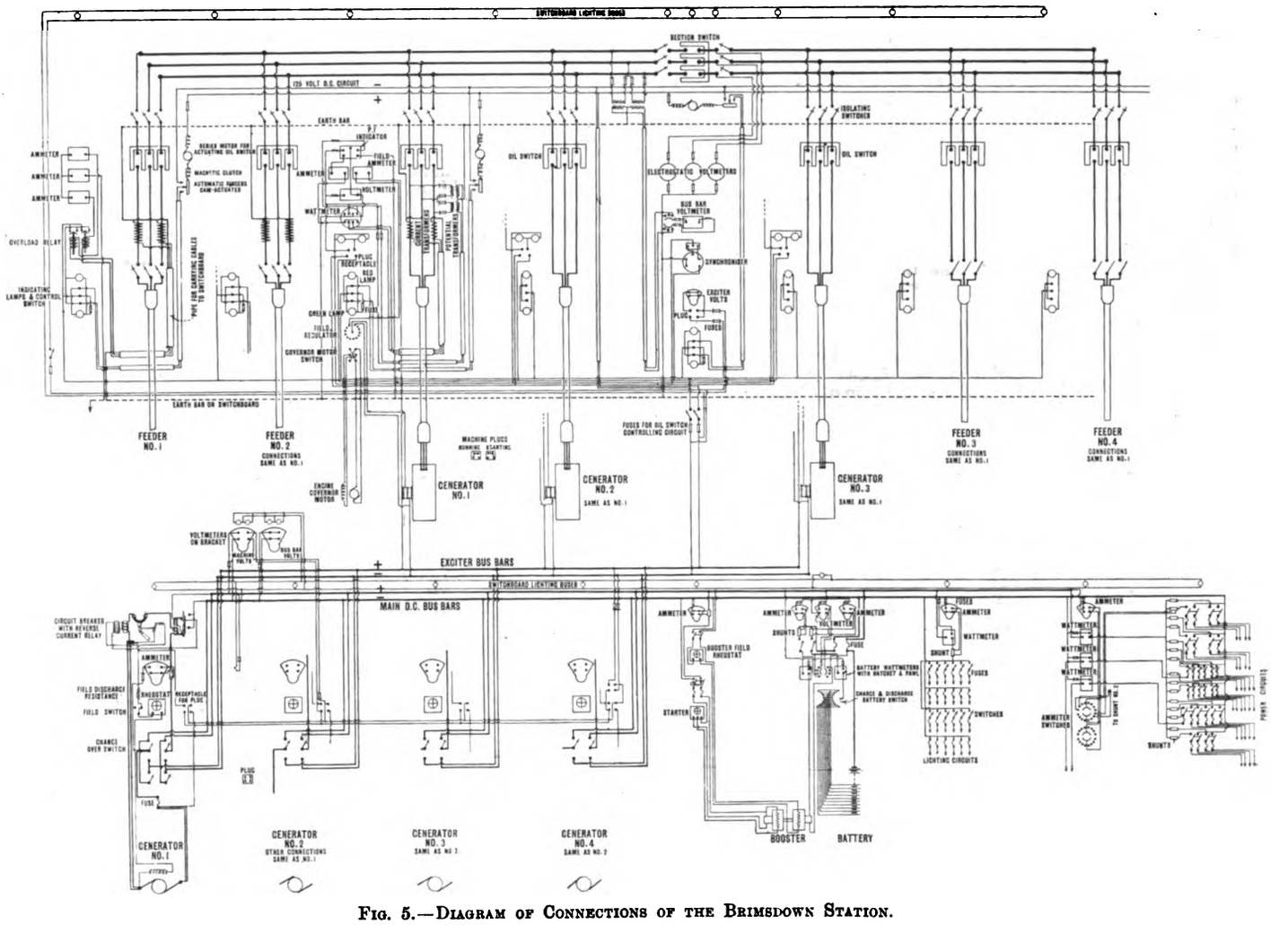

FIG. 5.—DIAGRAM OF CONNECTIONS OF THE BRIMSDOWN STATION.

board. Isolating switches are provided, by means of which it is possible to disconnect the oil switches from the high-tension circuits if necessary. Each pole of the switch is fixed in a separate brick compartment, provided with a suitable metal door. Arrangements are made whereby the switch may be operated manually.

Although the switchboard is equipped with all measuring and controlling devices for the high-tension circuits, there are actually no circuits carrying high-tension currents on the switchboard itself. All high-tension measurements are effected by means of current transformers. In order to guard in every possible way against fire risks, the roof above the high-tension switchboard and the oil switches on the gallery is lined with "Uralite." There is plenty of room left at both ends of the switchboard for future extensions. At present, the board consists of the following panels:—Three three-phase generator panels, one general panel, four three-phase feeder panels, three blank generator panels and four blank feeder panels. The panels are of white marble, 2in. thick, and consist of an upper part and a lower part. They are fixed to vertical angle irons with nickelled bolts and washers in such a way that the framework is not visible from the front. On each generator panel are mounted the following apparatus:—One horizontal edgewise power-factor indicator, one horizontal edgewise voltmeter, one polyphase recording wattmeter, one four-point potential receptacle, one ammeter for the field circuit, one single-pole field switch, one field rheostat with its hand-wheel at the front of the board, two synchronising lamps, two signal lamps for indicating whether the high-tension oil switches are closed or open, one illuminating lamp and shade and one double-pole switch for the oil switch motor. On the interconnector panel are the following instruments:—One horizontal edgewise voltmeter, one double-pole three-way voltmeter switch, one dial synchroniser, two signal lamps, one four-point receptable, one double-pole single-throw switch for the oil switch control circuit, one continuous-current voltmeter for the exciter circuit and one lamp bracket with lamp

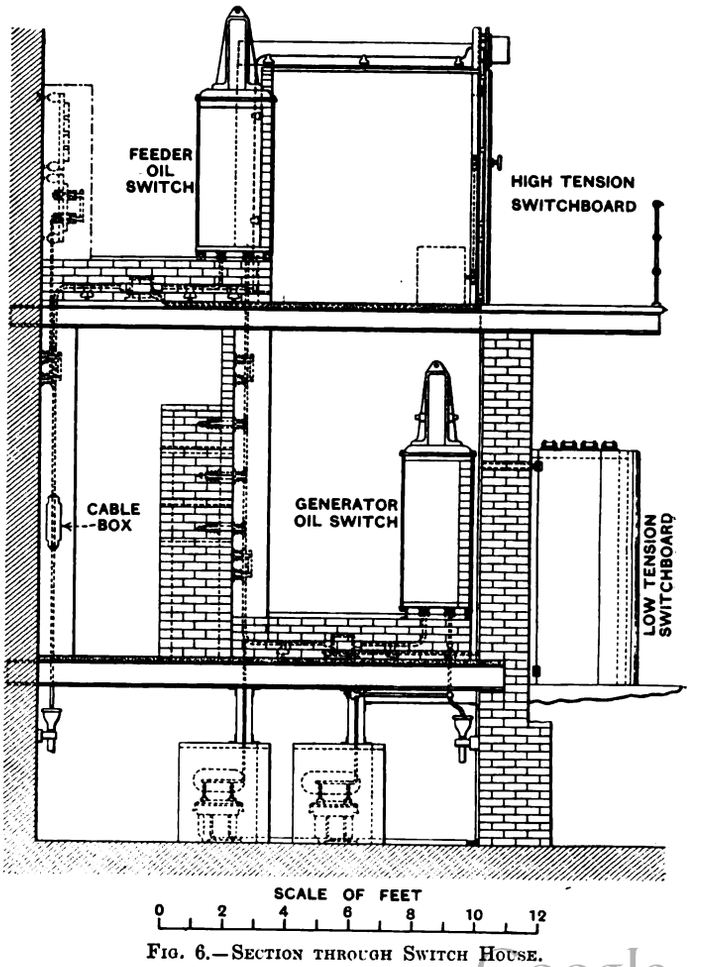

FIG. 6.—SECTION THROUGH SWITCH HOUSE.

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and shade. The out-going feeder panels are equipped with the following devices :—Three horizontal edgewise ammeters, two signal lamps and one lamp bracket with lamp and shade. On the top of the board are three electrostatic voltmeters by Messrs. Kelvin and White. One pole of each is connected to one of the phases of the high-tension system of the station, while the other poles are all connected to earth. It has been pointed out before that the neutral point of the star-connected alternators is not earthed, and the arrangement of the three electrostatic voltmeters allows, therefore, any "earth" to be detected at once. After erection, all high-tension circuits and the apparatus in connection with them were subjected to an alternating pressure of 20,000 volts for half an hour. A screen of expanded metal forms an extension of the high-tension board on either side of it, right up to the walls at the ends of the gallery. Access to the back of the high-tension board is gained through either of two doors in the screen. "Earth" is represented by a bare wire fixed in various parts of the station and connected to all metal parts which are in any way liable to become alive accidentally. This earth strip is connected to the earth plate used for the lightning conductor.

The low-tension switchboard is on the ground floor, in front of the exciter sets and near to the battery booster and the battery room, as indicated in the drawings. Between the low-tension board and the wall ample room has been left for carrying out all necessary operations. There are four continuous-current generator panels, one battery booster panel, one battery panel, one panel for the power supply in the station, one station lighting panel and one voltmeter equipment at the side of the board (see Fig. 7). The circuit-breakers on the generator panels are of the B.T.-H. magnetic blow-out type; the continuous-current voltmeters and ammeters of the Thomson astatic moving coil type; similar instruments for alternating currents are of the inclined coil type; the quick-break switches are of the B.T.-H. knife-blade type, as are also the lever switches by the same firm; the fuses are partly of the magnetic blow-out type, being provided with guards to protect both the surface of the switchboard and the hand of the operator.

For connection between the alternator terminals and the alternator oil switches B.I.W. three-core cable is used, each core having a section of 0·1 sq. in. Each cable is laid in a separate U-shaped Doulton trough with brick covers. At the point in the cable tunnel where the cable rises to the alternator terminals, a B.I.W. connecting box for three-core cable connection is fitted. Connections for the low-pressure system are made throughout by means of 600 megohm grade V.R. cables. Lead-covered cables are made use of in damp places and between the station and outside structures. The connections between the continuous-current dynamos and their panels are laid in Sykes self-centreing earthenware ducts. For the 100kw. sets two cables in parallel are used, each having 0·5 sq. in. section, while for the 50kw. sets one cable only is employed. In the engine room there is a 25-ton overhead travelling crane, by Messrs. Carrick and Ritchie. All motions are worked by one electric motor through suitable clutching and gearing arrangements, but it is also possible to operate the crane by hand. The span is 45ft. and the hook of the crane clears the floor by about 21½ft. All operations are controlled by one man on the platform on the top of the crane, and the altering of the gear (in connection with the lifting and traversing motions) from single to double purchase is done by levers from above. The motor is a B.T.-H. totally-enclosed series wound 10 H.P. machine, running normally at about 900 revs. per min. An automatic brake controls the lifting of the load and holds it at any height. Before leaving the makers' works the crane was tested with a load of 30 tons.

A battery of 63 Pollak cells, in lead-lined wooden boxes, works in conjunction with the low-tension system. Its capa-

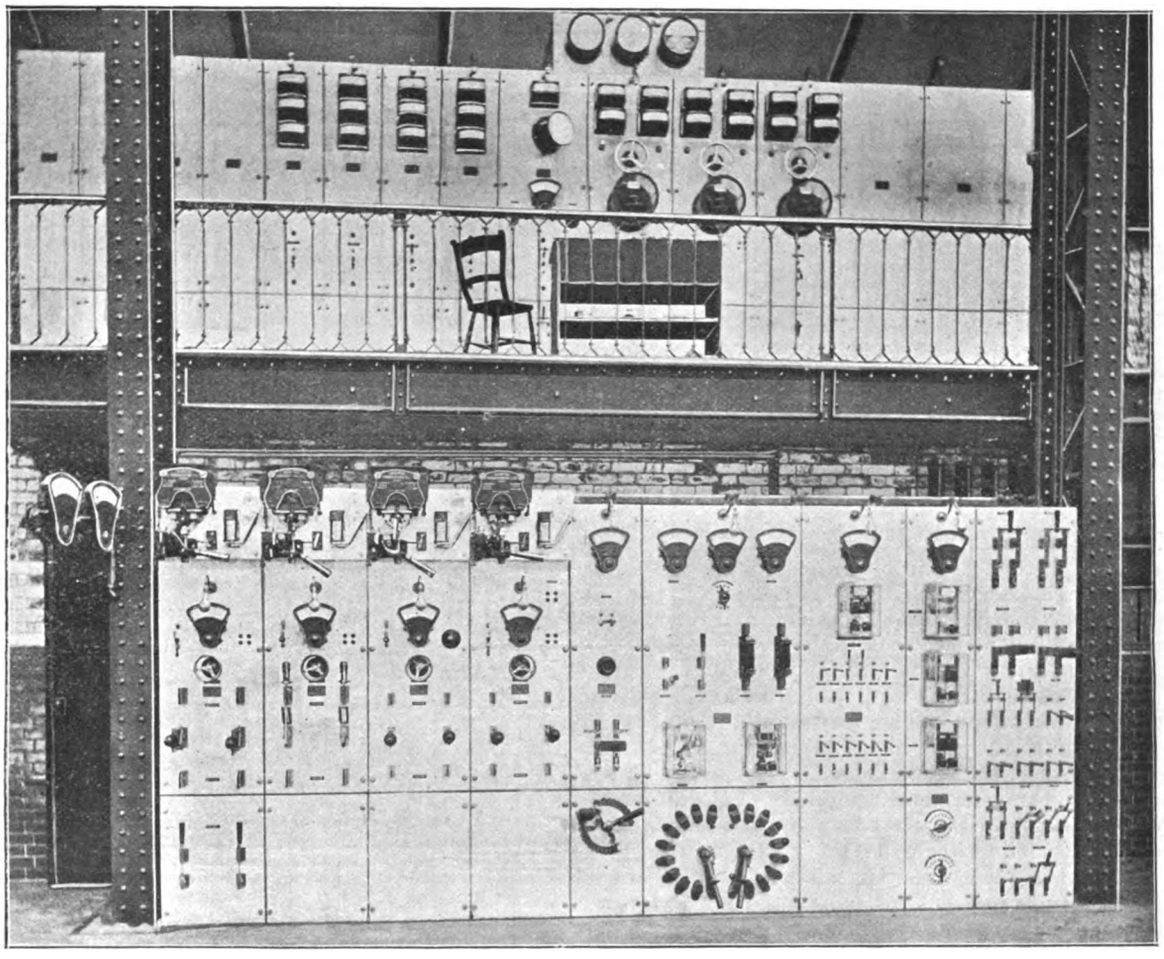

FIG. 7.—VIEW OF HIGH-TENSION AND LOW-TENSION SWITCHBOARDS.

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city is given as 629 ampere-hours at a one hour's discharge rate and 1,230 ampere-hours at the 10-hour rate. Each cell consists of 17 positive plates and 18 negative ones, and its total weight is approximately 530lb. Including the acid, the weight of the battery is about 21 tons. A hand-travelling crane for dealing with loads up to 15 cwt. is suspended from girders running down the centre of the battery room.

Distributed through the buildings and grounds are 14 7-ampere Crompton open arc lamps, connected in pairs across 110-volt leads. In the engine room are four arc lamps of the same size and type, but fitted with opal globes.

(To be concluded.)

On Saturday last Sir Francis Cory-Wright, Bart., D.L., formally opened the first section of the important and extensive system of electric tramways or light railways promoted by the Middlesex County Council. When completed the enterprise of the County Council will provide tramway facilities over about 50 miles of the main roads in the county, where at present there is no means of cheap, easy and rapid intercommunication. By obtaining powers for this improvement the Middlesex County Council has constituted itself the sole tramway authority in its area. In order, among other reasons, to continue this uniform system into neighbouring districts, the County Council has arranged to lease the working of the Middlesex electric light railways to the Metropolitan Electric Tramways (Ltd.), a company whose tramway interests extend into the counties of Hertford and Essex and also into the County of London. About three weeks ago this company opened for public traffic about 4 miles of tramway, which it had converted from horse traction to electric traction on the overhead system. This line was described in *The Electrician* of July 29th, and the present series of articles is descriptive of the method of supplying power to it and to the Middlesex County Council light railways.

In addition to that portion opened on Saturday, other important sections of the Middlesex light railways are under construction and will be opened for public traffic in the near future. The routes may be described as comprising the four great radial roads from Willesden to Wembley, Cricklewood to Edgware, Highgate to High Barnet, and Wood Green to Enfield, while cross routes form connecting links between the trunk lines. Three of the routes extend into the neighbouring county of Hertford, where the County Council has promoted light railways and agreed to lease them to the Metropolitan Electric Tramways (Ltd.) on terms similar to those arranged by the Middlesex County Council. Running powers have been granted over the Walthamstow light railways, so that the area of the whole electric tramway and light railway enterprise extends from Willesden in the west to Walthamstow and Woodford in the east. The London county boundary practically forms the southern frontier, and towards the north the benefits of electric traction will be carried as far as Watford on one side and Cheshunt on the other. Reference may also be made to the map published in our issue of July 29th.

Not the least interesting part of the enterprise of the Middlesex County Council is the arrangement made between the Council and the Metropolitan Electric Tramways (Ltd.) The Council holds all the light railway orders, and has leased the lines to the company until 1930. The cost of constructing the track is borne by the Council, and the electrical equipment and rolling stock are provided by the company. An average of 4½ per cent. upon the Council's expenditure is paid by way of rent; out of the gross receipts the company receives an average of 4½ per cent. on its capital expenditure; and the net revenue, after deducting working expenses, &c., is divided between the Council and the company in the proportion of 45 per cent. to the Council and 55 per cent. to the company. There will be no workmen's fares, as "the whole of the travelling public will be given the benefit of the cheap fare prescribed by Parliament for the working man."

Sir Francis Cory-Wright, in declaring the new lines open, said he hoped the entire 50 miles would be working within three years and then they proposed to commence another 50 miles. He considered the Council had made an excellent bargain, and mentioned that the cost of constructing the lines, exclusive of cars, &c., was nearly £30,000 a mile.

Mr. E. Garcke, on behalf of the Metropolitan Electric Tramways (Ltd.), said he trusted that the relations between the Council and the company would ever remain cordial. As a symbol of the control which the Council had the power of exercising over the company, he presented Sir F. Cory-Wright with a silver controller handle for starting the first car.

Sir Ralph Littler, K.C., said he was extremely gratified to think that people had at last been converted to opinions which he had advanced 12 years ago. At that time he had advocated overhead electric traction in that very locality, but the work was objected to then on the score of "hideous standards" and "large numbers of accidents."

Subsequently the first car was started by Sir Francis Cory-Wright, and a most successful run made from Tottenham to Wood Green via Lordship-lane, and over the tramways of the Metropolitan Electric Tramways (Ltd.) from Wood Green to Tottenham via Manor House and Seven Sisters.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Transactions of the Canadian Institute." Vol. VII. Part 3. No. 15. March. (Toronto: Murray Printing Co.) $2.

"Carborundum." (Monographien über angewandte Elektrochemie, Vol. XIII.) By F. A. J. FitzGerald. Translated into German by Dr. Max Huth. (Halle-a-S.: Wilhelm Knapp.) 2m.

THE HOOKHAM PREPAYMENT METER.

For use with shillings only, the Hookham prepayment meter has been on the market about a year, but for pence only, the instrument which we propose to describe is an entirely new departure. The accompanying illustration shows all the main features of this prepayment meter as arranged for continuous currents. A is the check reservoir, drawn with part of the exterior removed so as to exhibit the checks, consisting of a number of small steel spheres contained

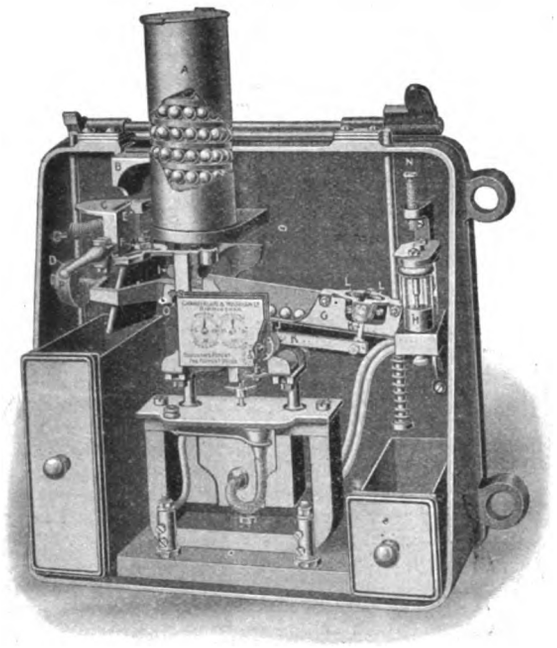

Fig 1.—Mechanism of Meter.

in a spiral groove. The checks are put into this groove from the top, and escape one at a time at the bottom. B is the slot into which coins are inserted so as to fall into the receptacle C. D is a lever projecting through the front of the case. After a coin has been inserted and has fallen into C, the lever D is moved to the left; the coin standing edgewise in C first encounters and lifts the catch E, thus allowing

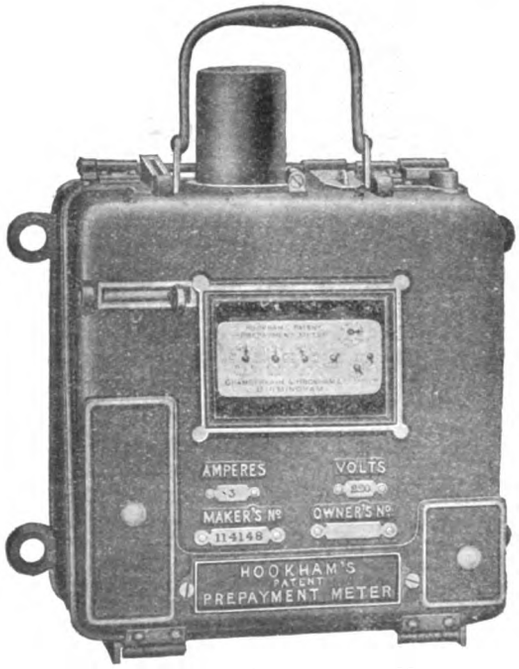

Fig. 2.—External Appearance of Meter.

D to be moved still further; it then falls over the edge of an inclined plane F, which prevents the possibility of D returning until the coin has been discharged into the coin drawer on the left. The forward movement of D works a small pusher under the check reservoir which carries out a check and drops it into a pivoted beam G. One check is sufficient to depress the beam, thus causing contact to be made by means of the mercury cups H and permitting a supply of current to pass to the lamps. Any number up to eight checks may,

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however, remain in the beam, allowing the customer to put in a maximum of eight coins at a time. Each check as it falls into the beam passes over and tilts a small weighted lever at I, which is so arranged that if the beam becomes full of checks more cannot issue from the reservoir. This in turn prevents any more coins being inserted until, under the action of the meter, a check has passed from the beam.

The release of the checks from the beam is effected through the medium of the counting train of the meter. One of the wheels carries the crank-pin J, which, in rotating, rocks the connecting rod and lever K, K backwards and forwards. To the lever K is attached a horizontal bar carrying two small vertical screws L, L; the whole arrangement forms a kind of escapement, the slow to and-fro movement of which releases the checks one at a time. The speed of the meter and the wheel train of the counter are so adjusted that the desired value in electric current releases one check from the beam. After escaping from the beam each check falls into the check drawer on the right-hand side of the meter. When the meter has been in use for some time the coins are collected and all the checks in the drawer returned to the reservoir.

The coin and check drawers are secured by vertical spring bolts at the back of the meter, which are depressed by the movement of a horizontal bar along the top of the case. The movement of this bar also secures the cover for the check reservoir, and it carries a lid which seals a small hole in the case. This hole is provided so that a screw-driver can be inserted for the purpose of raising the screw N, which, when down presses the end of the beam firmly down upon the mercury cups, effectually sealing them up and preventing loss of mercury, or oil with which it is covered, in transit. This screw must be raised to its fullest extent after fixing the meter. It is necessary to remove the two drawers before opening the front of the meter. This only need be done in order to put the meter ready for working after transit by rail, and when this has been done the cover may be closed and screwed up and the screw sealed, the sealing device being released when the meter is connected up.

Different counting trains are provided according to the price per unit which is to be charged, and they are stamped accordingly. The wheel on the worm spindle may be varied according to the voltage of the supply and the constant of the meter, in the same way as in the ordinary Hookham meters, and change wheels for this purpose can be supplied. The dial on the right-hand corner of the counter in Fig. 2. shows the consumer how many coins are still left unused in the beam, while the two dials below indicate to the collector the number of coins he ought to find in the drawer. It reads up to 999 B.O.T. units. It will be seen that the prepayment mechanism is of a very simple description and is not liable to get deranged. The more important details are, moreover, capable of adjustment. It is important that the beam should swing perfectly freely on its pivots and it must be so balanced that when empty it rises up out of the mercury cups and yet the weight of one check will depress it into them. The position of the weight P may be adjusted to effect this if necessary. The relative position of the counter on the meter and the escapement on the beam should allow of the crank-wheel J turning round with perfect freedom when the beam is down and no checks in it. The position of the screws L, L is such that the to-and-fro movement just allows of a check passing under each when at its highest position.

An ordinary Hookham current meter performs the actual current measuring, and the advantages claimed for the instrument are that it contains no clockwork and requires no winding. Also, that the fall of potential is very small, all parts are exceptionally simple and strong, there is a visible and permanent record of the consumption, the amount prepaid but not consumed can be seen, the apparatus is unaffected by variations in coins and is provided with a certain and reliable switch.

PROF. HORACE LAMB'S PRESIDENTIAL ADDRESS TO SECTION A (MATHEMATICS AND PHYSICS) OF THE BRITISH ASSOCIATION.*

(*Concluded from page 723.*)

If we look back for a moment to the views currently entertained not so very long ago by mathematicians and physicists, we shall find, I think, that the prevalent conception of the world was that it was constructed on some sort of absolute geometrical plan, and that the changes in it proceeded according to precise laws; that, although the principles of mechanics might be imperfectly stated in our text-books, at all events such principles existed, and were ascertainable, and, when properly formulated, would possess the definiteness and precision which were held to characterise, say, the postulates of Euclid. Some writers have maintained, indeed, that the principles in question were finally laid down by Newton, and have occasionally used language which suggests than any fuller understanding of them was a mere matter of interpretation of the text. But, as Hertz has remarked, most of the great writers on dynamics betray, involuntarily, a certain *malaise* when explaining the principles, and hurry over this part of their task as quickly as is consistent with dignity. They are not really at their ease, until, having established their equations somehow, they can proceed to build securely on these. This has led some people to the view that the laws of Nature are merely a system of differential equations; it may be remarked in passing that this is very much the position in which we actually stand in some of the more recent theories of electricity. As regards dynamics, when once the critical movement had set in, it was easy to show that one presentation after another was logically defective and confused; and no satisfactory standpoint was reached until it was recognised that in the classical dynamics we do not deal immediately with real bodies at all, but with certain conventional and highly idealised representations of them, which we combine according to arbitrary rules, in the hope that if these rules be judiciously framed the varying combinations will image to us what is of most interest in some of the simpler and more important phenomena. A complete description of even the simplest natural phenomenon is an obvious impossibility; and, were it possible, it would be uninteresting as well as useless, for it would take an incalculable time to peruse. Some process of selection and idealisation is inevitable if we are to gain any intelligent comprehension of events. The whole course of physical sciences and the language in which its results are expressed have been largely determined by the fact that the ideal images of geometry were already at hand at its service. The ideal representations have the advantage that, unlike the real objects, definite and accurate statements can be made about them. It is no doubt hard to divest oneself entirely of the notion conveyed in the Greek phrase ἀεὶ ὁ θεὸς γεωμετρεῖ, that definite geometrical magnitudes and relations are at the back of phenomena. It is recognised, indeed, that all our measurements are necessarily to some degree uncertain, but this is usually attributed to our own limitations and those of our instruments rather than to the ultimate vagueness of the entity which it is sought to measure. Everyone will grant, however, that the distance between two clouds, for instance, is not a definable magnitude; and the distance of the earth from the sun, and even the length of a wave of light, are in precisely the same case. The notion in question is a convenient fiction, and is a striking testimony to the ascendancy which Greek mathematics have gained over our minds, but I do not think that more can be said for it. It is, at any rate, not verified by the experience of those who actually undertake physical measurements. The more refined the means employed, the more vague and elusive does the supposed magnitude become; the judgment flickers and wavers, until at last in a sort of despair *some* result is put down, not in the belief that it is exact, but with the feeling that it is the best we can make of the matter. A practical measurement is, in fact, a classification; we assign a magnitude to a certain category, which may be narrowly limited, but which has in any case a certain breadth.

By a frank process of idealisation a logical system of abstract dynamics can doubtless be built up. Such difficulties as remain are handed over to geometry. But we cannot stop in this position; we are constrained to examine the nature and the origin of the conceptions of geometry itself. Most of us have been forced at length to acquiesce in the view that geometry, like mechanics, is an applied science; that it gives us merely an ingenious and convenient symbolic representation of the relations of actual bodies; and that, whatever may be the *a priori* forms of intuition, the science as we have it could never have been developed except for the accident (if I may so term it) that we live in a world in which rigid or approximately rigid bodies are conspicuous objects. On this view the most refined geometrical demonstration can be resolved into a series of imagined experiments performed with such bodies, or rather with their conventional representations. It is to be lamented that one of the most interesting chapters in the history of science is a blank; I mean that which would have unfolded the rise and growth of our system of ideal geometry. The finished edifice is before us, but the record of the efforts by which the various stones were fitted into their places is hopelessly lost.

It is possible, however, to uphold the importance of the part which abstract geometry has played, and must still play, in the evolution of scientific conceptions without committing ourselves to a defence, on all points, of the traditional presentment. The consistency and completeness of the usual system of definitions, axioms and postulates has often been questioned; and quite recently a more thoroughgoing analysis of the logical elements of the subject than has ever before been attempted has been made by Hilbert. The matter is a subtle one, and a general agreement on such points is as yet hardly possible. The basis for such an agreement may, perhaps, ultimately be found in a more explicit recognition in the empirical source of the fundamental conception. This would tend, at all events, to mitigate the rigour of the demands which are sometimes made for logical perfection.

Even more important in some respects are the questions which have arisen in connection with the applications of geometry to pur

* Delivered 18th Aug. Abstract.

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poses of graphical representation. It is not necessary to dwell on the great assistance which this method had rendered in such subjects as physics and engineering. The pure mathematician, for his part, will freely testify to the influence which it has exercised in the development of most branches of analysis; for example, we owe to it all the leading ideas of the calculus. Modern analysts have discovered, however, that geometry may be a snare as well as a guide. In the mere act of drawing a curve to represent an analytical function we make unconsciously a host of assumptions which are difficult not merely to prove, but even to formulate precisely. It is now sought to establish the whole fabric of mathematical analysis on a strictly arithmetical basis. To those who were trained in an earlier school the results so far are in appearance somewhat forbidding. If the shade ofone of the great analysts of a century ago could revisit the glimpses of the moon, his feelings would, I think, be akin to those of the traveller to some mediæval town, who finds the buildings he came to see obscured by scaffolding, and is told that the ancient monuments are all in process of repair. It is to be hoped that a good deal of this obstruction is only temporary, that most of the scaffolding will eventally be cleared away, and that the edifices when they re-appear will not be entirely transformed, but will still retain something of their historic outlines. It would be contrary to this spirit of the address to undervalue in any way the critical examination and revision of principles; we must acknowledge that it tends ultimately to simplification, to the clearing up of issues, and the reconciliation of apparent contradictions. But it would be a misfortune if this process were to absorb too large a share of the attention of mathematicians, or were allowed to set too high a standard of logical completeness. In this particular matter of the "arithmetisation of mathematics" there is, I think, a danger in these respects. As regards the latter point, a traveller who refuses to pass over a bridge until he has personally tested the soundness of every part of it is not likely to go very far; something must be risked, even in mathematics. It is notorious that even in this realm of "exact" thought discovery has often been in advance of strict logic, as in the theory of imaginaries, for example, and in the whole province of analysis of which Fourier's theorem is the type. And it might even be claimed that the services which geometry has rendered to other sciences have been almost as great in virtue of the questions which it implicitly begs as of those which it resolves.

I would venture, with some trepidation, to go one step further. Mathematicians love to build on as definite a foundation as possible, and from this point of view the notion of the integral number, on which (we are told) the mathematics of the future are to be based, is very attractive. But, as an instrument for the study of Nature, is it really more fundamental than the geometrical notions which it is to supersede? The accounts of primitive peoples would seem to show that, in the generality which is a necessary condition for this purpose, it is in no less degree artificial and acquired. Moreover, does not the act of enumeration, as applied to actual things, involve the very same process of selection and idealisation which we have already met with in other cases? As an illustration, suppose we were to try to count the number of drops of water in a cloud. I am not thinking of the mere practical difficulties of enumeration, or even of the more pertinent fact that it is hard to say where the cloud begins or ends. Waiving these points, it is obvious that there must be transitional stages between a more or less dense group of molecules and a drop, and in the case of some of these aggregates it would only be by an arbitrary exercise of judgment that they would be assigned to one category rather than to the other. In whatever form we meet with it, the very notion of counting involves the highly artificial conception of a number of objects which for some purposes are treated as absolutely alike, whilst yet they can be distinguished.

The net result of the preceding survey is that the systems of geometry, of mechanics, and even of arithmetic, on which we base our study of nature, are all contrivances of the same general kind: they consist of series of abstractions and conventions devised to represent, or rather to symbolise, what is most interesting and most accessible to us in the world of phenomena. And the progress of science consists in a great measure in the improvement, the development, and the simplification of these artificial conceptions, so that their scope may be wider and the representation more complete. The best in this kind are but shadows, but we may continually do something to amend them.

As compared with the older view, the function of physical science is seen to be much more modest than was at one time supposed. We no longer hope by levers and screws to pluck out the heart of the mystery of the universe. But there are compensations. The conception of the physical world as a mechanism, constructed on a rigid mathematical plan, whose most intimate details might possibly some day be guessed, was, I think, somewhat depressing. We have been led to recognise that the formal and mathematical element is of our own introduction; that it is merely the apparatus by which we map out our knowledge, and has no more objective reality than the circles of latitude and longitude on the sun. A distinguished writer not very long ago speculated on the possibility of the scientific mine being worked out within no distant period. Recent discoveries seem to have put back this possibility indefinitely; and the tendency of modern speculation as to the nature of scientific knowledge should be to banish it altogether. The world remains a more wonderful place than ever: we may be sure that it abounds in riches not yet dreamed of; and although we cannot hope ever to explore its innermost recesses, we may be confident that it will supply tasks in abundance for the scientific mind for ages to come.

One significant result of the modern tendency is that we no longer with the same obstinacy demand a mechanical explanation of the phenomena of light and electricity, especially since it has been made clear that if one mechanical explanation is possible, there will be an infinity of others. Some minds, indeed, revelling in their new-found freedom, have attempted to disestablish ordinary or "vulgar" matter altogether. I may refer to a certain treatise which, by some accident, does not bear its proper title of "Æther and *no* Matter," and to the elaborate investigations of Prof. Osborne Reynolds, which present the same peculiarity, although the basis is different. Speculations of this nature have, however, been so recently and (if I may say it) so brilliantly dealt with by Prof. Poynting before this section that there is little excuse for dwelling further on them now. I will only advert to the question whether, as some suggest, physical science should definitely abandon the attempt to construct mechanical theories in the older sense. The question would appear to be very similar to this, whether we should abandon the use of graphical methods in analysis. In either case we run the risk of introducing extraneous elements, possibly of a misleading character; but the gain in vividness of perception and in suggestiveness is so great that we are not likely altogether to forego it, by excess of prudence, in one case more than in the other.

We have travelled some distance from Stokes and the mathematical physics of half a century ago. May I add a few observations which might, perhaps, have claimed his sympathy? They are in substance anything but new, although I do not find them easy to express. We have most of us frankly adopted the empirical attitude in physical science; it has justified itself abundantly in the past, and has more and more forced itself upon us. We have given up the notion of causation, except as a convenient phrase; what were once called laws of nature are now simply rules by which we can tell more or less accurately what will be the consequences of a given state of things. We cannot help asking, How is it that such rules are possible? A rule is invented in the first instance to sum up in a compact form a number of past experiences; but we apply it with little hesitation, and generally with success, to the prediction of new and sometimes strange ones. Thus the law of gravitation indicates the existence of Neptune; and Fresnel's wave-surface gives us the quite unsuspected phenomenon of double refraction. Why does Nature make a point of honouring our cheques in this manner! or, to put the matter in a more dignified form, how comes it that, in the words of Schiller,*

> Mit dem Genius steht die Natur im ewigen Bunde,
> Was der eine verspricht, leistet die andre gewiss?

The question is as old as science, and the modern tendencies with which we have been occupied have only added point to it. It is plain that physical science has no answer; its policy, indeed, has been to retreat from a territory which it could not securely occupy. We are told in some quarters that it is vain to look for an answer anywhere. But the mind of man is not wholly given over to physical science, and will not be content for ever to leave the question alone. It will persist in its obstinate questionings, and, however hopeless the attempt to unravel the mystery may be deemed, physical science, powerless to assist, has no right to condemn it.

I would like, in conclusion, to read to you a characteristic passage from the address of Stokes in 1862 which has formed the starting-point of this discourse:—

> In this section, more, perhaps, than in any other, we have frequently to deal with subjects of a very abstract character, which in many cases can be mastered only by patient study, at leisure, of what has been written. The question may not unnaturally be asked, If investigations of this kind can best be followed by quiet study in one's own room, what is the use of bringing them forward in a sectional meeting at all? I believe that good may be done by public mention, in a meeting like the present, of even somewhat abstract investigations; but whether good is thus done, or the audience merely wearied to no purpose, depends upon the judiciousness of the person by whom the investigation is brought forward.

It might be urged that these remarks are as pertinent now as they were 40 years ago, but I will leave them on their own weighty authority. I will not myself attempt to emphasise them, lest some of my hearers should be tempted to retort that the warning might well be borne in mind, not only in the ordinary proceedings of the section, but in the composition of a presidential address!

* Applied by Herschel to the discovery of Neptune.

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ON LARGE BULB INCANDESCENT ELECTRIC LAMPS AS SECONDARY STANDARDS OF LIGHT.*

BY J. A. FLEMING, B.A., D.SC., F.R.S.

For the last eight years the author has employed as a secondary standard of light a type of large bulb carbon filament electric incandescent lamp which was first devised by him in 1895 in connection with photometric work carried on in the Pender Electrical Laboratory of University College. These lamps were made by the Edison and Swan Electric Light Co., and a description of them, as well as a discussion of the principle underlying their construction, will be found in *The Electrician*, Vol L., p. 441.† These lamps are intended to be used in a process of photometric "double weighing," described in *The Electrician*, Vol. LI., p. 482, and in the *Proceedings* of the Institution of Electrical Engineers, Vol. XXXII., p. 144.

In connection with the construction of these large bulb lamps, the following points are important:—The filament should preferably be in the form of a single loop or horseshoe, and should be mounted in the large cylindrical bulb with great care, so that the plane of the loop lies in the axial line of the lamp, filaments being selected with the two sides of the loop in the same plane and not distorted. In some cases it is desirable to anchor the filament by a loose loop of platinum wire, sealed into the bulb, but such loop of wire should not touch the filament or constrain it when the lamp is at rest or in use. Owing to the fact that the 16 c.p. 100-volt filament is about 9in. in length, it is desirrble, if possible, to employ a 10 c.p. 60 volt large bulb photometric lamp as a standard. The 16 c.p. 100-volt lamp of this type is much used, and the 16 c.p. 200-volt lamp has been made but is not recommended. It is not desirable to employ two filaments in parallel, as they may then be at different temperatures; but they can be placed in series, one loop within the other, and both lying in the same plane. In setting the lamp in the photometer, great care must be exercised to adjust the lamp axis perfectly vertical, and a plumb line should be employed to mark the position of the mean line of the filament as read on the scale of the photometer bench.

In the use of these lamps, the following precautions should be taken (i.) The lamp should never be raised above the voltage marked upon it by the manufacturer. (ii.) In the next place, great care should be taken that good contact is made between the socket and the sole-plate on the lamp; it is better, therefore, to solder a pair of wires to each sole-plate of the lamp collar, one pair being employed as the leads for the current to the lamp, and the other pair as potentiometer or voltmeter wires to ascertain the exact potential difference between the sole-plates of the lamp. This adjustment of potential is best effected by means of a variable rheostat and a potentiometer. In the certificate issued with each of the Fleming-Ediswan photometric lamps, a statement is made of the exact voltage and current at which the lamp gives a certain candle-power at a certain temperature. If used with the above precautions, experience accumulated during the past eight years has shown that these lamps are capable of preserving an exceedingly constant candle-power, and that as standards of light they are more portable and require none of the corrections necessary in the case of flame standards.

The great objection which may be urged against the use of all flame standards is the degree to which their candle power is affected by moisture in the air and changes in barometric pressure. It has been shown by researches made at the Reichsanstalt on the Hefner lamp that the light emitted decreases about 0·5 per cent. with every additional litre of water vapour present in the atmosphere above a certain normal value. Taking the average variations of moisture in the air from month to month, we find that this implies a variation of about 4 per cent. in the light emitted in the Hefner lamp between the wet and dry seasons of the year; this variation greatly exceeds the limits of possible error in photometric observations. With very little care photometric comparisons can be made within 1 per cent., hence comparisons with a flame standard are not sufficiently definite unless the value of the flame standard has been corrected for moisture and barometric pressure. The authorities of the Berlin Reichsanstalt take the standard state of the atmosphere with regard to moisture to be that in which it contains 8·8 litres of water vapour per cubic metre of dry air. The atmosphere of Berlin, however, is distinctly drier than that of London, and the author has been informed by Dr. Glazebrook, F.R.S., Director of the National Physical Laboratory of England, that he considers for Great Britain it will be better to take as a standard state 10 litres of water vapour per cubic metre of dry air as more nearly representing the average state of the British atmosphere.

Dr. Glazebrook has made a prolonged study of the Harcourt pentane 10-candle lamp, in regard to variation of candle-power of the latter with atmospheric moisture and pressure, the results of which he will no doubt make known in due time; meanwhile, he has privately communicated to the writer information which shows that the correction of the candle-power in the pentane lamp due to moisture in the air or, rather, deviations from the standard state of moisture, is at least as great as that of the Hefner lamp. There seems reason to believe that this correction would be about the same for all flame standards. Dr. Glazebrook has been so kind as to communicate to the writer a formula for the correction of the pentane lamp for variation in illuminating power due to atmospheric moisture and pressure which he has obtained, but it must be considered as merely privately and unofficially furnished, and therefore subject to any future correction by him.*

Taking the Harcourt 10-candle pentane lamp to emit a light of 10 c.p. when the barometric pressure is 760mm., and the atmospheric moisture 10 litres per cubic metre, then the candle-power corresponding to a barometric pressure of *b*mm. and a hygrometric state of *e* litres of water vapour per cubic metre, he finds that candle-power can be expressed as follows:—Candle-power of the Harcourt pentane lamp$=10+0{\cdot}066(10-e)-0{\cdot}008(760-b)$. The water vapour present may often reach 15 or 16 litres per cubic metre. This variation alone will decrease the candle-power by 3 per cent. or rather more. Hence, if the correction is not applied and the pentane lamp is then used directly to standardise an incandescent lamp and assumed to be 10 c.p., the candle-power of the electric lamp may be marked as much as 3 per cent. too high. In other words, an error of nearly 0·5 candle may be made in marking a 16 c.p. lamp. This source of error only presents itself in comparing a flame standard with an incandescent lamp. When two flame standards such as coal gas and pentane are being compared the atmospheric moisture affects both flames about equally.

The writer has recently had careful tests made to ascertain if these large bulb incandescent lamps gave the same candle-power at the same voltage and current irrespective of variations in the temperature of the surrounding atmosphere. With this object an experiment was made by Mr. G. B. Dyke in the photometric gallery of the Pender Electric Laboratory at the suggestion of the author. A large iron box was provided having an oval hole in front about the size of one of the large bulb lamps. A lamp of this description was mounted on a socket and suspended in this box with its axis vertical. At the bottom of the box were placed some coils of iron wire which could be heated by an electric current. In this manner the temperature of the air in the box was gradually raised and the lamp was surrounded by an atmosphere of warm air. The temperature of this air was taken by four thermometers placed in the box. The readings of these thermometers were taken together with the candle-power of the lamp and the values found to be as follows:—

Atmospheric temperature in centigrade degrees.					Candle power of large bulb lamp.
I	II.	III.	IV.	Mean.	
23·6	24·4	22·8	22·8	23·4	13·84
27·4	27·7	28·0	26·4	27·4	13·81
42 0	44·4	46·9	37·5	42·4	13·81
67·2	69·4	77·2	53·3	66·8	13·77

Hence it is clear that there is practically no change in the candle-power of the lamp with change of temperature of the surrounding atmosphere.

In equipping an electrical laboratory with the means of preserving a standard of light, the author recommends the following procedure as the result of eight years' experience of it. A stock, say, of 12 of the large bulb photometric lamps is provided. Those of the writer's pattern, issued by the Edison and Swan United Electric Light Co., are each sent out in a stout millboard box. These lamps should all have their candle-power carefully determined at a marked voltage, so chosen that the efficiency is about 4 watts per candle. The current at this voltage should be measured. This candle-power, current and voltage should be marked on the box. If this calibration is made against a flame standard, then the greatest care should be taken to correct the value of the flame standard for atmospheric moisture and pressure. The candle power ratios of these lamps should be taken, and six of them should be preserved as ultimate standards of reference for the adjustment of the other six. These last may be used for setting the comparison lamp in the photometer, and they should be compared at intervals with the first six lamps which are reserved as prime standards of reference. If the six working lamps are used turn and turn about and inter-compared with the reference standards, they may be used thousands of times without being actually burning for more than a few hours, and the tradition as to the limit of light or illumination can be transmitted without risk of change.

*Abstract of a Paper read before Section G of the British Association.

†They are also described and illustrated in the author's "Handbook for the Electrical Laboratory and Testing Room," Vol. II., and in the *Proceedings* of the Institution of Electrical Engineers, Vol. XXXII., p. 132.

*A short resumé of these researches is given in a Paper by Mr. C. C. Paterson, who has conducted the experiments at the National Physical Laboratory on this subject. It is published on p. 751 of this issue of *The Electrician*.

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As an instance of the utility of these lamps in the comparison of flame standards, it may be mentioned that the author recently sent three of these large bulb standard lamps to Berlin by his assistant, Mr. W. C. Clinton, and they were photometrically measured in the Physikalisch Technische Reichsanstalt at Charlottenburg. The same lamps were subsequently taken to the National Physical Laboratory, Bushy House, Teddington, and measured independently. In Berlin the standard of comparison was a Hefner lamp, and at Bushy House it was a Harcourt 10 c.p. pentane lamp. The ratios of the certified readings gives us the value of the Hefner unit in mean British candles, and it is close to the value usually assumed. These three lamps are called Pender IV., Pender VI. and Pender X. respectively. The results are tabulated below :—

Lamp mark.	Value of the illuminating pwr. in Hefner units assigned at the Reichsanstalt. H.U.	Value of the illuminating pwr. in British candles assigned at the Nat. Phys. Lab. C.P.	Value of the Hefner unit in British candles.
Pender IV.	15·1	13·41	0·888
Pender VI.	12·6	11·12	0·883
Pender X.	15·9	14·07	0·885

The mean value of the ratio is 0·885.

The lamps were all measured at 96 volts, and the current values obtained at the Reichsanstalt agreed with those obtained at Bushy House within 1 part in 1,000. Hence we may take it that the above fraction represents very nearly the ratio between the Hefner unit as employed at Berlin and the mean British candle as employed in London as a standard of illumination.

In connection with these large bulb lamps, the author has arranged a simple apparatus consisting of a large bulb lamp, a rheostat and an ammeter, the range of which comprises merely the ordinary lamp currents. The ammeter is, however, not graduated to read amperes, but graduated to read candle-power, so that if the rheostat is adjusted to make the ammeter needle point to any part of the scale, that scale reading would at once, without further calculation, give the candle-power of the lamp in the normal direction. Although this apparatus is not accurate enough for laboratory purposes, yet for workshop or generating station purposes it is a convenient arrangement for obtaining a fairly accurate standard of light without the complications involved with the use of the potentiometer.

THE DISTRIBUTION OF MAGNETIC INDUCTION IN MULTIPOLAR ARMATURES.*

BY W. M. THORNTON, D.SC.

The progress of the constructional development of dynamo-electric machines has been characterised by the utilisation of all parts, copper or iron, to their fullest temperature limit, with the result that the weight of a machine for a given output is much less than what it was ten years ago. A comparison of many machines will, however, show, that in one point—the radial depth of the armature core—there is still a wide difference of practice, arising, no doubt, from the fact that there has been little or no direct investigation of the distribution of magnetism within the core upon which to base a scientific treatment.

The most suitable radial depth for the armature core of continuous or alternating-current machines can be found by a consideration of the manner in which the induction is distributed from the periphery inwards at a section midway between the poles. This depends upon the pole spacing, the length of the air-gap, the flux density within it, and upon the radial depth of the core. The following investigation is a study of the effect of each of these upon the flux density in the core. For this purpose the magnetic circuit of a multipolar machine was reproduced in miniature (Fig. 1). Each of the four poles could be adjusted by means of slots in the cast-iron yoke, and the length of the air-gap varied by thin sheet-iron washers inserted between the pole and the yoke. The pole-tips were well rounded, and the flux density in the gap, as explored by the bismuth spiral, was found to be the same at all parts of the pole-face.

The armature, which in this case was not intended to revolve, consisted of stampings of the usual thickness and 6in. diameter, threaded on a mild steel bolt To guard against the distorting influence of the nut and bolt-head, thick hard wood washers were used, so that the magnetic path was confined to the stampings. Along a radius of the core small holes were drilled, and five search coils wound to enclose successive areas at different depths. Each coil had 10 turns of fine double-silk-covered wire with the ends brought to terminals on one of the wooden washers, from which connection could be made to a ballistic galvanometer.

* Paper read before Section G of the British Association at Cambridge, August, 1904.

The field-magnet windings were of specially insulated wire, and were excited in parallel from large storage cells with a resistance in series with each. The four coils had not quite the same resistance, and the flux densities in each gap were set to equality by adjusting the exciting currents. Once set, the densities remained relatively the same, and any desired flux density in the gap could be obtained by changing the number of cells. In all the experiments the flux densities in the gaps were tested for equality before each set of readings.

The pole-spacing and air-gap length having been set as desired, and the line of the search coils placed midway between the poles, the cell current was switched on and the magnetisation allowed to become steady. The circuit was then quickly broken, and the throw of the ballistic galvanometer read. The residual magnetism was in all cases too small to be accurately measured by the bismuth spiral, and has not been taken into account in drawing the curves The error in any case will not exceed 2 per cent., on account of the large demagnetising effect of the gap.

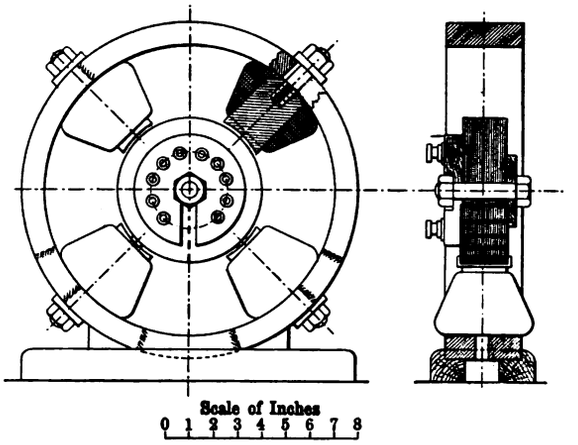

FIG. 1.—EXPERIMENTAL MAGNETIC CIRCUIT.

The experiments were divided into three sets. In each the air-gap was kept the same throughout, the pole-pitch and current varied. For each different pitch from four to six readings were taken with flux densities increasing gradually from 2,000 to 11,000 lines per square centimetre. The results are recorded graphically in Fig. 2. These curves show how the core flux changes when that in the gap is varied.

There are several points of interest which are at once evident. Thus, the depth at which the maximum density is found is *independent of the intensity of magnetisation* except when the air-gap is small and the density great, in which case the maximum is

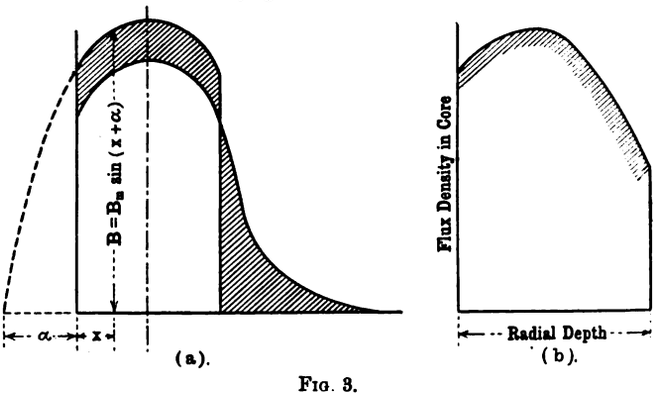

FIG. 3.

slightly deeper at the higher values. Again, the position of the maximum is *independent of the length of the air-gap*, depending only upon the pole-pitch. The wider the pole-pitch the deeper is the maximum and the greater the flux density towards the centre.

The ratio of the maximum density to that in the gap is *greatest when the pole-pitch is small*, as shown by the following table :—

Table I.—*Ratio of Maximum Core Flux to Flux Density in Air-gap. Length of Air-gap 0·114cm.*

Flux density in air-gap.	Angle between centre line of poles.		
	51deg.	65·5deg.	81deg.
3,500	1·28	1·14	0·86
4,000	1·35	1·15	0·92
5,050	1·35	1·19	0·97
6,260	1·37	1·23	0·99
8,500	1·3	1·2	0·96
11,000	1·34	1·12	0·97

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There is also a value of the air-gap density for which the ratio is a maximum, in this case a little over 6,200 lines per square centimetre. In other words, there is one particular value of it which makes the core distribution most unequal.

Since the area included between the axes and any curve represents the total induction through the core midway between the poles, it is seen from the curves of Fig. 2 that by reducing the polar arc from 81 to 51deg. more lines enter the core (other things being the same) when the air-gap is small, but when it is large fewer lines enter. Thus, with an air-gap of 0·38cm. and a flux density in it of 5,000 lines per square centimetre, reducing the polar arc from 81 to 51deg. causes a decrease of 17 per cent. in the total core flux. When the air-gap is 0·178cm. and the flux density the same the reduction is only 2·5 per cent., but with a gap of 0·114cm. and the same flux there is an *increase* of 3 per cent. Raising the flux-density to 11,000, the increase with the smallest air-gap is 10 per cent. The flux crossing the air-gap is the same in each case, the change is, therefore, in the leakage. Turning to Fig. 5, the total flux at section A is 12 per cent. greater than at B. Thus 12 per cent. of the total induction enters the core as a fringe from the pole-tip. That this should increase with the pitch is to be expected, but that it decreases in certain cases points to the conclusion that the reluctance of the outer layers of the iron cannot be neglected in the consideration of core flux. The path through the iron between the pole tips is four times longer when the pole-pitch is 81 than when it is 51deg. The increase in leakage between the poles in the latter case is more than counteracted by the decrease of the reluctance of the core, which permits more lines to enter.

The induction through the inner portion of the core is in all cases low, and where the pole-pitch is small falls off rapidly after the maximum is passed. When the pole-pitch is large the tops of the curves of distribution are nearly sinusoidal, so that by stopping the core at twice the depth of the maximum from the periphery and keeping the total flux the same, the curve of density would be somewhat as follows, Fig 3*a*, the portion added being equal to that cut off.

It is not, however, the intermediate but the smallest pole-pitch used in the experiments which corresponds to the usual conditions of practice, the ratio of pole-face to pole-pitch being 0·72. If a straight line is drawn joining the points where the centre lines of the poles cut the armature periphery, it will form a chord whose greatest depth from the arc corresponds with the observed depth of the maximum flux density. In small smooth core armatures this may be used as a guide to the position of the maximum. The distribution in slotted cores is the subject of an investigation now in progress, but it may be inferred that the maximum will lie not far from the middle of the chord joining the intersection of the centre lines of the poles and the arc through the bottom of the slots. The curve of distribution will be in general of the form shown in Fig. 3*b*. To illustrate the importance of this in practice, consider the curve corresponding to a gap flux density of 6,260 lines per square centimetre. In the experimental model the half pole-face is 2·54cm wide, so that if an average armature flux density is desired equal to 0·7 of that in the gap it is, on the assumption that the flux density is inversely proportional to the area, equivalent to making the core 3·6cm. deep. But by inspection of the curve in the right-hand bottom set in Fig. 2 it is seen that nearly one-half of this depth is inefficient, the two outer centimetres carrying 80 per cent. and 2·5cm. 90 per cent. of the total magnetism. Increasing the radial depth beyond this latter value does not lower appreciably the flux density in the outer portions of the core, the total flux being kept the same.

The path of each line of force is that of least reluctance. There is, therefore, greater concentration along the shortest chord until the permeability there falls owing to the increased density, and a longer path with higher permeability offers less reluctance. If the ratio l/μ remained constant for all lines in the core there would be uniform flux density over the section midway between the poles. The effect of increasing the pitch of the poles upon the armature distribution can be well seen by comparing curves for the same air-gap and air-gap density in each set of curves of Fig. 2. In the same way the effect of changing the air-gap can be examined by grouping corresponding curves in each case as in Fig. 4. One sees that when the gap is long more lines enter the core than when it is short, though the flux density in the air-gap is the same. The total pole-tip fringe must therefore be greater.

The curves so far considered show the distribution midway between the poles, the position of maximum total induction. To examine it between this position and the pole centre line, where, if there is symmetry the flux density is zero in the core, the latter was moved so that the radial line of the exploring coil occupied in turn the positions A, B, C, D, Fig. 5, and the readings taken as

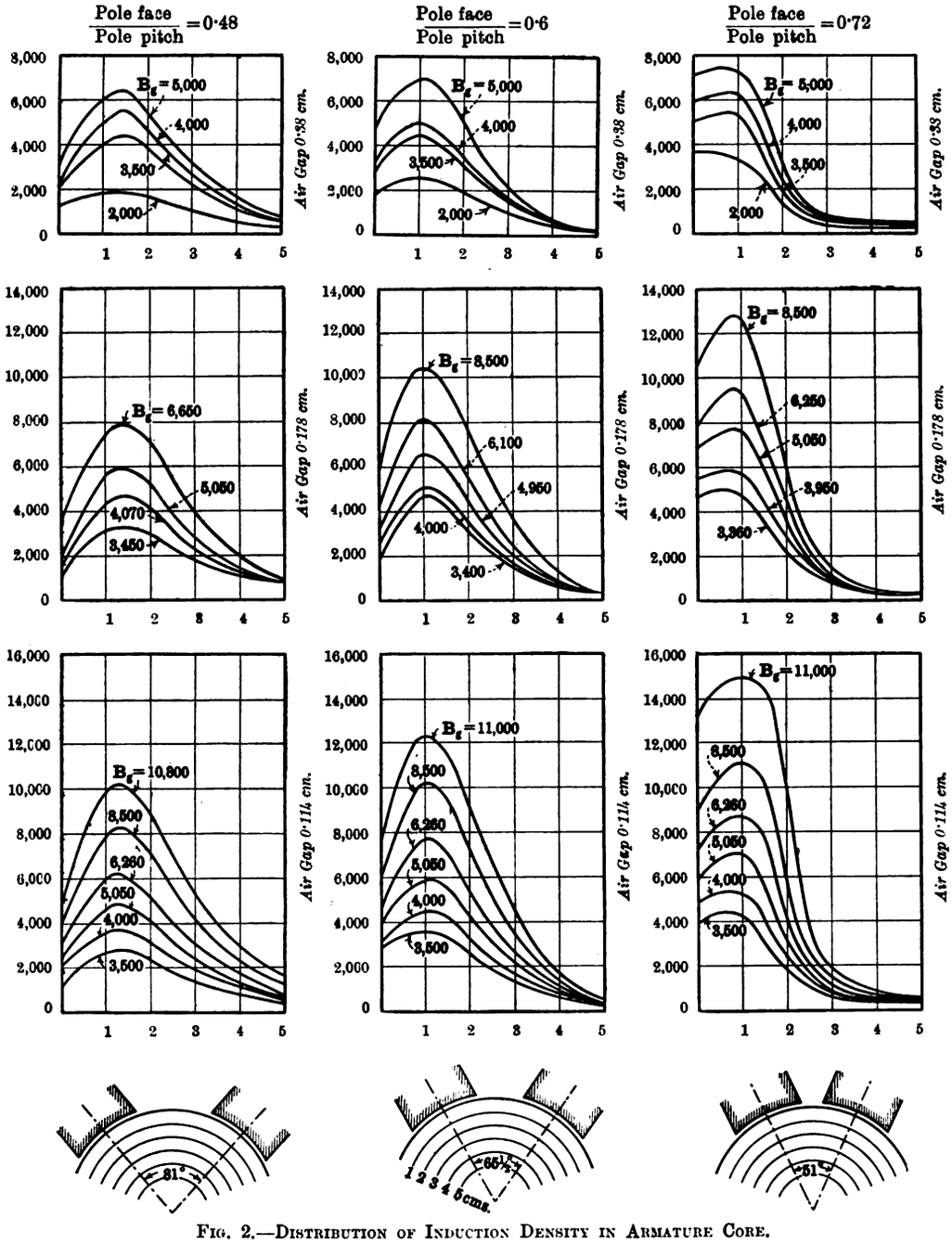
Pole face / Pole pitch = 0·48
Pole face / Pole pitch = 0·6
Pole face / Pole pitch = 0·72
Air Gap 0·38 cm.
Air Gap 0·178 cm.
Air Gap 0·114 cm.
81°
65½°
51°
1 2 3 4 5cms.

Fig. 2.—Distribution of Induction Density in Armature Core.

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before with the pole-pitch, air-gap and flux density in the air-gap kept constant. The curves obtained are in Fig. 5. From them one is now able to see how each point of an armature core passes through its cycle of magnetisation. Take, as in Fig. 6, a convenient base to represent the pole-pitch and mark the positions occupied by the coils. At each of these set up ordinates which are the values of the ordinates of the corresponding curves of Fig. 5, A, B, C, D, at the

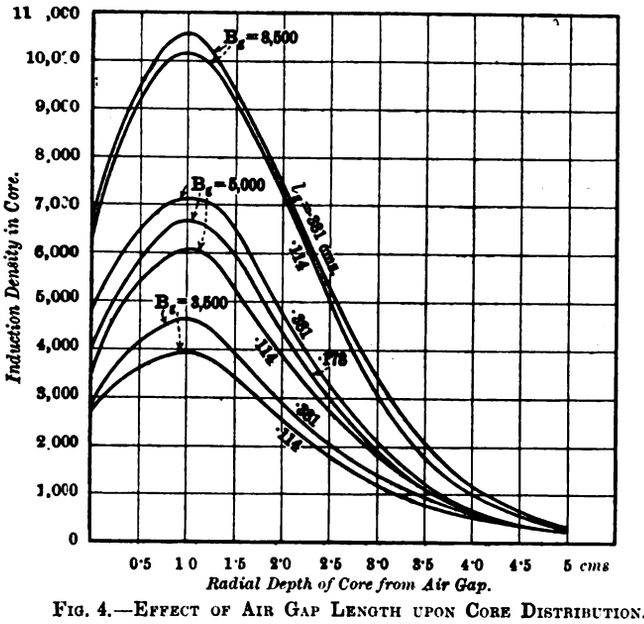

FIG. 4.—EFFECT OF AIR GAP LENGTH UPON CORE DISTRIBUTION.

periphery, and at 0·5, 1·0, 1·5, 2·5, 3·5 and 4·5cm. depth. Joining respective points the curves of magnetic change at each depth are obtained. At the circumference there is a large third harmonic, which is also seen with a smaller amplitude at 0·5cm. At 1cm. the curve is flat topped, at 1·5 more rounded, and approximates to a sine wave at 2·5cm.

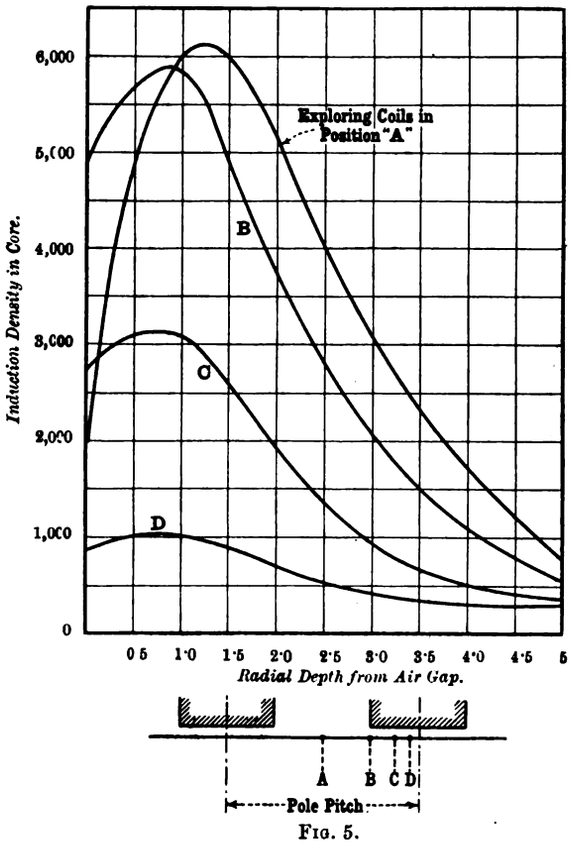

FIG. 5.

Both hysteresis and eddy current losses are affected by the shape of the cyclic curve but not, according to a calculation, sufficient to appreciably change the efficiency of a machine as compared with that obtained on the assumption of uniform distribution. There will, however, be more heating in the outer layers below the slots; and since deepening the core does not much reduce the outer flux density the inner layers are positively harmful by shielding the hotter layers from the cooling effect of windage and by acting as a heat reservoir.

A general formula for the best radial depth of smooth core armatures, which have relatively large air-gaps, can be found from the curves of Fig. 2. It will also apply to slotted cores since the influence of the slots is in effect to lengthen the gap. Suppose that in every case the core is stopped when the flux density at the inner surface is one-half the maximum flux density in the iron, which appears from the curves to be a suitable point. It is found by trial that all the points on the curves where this is so lie at the same radial depth, and in every case the radial depth bears a ratio to the pole pitch which only differs by a few per cent. over the widest range of pole-pitch used. Writing, therefore, $d=kp$ where d is the radial depth and p the pole pitch, the value of k found from the curves, is 0·3. In other words the best radial depth is, on the above assumption, 30 per cent. of the pole-pitch. The ratios of radial depth to the radius are, of course, not constant. Writing

$$p=\frac{2\pi r}{n}, \text{ then } d=\frac{2\pi kr}{n}, \text{ or } \frac{d}{r}=\frac{1\cdot8}{n}.$$

There is, therefore, a reasonable scientific basis for the designer's rule that the ratio of radius to radial depth should be half the number of poles. If an examination is made of miscellaneous designs of machines, it is found that this condition is sometimes, but not always, fulfilled.

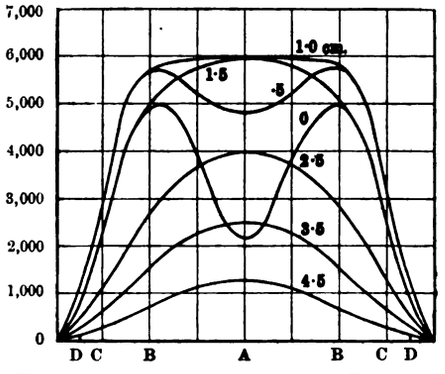

FIG. 6.—HALF-CYCLES OF MAGNETISATION AT DIFFERENT DEPTHS IN ARMATURE CORE.

It is suitable for a first approximation, and working values should be made somewhat less, because the density at the inner surface diminishes from the midway position towards the centre line of each pole.

Conversely in all existing machines which have this proportion the flux density at the inner surface is always half the maximum value in the core, and can be found from Table I., or by direct reference to the curves of this Paper.

SOME INVESTIGATIONS ON THE 10 c.p. HARCOURT PENTANE LAMP.*

BY CLIFFORD C. PATERSON.

The 10 c.p. pentane lamp designed by Mr. Harcourt is now generally accepted in this country as the standard of illuminating power, and has been adopted, with slight alterations, by the principal gas companies in the United States. In this Paper it is proposed to give briefly the results of investigations carried out at the National Physical Laboratory in order to determine the change in the candle-power of the lamp due to variation: (1) in barometric pressure, (2) in the quantity of water vapour present in the air. It has been generally admitted that changes occur in the illuminating power due to these causes, but that in the case of comparisons between the pentane standard and gas lights, the latter will probably be affected to the same extent as the standard lamp, rendering any correction unnecessary. This is by no means the case when photometric comparisons are made between the pentane standard and a source of light unaffected by atmospheric conditions—as, for instance, an electric glow lamp—and errors of the order of 5 per cent. may be introduced into candle-power measurements if corrections are not made for the hygrometric and barometric conditions existing at the time.

In order to ascertain the amount of variation, photometric comparisons were made against two large bulb Fleming-Ediswan electric standard glow lamps. The double comparison method only was employed, and the two electric lamps used to standardise a comparison glow lamp anew for each experiment, so that it was only necessary to burn the standards for five or ten minutes at a time.

* Paper read before the British Association, 1904.

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It is found convenient to state humidity volumetrically as the number of litres of water vapour to a cubic metre of pure dry air at the barometric pressure existing at the time; so that if b=reading of barometer in millimetres, e=aqueous pressure, e_1=vapour tension of carbon dioxide present in the atmosphere, then the litres of water vapour per cubic metre of pure air

$$=\frac{e}{b-e-e_1}\times 1000.$$

Upwards of 60 observations have been made on different days over a range of humidity varying from 5 to 20 litres per cubic metre, which are about the limits obtained under ordinary conditions in a well-ventilated photometer room; 80 per cent. of these, when corrected by means of the formula fall within + or − one-half per cent. of 10 c.p. The barometric pressure in these observations has

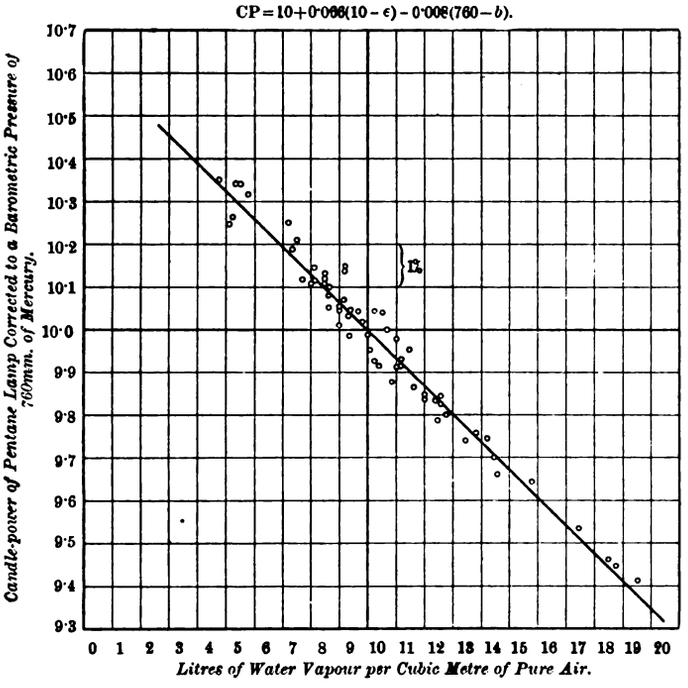

DIAGRAM SHOWING VARIATION IN ILLUMINATING POWER OF THE 10 C.P. HARCOURT PENTANE LAMP, DUE TO THE PRESENCE OF WATER VAPOUR IN THE ATMOSPHERE.

varied from 739mm. to 780mm. of mercury, so that, applying the method of least squares for these two variables, the following formula has been obtained for correcting the candle-power of the lamp to the standard atmospheric conditions of 760mm. of mercury and 10 litres of water vapour per cubic metre of pure dry air,

$$\text{Candle power}=10+0{\cdot}066(10-\epsilon)-0{\cdot}008(760-b),$$

where ϵ is the humidity as explained above and b the height of the barometer in millimetres.

From this it will be seen that a variation of 1 litre per cubic metre in the moisture causes a variation in candle-power of about 0·7 per cent., and that 10mm. change in barometric pressure brings about an alteration of 0·8 per cent. in the illuminating power of the lamp. The standard humidity of 10 litres per 1,000 has been fixed upon as being the mean value for three years found at Kew Observatory. The figure is also borne out by observations made at the Meteorological Office in Victoria-street, London.

EFFECT OF THE ATMOSPHERE ON THE CONDUCTIVITY OF ALUMINIUM ALLOYS.*

BY ERNEST WILSON.
(Professor of Electrical Engineering, King's College, London.)

The physical properties of certain light aluminium alloys have formed the subject of communications,† and, as stated therein, a specimen of each alloy was placed on the roof of King's College, London, in order to investigate the effect of exposure to London atmosphere. The specimens are in the form of wire 0·126in. (3·2mm.) diameter, and were placed on the roof on June 11, 1901. They have been taken down in July of each of the years 1902-3-4. and their electrical resistance measured. The results are set forth in the table.

It was shown that during the first two years' exposure the series of copper-aluminium alloys (Nos. 16, 4, 13, 14, 15) diminished conductivity to a greater extent the greater the percentage of copper. It will be seen that this process has progressed still further, but the yearly variation is not now so great as during the first year. This last year's exposure still confirms the conclusion previously arrived at that copper alone should not be used in fairly large quantities when alloyed with aluminium to be exposed to London atmosphere. Of the nickel-copper-iron-aluminium alloys (Nos. 20, 21) the former (No. 20) has changed comparatively little, and it is richer in nickel; the latter (No. 21) is richer in iron and shows a gradually increased rate of deterioration. Each of these alloys has a comparatively high tensile strength. The nickel-copper-aluminium alloy (No. 22) which showed such remarkably increased tensile strength as compared with good commercial aluminium has now (like No. 21) considerably diminished total conductivity. On the other hand, the manganese-copper-aluminium alloys (Nos. 10, 9, 23) have suffered comparatively small diminution in conductivity, and No. 23 has a comparatively high breaking load. The iron-copper-aluminium alloy (No. 24) has also shown little change in conductivity during the three years' exposure, and its breaking load is considerably higher than that of good commercial aluminium. The alloy No. 17 has suffered small diminution in electrical conductivity.

It was thought that an examination of the structure of these alloys by aid of micro-photography might throw some light upon the great difference which exists between some of their physical properties. Alloy No. 22 has a breaking load of 45,900lb. per square inch, as compared with about 28,000lb. per square inch for ordinary drawn commercial aluminium. After grinding and etching with various solutions, practically no structure could be discovered under a magnification of 800 diameters. Considering the remarkable crystalline structure exhibited by ordinary commercial aluminium near the surface of an ingot when allowed to solidify at an ordinary rate, the want of structure in these alloys may be attributed to the process of drawing down. The inference is that the great difference which exists between their tensile strengths and other qualities is probably not due to variation in structure.

I am indebted to the Council of the Royal Society for a portion of the Government grant, which has enabled me to carry out these experiments in micro-photography, and I wish to acknowledge the help I have received from Mr. R. E. Shawcross.

No. of specimen.	Analysis.						Specific resistance in 10^{-6} ohm at 15°C. before exposure in 1901.	Percentage variation of electrical resistance at 15°C.				Breaking load in lbs. per sq. in. of cross section.
	Si.	Fe.	Cu.	Ni.	Mn.	Zn.		During 1901-2, taken on value in 1901.	During 1902-3, taken on value in 1902.	During 1903-4, taken on value in 1903.	During 1901-4, taken on value in 1901.	
16	0·31	0·37	0·11	..	..	..	2·92	1·04	0·65	−0·18	1·50	26,600
4	0·38	0·25	0·16	..	..	..	2·88	1·86	1·10	1·81	4·83	25,700
13	0·38	0·25	1·58	..	..	..	3·34	3·49	1·79	0·88	6·25	39,000
14	0·40	0·31	1·86	..	..	..	3·25	5·24	1·52	1·00	7·91	40,600
15	0·40	0·40	2·61	..	..	..	3·34	7·20	2·77	3·06	11·51	43,500
1	0·38	0·22	0·17	..	..	0·62	2·86	3·54	1·05	2·34	7·07	28,100
2	0·43	0·28	0·30	..	..	1·20	2·94	2·67	3·09	0·00	5·84	30,500
5	0·43	0·39	0·09	..	..	2·04	3·07	2·33	1·14	0·70	4·21	26,000
7	0·37	0·25	0·05	0·75	..	..	3·05	1·22	0·73	1·68	3·66	29,700
8	0·35	0·29	0·09	1·19	..	..	3·24	2·10	0·11	2·05	4·28	33,700
20	0·37	1·10	0·06	2·25	..	..	3·18	1·55	0·23	0·27	2·05	38,600
24	0·35	1·16	0·09	..	..	..	2·97	0·765	0·76	0·15	1·68	31,800
3	0·37	0·28	0·59	..	..	0·59	3·06	2·52	0·82	1·28	4·67	30,500
6	0·39	0·31	0·63	..	..	1·20	3·12	2·02	0·12	1·41	3·58	30,900
17	0·35	0·53	0·10	0·83	..	0·90	3·03	0·63	0·50	0·72	1·89	31,700
12	0·31	0·59	0·19	1·09	..	0·73	3·33	1·26	1·02	0·00	2·24	31,700
18	0·43	0·40	0·21	1·13	..	1·94	3·24	2·29	1·07	0·75	4·14	34,500
19	0·35	0·29	0·11	2·01	..	1·77	3·26	2·60	0·81	1·81	5·31	36,200
11	0·39	0·56	0·24	2·31	..	0·38	3·48	1·95	0·425	1·90	4·31	34,500
22	0·37	0·43	1·08	1·29	..	..	3·41	−1·42	3·96	4·30	6·90	45,900
21	0·39	2·57	0·10	1·39	..	..	3·24	−0·97	3·28	7·14	9·50	42,200
10	0·32	0·54	0·02	..	0·05	..	3·09	0·783	0·31	1·02	2·12	29,000
9	0·31	0·35	0·03	..	0·35	..	3·30	1·94	−0·55	0·92	2·31	30,500
23	0·44	0·56	0·09	..	1·78	..	3·49	2·34	0·00	0·37	2·71	35,300
Al.*	0·14	0·31	..	..	..	..	2·76	not exposed	2·70	0·87	3·58†	28,200

* Commercial aluminium. † Taken on value in 1902.

* "The Electrical Conductivity of certain Aluminium Alloys as Affected by Exposure to London Atmosphere, and a Note on their Micro-structure," read at the British Association, 1904.

† See *Journal* Institution of Electrical Engineers, 1902, Part 154, Vol. XXXI.; British Association Reports, 1901, 1902, 1903; *The Electrician*, Vol. XLVIII., pp. 387, 389, Vol. XLIX., p. 868, and Vol. LI., p. 898; also *Journal* of Society of Arts, December 13, 1901.

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ANNUAL REPORT OF THE ELECTRICAL INSPECTOR OF FACTORIES AND WORKSHOPS.

In his report for the year 1903, Mr. G. Scott Ram, electrical inspector of factories makes some very pertinent remarks and brings forward some interesting statistics. We give herewith, an abstract of the report.

The most noticeable feature in regard to the electrical industry generally is its great activity and growth. The increase in the use of electrical energy particularly for motive power purposes in factories is very rapid and the number of factories putting in their own electrical generating plants is greatly extending. The power is, however, in increasing proportion taken from the mains of public electricity supply undertakings, which encourage the use of electrical power in factories by supplying the energy at very low rates and often by letting out the motors on an easy hire system.

I.—Reported Accidents at, or in connection with, Electrical Stations of Electricity Supply Companies and Local Authorities for 1903.

(*a*) *Mechanical Accidents.*

	Non-fatal.	Fatal.
At engines and dynamos (not including falls)	11	—
At boilers and steam plant (not including falls)	29	—
At coal handling plant (not including falls)	7	—
Falls	34	6
Struck by falling bodies	23	4
Miscellaneous	18—122	—10

(*b*) *Electric Shock and Burns.*

Working on "live" switchboards (skilled persons)	10	—
Persons not in employ of occupier working on "live" switchboards	4	—
Unskilled persons cleaning switchboards supposed to have been made "dead"	3	—
Faulty apparatus	4	—
Miscellaneous	5—26	—

Six of the fatal mechanical accidents occurred to persons who were engaged on constructional work in connection with extensions of plant or buildings. The other four occurred in the ordinary routine work of the stations. Two occurred to stokers who fell when in the act of blowing down the gauge glasses of boilers at a considerable height from the floor. Many of the falls were due to the want of proper guards or hand-rails, &c., particularly in the boiler houses, where manholes, pipe trenches, &c., are often unguarded, and passage-ways on the edge of high boiler flues, economisers, &c., are unfenced.

Fortunately, there were no fatal electrical accidents in this class of stations, but the 26 non-fatal cases, 20 of which occurred at switchboards, were nearly all severe, and in one or two it is doubtful if the injured persons will be able to resume their occupation. The practice of doing work on "live" switchboards is always hazardous even at low electrical pressure and for persons fully acquainted with the dangers. The necessity for such work arises generally from the switchboards being so constructed that the electrical pressure cannot be cut off from any part of the board without causing a total interruption of the supply. As such a stoppage, even for a few minutes only, would put consumers to an inconvenience, repair work, &c., is carried out on the "live" boards. If switchboards were more generally arranged in sections, any one of which could be disconnected without interfering with the use of the remaining sections, the danger would be lessened. The same remarks apply in the case of the next division. It is a very usual condition, when a switchboard is to be extended or altered, that a contractor has to carry out the work without in any way interfering with the ordinary supply of electricity, and therefore has to do so without the pressure being cut off. Even if this operation is conducted under the continuous supervision of an engineer of the supply undertaking, it appears hardly fair that the contractors' workmen should have to take the risk, and frequently there is no such supervision. Accidents in cleaning switchboards "supposed to be dead," generally in sub-stations, are apt to be very serious in their results, and it might be supposed that they are capable of being brought about by culpable negligence only. They are certainly sometimes due to carelessness on the part of the responsible person, but they may also be caused by the use of complicated connections, the arrangement of which is not fully grasped at the time by the person in charge; or they may happen through the failure of the system adopted for showing that everything is safe. The methods adopted are usually of a negative character, such as a voltmeter giving a zero reading, or certain lamps remaining unlighted when switched on. These or similar methods may be used together, but experience has proved that each may fail at the same time through some trifling cause, such as a loose contact, and serious accidents result. The use of the telephone, to ascertain that the feeding main, or mains, have been disconnected at the far end, offers a useful protection, but still one in which it is conceivable a mistake might readily be made. The distance of sub-stations from the generating or feeding station is often so great that it is impracticable for the sub-station engineer to personally see that the mains are turned off and the switches locked at the generating station. The only positive method of ensuring that the sub-station board is safe, therefore, appears to be to put the 'bus bars and other conductors to "earth." This method is adopted in the stations of one or two important undertakings working at extra high pressures. There is likely to be some risk in carrying out this method if the connection to "earth" happens to be made when the pressure is accidentally on, but the risk of personal injury could be made much less than would be the case were cleaning operations undertaken on the unexpectedly "live" board. The cleaning, or dusting, of switchboards is, in some stations, done by means of an air blast, an air compressor being driven by an electric motor, and the blast being directed by a flexible rubber hose-pipe. This method is no doubt a very convenient one, but experience shows that it is not effective for the purpose of keeping insulators sufficiently clean to prevent leakage in the case of very high electrical pressure, at any rate in damp weather, when there is also the risk of the air blast itself containing water, which has been condensed during the process of compressing.

The similar accidents at private (*i.e.*, not for public supply) electrical generating stations are as follows:—

II.—Accidents at Private Electrical Generating Stations.

(*a*) *Mechanical.*

	Non-fatal.	Fatal.
At engines	3	3
At boilers and steam plant	4	—
By falls or falling bodies	8	—
Various	6—21	—3

(*b*) *Electrical.*

Working on "live" switchboards	9	—
At dynamos	2—11	—

Working on "live" switchboards in factory generating stations is seldom excusable, because in very few is it necessary that the electrical supply be maintained continuously. Any work can, therefore, be done after factory hours, when the supply is shut down.

III.—Reported Electrical Accidents in Factories, Engineering Works, &c.

	Non-fatal.	Fatal.
Burns from arcing of switches	16	—
Burns when replacing fuses	7	—
Unprotected conductors, switches, terminals, fuses, &c.	17	2
Faulty apparatus (other than switches)	13	—
Carelessness or ignorance	17	—
Welding without glasses	2	—
Electric travelling cranes—		
(*a*) Insufficient protection of trolley wires	8	1
(*b*) Unprotected switches and apparatus in driving cage	13	1
(*c*) Carelessness	1	—
To persons engaged in testing dynamos, transformers, &c., in course of manufacture	16	—
Explosion of gases when charging secondary batteries in confined and badly-ventilated chamber	6—116	—4

The accidents occurring in connection with the use of electricity, mostly for motive power, in factories, are, as last year, nearly all due to badly designed or unprotected apparatus. Burns caused when replacing fuses occurred at motor fuses by short-circuiting the terminals, and would have been avoided if the fuses had been in the circuits between the double-pole switch and the motor, instead of the switch being between the fuses and the motor, so that the electrical pressure could have been first cut off. The non-protection of switches, fuses, terminals, &c., is far too common, and particularly with alternating currents, or pressures over 250 volts, offers great danger to persons employed and is at variance with all recognised regulations, such as those issued last year by the Institution of Electrical Engineers and those of the principal fire insurance offices and also with those of the Board of Trade, where the supply is given from the mains of electrical supply undertakings at pressures above 250 volts. In spite of these regulations, however, installations continue to be put up, often by well-known firms, and sometimes with the assistance of a consulting engineer, without any such protection. In one of these two fatal accidents the switch was "protected" in a manner which is very common, but entirely useless as a protection for the persons having to work the switch, the latter being enclosed in a wood box, the lid or door of which has to be opened in order to get at the switch handle, thereby exposing all the "live" portions. Protection of switches should be by a cover which does not have to be opened for use, the handle being outside the cover, which should effectually screen all charged metal, so that the switch could be safely used, if necessary, in the dark.

The adoption of electricity for driving overhead travelling cranes in engineering shops, &c., is rapidly increasing. The number of accidents from shock is, however, large in proportion, and is due entirely to the neglect of proper precautions. Bare wires, connected with the electricity supply, are hung from end to end of the room and sliding contacts attached to the crane collect the electric current from them. Unlike tramway systems, however, the rails are not used for the return current, therefore there are always two trolley wires if continuous current is used, and three or more if two-phase or three-phase alternating currents are used. These trolley wires are fixed in various positions, the safest being probably overhead, away from the walls of the building, and at such a height that they cannot be reached by persons on the crane. Frequently, however, this position is impracticable, owing to the height of the roof above the crane being insufficient, or to the construction of the crane not allowing it. The more usual position is on one wall, either above or below the crane rail. If above, they should be fixed at such a height as to be out of reach of a man standing on the gantry. The trolley wires are necessarily bare, but this is no reason why they should not be adequately protected at places where they are likely to be touched. As a rule, access to the driving cage of a crane is by no means easy or safe, quite apart from any electrical dangers. The crane driver has frequently to climb a vertical ladder fixed to the wall, and then walk along the narrow gantry, with or without a handrail to hold on by, and after a "Blondinian" performance to get from one crane girder to the other, has to perform a final gymnastic feat to get into the cage. Of course, many men think nothing of climbing or working at

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dizzy heights unfenced, but the records of accidents in the building trade show that even such men are apt to come to grief, and there is no reason why these dangers should be unnecessarily added to the lot of the crane driver. It can readily be imagined that the dangers are much greater when he has to look out for and avoid touching electric wires over which he may have to step or under which he may be obliged to crawl. Protection can be and always should be provided, so that the the crane driver can get to the cage without running any risk of coming into contact with them, and if the wires are within reach of a man in the cage, or when getting in or out, a protecting shield should be attached to the crane, so as to move with it and be of service in whatever part of the room the crane may be. It should be remembered that a shock, although, perhaps, trivial in itself, may easily lead to serious results by causing a man to fall from a height. It is desirable that a switch, capable of cutting off all pressure from the trolley wires, be fixed in the room and within reach of the ground.

Owing to the confined space in the cage and the responsible duties of the crane driver, it is particularly important that he should be protected from electric shock, and yet it is the rule rather than the exception to find switches, resistances, fuses, terminals, &c, all unprotected and surrounding him, so that he has constantly to be on his guard to avoid touching them. The cage itself, being wholly or in part made of metal, offers special facilities for receiving a shock to earth should there be any exposed conductors or leakage which may cause other metal to become electrically charged. This construction cannot well be avoided, and, therefore, the protection of all conductors should be complete, and all other metal, including frames and cases of resistances, switch covers, metal switch and regulating levers, motor frames, hand rails, &c., should be carefully electrically connected to the main crane girders, which in turn should be connected to "earth," so that it is impossible for any part to become electrically charged above earth potential. In some modern works, where the construction of the building is of steel, the rails on which the crane runs are attached to the steel work and are consequently "earthed," but in most works the rails are laid on timbers and are therefore not "earthed." An illustration of what may happen in this case is afforded by an accident which occurred recently. Through a trivial cause a leakage occurred and the whole crane became electrically charged (200 volts alternating). The crane was handling boiler plates at the time. Several men who were guiding the plates on the floor of the shop received shocks and called out to the crane driver, who, seeing that something was wrong, started to leave the cage, but in attempting to do so he received a shock and was rendered insensible, but fortunately did not fall out of the cage. This shows the necessity for such precautions as I have indicated and for electrically bonding the crane rails and efficiently connecting them to earth. The handrail along the wall above the rail ledge should be treated in the same way. Care should also be taken that there is a good connection through the wheels of the crane to the rails. It is conceivable that the lubricant used for the wheels might insulate the crane, but this possibility is easily guarded against by providing a rubbing contact on the wheels or direct to the rails.

Mechanical accidents incidental to the use of electricity have also occurred in connection with cranes. Thus the current may become shut off for some reason while the crane is working and may suddenly come on again while the crane driver is not prepared for it and an accident may result. Not long ago a fatal accident occurred in this way. The current stopped suddenly while the crane was travelling. The driver got out of the cage to ascertain what was wrong. He found that one of the trolley contacts had run off the wire. He replaced it and the crane moved on and crushed him. This accident was due to the man omitting to turn off the main switch before he left the cage. To avoid a repetition of such an accident, the firm and others in the district have, at the suggestion of Mr. Hilditch, H.M. Inspector of Factories, adopted a switch to be worked by the door of the cage, so that the driver cannot get out without shutting off the switch. The convenience and ease of working electrically driven cranes is so great compared with either hand or steam power that it is to be expected that they will be eventually adopted in all engineering works where much crane work is required, and there seems no reason why they should not be rendered perfectly safe from an electrical point of view. Traversing tables and other travelling machinery in steel and other works are now not unfrequently worked by electricity, and here again precautions against shock are not adequately observed, particularly in the matter of the trolley wires, although protection could in general be readily afforded.

The next class of accidents, those occurring to persons engaged in the electrical testing departments of manufacturing electrical engineers, is small in consideration of the number of persons employed and the dangers of the occupation. That the accidents are few is doubtless due to the fact that those in charge of test rooms are necessarily persons who have a full knowledge of the dangers, and either personally superintend the operations or entrust them to assistants who are fully competent. Carelessness for the safety of others is, however, sometimes apparent, as when, as I have occasionally found, high-pressure electrical testing of cables or apparatus is conducted in a room not wholly set apart for the purpose and without any temporary barriers to keep other persons from danger. Although the electrical connections, &c., for making pressure or other tests are necessarily, to a great extent, of a temporary nature, being specially constructed or set up for each test, greater safety might often be secured in the more permanent parts of the arrangements.

There are, no doubt, important lessons to be learned from the Bristol fire, some of which, however, are by no means new. The fact that the arc which raged for about 8 minutes with 2,000, or so, kilowatts of energy behind it, was not confined to one cell of the switchboard cannot be regarded as a matter for surprise. That it did not extend to more than a few panels seems rather to offer an argument in favour of the principle of cellular construction, but it also appears that in the design of such type of switchboard special regard should be observed to the size of the individual cells, and the thickness, material and support of the dividing partitions, in view, not only of maximum working power to be dealt with in each panel, but also of the maximum power which may be concentrated in any one cell in case of an arc forming a short-circuit and drawing all the power of the station or stations to that one panel. The Bristol accident did not cause any serious personal injuries. Although several persons received burns they did not stay away from work for the necessary period after the accident to require notice to be sent to H.M. Inspector of Factories for the district.

The safety of employés in electrical generating stations of public supply undertakings undoubtedly receives much greater attention than was the case a few years ago. Some modern stations are admirably designed in this respect. There are, however, some new stations where the contrary is the case and a want of appreciation of danger is evident. Some have been designed apparently by persons who have not themselves had that experience in the daily working of such stations as is necessary to enable them to regard switchboard design from the point of view of the switchboard attendant or the engineer-in-charge, and who have apparently left such important details to take care of themselves. It is not sufficiently borne in mind by some of the designers of switchboards for electricity supply undertakings that the supply has to be continuously maintained and, consequently, that the main switchboard when once put to work must remain in use, and should, therefore, be so arranged that any repairs, adjustments or cleaning can be undertaken with the least possible danger to the workman, as it is inevitable that work upon the board becomes necessary after a time. The question of breaking heavy circuits, particularly at high pressures, at open-fronted switchboards, is one which has not received sufficient attention in regard to the safety of the switchboard attendant. There is no doubt that a system of distant control, or one which provides a substantial screen between the switchman and the switches and fuses, affords greater safety and should always be adopted when either the power or the pressure exceed certain limits.

In the distribution of electrical energy about a factory or engineering works, there is no reason why complete protection should not be afforded. In cases where the electricity is obtained from the mains of a public electricity supply undertaking, the Board of Trade regulations provide for protection of conductors, switches, &c., on the consumer's premises where the supply is at pressures above 250 volts. These regulations are very useful so far as they go, but they do not cover the ground sufficiently from the point of view of the Factory Act, and do not apply in any case in factories having their own generating stations. In many places the supply authorities, on whom these regulations are imposed, carefully observe them, but this is by no means always the case, and grave dangers sometimes result. Some supply authorities are even lax in the matter of the protection of their high-pressure apparatus on consumer's premises. I have more than once found transformers, &c., belonging to supply companies on factory premises unprotected in any way.

The electric shock accidents of the year again emphasise the dangers of alternating currents even at low pressures. The four fatal accidents were all from alternating currents, the greatest pressure being only 440 volts. In addition to accidents reportable under the Factory Act, I investigated one, on behalf of the Mines Department, which occurred in a coal mine. This was again a case of alternating current, three-phase 550 volts. Two men were killed, and others received shocks more or less severe. As not unfrequently happens in fatal cases, the persons killed were hardly marked at the point of contact, whilst another man who was rendered insensible and subsequently recovered, and who received a prolonged shock, had his fingers burnt to the bone. An accident such as this would not be possible under the proposed regulations which have since been issued in the Report of the Committee on the Uses of Electricity in Mines. The fact that the pressure of the supply is only one factor out of many, in determining danger to life in case of shock, is also illustrated in the case of three of the non-fatal accidents which occurred on a 6,500-volt three-phase system. Two resulted in very severe burns. In one case the victim was standing on a cement floor and obtained a shock to "earth." The shock must have lasted for a full minute, during which time his thumb, which rested on the "live" conductor, was severed from his hand, and the toes of both feet were burnt off through his boots. In spite of this manifestation of the destructive power of the current, the man was not killed.

Mr. Ram's recommendations with regard to electrical substations (published in *The Electrician* of May 13) are included as an Appendix to the report.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Energy Spectrum of the Mercury Lamp.—Hagen and Rubens were the first to succeed in employing the thermo-couple for the determination of energy curves in the ultra-violet spectrum. That their measurements only extended down to 250$\mu\mu$ was due to the small intensity of the arc lamp beyond that limit. Pflüger, by using a spark-gap as a source, pushed the limit down to 185$\mu\mu$, and even further on getting rid of the absorbing air-gap. E. Ladenburg has added to these results a determination of the energy spectrum of a quartz mercury arc lamp as constructed by Heraeus. The spectrum shows two series of well-marked lines, one of them being at wave-lengths 253, 311, 363, 433 and 546, while the other is at wave-lengths 297, 404 and 576. These series both show a steady increase of intensity in the order mentioned, and the author suspects

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some underlying regularity, though he cannot establish a connection with Kayser and Runge's formulæ.

[E. Ladenburg, *Physikalische Zeitschrift*, August 15, 1904.]

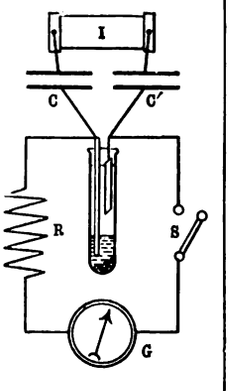
A Radio-active Gas from Petroleum.—It is known through the researches of Thomson, Strutt, Adams and others that the water of various wells contains an emanation resembling the emanation of radium, or even identical with it, to judge from its rate of decay. E. F. Burton has now extracted an emanation from raw paraffin oil which is similar in all respects to that of Cambridge tap water. The oil was taken from the borings of Petrolia, Ontario, at a depth of 465ft., the stratum being limestone. The oil is, however, most likely derived from the Trenton formation below. The induced conductivity of the air charged with the emanation falls to one-half in 35 minutes. The emanation itself falls to half its value in 3·125 days. This indicates that the radio-active substance contained in the petroleum is a little more stable than the radium emanation.

[E. F. Burton, *Physikalische Zeitschrift*, August 15, 1904.]

Emanation of Selenium.—J. J. Taudin Chabot suspects selenium of giving out a new radiation or emanation, which, however, is slow in action and difficult to detect. With an exposure of 1,008 hours he obtained an impression on a bromide plate, and the impression was greatly strengthened if the selenium was traversed by a current. The effect is much enfeebled by the interposition of paper. The author adds: "If this is a reciprocal expression of the sensitiveness of a selenium conductor to light, this might be put beside the fact of the absorption of selenium, which at $\lambda = 0{\cdot}7\mu$ has the maximum effect upon its conductivity.

[J. J. Taudin Chabot, *Physikalische Zeitschrift*, August 15, 1904.]

Schlömilch Wave Detector.—M. Dieckmann publishes some investigations which go to show that the electrolytic wave detector devised by Schlömilch is actuated not by a thermal process, but by a process of polarisation. His apparatus is shown in the diagram, where the detector is shown in the form of a test-tube filled with concentrated sulphate of copper covered with a dilute solution of common salt. The positive electrode is a copper wire whose extreme end only is in contact with the sulphate, while the negative electrode is a piece of zinc which dips into the salt solution. The resistance R is 1,590 ohms. The electrodes were connected through condensers C and C′ with a small induction coil I. If the copper electrode only dips into the upper part of the test tube, the galvanometer only indicates 0·022 milliampere, but if the positive portion of the alternating E.M.F. destroys the polarisation layer, the deflection goes up to 0·48 milliampere. On the other hand, if the copper dips into the sulphate solution, the current is reduced instead of increased by the working of the inductor. Thus the cell may be made to work at will either as a coherer or as an anti-coherer.



[M. Dieckmann, *Physikalische Zeitschrift*, August 15, 1904.]

Absorption of Energy in Condensers.—R. F. Earhart has applied Rayleigh's phasemeter to the measurement of the absorption of energy in dielectrics. An attempt was made to study the change in absorption in a condenser when changing its capacity, without changing the amount of the dielectric possessing absorption. With this end in view, several condensers were laid up, consisting of tinfoil and paper. These condensers were placed in a letter press, so that by varying the pressure the capacity could be varied, and an attempt made to determine whether the absorption changed under these conditions. The condensers after being prepared as described were heated to a temperature of approximately 120°C. and maintained at that temperature for several hours in order to rid the paper of water vapour, so far as possible. The whole arrangement was then placed in an air-tight box and the press operated through a stuffing box, the object being to prevent any change in the dielectric. This precaution does not, of course, eliminate water, but merely makes possible a constant hygrometric state. In the case of certain condensers variations in capacity of from 0·5mfd. to 1·2mfd. were obtained, but the results hardly admit of quantitative discussion. The efficiency in most cases was above 99 per cent., corresponding to a power-factor of 0·003. Ten condensers were laid up at different times and the results based on several hundred sets of readings. In eight of the 10 cases the condensers showed an increase in absorption with increase in capacity. In the other cases no change could be detected. It seems possible to explain the increase in absorption in this way. A condenser of the type described is made up of two dielectrics: First, air possessing no absorption; second, of a medium possessing some absorption. In increasing the capacity we are squeezing out air or the non-absorbing medium, while the absorbing medium forms a larger proportion of the combination dielectric.

[R. F. Earhart, *Physical Review*, July, 1904.]

Negative Charge of Thunderclouds.—A. B. Chauveau reports an observation of the dissipation of positive electricity on the summit of the Eiffel tower in the course of a thunderstorm on August 4th, in which the coefficient of positive dissipation showed an unusual predominance over the coefficient of negative dissipation. Up to 6 p.m., the latter coefficient maintained its usual predominance, even rising as high as 4·9. But this ratio was suddenly reversed, the positive dissipation reaching an even greater predominance during the rainstorm which accompanied the thunder. The negative dissipation maintained its usual value, and showed no remarkable effects. The author connects the positive dissipation, which indicates a great prevalence of negative electricity, with the same phenomenon observed near a waterfall.

[A. B. Chauveau, *Comptes Rendus*, August 8, 1904.]

Records of American Electrical Engineering Graduates.—Some interesting data relating to graduates of the Worcester Polytechnic Institute of Worcester, Mass., are given in the *Journal* of that Institute. A recent report of the United States Bureau of Education shows that a boy with a common school education has practically one chance in 9,000 of general recognition as a successful man in some department of human endeavour and usefulness. A high school education increases his chances of such success by about 22 times, while a college education gives a young man about 10 times the probability of success and advancement possess by the high school graduate, or about 200 times the opportunity open to the boy with only a common school education. Mr. Dodge, in his recent presidential address before the American Society of Mechanical Engineers, stated that from carefully-prepared averages he found that in engineering work the average unskilled man at 22 years of age had reached his maximum earning capacity of $510 per year, which, capitalised at 5 per cent., gave him a potential value of about $10,000. The shop-trained man reached his maximum of $790 per year at 24 years of age, while the curve of income for the technical school graduate of 10 years' standing was still rising at 32 years of age, when he received an annual income of $2,150, which gave him a potential value of $43,000 when capitalised at 5 per cent. Although this result, as shown by Mr. Dodge, has been criticised as being more favourable to the technical graduate than is justified in the average case, particulars which have recently been prepared from data received from graduates of the Worcester Polytechnic Institute in electrical engineering substantiate the conclusions drawn by him and further emphasise the value of a thorough technical training. As the department of electrical engineering at the Worcester Polytechnic Institute has been established but eight years, there are data available for this period only, but during this time a large number of students have graduated, and data have been received from a sufficient number of them to represent conditions fairly. It appears that the average graduate at the end of eight years may expect to receive an income of about $1,900; or, if he has been a graduate student at the Institute for one year, his income is shown to average about $2,500, which, capitalised at 5 per cent., gives him the income on an investment of about $50,000.

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In the matter of pleasing everybody—a feat the organisers of a meeting are bound to attempt—these officials have an especially difficult task. The difficulty springs from the very nature of the Association. For one phase of the great aim of the Association—the advancement of science—is to excite, in those possessing social and political position and influence, interest in science or sympathy with its ambitions; while another phase of that same aim is the stimulation of research and the dissection and dissemination of the results. Thus the dilettante and the devotee, the amateur and the professional, are invited to the same symposium; can we wonder that complaint easily arises at the constitution of the programme? Still another inherent difficulty, one more directly concerning us, springs from the fact that the gathering is a holiday affair, and that the majority of the units demand holiday work. To keep this in view is among the duties of the sectional committees. Were it but kept in mind in the selection of pabulum for the sections there would be fewer recondite and undebateable Papers. There would be less boredom from the crank, there would be fewer communications on isolated and dry points in large subjects caviare to the general, and, as a consequence, there would

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be more leisurely consideration of the contributions of general interest or recognised importance, and the annual meetings of the Association would serve to mark the steps in the development of each new phase of scientific thought in a more definite manner than in recent years. Above all, there would a greater number of formal debates on broad subjects with a clear issue, announced well beforehand, than is the case at present. The general correctness of this last recommendation is well exemplified in the transactions of the meeting just concluded. For of all the routine work in Section A the two items most widely appreciated were the debate on N-rays, opened by Prof. LUMMER, and that on the radio-activity of ordinary matter, initiated by Prof. THOMSON. We will take this opportunity of recording our impressions.

The debate on N-rays was remarkable chiefly for its one-sidedness. Perhaps this might be accounted for by the undiluted strength of the Teutonic element, just as a racial physiological or psychological susceptibility may be supposed to have confined positive evidence of N-rays to the Romance physicists. But an easy explanation of the abundance of the negative evidence, which seemed to be accepted by the meeting as valid evidence against the objectivity of the phenomena, remained unspoken during the debate. This explanation is, merely, that perhaps the eyes of BLONDLOT'S antagonists are not yet sufficiently trained to repeat his experiments. The other debate, on the radio-activity of ordinary matter, was remarkable above all for the masterful conclusiveness of the communication which opened it. Speaking from the fulness of knowledge, and with all the authority of the master-mind which, in the Cavendish Laboratory, has guided numerous followers during several years from the beginnings of the subject through all its labyrinthine windings, Prof. J. J. THOMSON left little room for criticism, and appeared in a position even stronger from the incidence of the criticism that did arise. There is no doubt that the great bulk of his hearers accepted at once and completely that doctrine of the radio-activity of ordinary matter which he upheld.

Apart from its undoubted great success as a social gathering, apart from the uniform high quality of its contributions to the advancement of science, the Cambridge meeting has proved of exceptional interest because of the philosophical cast given to its physics by its President and by the President of Section A. The address of Mr. BALFOUR we dealt with last week. To place it in contrast with that of Prof. LAMB, we should notice that one of its chief features is its eager acceptance of and confidence in the new, its hasty dropping of the old. Prof. LAMB, on the other hand, eyeing the new doctrines with the calmness of the expert, welcomed them shyly and put them with the old. Again, Prof. LAMB's philosophy is not that of the philosophers, but is that of the physicists, and has arisen out of the modern tendency to examine rigorously the validity in logic of the most fundamental conceptions in mathematics and mechanics. So frankly did he, as a mathematician, show the effect of this tendency that his confessions had all the force of revelation for the physicist. He disclosed his suspicion that the boasted "exact" sciences are, after all, but highly artificial, conventional symbolisms for expressing some of the properties of highly ideal bodies. He confessed, even, his doubts of the ultimate truth of our conceptions of pure quantity. And thus we are led to a striking summary of the revolution which twenty years have accomplished in the trend of the sciences within the purview of Section A. We may state it thus: That twenty years ago physicists were hoping to reduce physics to an exact science; and that now mathematicians are beginning to regard the mathematics as applied sciences.

We might venture to enquire, briefly, into the way in which these musings at the British Association may touch the engineer. Engineers, even electrical engineers, are so continuously engaged in the study of gross matter, that they are apt to under-estimate the influence on the course of events of things far subtler. The character of the addresses we have just been examining seem to us to point plainly the direction in which the current of scientific thought is turning. They are not the cause of this turning; but they indicate the existence of the stream, and show how the tide of thought is bearing. They may, moreover, to some extent influence that tide, and assist the fixing of the path of research and advance. If, then, it be admitted that other paths might possibly have been chosen, and if it be true that the science of one day is the practice of the next, then it will follow that we shall all of us be borne by the stream our men of science are embarked on, in the particular direction we have seen dimly outlined in the British Association addresses.

THE BRITISH ASSOCIATION AT CAMBRIDGE.

BY OUR SPECIAL CORRESPONDENT.

Thursday, August 18th.

The work of the sections began with the delivery of their addresses by the various presidents. The mathematics and physics section met in the drawing office of the engineering laboratories. There was a very large attendance of members and a brilliant array of leading physicists and mathematicians including many eminent European and American men of science. The presidential address was a splendid effort and was most warmly received. It dealt principally with the evolution of mathematical physics, especially in its connection with the work of Stokes, the president of the section at the Cambridge meeting in 1862. A lengthy abstract of the address is concluded on another page. In the course of proposing the vote of thanks, Mr. Balfour, picking out the statement, "We have given up the notion of causation; what were once called the laws of Nature are now simply rules by which we can tell more or less accurately what will be the consequences of a given state of things," charged Prof. Lamb with heresy; and expressed the hope that physicists would ever believe in the objectivity of the laws of Nature. Lord Kelvin, in seconding the motion, remarked that not only now were physicists and mathematicians in trouble about their souls, as Prof. Lamb has indicated, but they always had been and always would be. Nevertheless, and in spite of the marvellous development of the sciences since 1841, when he came as a student to Cambridge, the faith of mathematicians and physicists in inertia and the law of gravitation was still quite unimpaired. The want of confidence felt at present was due to the great complexity of the mass of puzzling phenomena recently put before us by the prosecution of radio-active research.

At the close of these proceedings Section A divided itself for the reading of Papers into two portions, one for mathematical Papers (there were nine Papers down) and the other for physics (nine Papers). But a considerable proportion of the audience wandered through a labyrinth of corridors and stairs into another part of the engineering department to hear the Hon. C. H. Parsons deliver his presidential address to Section G. This address was reproduced in last week's issue. Its chief feature was its pessimistic comments on the evils and injustices that arise from the defects of our patent laws. Mr. Parsons thinks they could be so remedied that systematic inventing would be greatly stimulated. He gave ærial navigation as an instance of what could almost certainly be achieved by the organised research of a body of engineers; but his main illustration took the form of a detailed design intended to show the possibility of penetrating by means already at hand to a depth of 12 miles into the earth's crust at a cost of about five millions sterling. Mr. Balfour again officiated as mover of the vote of thanks, but in commenting on the address committed himself only to the opinion that patent law reform

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must be international to be effective, and to a doubt whether any such betterment would persuade business-men to project and support such huge schemes as that just described.

A pleasant incident at this stage was the presentation to Mr. Parsons by Prof. Schröter, of Munich, of the Grashof medal awarded to him at the Frankfort meeting of the German Society of Engineers. The medal was accompanied by a diploma panegyrising the work of Mr. Parsons on the steam turbine, and was bestowed with a happy speech by Prof. Schröter. The recipient, in replying, described how the turbine had been suggested to him by Wheatstone's revolving mirror, and how, after starting work on it, he found more than 100 patents for much the same thing filed in the Patent Office. The elastic bearings of a cream separator suggested the style of bearing in use in the turbine. So he claimed his own case as an illustration of the doctrine he had already enunciated—that many sow for one to reap.

Meanwhile, in Section A, some very abstruse Papers, in mathematics and mathematical physics, were being read but not discussed. At any rate, the tone of such discussion as arose on the Papers of electrical interest suggested that contemplation was desirable before criticism. Perhaps Prof. Larmor's note "On the Relation of Röntgen Rays to Ordinary Light," was the most striking item. It propounded the conundrum whether a series of arbitrary pulses (such as Röntgen-rays are presumed to consist of) can be expected to penetrate a portion of matter placed in their path as do regular disturbances (such as light waves). In other words, though these pulses behave like light in undergoing diffraction, they might not so behave for refraction. Lord Rayleigh and Prof. Schuster wrestled with this riddle for some time without perceptible result.

In the afternoon the members attended in great numbers a garden party given at Emmanuel College by the High Sheriff; and in the evening a reception in Trinity College by the Local Committee.

Friday, August 19th.

To Section A the president of the sub-section of astronomy and cosmical physics gave his address, and then the meeting proceeded with the reading of astronomical and mathematical Papers. Section G began business at ten by the reading of Mr. Dugald Clerk's Paper, "Flame Temperatures in Internal Combustion Motors." This was followed by Prof. H. B. Dixon "On the Specific Heats of Gases at High Temperatures," and by Prof. B. Hopkinson on "Exhaust Gas Calorimetry." These three Papers were discussed together. The first Paper, which we commence in another part of this issue, deals mainly with Mr. Clerk's method of increasing the efficiency by adding compressed air or other gas to keep down the flame temperatures during the explosion epoch. Prof. Dixon's Paper arose out of a point in the former Paper; for a possible contributory cause of the suppression of heat in gas engines is that the specific heat of the gases may be much greater at high pressures and temperatures than at low. The Paper described the author's experiments on this point. Their conclusion, obtained by inference from the observed velocity of compression waves in various gases, was that, in general, the specific heat diminished with increasing temperatures. To this conclusion Sir A. Noble took some exception, and gave instances of indications that at very high pressures and high temperatures the variations were opposite in direction. Prof. Hopkinson's Paper described a calorimeter for measuring the heat carried away from the cylinder by the exhaust gases, and proposed that this measurement, coupled with that of the heat carried off by the cooling water in cylinder jacket and piston might, for the measurement of heat efficiency, take the place of measuring the heat supplied. This latter—the ordinary—method of making up the heat account is tedious and expensive, and, besides, uncertain in the case of large engines using producer or furnace gases.

Prof. Hopkinson, in discussing Mr. Clerk's Paper, offered a theory to account for the phenomenon of suppressed heat. He considered that in the course of the explosion in a gas engine, motions of the gas so violent might be set up as to store in the kinetic form considerable energy. This energy would be dissipated in the course of the stroke and appear as heat, and so account for what some engineers attributed to after-burning. Later this view, at any rate as regards its possibility, was encouraged by Lord Kelvin, who seemed at the same time to lean towards the after-burning theory. Prof. Dixon offered evidence that both violent motion and slow burning took place in exploding gases, with, in some cases at high temperatures, dissociation phenomena as well caused delayed chemical combination. But Mr. Clerk expressed emphatically his disbelief of the possibility of the storage of so much energy in turbulent motion. He believed rather in the after-burning accounting for most of the effect observed. In other words, the chemical combination lags behind the inflammation.

This subject had engrossed the meeting so long that two other Papers, one on "The Receiver Drop in a Compound Engine," and another on "Some Throttling Experiments with Superheated Steam," had to be rather summarily disposed of.

Saturday, August 20th.

To-day the gathering has dispersed in many directions by some dozen of well-organised excursions to places of interest in the vicinity. None of the visits this year possess industrial interest. Of course, the Cavendish laboratory, the engineering and other laboratories are open every day and supply sufficient pabulum of a technical character.

Monday, August 22nd.

In Section A the first electrical Paper was read by Prof. H. Rubens, of Charlottenburg, on "'Rest Strahlen' and the Optical Qualities of Metals." The term "Rest Strahlen" is used to denote those ultra-red rays of extremely great wave-length, which were first obtained by Prof. Rubens by a process of repeated reflection of light from a number of polished surfaces. He has found that such long waves give results according extremely well with Maxwell's formula connecting the reflecting power of metals with their conductivity; a formula which has not hitherto been supported by experiment. This result, as Prof. Rubens pointed out, brings into the region of possibility the determination of the ohm in absolute measure by optical experiments. Several eminent physicists took part in a short discussion, an especially noteworthy remark falling from Prof. Larmor, who expressed some surprise that the value of the conductivity inferred from experiments with high-frequency oscillations should turn out to be the same as that obtained by measurements with steady currents.

Dr. Glazebrook outlined the contents of the report of the committee on the construction of practical standards for electrical measurements, and described, with the aid of lantern slides, the research work which has been or is about to be carried out at the National Physical Laboratory.

It was rather late when Dr. Lummer, of Charlottenburg, rose to open a discussion on N-rays, and more Papers were to follow, so this interesting topic had but little time given to it. Moreover, Prof. Becquerel had, unfortunately, left the room, Dr. Lummer started with the very candid statement that the subject would not have been worth notice but that the French Academy had recently awarded a prize to Blondlot for his work on N-rays. He was aware, of course, of the photographic evidence which had been produced for the existence of N-rays, but thought the exact procedure in these experiments had yet to be carefully scrutinised. He quoted Becquerel's opinion that N-rays have their effect by being reflected into the eye and augmenting the sensitiveness of the retina. As for himself, he was inclined to the opinion that the result was largely physiological, perhaps even in some degree psychological. He described, to illustrate this physiological possibility, an experiment which can be performed with a candle in one's bedroom—though, as he said, the observer's time would be much better occupied in sleep. The experiment consists in approaching a candle towards the eye in a line parallel to and to one side of the visual axis. At a certain distance the pupil begins to undergo contractions, giving the impression of variable luminosity. Finally, Dr. Lummer asked those who had tried to detect N-rays to hold up their hands, and some 15 members responded; but of these in answer to an inquiry if positive results had been attained, only one replied. This gentleman, after being congratulated on his privileged eyes,

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described cases in which an observer watching a phosphorescing screen had detected the approach to the back of the screen of pieces of various substances. Prof. Rubens remarked that he had once persuaded himself he could trace dimly the motion of his hand behind such a screen, but had found he could not do likewise with other people's hands. He thought, therefore, that "suggestion" had a great deal to do with the alleged phenomena. Mr. J. Butler Burke gave evidence of the effects of "suggestion," and pointed out in this connection that since Blondlot's measurement of the velocity of Röntgen rays is interlinked to some extent with his N-ray researches, that measurement ought to be carefully repeated. Thus, it will be seen, the feeling of the meeting was one of cautious, not to say uncharitable, scepticism.

The proceedings in Section G opened with the reading of a Paper on "The Use of Electricity on the North-Eastern Railway and upon Tyneside," presented by Messrs. Merz and McLellan. Much of the matter of this lengthy communication is already familiar to our readers, as it has recently been treated fully in our columns. It will be remembered that the great development of the use of electrical energy on Tyneside for general purposes enabled the Newcastle Electric Supply Co. to undertake delivery to the railway company at a much lower rate than that at which the company themselves could have generated. Since, apart from the railway, the factories of the district, employing some 40,000 men, depend for their energy mainly on one power station, an outline of the design of this station appropriately concludes the Paper.

The president suggested the possibility of levelling up the load curve by electrochemical usage; in a certain case the cost was thus reduced to 0·2d. per kilowatt-hour. Other speakers raised points touching on the feasibility of overhead wires (in view of recent accidents), on early American traction experience, on the testing of fuel and flue gases, and on the economic standing of these large concerns. Mr. McLellan, in replying, alluded first to their great indebtedness to the steam turbine. He said that with the present direct-current system overhead wires were impossible, as currents up to 1,600 amperes had to be collected; but the use of single-phase current would alter that. The American system which had been mentioned as running in 1899 used lighter cars and had a smaller traffic than the North-Eastern, and so was not comparable with it. As regards the testing of fuel and flue gases calorific tests and analyses were made weekly.

Mr. W. M. Mordey then read a Paper on "Energy Losses in Magnetising Iron," communicated by him and Mr. A. G. Hansard. They draw attention to the fact that many engineers are content to measure the hysteresis loss by Ewing's tester and to neglect the losses due to eddy currents. They recommend the wattmeter method, which gives the total loss, and they record the results of their experiments on sheets of 14 mils, 19 mils and 25 mils thick at inductions of 2,500 to 10,000 and frequencies of 50 and 100. Their figures show the eddy current loss to be from 36 to 64 per cent. of the total, while it increases rather less quickly than $(\text{thickness})^2$ and $(\text{periodicity})^2$. They further find that rise of temperature diminishes the eddy loss by 27 per cent. between 40°F. and 167°F. They conclude that until some good magnetic material of high specific resistance is introduced the only way to reduce eddy losses is to use as thin iron as possible.

In the discussion, Mr. Hadfield suggested that temperature changes might account for some anomalies in the results, and stated he had been experimenting with an aluminium-iron alloy of low hysteresis and a resistance three or four times that of pure iron. At present the difficulties of rolling it prevent its use. Prof. Ayrton said that Prof. Perry, ten years ago, had called attention to the great importance of eddy current loss; and Mr. G. G. Stoney suggested that the shape of the alternating wave might affect the results, a number of tests on large alternators having shown the eddy current loss to be 90 per cent. of the total.

A Paper by Mr. Campbell Swinton on "Electricity from Water-power" was, in the author's absence, taken as read. The Paper gives some interesting statistics of existing hydro-electric plants and proceeds to sketch a number of schemes projected in this country and the United States.

The next Paper was by Dr. Sumpner and Mr. R. W. Weekes. It described a modified Hopkinson method for testing induction motors by coupling two with a belt and pulleys of slightly different size, so that one machine runs about 3 per cent. below synchronous speed and is thus a motor, while the other is about 4 per cent. above synchronous speed and generates current. This current is sent into the other machine and the losses are made up from an outside source of supply. If it is desired to vary the load there must be resistances in the rotor circuit. The power taken from the mains has a very low power-factor, hence the current may exceed that from the generator although the power is only about one-third the generator's power. An interesting point is that the loss in the belt drive and the slip of the belt can easily be determined with accuracy by this method. In the discussion Mr. W. Cramp doubted whether this method was comparable in usefulness to the Hopkinson direct-current test owing to the large number and smaller reliability of the instruments needed. He preferred for induction motor tests the Heyland diagram and a continuous-current method which he had devised.

Dr. Thornton's Paper on "The Distribution of Magnetic Induction in Multipolar Armatures" came next. It is reprinted in another part of this issue. There was no discussion.

Dr. J. A. Fleming contributed a Paper in which he described the use of large bulb incandescent lamps as secondary standards of light, and Mr. Clifford Paterson gave an account of his investigations on the effect of variation of pressure and moisture on the 10 c.p. Harcourt pentane lamp made at the National Physical Laboratory. These will be found on another page. In the discussion on the two Papers Mr. Vernon Harcourt suggested an inquiry into the effect of moisture and pressure on the gas flame which was being measured; this would be interesting though more difficult. Dr. Glazebrook pointed out that there was a variation of the standard of 5 per cent. on each side of the mean under ordinary atmospheric conditions, and asked how the formula obtained compared with that for the Hefner standard. Prof. Ayrton inquired whether any erratic variation of light even with the voltage constant had been noticed.

In reply, Mr. Paterson stated that the variation of the Hefner standard for moisture was 0·5 per cent., as against 0·7 per cent. for the pentane lamp, and with pressure a variation about a quarter of that found for the pentane lamp.

Tuesday, August 23rd.

This morning had been set apart for the bulk of the Papers on radio-activity and allied subjects, so a very large attendance was recorded in Section A. Prof. Schuster read the first Paper, "On the Ionisation of the Atmosphere." He began by pointing out that the continual presence in the atmosphere of free ions implies the existence of some ionising agency. At any moment when the degree of ionisation is not altering rapidly, the rate of ionising due to this agency and the rate of recombination of the ions must be equal. Thus a measurement of the rate of recombination gives also the degree of natural ionisation which is proceeding at that time. To measure this rate of recombination, he draws the air through a tube into an electroscope of the type used by Elster and Geitel. Near each end of the tube is a tubulure, through which radium can be allowed to act on the flowing air. If the radium is placed at the end near the electroscope, an increased leak is recorded by the gold leaves; but if placed at the far end of the tube a smaller leak is obtained. The difference is due to the recombining of ions, and from it can be inferred the rate whose value is sought. This, it may be repeated, is the measure of the rate of ionisation, in the air at the place of experiment, due to natural causes. Measurements of this quantity have been made at different places, and have shown that in the air of towns and in air confined in vessels the rate is much the same, and greater than in the pure air at high elevations, though, it should be noticed, the actual number of ions present is usually smaller in confined air than in the atmosphere of the mountains. The author impressed on the meeting the importance of recording continuously at, say, meteorological observatories the variations of this natural rate of ionisation, and promised shortly to produce an automatic registering apparatus. Incidentally, Prof. Schuster mentioned an interesting observation he had made with his apparatus.

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He had found that on taking the instrument out of doors the rate of leak observed increased considerably. He suggested that the change of temperature might produce convection currents within the apparatus, which brought into the reckoning a variety of slow-moving electrons which escaped the usual mode of measurement.

Lord Kelvin remarked that in the dark ages of science about the middle of the nineteenth century, the striking variations of the rate of leak were well known, and were, in fact, studied exhaustively and given the name "electric frequency." He now had to express his sorrow that he then accepted the current notion that these variations were due to the varying prevalence of specks of dust and spherules of water, and had not more closely investigated the phenomena. He supported warmly Prof. Schuster's proposal of continuous records. Perhaps, after all, the gold leaf electroscope might turn out to be the best weather prophet. Dr. Geitel rose to point out that in these measurements radium was a dangerous auxiliary. For example, the emanation introduced into the electroscope might greatly disturb the validity of the results. To this the author replied that the mode of experiment, in his opinion, eliminated this error. Prof. Elster then described how great were the variations of a similar natural quantity—namely, the radio-active deposits on exposed negatively-charged conductors. This had been found to be some 30 times larger in mountainous regions than on the plains; its variation should, therefore, be recorded along with those studied by Prof. Schuster.

The president now called upon Prof. J. J. Thomson to open a discussion on the radio-activity of ordinary matter. Prof. Thomson started out by defining as radio active any substance which can produce conductivity in a gas from which it is completely separated by screens impermeable to common matter. Now, in making direct experiments on ordinary materials a great difficulty arose from the wide prevalence of radio-active substances; soil, water, air, even samples of flour showed their presence. Thus, the only method apparent was to examine the radiations given out by matter; and here the presence of impurities caused trouble. Further, the question arose, In any particular case, is the radiation observed but secondary? We know that the atmosphere is traversed perpetually by very penetrating radiations; may not these excite activity in the substances under examination? Almost simultaneously McClellan and Strutt had shown that certain metals do give out radiations, by measuring the rate of leak in closed metal vessels. Both had found that the amount of ionisation depended on the metal of the vessel and on its volume; that with vessels about a litre capacity the leak with lead was twice that with zinc. Thus the ionisation could hardly be a spontaneous action of the gas, but might arise from interaction of gas and metal. Later, it was discovered that on placing apparatus such as this inside a lead cistern and repeating the measurements the rate of ionisation decreased. In fact, the holding of a sheet of lead above the apparatus to shield it from the sky diminished the leak; or the placing of the lead below the apparatus to shield it from the earth again diminished the leak; and, most remarkably, these two last effects were of precisely the same magnitude, as had been shown by Mr. Cook in Canada and by observers in the Cavendish Laboratory. It is found, however, on increasing the thickness of lead in these experiments, that a limit is soon reached. Mr. Cook surrounded his apparatus with half a-ton of lead, and found the decrease in the leakage rate no greater than with an envelope of 2in. thickness. A student of the Cavendish Laboratory had sunk his apparatus 60ft. into a deep lake. There was still an unalterable residual effect. Mr. Wood had, therefore, determined the exact effect of screening in diminishing the ionisation in equal volume vessels of various metals. In a leaden vessel the diminution was 10 per cent., in one of tin 22½ per cent., in iron 23½, in aluminium 18½, in zinc 26½. The variation among these figures give an idea of the amounts of secondary radiation.

A prolonged series of experiments was being carried out by Mr. Campbell of the Cavendish Laboratory on this residual ionisation which remains after shielding is complete. The vessels in which he measured the leak are of variable volume, consisting essentially of two plates movable to and from each other. The ionisation produced by a metal is measured by making the vessel of that metal. It is found that curves plotted with saturation currents as ordinates, and distances between the movable walls as abscissæ, are at first convex towards the axis of ordinates, but soon coincide with upward-sloping straight lines. Now, since very penetrating radiation from the walls would produce effects in the gas varying only because the volume of gas acted upon increases by separating the walls, the curve for such radiation would be a sloping straight line. With soft (*i.e.*, easily absorbed) radiation, on the other hand, increase of distance between the plates after a certain value has no result, because such radiation operates only on layers of gas near the walls. Hence, in this latter case lines consisting of a curved part and a horizontal straight part are to be expected. As a matter of fact, the experimental curves are all found to be resultants of a pair of such as have just been described. Thus, Mr. Campbell has established the existence of two kinds of radiation from metals, and for each of several substances has obtained from his curves a measure of the penetrative power of the soft rays. He has found, for instance, that the soft radiation from carbon is more penetrating than that from lead. Relative values of the amounts of soft and hard rays given by various metals are: Lead 4·6 and 0·3, aluminium 1·2 and 0·6, platinum 0·0 and 2·2, zinc 0·9 and 0·4. These figures have been tested by comparing the ionisation calculated from them, and observed in actual experiment, produced by the radiation which penetrates into a closed vessel through an aluminium window from a plate of the tested metal placed outside.

These experiments, in Prof. Thomson's opinion, show without doubt that there is a radiation peculiar to each metal. It can not be due to traces of radio-active metals in the ordinary substances experimented upon, for properly cleaned samples from widely different sources gave concordant results. But there does remain the bare possibility that an extremely penetrating radiation pervades all space, setting up in ordinary substances secondary radiations peculiar to themselves. Against this stands the fact that passage through 60ft. of water affects its amount imperceptibly, though that it is absorbable is shown by its postulated power of exciting secondary radiation. The supposition, therefore, involves the existence of incredibly enormous streams of energy.

Still another mode of attack on this problem of the radio-activity of ordinary matter is suggested in the question, Does ordinary matter give off a radio active gas or emanation? Prof. Thomson described his own attempts in this direction. He had dissolved salts in distilled water, waited a week or two, bubbled air through to take up the emanation and examined the resulting ionisation. But the results had been very irregular; and efforts to stimulate the solutions by introducing capsules of radium had not assisted. But some indirect evidence was available from Elster and Geitel's observations that as time goes on the ionisation in a closed vessel increases, the pace of this increase depending on the size of the vessel; being ultimately in vessels of ½ litre about 20 to 30 per cent., in vessels of 2 or 3 litres twice as much. McClellan, in Canada, has studied this time-effect of the influence of the walls. Lead gives most quickly the steady state, tin next and zinc next. This time is a measure of the length of life of the emanations, which, therefore, can be seen not to be the emanation of radium. Again, Wood found that on heating closed tin vessels the internal ionisation increases, and that a further heating has no effect until a period of rest has been allowed. This resembles the general experience with the better-known emanations. A curious observation by Mr. Wood, that an application to a lead surface of non radio-active nitric acid increases the ionisation produced by the lead, recalls the fact that a solid radium salt, when its surface is caked, gives out little emanation. Perhaps the action of the nitric acid applied is to render the lead surface more permeable to the gaseous emanation.

Dr. Geitel continued the debate by expressing his opinion that the Cavendish Laboratory had almost demonstrated the radio-activity of ordinary matter. He should not feel satisfied, however, without still more experiments. A part of the effects observed, he was inclined still to think, might be due, indirectly, to extraneous radiation. It seemed neces-

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sary now to find building materials for laboratories less radio-active than those hitherto employed.

Prof. Schuster, remarking on the striking experiments on the shielding effects of plates of lead held above and below a vessel in which a gas was undergoing ionisation, thought that a great mass like the earth ought, if the radiation was very penetrating and came from every portion of it, to be much greater in amount than that coming from the sky, whereas these quantities would seem from the experiments to be equal. Perhaps the effects observed might be better explicable by supposing that the lead screens acted by giving out radiations which annulled the influence of radiation proceeding from the earth.

Lord Kelvin asked if it was possible that the radio-activity of radium salts was to any extent a surface effect. Sir Oliver Lodge declared that in the electric theory of matter all matter ought to be radio active, and that it might almost be said that the burden of the disproof of that theory rested on its opponents. He asked, besides, if this radio-activity of ordinary matter might be the cause of fogging of photographic dry plates and films which had been kept a long time.

Prof. Thomson's reply to Lord Kelvin's question was that in the case of uranium the radiations depended on the mass of the salt only and not on the extent of its surface. To Prof. Schuster he pointed out that unless the radiation from the matter of the earth was infinitely penetrative, its amount from the whole globe would be no greater than the amount from a comparatively thin layer. Again, taking the connection between radiation and absorption into account in the case of the atmosphere, as much radiation could be expected from the body of air, in spite of its small density, as from the earth.

Dr. G. A. Blanc, of Rome, described the results of his experiments on the radio activity of the sediments and floating matter of the hot springs at Aix-le-Bains. It drew from Prof. Elster an account of some of his experiences with matter brought up from great depths by springs and volcanoes. There was no rule that such substances were always radio-active. Prof. J. J. Thomson told how the most highly radio-active natural water he had met with was that from the well of a certain brewer whose name he had sworn never to divulge; the radio-activity of his water would, this unenterprising brewer thought, prove no recommendation for his beer.

Lord Kelvin then described his plan of a combination of atoms and electrons which would have the properties of polonium or radium. The combination which he offered to represent polonium consisted of two Aepinus atoms in contact with positive charges, each $4e$, just held together in spite of their mutual repulsion by an electrion (charge e) between them. This configuration would be one of unstable equilibrium, and a small outward displacement of either atom would lead to its explosive propulsion away from the other. The electrion would remain with one of the atoms and vibrate within it. The energy given up in this process is $6e^2/r$, a quantity which may be very large if r is extremely small; and it is manifested in the projection of α-rays and electromagnetic radiation. The model proposed by Lord Kelvin for atoms of the radium type consists of an Aepinus atom with positive charge $\frac{1}{4}e$ having two electrions placed at the ends of a diameter. The equilibrium would be unstable; its failure would result in the production, certainly of β-rays, and sometimes of α rays. Lord Kelvin admitted that these models would lead one to expect a temperature variation of the radio-activity of a substance, since the increased molecular agitation on heating would inevitably disturb the equilibrium positions described. He explained that he proposed these rough models where statical equilibrium only is involved, because he knew of no instance in the whole of dynamics, of systems choosing successive stages of stable motion such as was proposed by the upholders of the most commonly-accepted form of the electronic theory of matter. Regarding this theory of the atom and its associated disintegration hypothesis, its advocates had at first so alarmed him by statements that the emission of energy from radium went on "for ever," that he did, at last year's meeting, deny its possibility, and suggested the existence of an external source of energy. Now that he saw he had misunderstood their statements, he abandoned the external source in favour of the intra-atomic source of energy.

Dr. H. A. Wilson read a Paper on "The Electrical Conductivity of Flames." The method of experiment consisted of introducing two electrodes into the flame, establishing and maintaining a potential difference between them, and exploring the path of the current through the flame by the aid of a movable platinum wire. A very elongated flame-circuit was obtained by using a horizontal burner made from a quartz tube by making holes in it along a generator. The results obtained showed that the potential falls along a flame in much the same way as along a vacuum tube; and the agreement with a formula given by J. J. Thomson shows that the ionisation per unit volume is uniform throughout the flame.

Dr. O. W. Richardson then read a communication on certain electrical properties of hot bodies. The author had previously shown that the negative ionisation from hot metals in vacuo followed a formula of the type $e^{-b/\theta}\theta^{\frac{1}{2}}$, where θ is the absolute temperature. It is shown in the present Paper that the temperature variation of the positive leak in vacuo, at temperatures so low that the falling off with time is not perceptible during the course of the experiments, are also represented by a formula of the above type, which, therefore, applies to all cases of ionisation by hot bodies whether the phenomenon is reversible or not.

An important Paper by Mr. J. H. Jeans on certain improvements he has introduced into the computation of the size of molecules, and giving some striking results, had to be read too quickly, and is, besides, too abstruse to be summarised. And Mr. Macfarlane Gray's Paper on "Dr. Grindley's Experiments on Steam in the Light of the Ether Pressure Theory" was taken as read.

In Section G, after the report of the Mersey Tidal Regime Committee, and the reading of Sir Hanbury Brown's Paper "On the Control of the Nile," Mr. J. H. Wicksteed, President of the Institution of Mechanical Engineers, described a 300-ton Universal testing machine for full sized structural members, recently built by Messrs. Buckton of Leeds for the French Government. It will admit a column or strut 88ft. long by 3ft. 3in. square or a beam 3ft. 3in. broad, 6ft. 6in. deep and 20ft. between supports. It will shear a bar of mild steel 8in. by $2\frac{1}{2}$in. or break a steel wire rope 9in. in circumference. It can be quickly adjusted for different sorts of tests or different lengths of specimens.

Prof. O. J. Arnold described tests in which a rapidly alternating bending stress was applied to boiler plate steel. Working up to speeds of 266 alternations per minute, it was found that the number of alternations (counted automatically) required to produce fracture varied inversely as the frequency. On the 1in. boiler plates tested it was found that specimens $\frac{3}{8}$in. thick cut from the inside gave much lower results than those from the outside. This effect persisted in spite of various forms of heat treatment, nevertheless no difference in the micro-structure could be detected.

In the discussion, Prof. Barr elicited that the specimens were carefully smoothed, so that surface effects could not produce the results obtained. Dr. Glazebrook doubted whether any such actions took place in practice, and stated that he was having some tests made on different lines. Prof. Hopkinson thought that the application of pure tensile and compressive stresses would be more instructive than a bending stress, in which only a small portion of each section underwent the maximum stress; while Mr. Wicksteed considered the large difference found between the two sides of the same boiler plate the most interesting and useful point. Mr. Maccall mentioned the Owens College machine, which produces pure tension and compression at speeds up to 2,000 alternations per minute. Figures from it partly corroborate Prof. Arnold's results, even for stresses below the static yield stress. The President alluded to the great importance of this subject in connection with such cases as railway axles, especially where there were any sharp corners.

Mr. R. A. Hadfield described the alloys discovered by Dr. Heusler, which, though composed of the non-magnetic metals copper, manganese and aluminium, possessed considerable magnetic powers. The best results with a given percentage of manganese are obtained when the percentage of aluminium is roughly one-half that of the manganese—*i.e.*, with one atom of aluminium to one of manganese. An alloy

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exhibited contained 60 per cent. copper, 26 per cent. manganese and 14 per cent. aluminium, and was magnetically nearly equal to cast iron. Unfortunately, it is very brittle and all attempts to draw or forge it have failed.

In discussion it was mentioned that *non-magnetic* alloys containing as much as 88 per cent. iron had been produced and that a certain amount of aluminium increases the magnetisability of iron. Dr. Glazebrook asked whether cooling curves had been taken and suggested that manganese may be magnetic at exceedingly low temperatures and that the copper and aluminium alloyed with it may raise the temperature at which the magnetism disappears. In reply to the President, Mr. Hadfield said that adding iron to this alloy would give it the characters of a manganese steel and, therefore, make it non-magnetic. This implies, paradoxically enough, that iron may be added to a magnetic metal so as to abolish its magnetic properties.

In the afternoon Prof. Poynting gave an address of a popular character on "Radiation in the Solar System." He defined the radiation he meant to speak about as the stream of energy which passes continuously from the sun with the velocity of light, and proceeded to explain Stefan's law that the radiation from a black body varies directly as the fourth power of its absolute temperature. He showed how, mainly from this law, the temperature of the sun had been estimated as 6,250°C. (absolute), and computed the temperatures a small black body would assume if placed in space at the distances of the respective planets. The temperature of the planets have thus been calculated to be: Mercury 196°C., Venus 79°C., Earth 17°C., Mars – 38°C. Then he turned to the pressure effects of radiation, and applied the theory to show how extremely small particles are expelled from the solar system by the preponderance of the radiational repulsion over gravitational attraction, while larger free particles, say 0·01cm. across, have their orbital motion so affected that in the course of time they fall into the sun.

Prof. Windt, of Utrecht, described the method by which he succeeded in demonstrating diffraction of Röntgen rays. He showed lantern-slides of the radiographs from which he deduced the wave-length of the rays. Meanwhile, in a neighbouring quadrangle Major Baden-Powell showed to an interested crowd a variety of aero-plane experiments.

Wednesday, August 24th.

Although, as a rule, the last day has only a thin attendance, there was a large number of Papers down for reading in Section A. Prof. Fleming read the first, on "Electric Waves along Spiral Wires, and on an Appliance for Measuring the Length of the Waves used in Wireless Telegraphy." Prof. Fleming's modification of Seibt's experiment has been described before in these columns, but this morning he introduced the novelty of locating the nodes and loops of potential along the helix by means of a neon "vacuum tube." The remarkable glow of these tubes enabled him to give a brilliant demonstration in broad daylight. As will be remembered, Prof. Fleming sets the helix into electrical vibration by dielectric coupling with an independent oscillator circuit whose spark-gap is fed by an induction coil. The wave-length of the oscillator's vibration can, therefore, be measured by isolating a complete wave on the helix by means of a sliding earthed saddle, using a neon tube as indicator. The capacity and inductance of the oscillator are known by previous measurements. Thus the inductance of an odd coil of wire can be determined by inserting it in the oscillator circuit, and observing its effect on the wave-length isolated, as described above, on the helix. Inductances as small as that of a yard of wire arranged as a few loose turns can thus be measured with certainty.

Mr. Field's Paper on eddy current losses in the lead-sheaths of three phase cables announces the law that these losses go up as the sixth power of the diameter. This large rate of increase soon imposes a limit on the size of cable practicable. The law requires some modification if the skin-effect is taken into account. Again, in three-core cables, and with cores of circular cross-section, proper construction can reduce the external field so as to render its effects small, but then there is considerable eddy-current loss along the centre of the core. Thus, in any case, an early limit is set upon the size of cables.

Prof. Knott then read a Paper, entitled "Magnetic and Electric Properties of Nickel at High Temperatures." He has found that by using nickel foil instead of the nickel wire usually employed in similar researches hitherto, that the alteration of resistance by magnetisation is perceptible in low fields. He turned this to account in studying the effect of temperature variation on the increase of resistance due to magnetisation. He found that at a temperature of 340°C. nickel becomes non-magnetic, and the resistance unalterable by magnetic force. Before falling to zero, however, the change of resistance in a given field undergoes a sudden temporary increase. It is noteworthy that the susceptibility of nickel vanishes through heating sooner in low that in high fields.

Prof. Barrett and Mr. Hadfield gave a communication describing the results of their measurements of the thermal conductivity of a series of iron alloys. Manganese-iron, nickel-iron and tungsten-iron series were examined, besides two nickel-manganese-iron alloys. They found that in every case the thermal conductivity varies along a series exactly as does the electrical conductivity. Thus the highest resistance metal known, a nickel-manganese-iron of percentage proportions 5, 25, 70 has also lowest thermal conductivity. Hence, from the known rule for electrical conductivity, we get for thermal conductivity the parallel statement: The alloying with iron of a metal of greater atomic mass reduces the thermal conductivity.

In Section G two electrical Papers were read, one by Mr. H. Darwin on "An Electric Temperature Alarm," the other by Prof. E. Wilson describing the effect of exposure to London atmosphere on various aluminium alloys. Prof. Wilson's Paper is given on another page. The remaining two electrical Papers were taken as read. One was by Mr. William Cramp, on "A New Method of Testing Alternating Current Motors by Continuous Current"; the other was by Mr. Killingworth Hedges on "The Action of Lightning Strokes on Buildings"; both these Papers will appear in a future issue.

BOARD OF TRADE REPORTS ON LIVE RAIL ACCIDENTS.

Three reports on live rail accidents have recently been issued by the Board of Trade. The first of these is by Major Druitt, and relates to the death of Patrick Flood, which occurred at Formby, on the Lancashire and Yorkshire Railway on June 9th. In this case Flood, while trespassing on the railway, came in contact with the live rail and was killed by the shock. Another man, Mathews, who was with the deceased, also received a bad shock and burns, but recovered. The report continues:—

The evidence available is simple and is to the effect that the fireman of a shunting engine, by name J. Rigby, employed in the sidings of the power station at Formby, about half a mile south of Formby station, heard a shout at about 3:20 p.m. on the day in question, and looking towards the line saw two men lying across the live rail about 40yds. to 50yds. away from him. He told his driver, F. Evans, who was alongside the engine, who at once ran across to the power station 40yds. or so away to tell the attendants. Rigby at once ran to the men but did not touch them. Evans, on reaching the power station, at once told the switchboard attendant that some men were on the live rail, and Mr. O'Brien, the resident electrical engineer at the station, who was in the engine room, on hearing the report at once had the current cut off and ran out to where the men were lying. He immediately lifted both clear of the line, and with his assistants tried to restore them by means of artificial respiration with the result that Mathews came round, but Flood was dead. Evans, the driver of the engine, states that it was two minutes at the outside from the time Rigby told him of the men being on the rail to the time the current was cut off, so this was done and the men were removed from contact with the live rail with as little delay as possible after the occurrence. Flood appears to have received a more severe shock than Mathews owing to his boots being so worn out that if he stepped on to the live rail, as he probably did, he would be practically barefooted, and as it had been raining heavily just previously, all the conditions were favourable for a very bad shock, and it is very probable that he was killed instantaneously on stepping on to the live rail. The men had not been noticed previously to their being seen on the rails, but it is supposed that they got over the fence just opposite the power station, and were crossing the line to go to it. It will be seen that this occurrence was entirely due to the men being trespassers on the railway. The nearest public level crossings for foot-passengers are 245yds. north of the point where the men were found, and 452yds. south of that point respectively. There is also a private footpath for the River

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Alt Commissioners 105yds. south of this point. There are notice boards at all level crossings pointing out the danger to trespassers from the electrification of the line in addition to "Beware of Train" notices. The new electrification notices have also been put up on the side of the line at places where people might be liable to trespass, such as alongside golf courses. The line is well fenced, the fencing near Formby power station consists of posts and five rails, the top rail being 4ft 3in. to 5ft. above ground level. Speaking generally, the company have protected the power rail wherever the public or company's servants (other than platelayers) have any occasion to be on business or duty along the whole of the line worked electrically. At the sides of bridge girders, in stations and alongside sidings, signal boxes, &c., protection has been given by either single or double boarding, the total length provided being 10 miles of double boarding and 6½ miles of single boarding out of a total length of single line of 47 miles. At level crossings the power rail ends 6ft. away on either side, and the current is carried under the wood decking by cables, and the ends of the power rails are protected by double boarding for a length of about 10ft. With regard to the protection of platelayers engaged, the gang I saw at work at Formby had the lower part of their shovel handles (*i.e.*, where the iron straps of the shovel are fastened to the handle) protected by insulating material, and I was told by the men that this protected them from shock if they accidentally touched the power rail with their shovels when packing the sleepers. The beaters have no metal work likely to come in contact with a man's hands when using them. Special precautions are, of course, taken for the protection of the men employed on the upkeep of the power rail, &c. The provision of the protecting boards, especially the inside one between the power and running rails, makes the work of packing the sleepers more difficult, as it is just under the running rail that packing is most required, and anything making that difficult is undesirable from a platelayer's point of view. The upkeep of the protective boarding will also require much attention, as the clearance between the shoe and the boarding must necessarily be small, and the latter will be liable to get out of place from the action of rain and sun; any contact between the two might easily result in a serious derailment. As far as experience goes at present, it does not appear necessary to provide boarding for the live rail for the whole length of the line in order to protect the men employed in working the traffic, repairing the line, &c., or the passengers.

The second report is by Lieut.-Col. P. G. von Donop, and relates to a fatal accident which occurred to porter Joseph Innes at Manors station, on the North-Eastern Railway, on June 13th. On the above-mentioned day, about 12:45 p.m., porter Innes was found lying dead on the line close to the down end of Manors railway station. He was found in the six-foot way between the up and down Tynemouth lines, and he was lying on his face parallel to these lines. The back of his head was in contact with the live rail of the up Tynemouth line and his face was touching the point rods which pass under the lines at this spot. Life was quite extinct at the time he was found.

The two live rails alongside the up and down main lines at the down end of the station are protected in the following way:—On each side of these rails is fixed a wood guard about 3in. distant from the rail, and extending to a height of 2in. above the upper surface of it. This guarding will, to a great extent, prevent the possibility of a person coming into contact with the live rail, whilst it does not interefere with the action of the shoe. The live rails alongside the up and down Tynemouth lines are similarly protected, but only to a very small extent, and at the point where Innes' body was found there was no guarding at all. The company's explanation of this difference is that there is a much larger necessary traffic of company's employés between the passenger station and the goods station across the main lines than there is between the passenger station and the granary across the Tynemouth lines. Porter Innes, to whom this accident occurred, was employed working a capstan at the granary. The main entrance to the granary is, it may be mentioned, from the road on the south side of it, quite clear from the lines.

In his evidence Mr. C. H. Merz, consulting engineer to the North-Eastern Railway Co, said with regard to protecting the third rail:—

One special point which is receiving attention at the present moment is the width between boards. It is obvious on looking at the protection itself that it is more efficient the narrower the distance between the boards, but this involves very careful consideration as to the variation and position of the shoe under working conditions. My own opinion, is that the road will be more difficult to keep in order the more protection there is. Probably, so far as working on the road is concerned, temporary guards or rubber mats or insulated tools would be of more use than guard planks. In fact, the permanent way men consider it most desirable that protection should be made removable, and if it was made removable and were removed in the case of working on the line it would, of course, be of no use as protection to those particular men. Broadly, the two distinctive types of protection are a type supported from the sleeper and a type supported from the rail. The difficulty in regard to the type supported from the rail is that in wet weather the woodwork becomes more or less of a conductor, and any iron work certainly takes the potential off the rail as the result of surface leakage and the thorough soaking of all timber with water. The difficulty in regard to the type supported from the sleeper is that unless metal is used to support the timber it is difficult to make it sufficiently rigid, that it interferes more with the upkeep of the permanent way, and if metal is used for supporting the timber that it brings the metal parts into close proximity to the third-rail itself. We have kept in mind throughout the design of the whole work a minimum clearance of 6in. from the rail to any metal parts in contact with earth, and we should certainly consider it dangerous to encroach upon this minimum distance. I do not think that protection could be done for less than £200 per mile of single track; this provides double guarding. In the present electrification scheme there is not less than 82 miles of single track.

In drawing his conclusions from the evidence, Lieut.-Col. von Donop formed the opinion that the spot at which the accident occurred being one at which the company's servants habitually cross the line, it was essential that precautions should be taken to guard them from danger arising from the live rail, and it is to be regretted that the live rails of the Tynemouth branch had not been guarded similarly to those of the main line.

It is satisfactory, however, to hear, as stated by Mr. H. A. Watson, the general superintendent, in his evidence, that orders have been given for double guarding to be provided for these lines at this spot forthwith, and that at the same time experiments are in progress as to the best form of guarding to be provided. Mr. Watson further states that his company are in consultation with their servants as to what other portions of the electrified line call for similar precautions, and that at all such places it will be provided forthwith. Special rules have also been issued to their servants in connection with the electrified lines; and for the protection of their permanent way men, indiarubber gloves and mats have been freely issued. The steps now being taken by the company are, I consider, satisfactory, and should undoubtedly tend to lessen the liability of their servants coming in contact with the live rail. At stations there is always a possibility of the company's servants having to cross the lines, and also a danger of the public accidently getting on to them. I consider, therefore, that guarding should be provided to all live rails where they pass through stations, and the company's attention is, therefore, drawn to the advisability of carrying out this further precaution.

The third report, which has also been drawn up by Lieut.-Col. von Donop, relates to the circumstances in which a boy named Jonas Whitehead met with his death on June 29th, when trespassing on the North-Eastern Railway, near St. Peter's station.

About 5:9 p.m. on the above-mentioned day Whitehead was found lying across the line about 50yds. on the down side of St. Peter's station, and there appears to be no doubt that his death was caused by his having come into contact with the live rails used in connection with electric traction on this railway. There are on the down side of the station some sidings where shunting is carried on, and for the protection of the company's employés engaged in the work the live rails at this point have been protected by double wooden guards, but these guards cease on the down side of the station, a short distance from the spot where this accident occurred. There is, also, about 250yds. on the down side of the spot where Whitehead's body was found a footpath level-crossing. At this crossing the live rails are broken, the current being carried across by a buried cable, and the ends of the live rail on each side of the crossing are well guarded by double boarding. But between the sidings near the station and the level-crossing the live rails are not guarded in any way, and it was on this portion of the line that the accident occurred. The line is enclosed on each side by a substantial stone wall, varying in height from 3ft. to 8ft., and running alongside the south side of the south wall is a footpath which is apparently much used. There is a subway under the line almost immediately under the spot where the accident occurred. It is understood that there is not a public right of way through this subway, but it is stated that it is, nevertheless, considerably used by the public. A boy named George Cooper Lowery was with the deceased, Jonas Whitehead, at the time the accident took place, and he gives very clear evidence as to the circumstances under which it occurred. Whitehead was in front, and Lowery thinks that he tried to jump the first live rail—viz., that of the up line, but that he tripped on it and fell, falling apparently across the two live rails. His body was in that position when he was found a few minutes later by the company's servants, and though steps were taken to endeavour to restore animation, it was ineffectual, and a doctor who shortly afterwards arrived on the scene pronounced him to be dead. The doctor states that death had been caused by the electrical current. The deceased had at the time of the accident no shoes or stockings on.

The point at which the boys climbed over the wall was identified by Lowery; the wall is at that point 5ft. in height, and there were very distinct footmarks on it showing that access to the railway is frequently obtained at that point. There were similar marks, too, on the wall on the north side of the line, where Lowery states that they would have climbed over that wall also. It is evident, therefore, from these marks that, in spite of there being a subway, trespassers do frequently cross the line at this point, and this view is confirmed by the evidence of Mr. Morley, the station master at St. Peter's, who states that people, and especially boys, frequently do so. I am not prepared, at the present time at all events, to recommend the Board of Trade to call upon railway companies to guard their live rails continuously. Guarding should not be necessary as far as the permanent way men are concerned, and it undoubtedly considerably interferes with them in the performance of their duties. But at all stations, sidings, signal boxes and such places where shunters, porters, signalmen and other employés of the company may have to cross the lines in the execution of their duties protection should certainly be provided and the public should also be efficiently protected at stations and level crossings. In this case the live rails adjoining the sidings at the down end of

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St. Peter's station were already guarded for the protection of the shunters, and at the level crossing 300yds. on the down side of the station, adequate steps had been taken, as described above, for the protection of the public using the crossing, But between the sidings and the level crossing there are no circumstances connected with the line which, in my opinion, call for the provision of guarding, either as far as the public or the company's employés are concerned. Considering, however, that the spot at which this accident occurred is one at which trespass appears to have been for some time past very common, I consider that under the altered conditions of the line some steps should be taken by the company to prevent access being so easily gained to their lines. Similar steps should also be taken at any other spots on the lines where trespass is common. I would also recommend that the guarding of the live rails be continued throughout the whole length of St. Peter's station, which, it was noted, is not the case at present.

Mr. A. P. Trotter, electrical adviser to the Board of Trade, has signified his concurrence with all the above reports.

FLAME TEMPERATURES IN INTERNAL COMBUSTION MOTORS.*

BY DUGALD CLERK.

Had we lived in an atmosphere of much greater density, it is probable that the internal combustion motor would have developed on very different lines from those actually followed. Assuming an atmosphere of double the present density, say 30lb. pressure absolute per square inch instead of 15, for given flame temperatures the explosion pressures would have been double, and the non-compression engine of Lenoir would have been much more successful; perhaps, also, the schemes of the earlier English inventors, such as Brown (1826), to produce a gas engine using vacuum and condenser like the steam engine, would have been crowned with success. Had we lived in a very dense atmosphere, say of the order of 70 existing atmospheres, there can be little doubt the compression combustion motor would not have appeared at all, because it would not have been really needed. The explosion pressures to be dealt with would have been so great that the necessity would have arisen for reducing pressure instead of increasing it. This is very well shown by some most interesting explosion experiments recently made by Mr. J. Petavel, of Victoria University, with gas and air mixtures previously compressed over 70 atmospheres and then ignited. These mixtures produced pressures of the order of 4 to 5 tons per square inch.

Figs. 1 and 2 are prepared from photographic diagrams which Mr. Petavel has been good enough to send me. They show Mr. Petavel's rising and falling curves with explosive mixtures with about one volume of gas to six volumes of air. It is quite apparent that a gas engine constructor existing in a world having an atmosphere 70 times as dense as our own would be dealing with explosion pressures of up to 5 tons per square inch at ordinary atmospheric pressure instead of the modest 100lb. per square inch, which is the limit of pressure obtained from ordinary gaseous explosions without compression at present. It is interesting to follow to some extent the effect of such changed conditions as these. It has long been assumed by gas engine designers that the heat loss to the enclosing walls of an explosion chamber does not increase in proportion to the increase of pressure or density of the gaseous mixture before explosion. No accurate measurements, however, appear to have been made under rigidly determined conditions until some experiments, also by Mr. Petavel, upon the loss of heat to atmospheres of different densities from incandescent

Spherical Enclosure Capacity 552 c.c.
Temperature of Enclosure. Before Firing, 18°C. After, 24°C.
Initial Pressure 77·3 Atms. (1136 lbs. per sq. in.) $\frac{Air}{Gas} = 6{\cdot}0$
Maximum Explosive Pressure = 646 Atms. (9508 lbs. per sq. in.)
$\frac{Explosive\ Pressure}{Initial\ Pressure} = 8{\cdot}4$

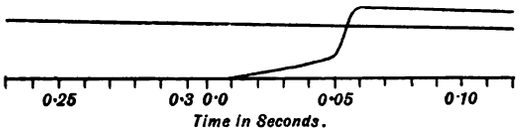


FIG. 1.—RISE OF PRESSURE.

Spherical Enclosure Capacity 551·91 c.c.
Temperature of Enclosure. Before Firing, 21°C. After, 27°C.
Initial Pressure 74·38 Atms. (1094 lbs. per sq. in.)
Maximum Explosive Pressure 654 Atms. (9618 lbs. per sq. in.)
Ratio. Air to Gas = 5·67
Ratio: Explosive Pressure to Initial = 8·8

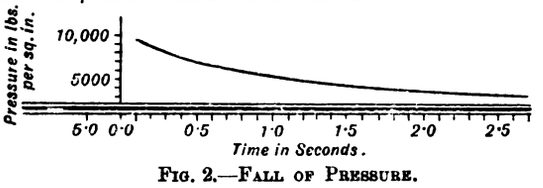
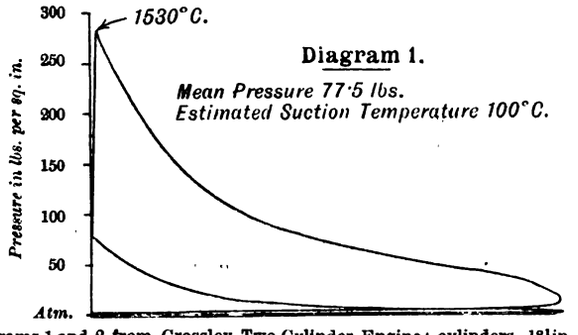
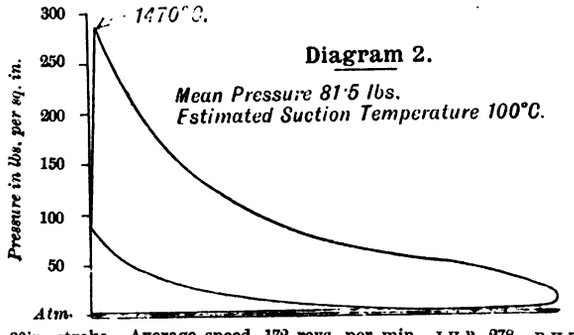
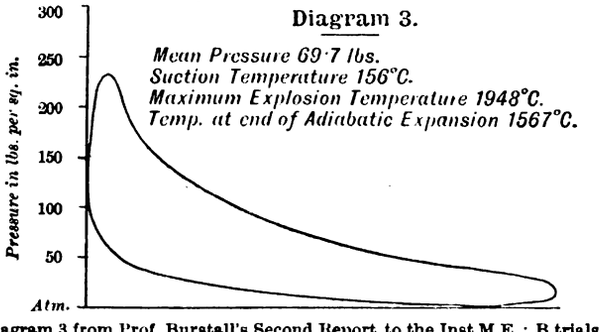


FIG. 2.—FALL OF PRESSURE.





Diagrams 1 and 2 from Crossley Two-Cylinder Engine; cylinders, 18½in. diameter by 30in. stroke. Average speed, 172 revs. per min. I.H.P., 278. B.H.P., 253 Indicated thermal efficiency, 30·3 per cent. Test made with Manchester Corporation coal gas, 607·5 B.Th.U. per cubic foot, lower heat value. Particular handed to author by W. J. Crossley, Esq.



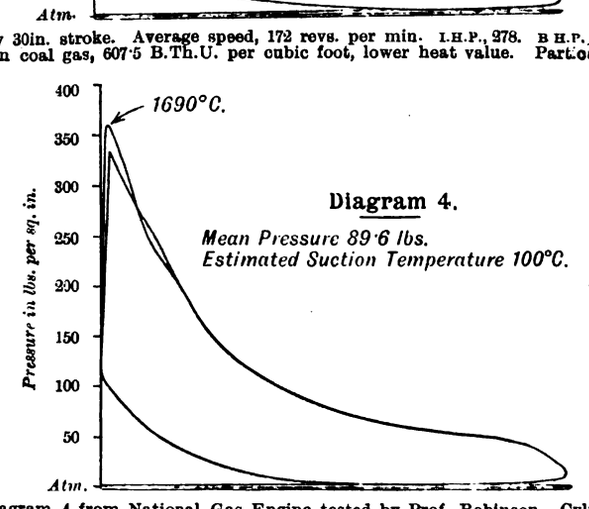


Diagram 3 from Prof. Burstall's Second Report to the Inst.M.E.; B trials, test 1. Engine cylinder, 6in. diameter by 12in. stroke. Speed, about 200 revs. per min. Indicated thermal efficiency, 19 per cent.

Diagram 4 from National Gas Engine tested by Prof. Robinson. Cylinder, 10in. diameter by 18in. stroke. Average speed, 170·3 revs. per min. I.H.P., 26·4. B.H.P., 23. Indicated thermal efficiency, 28·7 per cent.

FIGS. 3.

* Paper read before the Cambridge meeting of the British Association, 1904.

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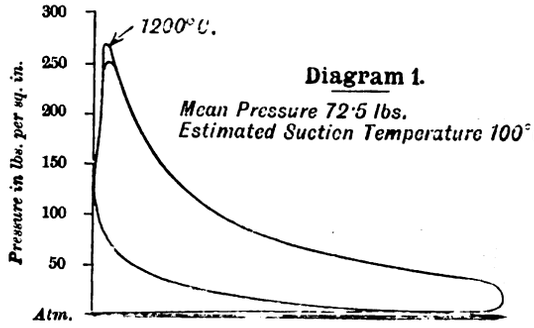
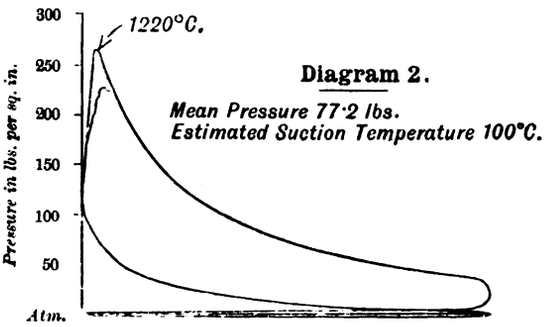
metallic wires kept at constant temperatures. Mr. Petavel finds (what gas engine people long believed) that the loss of heat increases relatively slowly with increase of density. Roughly, his figures appear to prove that, with an atmosphere of 100 density, the loss to the walls increases only six times that of the loss at unit density. This, of course, means that, if a gas engine could be operated in an atmosphere of double density, using exactly the same temperatures, the heat loss would not by any means be doubled. With the same temperatures, therefore, gas engines under such conditions would be more economical at the high-pressure atmosphere than at the low.

bility of securing equality of expansion of the metal parts in contact with the hot flame, it is interesting to consider what could be done by reducing cylinder dimensions and increasing mean pressures within a given cylinder. It becomes interesting, in fact, to consider whether there is no way of working at artificially enhanced atmospheric pressures, because it is obvious that such enhanced atmospheric pressures permit of great flame temperature reductions without requiring reduced maximum or mean pressures. With an atmosphere of double the existing density it is obvious that in a given engine mean pressures may be doubled, or, if desirable, mean pressures may be kept of the same value and flame temperatures reduced—that is, engines may be made much more powerfulfor a given cylinder diameter, and cylinder losses may be greatly reduced, not only by increased density, but by reduced temperatures capable of giving the desired pressures.

In small engines high temperatures may be used with compara-

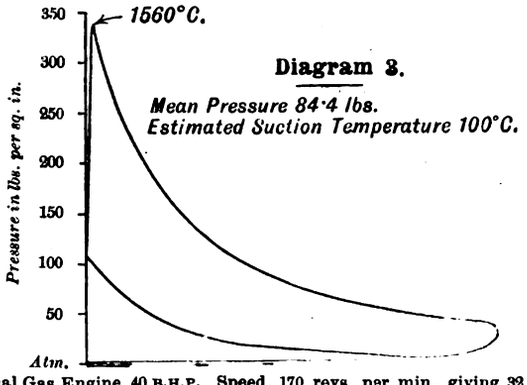


Stockport Engine, cylinder 20in. diameter by 27in. stroke. Speed, 182 revs. per min. I.H.P., 141. At Musker & Co.'s (Ltd.), Liverpool, using Wilson producer gas.

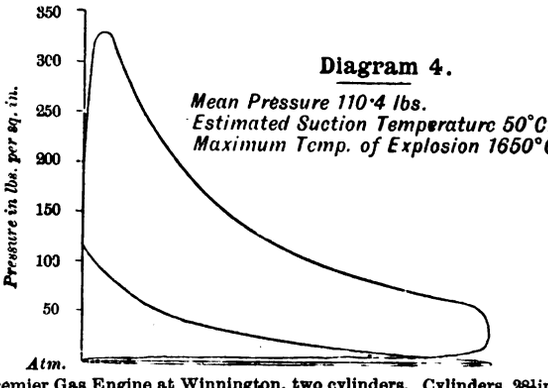


Stockport Engine, cylinder 18in. diameter by 27in. stroke. Average speed, 180. I.H.P., 113. At Musker & Co.'s (Ltd), Liverpool, using Wilson producer gas.

Diagrams 1 and 2 and particulars of test have been supplied to the Author by Messrs. J. E. H. Andrews & Co. (Ltd.).

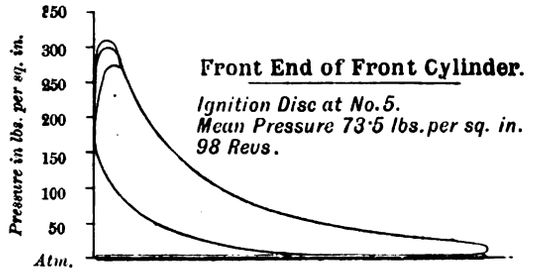


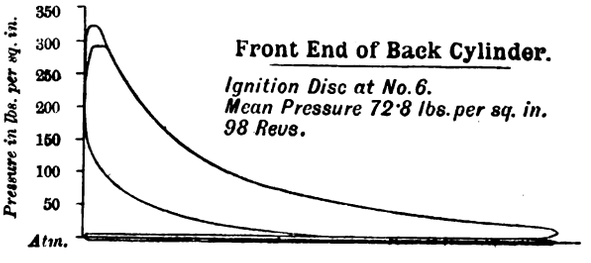
National Gas Engine, 40 B.H.P. Speed, 170 revs. per min., giving 32 B.H.P. at time of test; 4 explosions and 1 cut-out. Engine at work at Dowson's Works, Basingstoke, with Dowson suction gas plant using anthracite. Diagram taken by the Author.

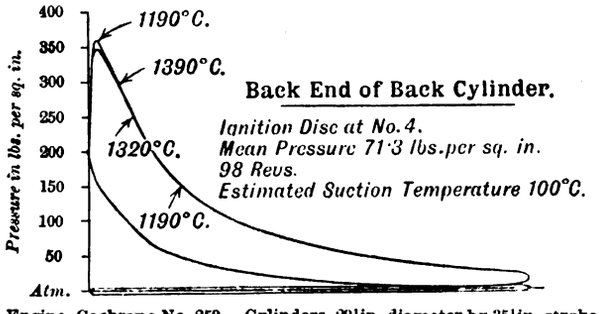


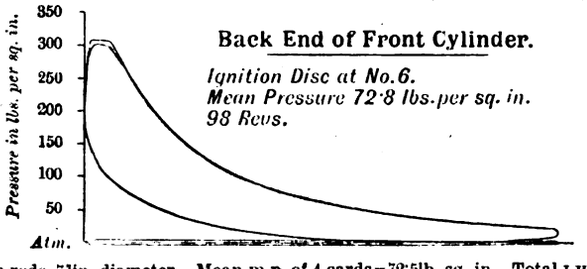
Premier Gas Engine at Winnington, two cylinders. Cylinders, 28½in. diameter by 30in. stroke. Air-scavenging cylinder, 43½in. diameter. Average speed, 128 revs. per min. Working with Mond gas. Pistons and exhaust valves watered. Diagram taken from engine by Mr. Humphrey in Author's presence.

FIGS. 4.









Gas Engine, Cochrane No. 250. Cylinders, 20½in. diameter by 35½in. stroke. Piston rods, 7½in. diameter. Mean m.p. of 4 cards = 72·5lb. sq. in. Total I.H.P. at 98 revs. = 810. Indicator diagrams taken on July 15, 1904, with temporary load on dynamo. Diagrams handed to Author by Mr. Westgarth.

FIGS. 5.

Something of this kind has been experienced by gas-engine constructors where engines have been operated at high mountain levels. Such engines usually experience not only loss of total power, but also some loss of heat efficiency.

In view of certain difficulties which are experienced, especially in large gas engines of considerable cylinder dimensions, due to impossi-

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tive impunity, and, accordingly, we find with both coal-gas and petrol engines flame temperatures in the cylinder as high as 1,800°C. to 1,900°C. With larger coal-gas engines operating without water-cooled pistons and exhaust valves lower temperatures become imperative, and, accordingly, we find in such engines the maximum temperature reduced to 1,500°C., or a little under. Nearly all makers have been forced to recognise the necessity of reducing flame temperature with unwatered pistons and exhaust valves where the cylinders are of dimensions of the order of even 18in. diameter. In coal-gas engines, accordingly, the gas and air passages are so set as to produce a sufficiently dilute mixture to prevent the temperature rising unduly. In engines using producer gases of various kinds, the temperature is naturally somewhat lower than with coal gas, so that special dilution is not so much required. This is also true of the very large engines using blast furnace gas. In such engines, where the main constituent of the gas used is carbonic oxide, the flame temperature possible is not high, mainly because of the slow-burning nature of the carbonic oxide and the small heat value per cubic foot of the mixture of blast-furnace gas and air. To study the question, I have calculated out from a number of recent diagrams the flame temperatures attained in standard engines of various types under the conditions found by the respective makers to give the best economy.

Fig. 3 shows diagrams taken from engines operating with coal gas by well-known makers—Messrs. Crossley, the National Gas Engine Co., and an engine built by Messrs. Fielding and Platt and experimented with by Prof. Burstall. From these diagrams it appears that the maximum temperatures range from 1,500°C. to over 1,900°C. Fig. 4 shows similar diagrams taken from engines using producer gas obtained from Dowson, Wilson, and Mond producers. Fig. 5 shows a series of diagrams taken from a very interesting tandem double-cylinder double-acting engine erected by Messrs. Richardsons, Westgarth & Co. at Middlesbrough, at the works of Messrs. Cochrane & Co., Middlesbrough. The temperatures on one of these diagrams have been taken out. In the producer-gas diagrams the temperatures, it will be observed, vary from 1,300deg. to 1,650deg. The blast-furnace gas diagram shows as a maximum temperature 1,400°C. In all the low-temperature diagrams it will be observed that the mean pressure obtained is somewhat low—70lb. per square inch, or under. Two years ago it appeared to me possible to reduce the maximum temperatures to 1,200°C., or something near that figure, while maintaining a mean pressure only heretofore possible with high temperatures. My idea was to increase the atmospheric pressure artificially, in order to work under conditions which would permit of any desired mean pressure without requiring a corresponding flame temperature. For this purpose I experimented with two engines—one of 7in. diameter cylinder by 15in. stroke and the other 10in. cylinder by 18in. stroke.

The 10in. by 18in. engine arranged for these experiments is one of the ordinary four-cycle type operated with coal gas. At the outer end of the stroke the piston over-runs a number of ports placed all round the cylinder, leading into an annular space which is carefully water-jacketed. Two sets of experiments were made with this engine. In one set an additional charge of air was used to increase the pressure within the cylinder after the ordinary charging stroke was complete. The air was compressed by means of a pump driven by belt from the flywheel of the engine. This air was passed into a reservoir, and the reservoir was connected to the annulus in front of the engine cylinder by a pipe. A piston valve was provided operated from the engine-valve shaft, which valve opened at a proper time to fill up the annulus. This annulus was thus filled with air when desired at a determined pressure. The valve actions were so arranged that when the piston over-ran the ports, just completing its charging or suction stroke, air was discharged into the cylinder by way of the ring of ports so as to fill up the cylinder to nearly the pressure in the reservoir, during the time the piston was crossing the ports in completing its out stroke and closing the ports in beginning its return stroke. The suction valve of the engine had to be closed a little earlier than usual to prevent the added charge of air from blowing back into the supply pipe. The exhaust valve, too, in this experiment had to be opened a little earlier to prevent the exhaust gases passing up the over-run ports. With this engine I am able to study the effect of adding an air charge to a charge drawn into the cylinder without altering the amount of gas drawn in.

Two diagrams are shown at Fig. 6. One diagram shows the ordinary diagram such as the engine gives without added air. It is not quite as good, however, as the usual diagram obtained from this type and size of engine, as the alterations have slightly impaired the efficiency. The thermal efficiency, however, calculated from the indicator, is 27·7 per cent. The usual results obtained from this engine show a thermal efficiency of 28·7 per cent. The other diagram with added air shows clearly the increase of efficiency due to dropping the temperature. The addition of air here increases the thermal efficiency of 27·7 to 34·4, while the temperature falls from about 1,700deg. to 1,200deg. The real improvement effected by the addition of air is better taken as compared with 28·7, the ordinary efficiency, rather than 27·7. A substantial improvement, however, is here shown—about 20 per cent on the diagram. In this particular experiment, the brake power with added air is, of course, considerably increased; but as the compressing pump was attached in an entirely experimental way, the results of the brake tests made during the experiments are not of much interest.

Another set of experiments were made on this engine, in which the additional atmosphere was supplied without a separate pump by means of the exhaust gases passing from the engine itself. In this experiment the same engine was used with the annulus and ring of ports at the front end of the cylinder, but here the piston valve was so operated in conjunction with the exhaust valve that the exhaust gases under pressure from the cylinder were allowed to pass through the front ports by way of a cooled pipe to a reservoir, and the opening of the ordinary exhaust valve was adjusted to discharge into the reservoir exactly the amount of exhaust required to give the desired exhaust pressure. At the end of the suction stroke, before the out end ports are over-run, the piston valve opens to the cold end of the reservoir, and shuts off communication to the hot pipe. Cooled exhaust products thus fill the ring, and, discharging into the cylinder, bring the pressure up to the artificial atmosphere desired.

(To be concluded.)

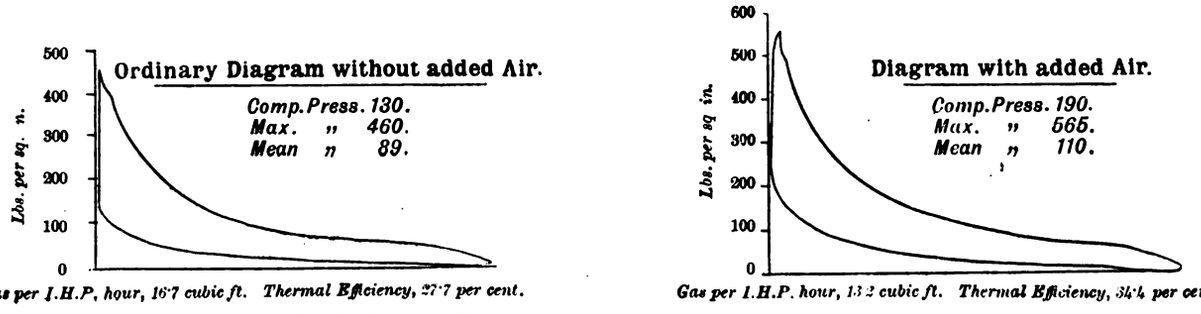

FIG. 6.—AVERAGE DIAGRAMS FROM 10IN. BY 18IN. NATIONAL ENGINE.

Prevention of Wasteful Internal Currents in Squirrel-cage Rotors.—With the ordinary type of squirrel-cage winding, the slightest inequality of air-gap at different points on the periphery causes poles of similar sign to have unequal strengths, and this sets up wasteful currents flowing from rotor bars under the strong poles to those under weaker poles of the same sign. Even if the current is not actually reversed under the weaker poles there is sure to be considerable overloading of certain bars and a corresponding underloading of others. In order to avoid this trouble, M. Osnos has recently taken out a patent for the use of split short-circuiting rings. Instead of solid rings short-circuiting the whole of the rotor bars at each end, he splits one or both of the rings peripherally into as many parts as there are pairs of poles, and these different parts are kept insulated from one another. In this way, whilst leaving the ordinary action (which depends practically on the effect of neighbouring north and south poles only) unaffected, idle currents are entirely prevented at the instants when the lines of fracture of the rings lie midway between two poles, and are much reduced when the lines of fracture lie parallel to the pole axles and also at all intermediate points of the revolution. It is claimed that the idle current losses are in this way reduced to one-quarter of their amount with solid rings.

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ON THE PARALLEL WORKING OF DELTA AND STAR-CONNECTED THREE PHASE-TRANSFORMERS.*

BY A. E. KENNELLY AND S. E. WHITING.

As is well known, there are four ways in which three transformers may be connected between primary and secondary three-phase mains. These ways are indicated in Figs. 1, 2, 3 and 4. They may be severally described as the ΔΔ, ΔY, YY and YΔ ways.

It is evident that for the ΔΔ and the YY methods of connection only (Figs. 1 and 3) is the ratio of transformation of each transformer the same as the ratio of transformation of the system, or as the ratio of the turns in the secondary and primary windings. For the ΔY method of Fig. 2, the ratio of transformation is $\sqrt{3}$ or 1·782 times the ratio of secondary to primary turns, while in the YΔ method of Fig. 4 the ratio of transformation is $1/\sqrt{3}$, or 0·5774 times the ratio of secondary to primary turns. Consequently, special ratios of secondary to primary turns are needed in ΔY or YΔ transformers, in order to produce standard transformation ratios, or working voltages between secondary and primary mains. In practice, ΔY and YΔ transformers are seldom used on this account.

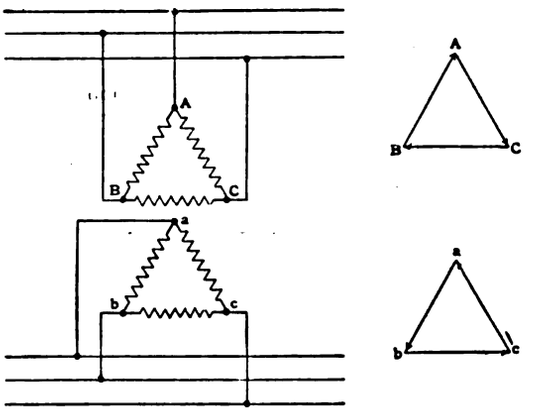

FIG. 1.—Δ Δ CONNECTIONS AND VOLTAGE DIAGRAMS.

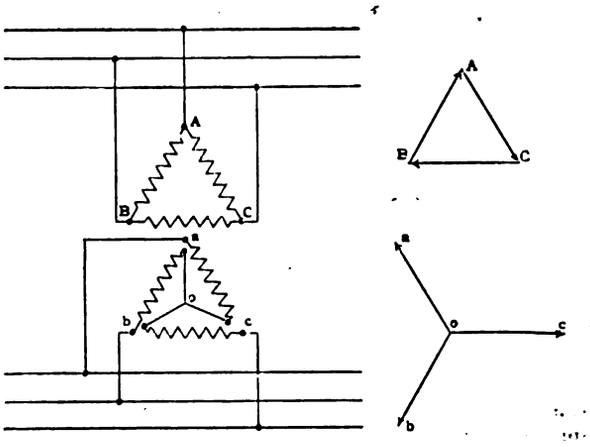

FIG. 2.—Δ Y CONNECTIONS AND VOLTAGE DIAGRAMS.

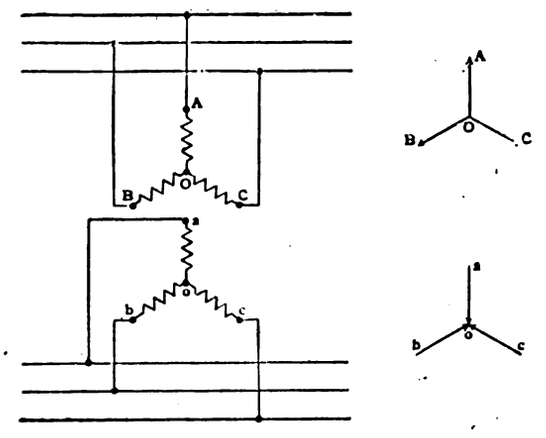

FIG. 3.—Y Y CONNECTIONS AND VOLTAGE DIAGRAMS.

Where two or more such groups of transformers have to be operated in parallel between the same sets of high-tension and low-tension mains, the ratio of transformation in each group must be made the same as the primary consideration. It should, however, be noted that equality of phase as well as equality of voltage is essential to parallel operation. Where the method of connection is identical in two groups to be paralleled—*i.e.*, in ΔΔ—ΔΔ, YY—YY, ΔY—ΔY and YΔ—YΔ associations, no difficulty in phasing is encountered. It is not generally known, however, that while ΔΔ—YY or ΔY—YΔ associations will work in parallel; yet

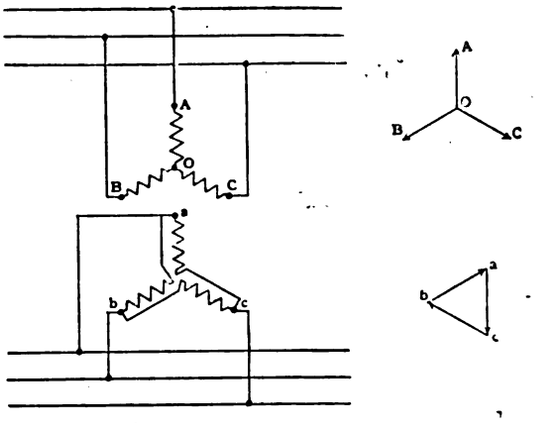

FIG. 4.—Y Δ CONNECTIONS AND VOLTAGE DIAGRAMS.

ΔΔ	transformers	will not	work	in parallel	with ΔY
ΔΔ	,,	,,	,,	,,	YΔ
YY	,,	,,	,,	,,	ΔY
YY	,,	,,	,,	,,	YΔ

So that out of the 10 possible associations above enumerated, of the four types of transformers represented in Figs. 1, 2, 3 and 4, six associations will be capable of operating in parallel, but four will not, owing to phase difficulties.

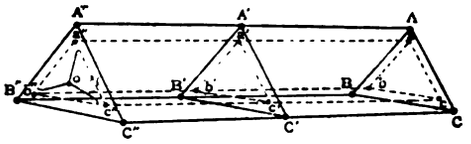

FIG. 5.—UNWORKABLE ASSOCIATION OF Δ Y TRANSFORMER WITH Δ Δ SYSTEM

Since Δ and Y-wound generators are known to work successfully together in parallel, it is sometimes assumed that ΔΔ and ΔY transformers are also capable of working together in parallel. But in the case of generators, a mechanical shifting of the relative positions of the two windings with relation to their respective magnetic fields is rendered possible as well as necessary, thus permitting of phase adjustment. In the case of ΔΔ and ΔY transformers in parallel, this shifting between winding and magnetic field is not mechanically possible. Hence, only six out of the 10 possible combinations of Δ and Y windings in primary and secondary groups are capable of working together in parallel. This is an important point to bear in mind, because if a ΔΔ – ΔΔ system of step-down transformers is installed as at ABC, A′B′C′, in Fig. 5, and an attempt is made to connect a ΔY transformer with the system, as at A″B″C″, in order to establish a secondary neutral point at O, the last transformer will refuse to work in parallel with the others, and the secondary mains *a′a″*, *b′b″*, *c′c″* will have to be cut. Any attempt to connect the secondary *a″b″c″* on the secondary system without cutting will involve a partial short-circuit between the last transformer A″B″C″ and the other transformers.

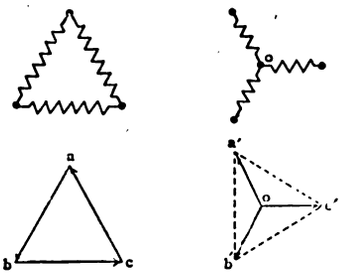

FIG. 6.—VECTOR DIAGRAMS OF Δ AND Y SECONDARIES ASSOCIATED WITH SIMILAR PRIMARY Δ GROUPS.

* From the *Electrical World* of New York.

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If the four cases of failure to co-operate are analysed, each will be found to present the condition shown in Fig. 6 or an equivalent condition. Here *abc* represent the vector triangle of E.M.F.s on the secondary mains produced by the ΔΔ transformer. The triangle *a'b'c'* represents the secondary E.M.F.s of a ΔY transformer operated from the same primary mains as the ΔΔ transformer of *abc*. In order to place the second set of vectors *oa'*, *ob'*, *oc'* in their proper topographic position, they must be drawn in parallel to *ca*, *ab* and *bc* respectively, as shown. This brings the resultant vector secondary voltages *a'b'*, *b'c'*, *c'a'* 30deg. out of phase with the corresponding voltages *ab*, *bc* and *ca* of the first group. If, now, we attempt to operate the secondary systems in parallel, say

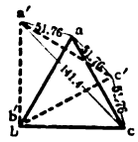

FIG. 7.—SECONDARY VOLTAGE DIAGRAM FOR ΔΔ AND ΔY ASSOCIATION, *b'* CONNECTED TO *b*.

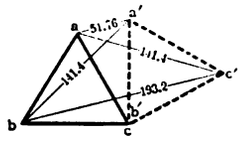

FIG. 8.—SECONDARY VOLTAGE DIAGRAM, *b'* CONNECTED TO *c*.

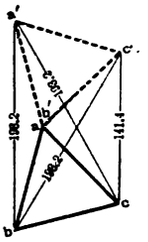

FIG. 9.—SECONDARY VOLTAGE DIAGRAM, *b'* CONNECTED TO *a*.

by first connecting *b'* with *b*, we obtain the condition of Fig. 7. If any side of the triangle *abc* represents, say, 100 volts, and likewise any side of the triangle *a'b'c'*, then

The voltage between	*a'*	and	*a*	will be	51·76	volts
,,	,,	*c'*	,, *a*	,,	51·76	,,
,,	,,	*c*	,, *c'*	,,	51·76	,,
,,	,,	*c*	,, *a'*	,,	141·4	,,

The effect is the same as though two similar bipolar three-phase generator armatures were placed side by side in the same bipolar magnetic field and rotated together after being clamped on the shaft at an angle of 30deg. apart. Either armature alone would be capable of supplying a three-phase system of mains; but the two armatures would not be capable of working in parallel so long as the 30deg. phase difference was maintained. If, for example, in Fig. 6, the points *abc* of the left-hand triangle are connected successively to the point *b'* of the right-hand triangle, the set of cross-voltages is a minimum, when, as in Fig. 7, *b'* is connected to *b*. When, as in

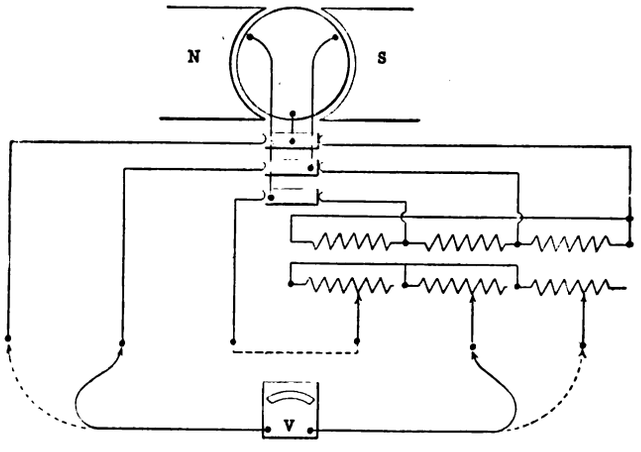

FIG. 10.—CONNECTIONS OF TEST.

Fig. 8, *b'* is connected to *c*, the average cross-voltage is greater; while if, as in Fig. 9, *b'* is connected to *a*, the set of cross-voltages is a maximum. If we take the most favourable case, that of Fig. 7, with *b'* joined to *b*, and connect *a'* to *a*, *c'* to *c*, in the attempt to parallel the two groups, we create two unbalanced E.M.F.s of 51·76 volts (for every 100 volts of the secondary system) free to produce enormous circulating currents which may be 10 times the full-load currents of the windings, a result that evidently prohibits parallel operation.

The above principles were practically tested by the authors in the following manner:—A three-phase delta-wound generator was motor-driven in such a manner as to produce 100 volts per phase at a frequency of about 60 cycles per second. This delta set of E.M.F.s was employed to excite a group of three similar transformers of adjustable transformation ratio. By selecting experimentally the number of secondary turns in each transformer so as to produce approximately 57·74 volts (tapping by inserting an exploring needle into the exposed secondary winding) and connecting the secondaries in Y, as shown in Fig. 10, two sets of three-phase E.M.F.s were obtained, as shown in Fig. 7. One of these was the primary set, *abc*, and the other the secondary set, *a'b'c'*, each set giving 100 volts per phase. With the vertex, *b'*, of the secondary system, connected to *b* of the primary system, the arrangement of Fig. 7 was produced. The various voltages, *cc'*, *c'a*, *aa'*, *a'c*, were all measured and found to agree with the magnitudes indicated in Fig. 7, within the limits of observational errors. Again, with *b'* of the secondary system connected to *c* of the primary system, the arrangement of Fig. 8 was produced with the voltages there indicated. Finally, with *b'* of the secondary system connected to *a* of the primary system, the arrangement of Fig. 9 was produced, with the voltages there indicated.

PAPERS AND REPORTS OF ELECTRICAL INTEREST READ AT THE BRITISH ASSOCIATION MEETING AT CAMBRIDGE, AUGUST 7 to 14, 1904.

Section A.—Mathematics and Physics.

Address of the President of the Section, Prof. Horace Lamb, F.R.S.

"The Reaction of the Radiation on a Moving Electron." Prof. M. Abraham.

"On the Relation of Röntgen Rays to Ordinary Light." Prof. Larmor.

"On 'Rest Strahlen' and the Optical Qualities of Metals." Prof. H. Rubens.

"Recent Work of the National Physical Laboratory." Dr. R. T. Glazebrook.

Report of Committee on Electrical Standards.

Appendix I.

"On Anomalies of Standard Cells." Mr. F. E. Smith.

"On the Effect of Electrical Oscillations in Optically Active Bodies." Prof. W. Voigt.

"A Correlation between the Electrical Conductivity of Air and the Variation of Barometric Pressure." Mr. J. Don.

"On the Ionisation of the Atmosphere." Prof. A. Schuster.

"Radio-activity of the Hot Springs of Aix-les-Bains. Dr. G. A. Blanc.

"Plan of a Combination of Atoms to have the Properties of Polonium and Radium." Lord Kelvin.

"Electrical Insulation in a Vacuum." Lord Kelvin.

"Electrical Conductivity of Flames." Dr. H. A. Wilson.

"Electrical Properties of Hot Bodies." Dr. O. W. Richardson.

"On a Volatile Product of Radium Emanation." Mr. W. C. D. Whetham.

"Electric Waves along Spiral Wires and on an Appliance for Measuring the Length of the Waves Used in Wireless Telegraphy." Prof. J. A. Fleming.

"Eddy-Current Losses in the Lead Sheaths of Three-Phase Cables." Mr. M. B. Field.

"Magnetic and Electric Properties of Nickel at High Temperatures." Prof. C. G. Knott.

"On the Electric and Thermal Conductivities of Certain Alloys of Iron." Prof. W. F. Barrett and Mr. R. A. Hadfield.

"Experiments to Decide Whether the Ether Moves with the Earth or not." Prof W. Wien.

"Note on the Tangential Stress Produced by the Oblique Impact of Light on a Surface." Prof. J. H. Poynting.

"The Kinetic Theory: Determination of the Size of the Molecules." Mr. J. H. Jeans.

"On the Magnetic Double Refraction of Colloidal Iron Hydrate." Dr. A. D. Denning.

"A New Apparatus for Producing Magnetic Fields of Force." Prof. M. Hartog.

"A Modification of FitzGerald's Model of the Ether." Mr. J. Butler Burke.

"On Dr. Grindley's Experiments on Steam in the Light of the Ether Pressure Theory." Mr. J. Macfarlane Gray.

"On Sunspots and Polar Auroræ." Prof. Birkeland.

"A Probable Cause of the Annual Variation of Magnetic Storms and Aurorae." Dr. W. J. S. Lockyer.

"Development of the Aero-plane." Major B. Baden-Powell.

Section G.—Engineering.

Address of the President of the Section. The Hon. C. A. Parsons.

"Flame Temperatures in Internal Combustion Motors." Mr. E. Dugald Clerk.

"On the Specific Heats of Gases at High Temperatures. Prof. H. B. Dixon.

"Exhaust Gas Calorimetry," Prof. B. Hopkinson.

"The Effect of Receiver Drop in a Compound Engine." Mr. J. W. Hayward.

"Superheated Steam, Throttling and other Experiments." Mr. A. H. Peake.

"The Use of Electricity on the North-Eastern Railway and on Tyneside." Messrs. C. H. Merz and W. McLellan.

"Electricity from Water Power." Mr. A. A. Campbell Swinton.

"Energy Losses in Magnetising Iron." Messrs. W. M. Mordey and A. G. Hansard.

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"Testing Alternating-current Motors by a Hopkinson Method." Dr. W. E. Sumpner and Mr. R. W. Weekes.

"Distribution of Magnetic Induction in Multipolar Armatures." Dr. W. M. Thornton.

"Large-bulb Incandescent Lamps as Secondary Standards of Light." Prof. J. A. Fleming.

"Some Investigations on the 10 c.p. Harcourt-Pentane Lamp made at the National Physical Laboratory." Mr. Clifford Paterson.

Report of the Mersey Tidal Regime Committee.

"A Universal Testing Machine of 300 tons for Full-sized Members of Structures." Mr. J. H. Wicksteed.

"The Effect of Rapidly Alternating Stresses on Structural Steels." Prof. J. O. Arnold.

"The Production of Magnetic Alloys from Non-magnetic Metals." Mr. R. A. Hadfield.

"Experiments Relating to the Effect upon the Mechanical Properties of Iron, and Alloys of Iron, produced by Liquid Air Temperatures." Mr. R. A. Hadfield.

"An Electric Temperature Alarm." Mr. H. Darwin.

"The Electrical Conductivity of Certain Aluminium Alloys as Affected by Exposure to London Atmosphere, and a Note on their Micro-structure." Prof. E. Wilson.

"Testing Alternating Motors by Direct Current." Mr. W. Cramp.

"The Action of Lightning Strokes on Buildings." Mr. Killingworth Hedges.

"Side-slips in Motor Cars; illustrated with a Model." Messrs. H. Darwin and C. V. Burton.

Section B.—Chemistry.

"Changes Produced by the β-rays." Sir William Ramsay.

"Note on the Influence of Radium Radiations on Atmospheric Oxidation in presence of Iron." Mr. H. J. H. Fenton.

"The Change of Conductivity in Solutions during Chemical Reactions." Mr. P. V. Bevan.

"Methods of Investigating Alloys, illustrated from the Copper-tin series." Messrs. C. T. Heycock and T. H. Neville.

"On the Bearing of the Colour Phenomena presented by Radium Compounds." Mr. W. Ackroyd.

LEGAL INTELLIGENCE.

"Commercial Thimble-Rigging."

At Birkenhead County Court on Saturday Judge Bowen Rowlands, K.C., heard a case in which Solomon Michael Van Hinden, of Newington, Liverpool, was sued by Messrs. Weston & Co., on a judgment summons for £30. 2s. 6d. It was elicited in the course of the proceedings that defendant was in receipt of £2 per week as manager of his wife's business. He at one time owned a shop in Newington, but had floated it into a company under the style of the S. M. Van Hinden Electrical Co. (Ltd.) The capital was £1,000, defendent being appointed one of two directors at a salary of £100. On June 10, 1901, his wife was appointed a director, and defendant and his wife had since acted as the board of directors, and he had also been secretary. He entered into an agreement with the company not to engage in a similar business within 100 miles of Liverpool, but in April, 1901, he opened a place in Birkenhead, and carried on business on his own account under the style of the British Louvre. The goods at this shop were supplied from the Liverpool shop of which he was managing director. Eventually the British Louvre owed the Liverpool shop £515, and this balance was treated as a good asset by the Liverpool company in their balance-sheet of 1902. The company then resolved to purchase the British Louvre from defendant for £750. An extraordinary meeting of the directors was held in February, 1902, defendant and his wife being the only persons present. At that meeting it was resolved that, in consideration of £800 owing by the company, debenture bond No. 1 should be issued and filed. At a meeting of the same directors on March 4, 1903, it was reported that a writ had been served upon the company at the suit of the debenture-holders (defendant and his wife), and a resolution was passed appointing a solicitor to consent to judgment in the terms of the writ of summons taken out by the said debenture-holders.

His Honour described the case as one of "commercial thimble-rigging," and made an order for payment of the amounts claimed by plaintiffs in two monthly instalments. Failing payment, defendant to go to prison for 28 days.

National Telephone Co. v. Palmer & Sons.

On Tuesday at Haverfordwest County Court, before Judge Bishop, plaintiffs sought to recover £32. There was a counterclaim by defendants for a like amount for breach of contract. The case was one of a number of similar actions down for hearing before special juries. The claim was for four years' telephone subscription (from March 14, 1901, to March 13, 1905). Defendants had, it appeared, signed an agreement to the effect that, in return for £8 per year, they were to have free access to such places as were included in the company's Pembroke telephone exchange area, and should also be connected with the trunk telephone service. The latter was opened up but the line was not taken to any other than Haverfordwest, and plaintiffs held that they were under no obligation to extend it.

For defendants it was contended that they were promised connection with Milford, Neyland, Pembroke Dock, Pembroke and Tenby, as a result of which promise they became subscribers. In the absence of such facilities they submitted that the telephone would have been no use to them.

The Canvasser of the company denied having given a distinct promise that other towns would be connected, but said they would be if sufficient subscribers were obtained.

Mr. K. L. PALMER said he was given distinctly to understand that exchanges with the other towns were to be established forthwith, otherwise he would not have signed the agreement.

After hearing the evidence, judgment was given for plaintiffs for £32. On the counterclaim (for damages for breach of contract as to trunk communication) the judge submitted to the jury the question whether the company through their agent agreed to establish exchanges in other places, and, if so, what damages had defendants sustained by plaintiffs' default. The jury answered in the affirmative and awarded £32. A question raised by plaintiffs as to the scope of the agency was adjourned for consideration, as were the other cases which depended, more or less, upon the judge's decision.

Gradon v. Fleck.

At Newcastle-on-Tyne County Court on Wednesday, before Judge Greenwell, Mr. T. Gradon, jun., electrical engineer, sought to recover £25 from Mr. W. C. Fleck, a builder, balance of an account for an electric light installation put in by plaintiff on the Bigg Market premises.

For plaintiff Mr. MEYNELL stated that defendant was engaged to build certain premises in the Bigg Market in 1902, Messrs. Mould & Tasker being architects. In January, 1903, the architects asked plaintiff to tender for the electric lighting, and his tender (at £55) was accepted. Plaintiff did the work, but when he applied for payment the architects said they had ordered the work as agents for the builder. A dispute had arisen between the builder and the architects about the quality of some of the building work. The owner had refused to pay the builder, and the architects had declined to certify for more than 90 per cent. of the contract price. Plaintiff subsequently received £30 under a special certificate from the architects. Their remedy was against Mr. Fleck, under the terms of the contract. Plaintiff got his order from the architects, and the latter said they acted as agents for Mr. Fleck. Plaintiff submitted that clause 20 of the contract gave the architects authority to give orders on behalf of Mr. Fleck.

Mr. A. TASKER (Mould & Tasker, architects) said he asked plaintiff to tender for the work and he completed it satisfactorily. All payments for sub-contractors were made through the builder. He certified for 90 per cent. of the money of the contract for work done. His firm refused subsequently to act for the owner, and a dispute arose, and 10 per cent. of the total contract price had been kept back. Defendant, he believed, had not been paid his last 10 per cent.

Mr. J. W. FRAZER, architect, gave evidence as to the custom in giving certificates under a contract.

For the defence, it was submitted that the architects never directed the defendant to pay anything else but the £30 that had been paid. Defendant had paid to plaintiff all the money he had ever received in respect of that particular work. It was also argued that the building owner was the person liable where a contractor had taken no steps to make himself personally liable, or had not made any contract with a specialist.

His Honour reserved judgment.

A Private Electric Railway for American Legislators.—According to the *Electrical World* of New York a novel electric railway service is to be established in Washington. The train will make frequent and rapid trips through an underground passage from the Capitol to the two new office buildings to be constructed for the use of the senators and members of the House respectively. On the main basement floor of the building will be the terminal station of an up-to-date little electric railway. The passenger cars will be open and will resemble the cars of roller coasters and scenic railways, although more luxuriously upholstered. The little train will go from its station through a brilliantly-lighted subway under the south-east lawns of the Capitol grounds, and within a very few seconds will halt in the sub-basement of the House wing. Here the members will disembark to find themselves within easy access of the private elevator leading to the floor of the House. As a counterpart to the House office building, Congress, in the session just closed made provision for the construction of an office building for the Senate. The House building is to be located opposite the south-east corner of the Capitol grounds, while the Senate building will occupy the corresponding square to the north-east. When it is completed the subway and electric transportation facilities provided for the House will be duplicated. In addition to the two tunnels leading respectively from the House building and Senate wings of the Capitol, the tunnel will be carried across to the east front, so that through trips may be made from the Senate building to the House building. Amply ventilated, lighted and heated, the interior of the tunnel will be of light coloured glazed brick, and all semblance of dampness will be done away with by the most modern methods of waterproofing. There will be passenger and freight trains in operation.

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MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An instructor in electric wiring is also wanted at West Ham Municipal Technical Institute for one evening per week for the ensuing session. Particulars from the principal until Sept. 1. See advertisement.

The governing body of the Battersea Polytechnic, London, S.W., require the services from September of an assistant lecturer in the department of mechanical engineering. Commencing salary £170. Particulars from secretary. See also advertisement.

Richardsons, Westgarth & Co. (Ltd.), Hartlepool Engine Works, Hartlepool, require a young man with good technical experience and ability for estimating and sales departments. See advertisement.

A lecturer and demonstrator in physics is required at University College, Nottingham. Commencing salary £130, rising by increments to £180 per annum. Applications (on forms to be supplied by the registrar) by Sept. 20. See advertisement.

Ilford Electricity committee require a station superintendent for their electricity works. Salary £150. Applications to the clerk, Mr. John W. Benton, Town Hall, Ilford, by noon Sept 3. See advertisement.

An assistant electrical engineer is required for the public works department, Lagos, West Africa. Salary £300 per annum with free single quarters. Further particulars are given in an advertisement. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., by 31st inst.

An electrical engineer is required to take entire charge of testing staff, both in and out of works. Applications to Works Manager, Crompton & Co., Arc Works, Chelmsford. See advertisement.

Instrument inspectors are required by Glasgow Corporation telephone department. Applications to the general manager, Mr. John Macfee, 65, Renfield-street, Glasgow. See advertisement.

Applications are invited for the position of lecturer in electrical engineering in the University of Sydney. Salary £500 per annum, with permission to carry on a certain amount of consulting practice subject to approval of Senate. Further particulars from the Acting Agent General for New South Wales (the Earl of Jersey), 9, Victoria-street, London, S.W., to whom applications by Sept. 10.

The Council of the County Borough of West Ham require a lecturer in electrical engineering at the Municipal Technical Institute. Salary £200 per annum. Application to principal by noon Sept. 1.

Willesden District Council are prepared to receive applications for the position of resident electrical engineer, to take charge of the distribution of electricity within the district. Salary £250 per annum. Particulars and forms of application from the consulting engineer (Mr. E. T. Ruthven-Murray), electricity office, Salusbury-road, Kilburn, London, N.W., to whom applications by Sept. 17.

The Electric Supply committee of St. Marylebone (London) Borough Council invite applications for the position of resident engineer and manager of their electricity undertaking. Salary £600 per annum. Applications to the town clerk (Mr. James Wilson), Town Hall, Marylebone-lane, London, W., by Sept. 5.

The committee of the City and Guilds of London Institute are about to appoint a professor of Mechanical Engineering and Applied Mathematics at Finsbury Technical College. Salary £600 per annum. Applications to the hon. sec., Gresham College, London, E.C., by Sept. 15.

An assistant lecturer is required in the department of mechanics of the Glasgow and West of Scotland Technical College. Salary £150 per annum. Applications to Prof. Longbottom by Aug. 31.

Assistant lecturers in physics and mathematics (salary £130 each) are required at the Hartley University College, Southamption. Applications to Principal by Sept. 10.

The Governing Body of the Northampton Institute, St. John Street-road, London, E.C., require a chief instructor in mathematics (day and evening, part time only). Salary £150 per session. Particulars from the principal (Dr. R. Mullineux Walmsley) and applications by Aug. 31.

Mr. R. M. Campbell, M.I.M.E., A.M.I.E.E., has been appointed works manager to Messrs. C. S. Rolls & Co., Lillie Hall, Earls Court, S.W., and 28, Brook-street, Bond-street, London, W. Mr. Campbell has had an exceptional experience in the construction of gas, oil and steam engines, and has been prominently associated with the automobile industry since its commencement. He has lately been elected a member of the National Standardising Committee of the British Association.

Mr. R. C. Tothill has been appointed canvasser to Exeter Corporation electricity department.

EDUCATIONAL NOTICES.

Battersea Polytechnic (London, S.W.).—The next term commences on 19th prox. Technical day college courses in mechanical and electrical engineering and day and evening courses in preparation for London University engineering degree are provided at this polytechnic. Prospectus from the secretary.

Birkbeck College, London.—The new session begins on Monday, Oct. 3. There are day and evening classes and systematic courses of instruction (lectures and laboratory) for the degrees of Science and Engineering of the University of London Further information can be obtained from the principal.

Durham College of Science (Newcastle-on-Tyne).—Courses are provided at this college for students proceeding to the degrees in Science or Letters or the diploma in the Theory and Practice of Teaching, and special facilities are offered for the study of agriculture, chemistry, mining, engineering and naval architecture. Matriculation and exhibition examinations begin Sept. 26, and lectures Oct. 4. Prospectuses from the secretary.

Glasgow and West of Scotland Technical College.—The next session begins on Sept. 27. The diploma of the college is granted in civil, mechanical and electrical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics, and architecture. The courses of study usually extend over three sessions, and special courses for individual students are arranged as required. The laboratories in the departments of physics, chemistry, metallurgy, mechanical and electrical engineering are equipped with the most approved apparatus. The preliminary examination of candidates for the diploma begins on Sept. 19. Prospectuses from the secretary, 38, Bath-street, Glasgow.

King's College (London).—The session 1904-5 commences on Wednesday, Oct. 5. Evening classes are also held for civil, mechanical and electrical engineering workshop practice, metallurgy, physics and all science subjects. Prospectuses from the secretary.

South-Western Polytechnic (Chelsea).—Complete three years' courses of instruction in electrical engineering are given at this Polytechnic during both the day and evening. Lectures and instruction in practical work are given in electrical engineering (elementary, intermediate and advanced), electrical design, instruments and lamps, alternating and polyphase currents, electrical wiring and fitting, and calculus for engineers. Particulars can be obtained from the secretary.

University College, Bristol.—The session 1904-5 begins on Oct. 4. Lectures on inorganic, organic and advanced chemistry will be delivered during the session. The laboratories are fitted with all improved means for the study of practical chemistry and metallurgy. The laboratory is opened on Monday evening, and lectures on inorganic chemistry, at reduced fees, are delivered. Prospectuses, &c., from the registrar and secretary, Mr. James Rafter.

University College, London.—The session 1904-5 will begin on Oct. 4. Arrangements have been made for post-graduate courses and for research work. Prospectuses can be obtained from the secretary.

Victoria University of Manchester.—The engineering drawing room and Whitworth engineering laboratory will open on Tuesday, Oct. 4, and lectures will commence on Oct. 5. Particulars of the course of instruction may be obtained from the registrar.

Aachen.—A large scheme for the electrical transmission of power is proposed to be carried out by the Ruhr Valley Damming Co. near Gemund. Turbine works are to be equipped for the utilisation of the water power and the generation of electrical energy for transmission at a pressure of 34,000 volts for supply to Aachen and district. The order for generators has, we understand, been placed with the Lahmeyer Co., and the Siemens-Schuckert Co. has secured the contracts for transformers and switchboards. Bare overhead conductors will be employed in the transmission.

Adelaide (S. Australia).—At the meeting of the Adelaide and Hindmarsh Tramway Co. last month to approve an agreement for the sale of the company's property to the Hindmarsh and Henley Beach Tramway Co., the chairman (Mr. C. A. Wyld) complained of the policy of the Government, who gave the companies no encouragement, and were keeping the matter of electrification in abeyance.

Buenos Ayres.—The Public Works committee have reported favourably upon Messrs. Sawyer & Lacaze's project for an electric tramway between the centre of the city and the western suburbs. The committee, who have been considering the mayor's project for municipal electricity works, recommend that tenders be invited for erecting and running the works, as they are of opinion that a company would manage the undertaking more successfully than the municipality.

Caerphilly.—On Monday the Council appointed an Electric Lighting committee, to whom the selection of an electrical engineer was referred.

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Chile.—In a report on Chile's trade for the year 1902 the figures show that the British share of electrical goods imported into that country represented an increase of £7,281 over 1901, the totals being respectively £11,452 and £4,171. There were also increases in scientific instruments and machinery.

Customs Decisions.—Recent customs decisions of the authorities at Johannesburg, Transvaal, fix a 2½ per cent. ad val. duty on electric accumulators, batteries, dynamos, cables, electric pumps, fans, electric motors, transformers, turbines and a large variety of machinery imported into the Transvaal.

Under the new customs tariff for Panama materials for the construction of telegraphs are admitted free of duty.

Dundee.—The Council is considering the request of the National Telephone Co. to place their telephone cables in the outlying districts underground.

The proposed electric power scheme which is being promoted by Mr. G. Balfour for supplying electric energy for power in the Dundee district was discussed by the Council last week. It was agreed that the report of the city electrical engineer (Mr. H. Richardson) should be printed and circulated.

Electric Conveyors in Australia.—The Victorian Government have voted £11,255 for the purchase and erection of electric wheat conveyors at the ports of Geelong and Williamstown. Tenders will shortly be invited.

Electric Driving.—At the meeting of the Brightside Foundry Engineering Co., Sheffield, on Wednesday, the chairman (Mr. Ambrose Firth) said the directors had decided to adopt electricity as motive power, and expressed his opinion that they would save money by doing so.

Electric Light for Retailers.—We have received from time to time many pamphlets prepared with a view of popularising the electric light, but it is due to Mr. C. Rockley, canvasser and general outside representative of the West Ham Corporation Electricity Department, to say that a little booklet he has recently issued is likely to prove the most effective of all. Mr. Rockley has adopted the method of devoting a section of the book to each particular line of retail business, and then pointing out the advantages which the electric light offers over gas to each individual trader, so that the butcher, the hatter, the hosier, the printer, the confectioner, &c., are particularly addressed in a manner which effectively appeals to them. The booklet is published by Messrs. Jacomb Bros., of Wingfield-road, Stratford, London, E., and can be obtained in quantities for general distribution, for which purpose it is unquestionably well suited.

Electric Tramways in Australia.—Malvern and Prahran (Victoria) municipalities propose to grant to the Melbourne Tramway Co. a concession for 30 years for the construction and working of electric tramways. It is proposed that the company pay £100 a year, and the concession may be extended to 50 years.

Gibraltar.—In a report for the year 1903 by the governor (Field-Marshal Sir George S. White) the following items of expenditure occur:—Direct-current generating plant, £8,000; new cables, installations, &c., £2,000 (this item appears twice in the accounts); electric fans and motors for hiring, £500; machinery for workshops and motors for the Orange Bastion pumping station, £2,800; final contribution to Colonial Government towards purchase of electric light works, £5,000.

Gillingham.—The income of the electric lighting department for the last half-year has exceeded the estimate by £500.

Glasgow.—In presenting the accounts of the electricity department at the Corporation meeting last week, the convener of the Electricity committee (Bailie Willock) said:—

The outstanding feature of the past year's accounts was a very satisfactory increase in revenue of £31,185 (21½ per cent. over previous year), working expenditure having only increased £10,599, or 20·7 per cent. Interest and sinking fund showed an increase of £6,182, but the gross balance, after meeting all statutory expenditure, was £42,522, compared with £23,290. The committee decided to write off depreciation on all items in the capital account on the same scale as last year. This depreciation amounted to £32,180, compared with £29,359. Had there not been an unexpected additional sum (£1,305) to be set aside for sinking fund, on account of a requirement of the Secretary for Scotland, and an increase of £3,122 in taxes over last year, the committee would have been able to meet the whole deficit of last year, but, as it was, they had been able to meet it to the extent of £10,341, and they had only a small debit balance of £3,554 to be carried forward. The number of consumers had increased by 2,311, the number of units sold had increased 3,184,631. The consumption of power consumers had been 2,873,941 units, an increase of 84 per cent. The revenue from the latter consumers was £16,508, and it was due to them that the works cost per unit sold had been lowered. The works costs had decreased nearly $\frac{1}{10}$d. per unit sold, while the total costs (including depreciation) had fallen to 2·35d., compared with 2·94d. last year. The reduction of capital during the 12 years' existence of the undertaking had been, by way of depreciation, £123,353, sinking fund £66,381. The coal consumption per unit sold showed a decrease. Had the consumption been on the same scale as last year, the total amount paid for coal would have been £1,100 more. It had been resolved, owing to the increased burdens to be borne by next year's revenue, on account of sinking fund being required to be set aside at increased rates, and on account of the additional taxes due to a higher valuation of the works and to a greater total for depreciation, that the price of current to the various classes of consumers should remain unaltered.

Mr. D. M. Stevenson complained that the department had obtained its surplus by taxing the consumer unnecessarily. They were charging a rate sufficiently high to give a big surplus and to write off depreciation at a rate quite uncalled for. The electricity department had already a sinking fund of £66,000, and they had depreciation written off to the amount of £128,000. The Secretary for Scotland had now imposed upon them for all future borrowings a sinking fund rate of 3½ per cent., which was equal to paying off the debt in 30 years. The committee ought to consider whether it was fair to go on accumulating enormous reserves and surpluses and charging a rate which was quite unnecessary for carrying on the undertaking in a thoroughly sound way.

Mr. Hugh Alexander and Mr. Russell also criticised the accounts. The latter said that, apart from land and buildings, 75 per cent. of the capital expenditure was on machinery or mains. Therefore, apart from the sinking fund, he did not think that any commercial undertaking would consider a less depreciation than 7½ per cent. sufficient.

Mr. A. Murray held that if they were to increase the sinking fund rate from 1 to 3½ per cent. it would be reasonable that the depreciation rate should not be quite so heavy.

The accounts were approved.

Great Northern & City Railway.—On Monday the arrangemen came into force by which season tickets between Great Northern suburban stations north of Finsbury Park and the City would also be available on the Great Northern and City Electric Railway without additional charge. Through ordinary tickets will now be issued between Great Northern suburban stations and stations on the G.N. & C. It is anticipated that this will materially increase the traffic receipts of both the G.N. & C. and the City and South London Railway.

Hampstead (London).—The report of the borough electrical engineer (Mr. G. H. Cottam) for the year to March last states that the electricity department has again beaten all previous records in the number of consumers connected during the year (575, against 544 in the previous year), in the number of 8 c.p. lamps connected (32,489, against 29,215) and in the number of units sold (678,586 against 472,400).

Works costs show a reduction of 0·16d. per unit, which would have been greater but for exceptional expenditure charged to revenue account. The cost of coal per unit sold was 0·96d. against 1·09d. in 1902-3. The total works costs amounted to £21,709, against £18,884, an increase of £2,825, and the units sold were 3,278,159 against 2,592,475, an increase of 685,684. The total costs (excluding interest and sinking fund) were 2·13d. per unit sold, against 2·36d., but with interest and sinking fund the actual total was 3·82d. against 3·99d. The income (excepting interest on investments) was £58,051, against £47,545. The net surplus was £5,796 against £4,441. The contribution to the rates was £3,211. 13s. 4d., bringing the total contribution to date to £12,388. The whole of the high-tension alternator switchboard has been removed and put in the centre of the two blocks of feeder panels, at the same time panels for larger machines having been put in. The large steam alternator, the delivery of which has been delayed, has now been erected, and three separately-fired superheaters (one for 40,000lb. and two each for 60,000lb. steam per hour) are being erected. An order has been placed with Messrs. Belliss & Morcom for altering the tandem compound engines to triple-expansion. It has been decided to put in next year six thermal storage drums in order to increase the steaming capacity and obviate putting in additional boilers. To encourage the day load the charges for power have been revised. During the year 5,520yds. of distributor, 2,303yds. of feeder, 696yds. of arc cable and 453yds. of 3-way conduits have been laid; and three new sub-stations have been built, making a total of 50 sub-stations and two transformer pits. The number of connections per mile of distributor has increased to 73, against 63 at March, 1903; 25 motors, representing 389 H.P., have been connected during the year, making totals of 38 motors and 431 H.P. Of this total the contractors to the Charing Cross, Euston & Hampstead Railway are responsible for 275 H.P. Appended to the report are a number of interesting tables and curves.

Heckmondwike.—The Council have offered their electrical engineer (Mr. G. H. Carter) an increase of £50 per annum in order to induce him to remain at Heckmondwike. Mr. Carter was, it will be remembered, recently appointed resident engineer at Acton.

Huddersfield.—The question of inviting electric motor manufacturers to appoint agents in Huddersfield is under the consideration of the Electricity committee.

Italy (South).—It is probable that an electric railway may shortly be constructed to serve the large plain at the back of Gioia Tauro, in Southern Italy. Abundant water power exists in the district to generate current for the purpose.

At Anacapri (1,000ft. above sea level) the associated academies of Munich, Vienna, Leipzig and Göttingen, established in October, 1901, a station for the observation and dispersion of electricity in the open air. The station has been placed in the charge of Dr. Vincenzo Cuomo, who has been provided with delicate and accurate apparatus for the measurement of electricity after the Elster and Geitel system. The adjustment and capacity of the apparatus was tested by Dr. Elster before being handed over to Dr. Cuomo. In

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1902 Dr. Cuomo published the first report of his daily observations, which, however, have extended over too short a period at present to permit of any definite conclusions being reached, but little doubt exists that results of great importance will eventually be arrived at.

Extensive public warehouses are about to be built near the port of Salerno, easy of access by land and sea. These buildings are to be furnished with electric lifts, and are expected to be completed by 1905.

Salerno is still lighted by gas, but a private company has recently obtained a concession to supply electric current to private consumers, and already nearly all the chief residences are lighted electrically. The company's concession is to last until the Tusciano Electricity Co. is ready to begin operations. The latter company is establishing extensive water power works at a fall of the River Tusciano into the Alveano. The hydro-electric plant for the works is nearly completed, and will be of 5,400 effective horse-power. The plant includes five 1,400 H.P. turbine engines. Energy will be distributed between Salerno and Torre Annunziata. The towns of Nocera, Pagani and others will be lighted electrically as soon as the Tusciano Company's supply is available. Besides the water power which it is proposed to utilise in the present scheme there is a further 10,000 H.P. available from the Tusciano fall, and this is to be utilised as required.

In connection with the new railway from Naples to Pompei and Ottaiano, which is now under construction (43km. in length), a section of the line between Naples and Valle di Pompei is to be worked by electricity. It is expected to be ready by September, 1905. There is also under consideration the construction of an electric tramway line from Salerno to Valle di Pompei (30km. in length) to be operated by the Picentino Electrical Co., whose works are situate a considerable distance from Salerno.

Indiarubber.—According to Messrs. Hecht, Levis & Kahn (Hamburg), the total world's production of rubber in 1903-4 amounted to 61,759 tons, compared with 55,603 in 1902-3. The total consumption was 59,666, against 55,276 tons. In Europe alone the arrivals were 33,027, compared with 29,268 tons, and the deliveries 26,236, against 31,047 tons, while stocks declined from 3,110 to 2,996 tons. The supplies of Para rubber were 29,800 tons in 1902-3 and 30,580 tons in 1903-4. In regard to prices, the highest figure for the four years ended 1903 was in Sept. 1900 (4s. 3¾d.). For 1900-1 the price was 3s. 9¼d., 1901 2 2s. 11½d., 1902-3 3s. 11d., and 1903-4 4s. 11d. in May and June, closing at 4s. 9½d.

Inquest.—On Monday an inquest was held at Marylebone by Mr. W. Schroder into the circumstances attending the death of a labourer named Saunders, in the employ of the Metropolitan Electric Supply Co., which occurred on 19th inst.

Mr. Barlow (Messrs. Barlow & Barlow) represented the company. The evidence was to the effect that deceased and other men were engaged in removing old electric cables and substituting new cables in Marylebone. Saunders and a labourer named Hennessy were together in a manhole, where a cast-iron pipe had to be cut to admit of the insertion of a new joint box.

EDWARD PEARCE, foreman of the gang, said he cautioned the men to be careful as the pipe enclosed a live main. Deceased asked him where he should cut the pipe, and he told him. The reason for cutting the pipe was to put in a new box. Such work was proper work for a labourer to do without any supervision. It was customary to cut the pipes whilst the electric current was on. Men were not supplied with gloves when doing such work, nor were the tools they used protected in any way. There were gloves on the spot to be used when paying the cable in. Deceased had, doubtless, driven the wedge too far when striking it with the hammer, and it penetrated the cable and touched the live conductor. The cable was insulated. He had never known a similar accident, al hough the same kind of work was done daily.

JOHN HENNESSY, the deceased's fellow-labourer, said deceased was at work cutting the pipe in the usual way, and to do so he used an iron chisel, after which he placed in a bursting wedge. He struck the wedge twice with a hammer and the second time called out "Oh!" and fell back against witness and rebounded on to the pipe. Witness received a slight shock. He had never known a wedge to go into the cable before. Deceased used the wedge in an upright position instead of on the slant.

Dr. F. W. SPURGIN, who made an autopsy, ascribed death to syncope consequent on electric shock.

Mr. J. W. DREW, superintendent of mains to the company, stated that since the occurrence it had been decided to include hole-boring and wedge-inserting in the category of dangerous operations, and instructions had been issued that the men engaged in this work must wear rubber gloves. The voltage of the cable was 500 volts.

A verdict of accidental death was returned.

Keighley.—On Wednesday the Council decided to apply for a provisional order authorising the construction of electric tramways in High-street and Bridge-street, to provide an alternative route through the centre of the borough.

Kidderminster and District Tramways.—Bewdley Corporation have decided to raise no objection to the Kidderminster & District Electric Light & Traction Co.'s application for an extension of two years in which to construct the Kidderminster-Bewdley electric line, provided the company give an undertaking that the tramway shall be constructed within the two years.

Leeds.—The Corporation electric tramway system will shortly be extended to the Woodhouse Hill district of Hunslet.

Light Railways.—The Board of Trade have confirmed the Cheltenham and District Light Railway (Extension No. 3) Order, authorising the construction of an additional line and the abandonment of part of another authorised line; also the Maidstone and Faversham Junction Light Railway (Extension of Time) Order.

London County Council Tramways.—Rapid progress is being made with the construction of an extension of the electric tramways along Tooting Broadway and thence westward by way of Defoe-road, Garratt-lane and South-street to a junction at Wandsworth with the present horse tramways from Westminster and the Hop Exchange (Southwark-street). The conversion of the latter routes to electric traction will be commenced as soon as the necessary street widenings can be completed.

Lytham.—St. Anne's-on-Sea Council have informed the District Council that they are prepared to give a supply of electricity in the district, and a conference between the representatives of both authorities is to be held to discuss terms.

Mansfield.—For the first nine months (to March 31) the gross profit on the electricity department was £825. After providing for interest and sinking fund (£1,784. 3s. 6d.) there was a deficiency of £959. 3s. 9d.

Municipal Trading.—Liverpool Corporation will submit a resolution at the forthcoming meeting of the Association of Chambers of Commerce at Manchester that

It is most desirable that action should be taken to induce the Government to consider the necessity for the adoption of the recommendations of the Joint Select committee of the House of Lords and the House of Commons on municipal trading.

New South Wales Tramways.—The revenue of the Government tramways department for the year ended June was £802,985, compared with £752,034, and the expenditure £673,625, against £654,165 in the previous year.

Newcastle-on-Tyne.—The lamp inspector (Mr. Geo. Lamb) has reported that 180 arc lamps will be required to light certain additional thoroughfares at a total cost of £2,250 (at £12. 10s. per lamp) per annum, including electric energy, ordinary maintenance charges, interest and redemption of capital expenditure. The total payment in respect to the existing 200 lamps was £3,100 per annum, and if the Tramways committee reduce the price from £15. 10s. to £12. 10s. per lamp per annum, a saving of £600 per annum on these 200 lamps will be effected, giving a total of £4,750 per annum for electric lighting by 380 arc lamps.

On Tuesday afternoon, at the special invitation of the chairman (Alderman Baxter Ellis) and the members of the Tramways committee, a number of members of the City Council made a survey of a portion of their municipal tramway system and an inspection of the power station, the new car-sheds, &c. Among the additions made to the plant since the last survey were a new 3,000 H.P. triple-expansion engine at the power station (direct-coupled to a Westinghouse direct-current generator), new car-sheds at Wingrove, and new lines from Byker to Welbeck-road and Church-street, Walker.

Personal.—Mr. J. Clifton Robinson, managing director of the London United Tramways (Ltd), has been placed on the Commission of the Peace for the County of Middlesex.

Pitlochry.—The residents are endeavouring to obtain the consent of the trustees of Mr. G. F. Barbour, of Bonskeid, to use the water power available at the Falls of Tummel for the generation of electric energy. Messrs. Middleton and Townsend have already reported favourably on the scheme.

Plymouth.—An inquiry was held last week into the application of the Council to borrow £20,000 for the extension of the Plymouth electricity undertaking and £4,462 for their refuse destructor.

The usual statistics were supplied by the town clerk (Mr. J. H. ELLIS), who said that their last Act exempted their electricity loans from the scope of the Public Health Acts. The electric lighting loan was required to purchase machinery and cables to meet the increasing demand for current. The electricity undertaking had made steady and satisfactory progress. The works were opened in September, 1899, with a plant capacity of 12,000 8 c.p. lamps. They were extended in 1901, the capacity then being 25,000 8 c.p., and again in 1902-3 to a capacity of 47,000 lights. The whole of the money they had sanction to borrow had been expended or was being expended, and they had now an application for 1,804 lamps which they were unable to satisfy. They had been running for three years at a profit, and their reserve and depreciation fund was £3,550. They had never charged a shilling to the rates in connection with the electricity undertaking. Strictly and legally they ought to have done so, but that matter had now been put right. The present loan was part of £48,000 required on the electrical undertaking, and would carry them on for two years at the present rate of progress.

Mr. E. G. OKELL (the borough electrical engineer) supplied technical details. In the year to March, 1904, they had connected nearly 7,000 8 c.p. lamps, which was twice their margin.

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Pontypridd.—The Council have decided to obtain a report upon the relative advantages of leasing or working the tramways.

Portsmouth.—The report of the general manager of the Corporation tramways (Mr. W. R. Spaven) for the year ended March 31 states that the total revenue was £94,174. 0s. 9d., and after deducting tolls paid to Portsdown & Horndean Light Railway Co., the net revenue is £92,916. 18s. 6d., an increase of £8,966. 16s. 6d. over the previous year.

Working expenses were £43,426. 14s. 4d., and after paying interest and sinking fund (£33,461. 12s. 8d.) the balance was £16,028. 11s. 6d. The average receipts per car-mile have dropped from 12·37d. to 12·19d. 18,204,426 passengers, or 1,848,734 more than the previous year were carried. The system of bonuses to motormen has had the effect of reducing the compensation paid to 0·04d. per mile, against 0·12d. per mile in the previous year. In the half-year ended September, 1903, 99 out of 104, and in the March half-year 90 out of 101 men earned the bonus. The capital expended totals £634,405. 14s., an increase of £14,253. 11s. 9d. for the year.

The Corporation are recommended to increase the salary of the electrical superintendent (Mr. W. S. Foale) from £300 to £400 per annum.

Rathmines (co. Dublin).—The accounts of the electricity department for the year ended March last show total capital expenditure £84,893. 1s. 9d., an increase of £10,631. 13s. 1d.

The year's revenue was £7,466.15s.; working expenses were £3,898.0s.3d., leaving gross profit £3,468. 14s. 9d. Sinking fund required £1,767. 12s., and interest £2,513. 4s. 4d., making the debit balance £477. 2s. 8d. 592,910 units were generated, of which 275,435 were supplied to public lamps and 236,326 to private consumers. The maximum supply demanded was 299kw.

Ravensthorpe.—The Council are considering a proposal made by Mr. W. B. Woodhouse, engineer to the Yorkshire Electric Power Co., for supplying electricity in bulk in the district.

Rome.—A scheme, prepared by Signor Ascenzi, for utilising the water power of the Tiber in the generation of electric energy has been approved by the Minister of Public Works, but the consent of the Rome Municipal Council has not yet been obtained. It is stated that 10,500 H.P. could be utilised.

Soothill Nether (Yorks.)—The Council are considering an offer by the Yorkshire Electric Power Co. to supply electric current in bulk at 1¼d. per unit for public lighting, and to supply current for power and lighting to private consumers at low rates.

Sydney (N.S.W.)—On the 8th ult. the supply of current from the new municipal electricity works was inaugurated. The consulting engineers for the scheme were Messrs. Preece & Cardew, the resident engineer being Mr. T. Rooke.

The generating station is at Pyrmont and the contractors were:—Dick, Kerr & Co., generating plant (boilers, engines and dynamos), £49,072; W. T. Henley's Telegraph Works Co., cables, £39,949; Stewart & Co., buildings, &c., £25,944; C. Richards, chimney stack, £2,800; Scrutton & Co., structural steel work, £10,499; Clyde Engineering Co., arc lamps, lamp pillars, &c., £10,399. Minor contracts for sub-stations, &c., brought the total amount of the original contracts to £141,152, and in addition £42,000 was expended on purchase of land, preliminary expenses, &c. A supplemental contract of the value of £23,000 for additional plant has been let to Messrs. Dick, Kerr & Co., making a total expenditure of £206,000. The capacity of the original plant was 2,280kw., and at present the customers (actual or prospective) required the equivalent of about 50,000 8 c.p. lamps. As there are 343 public arc lamps and a probable good demand for current for power, further extensions of the plant will have to made in the near future.

The Assuan Reservoir.—Sir William Willcocks, K.C.M.G., M.Inst.C.E., recently delivered a lecture at Cairo on the subject of the new Assuân Reservoir and Lake Mœris. The lecture has been prepared for publication and is issued by Messrs. E. & F. N. Spon, London. A full and particular description, accompanied by a number of maps, plans, &c., is given of this important undertaking, and those who take an interest in the development of Egypt under British direction will find much instruction in this work.

Tube Railway for New York.—The new tube underground electric railway between the city and Harlem (8 miles in length) will shortly be opened for traffic.

Uruguay.—The "Review of the River Plate" says the electrification of the Montevideo tramways will probably be commenced shortly.

Village Lighting.—Linlithgow County Council have formally approved the contract for the electric lighting of the villages of Broxburn and Uphall, and have decided to raise a loan of £3,000 for the purpose.

West Hartlepool.—Recently the borough electrical engineer (Mr. H. F. Friederichs) found it necessary to counteract the effects of exaggerated statements made by representatives of the gas interest in this town by preparing and issuing pamphlets which put before tradesmen and other ratepayers in a clear and concise manner the various advantages of electricity for power and lighting.

Electrical energy is supplied at West Hartlepool for power on a sliding scale, varying from 2d. per unit when less than 150 units per horse-power installed per quarter are consumed to 1½d. when 300 units are consumed. At present there are 95 motors varying from ⅛ H.P. to 60 H.P. connected to the mains, making a total of 556 H.P., and since the start of electricity supply in 1901 not a single motor has been discarded for any other system of power. From the table in the pamphlet we find that these motors are used for a great variety of purposes. In the pamphlet devoted to lighting the economy and other advantages of electric over other methods of illumination are clearly set out.

Copies of the pamphlet can be obtained by station engineers and managers from Mr. Friederichs.

Wisbech.—The Council have formally retained Messrs. Robert Hammond & Son as consulting electrical engineers in connection with the proposed municipal electricity scheme. An inquiry will shortly be held into the application for sanction to borrow £25,000 for the works.

Workhouse Lighting.—The Local Government Board have approved plans for the electric lighting of the Wolstanton and Burslem workhouse.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Council of the County Borough of *West Ham* invite tenders for the reconstruction of certain existing horse tramways of a route length of about 3 miles 3 fur. double track. Plans, &c., may be inspected at the office of the consulting engineer, Mr. J. E. Waller, M.Inst.C.E. (Messrs. Kincaid, Waller, Manville & Dawson), 29, Great George-street, Westminster, from whom copies of specification may be obtained. Tenders to the town clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, by 4 p.m. Sept. 7. An advertisement contains further particulars.

Swansea Corporation invite tenders for supply and delivery of two negative tramway boosters. Copies of specification, &c., from the borough electrical engineer (Mr. C. A. L. Prusmann, M.I.E.E.). Strand, Swansea. Tenders to the town clerk (Mr. Jno. Thomas) by noon Sept. 7. See also an advertisement.

Edmonton District Council are desirous of entering into an arrangement with a company for the exercise of their powers under their provisional order. Particulars and forms of tender after 31st inst. of the clerk (Mr. W. F. Payne), Town Hall, Edmonton, to whom tenders by noon Sept. 27. See also advertisement.

Hove Corporation invite tenders for the supply, delivery and laying in the parish of Aldrington of low-tension vulcanised bitumen, dialite or leadless paper cables, conduits, boxes, meters, &c. Tenders to town clerk (Mr. H. Endacott), Town Hall, Hove, by 6 p.m. of 30th inst.

Tenders are invited by the *Postmaster-General* until noon of Sept. 26 for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles. Forms of tender from the controller of stores (Mr. S. C. Hooley), Stores Department, G.P.O., 17-19, Bedford-street, London, W.C.

Torquay Town Council invite tenders for the erection of a chimney shaft (260ft. high) at their new proposed electric light and power station. Tenders to the town clerk before noon Sept. 12.

Worksop District Council invite tenders for underground cables. Tenders to the clerk (Mr. George H. Featherston) by Aug. 29.

Ilford Council require tenders by Sept. 12 for extensions of electricity station buildings.

Tenders are invited by the Director-General of Posts and Telegraphs, *Madrid*, for the supply of 25,000 porcelain telegraph insulators (No. 1 Spanish type). Full particulars are given in the "Madrid Gazette" for Aug. 19. Tenders have to be in by Sept. 16.

The Municipal Council of *The Hague* require tenders by Sept. 22 for 8,000 to 9,000 tons of steel rails, rail bonds, &c., for their electric tramways. Conditions, &c., on payment of 1s. 3d., from the Gemeente Werf, The Hague, Holland.

TENDERS RECEIVED AND ACCEPTED.

Among the orders for condensing plant received during 1904 by the Mirrlees Watson Co., Glasgow, are a number from municipal electric lighting and tramway departments, electricity supply companies, &c., including:—

Bradford (repeat), Bristol, Cardiff, Kilmarnock, Leeds, Northampton, Whitby and Willesden Municipal Electricity Departments; Clyde Valley Electric Light Co., Folkestone Electricity Co., Madeira Electric Light Co.; the Egyptian Government, &c.

The following tenders were received for the electric lighting installation (including mains, power supply, &c., in iron barrel) at the Free Schools, Bell-lane, London, E.C. The work was carried out to the specifications of the consulting engineers, Messrs. Owen Lucas & Pyke, the architect being Mr. E. R. Robson.

Leo Sunderland & Co. (*accepted*)	£1,498 10	Hampton & Sons	£1,709 0
Drake & Gorham	1,814 10	Smith, Walker & Co.....	1,706 10
		Belshaw & Co.	1,670 11

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Dartford District Council have accepted the following tenders:—Reason Mfg. Co., electricity meters (1 and 2 amperes £1. 10s., 5 amperes £2. 4s. each) and demand indicators (electrolytic type £1. 8s. 6d., magnetic £1); W. T. Burbey & Co., house service boxes (15-ampere 2-wire 7s. 6d., 15-ampere 3-wire 11s.); Western Electric Co., for house service cable and accessories.

The Buenos Ayres Grand National Tramways Co. have placed an order with the General Electric Co. (N.Y.), through the South American General Electric Supply Co., for 100 electric car equipments, each consisting of two 40 H.P. motors, with controllers, trolleys, &c.

Brighton Corporation have placed an order with the British Westinghouse Co. for circulating water pipes for Southwick power station at £550.

Salford Corporation have accepted the tender of the British Westinghouse Co. for the supply of electrical and mechanical tramcar appliances.

The tender of the local electric lighting company for public lighting in High Wycombe has been accepted by the Council at £13 a year each for 12 arcs and £3 each for 279 Nernst ½ ampere lamps.

Heckmondwike Council have placed an order with E. Green & Son for additions to the economiser at the electricity works.

BUSINESS NOTICES.

Messrs. Reunert & Lenz having given up the agency for Parsons' turbo-electric machinery, Messrs. C. A. Parsons & Co. have opened an office in Johannesburg, at Howard-buildings, corner Loveday and Main-streets, for the transaction of South African business. Mr. James Golder is resident engineer for the firm, who have already about 12 sets of turbo-generators in the country, ranging from 50kw. to 1,000kw., and hope to secure a share of the many orders that are likely to be placed for electric machinery in connection with the development of the gold mining industry in South Africa.

Mr. F. C. Gibbons, M.I.E.E., who was for many years one of the managing directors of Browett, Lindley & Co. (Ltd.), Patricroft, Manchester, but who severed his connection with the firm about a year ago in order to join Messrs. John Howden & Co., has now returned, and will in future be sole managing director.

Messrs. J. Lockhead and J. P. Rhodes (trading as the Huddersfield Electric Co.), Vance's-buildings, Cloth Hall-street, Huddersfield, have dissolved partnership. Debts by Mr. J. P. Rhodes.

BANKRUPTCIES, LIQUIDATIONS, &c.

Statutory meetings were held on Tuesday of the creditors and shareholders in the liquidation of Shippey Bros. (Ltd.), electrical engineers, &c., 14, King-street, London, E.C.

The official receiver (Mr. H. Brougham) reported that the company was formed December, 1887, capital £30,000, to acquire from Mr. A. Shippey the business of Shippey Brothers, with the plant, machinery, stock and certain patent rights. The purchase price was £8,000 in cash and shares, and in March, 1888, the company acquired, for £5,000 in shares, the interest of two ladies in certain other patents. In 1901 an arrangement was made with the Motor Traction Co. to finance Shippey Bros. (Ltd.) in consideration of receiving a proportion of the profits. That arrangement lasted for about 18 months, and would have to be carefully investigated. The unsecured debts were £3,238, against assets valued at £1,838, the total number of shares issued being £12,060. The company had apparently traded at a loss throughout.

In the bankruptcy of J. W. Hunter and A. Clapham (trading as Yorkshire Motor Car & Electrical Engineering Co.), 101, Kirkstall-road, Leeds, the first meeting of creditors will take place on 29th inst., at 22, Park-row, Leeds, and the public examination on Sept. 13 at Leeds County Court.

G. W. Warner and A. P. Bowen (trading as Warner & Co.), electricians, &c., 12, Holbein-place, Sloane-square, London, S.W., have been adjudicated bankrupt.

A meeting of the Single-Wire Multiple Telephone Signal Co. (Ltd.) will be held at Electra House, Finsbury Pavement, London, E.C., on Sept. 26 to receive an account of the winding-up.

Sale by Tender.—Messrs. Wheatley Kirk, Price & Co. have been instructed by the receiver of H. Sutton & Co., Ltd. (in liquidation) to sell by tender the whole of the stock upon the premises, 8, The Exchange, Muswell Hill, London, N., consisting of brass, copper and hammered iron electric light fittings, arc and incandescent lamps, flexible wire, telephones, &c. Catalogues and forms of tender from the auctioneers, 46, Watling-street, London, E.C., or Albert-chambers, Albert-square, Manchester. Additional particulars are given in an advertisement.

Sale by Auction.—Messrs. Percy Huddleston & Co. will sell by auction at 16, Long Millgate, Manchester, on Thursday next, at noon, without reserve, the stock of an electrical engineer, including dynamos, motors, cable and wire, switches, lamps, fittings, &c. Catalogues from the auctioneers, 72, Finsbury-pavement, E.C. See also advertisement.

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 30, Birley-street, Blackpool.

Mr. W. J. Crampton, 73, Queen Victoria-street, London, E.C., has for sale three electric motors. See advertisement.

Contractors' Plant.—Messrs. A. C. Wells & Co., of 102-104, Midland-road, St. Pancras, London, have for many years been engaged in supplying hand-power plant for various classes of work, and one of the most popular of their more recent introductions is a hand-power compressor with hand paint holder, as shown in the accompanying illustration (Fig. 1). This compressor is arranged to be worked by young unskilled labour, and is particularly handy, simple and cheap for use in places where it is not possible to connect up to power and where the painting plant required must be portable and light. The pump is surrounded by an outer chamber which forms an air reservoir, and oscillates upon the wheel centres. The operator, standing on the platform shown, keeps the machine steady when working. It is claimed that this simple plant will paint at a speed of from 1 to 1½ sq. yds. per minute. This piece of apparatus is not, however, suitable for lime washing, or where painting work is extensive or continuous. For these classes of work Messrs. Wells & Co. can supply suitable appliances, of which particulars will be supplied on request. Fig. 2 shows a patented oil-

FIG. 1.—HAND-WORKED AIR COMPRESSOR AND PORTABLE PAINTER.

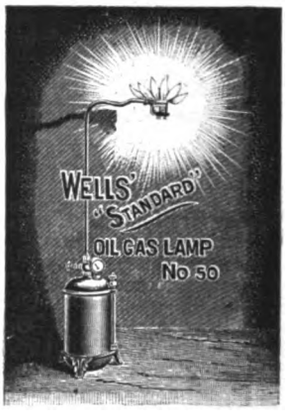

FIG. 2.

gas lamp designed to meet the requirements of a simple and cheap light, which cannot be blown out by the wind. In tramway, railway and general contracting operations these lamps are found to be invaluable. The burners used in these lamps are similar to those employed on the oil-gas generating lamps supplied by this firm. The oil tank measures only 10in. by 7in., holding 1½ gallons, supplying a 200 c.p. light for about six hours. The full catalogue of this firm's goods contains particulars of many other items of interest to contractors and erectors of engineering plant.

Catalogues, &c.—Messrs. Drake & Gorham, 66, Victoria-street, Westminster, S.W., have ready a new Nernst lamp catalogue. This firm are authorised licensees and agents for supplying these lamps to the trade, and such supplies can be obtained either from Victoria-street or from the branch offices at 47, Spring-gardens, Manchester, and Baltic Chambers, Wellington-street, Glasgow. Messrs. Drake & Gorham stock and supply all replacements and spares required for Nernst lamps and the accessories used in their installation, including patent suspensions, spring half-hood reflectors, ceiling fittings, water-tight fittings, shades, &c.

The General Electric Co.'s "Progress Sheet" for August illustrates and describes a new type of Stanley measuring instrument called the "Aperiodic," which has been designed "to meet requirements where absolutely deadbeat instruments are a necessity." Another addition has been made to the large range of "Freezor" fans. This is a portable fan supplied in two sizes, 12in. and 16in., with a current consumption of 55 and 110 watts respectively. A form of "Quadrant" tumbler switch is also illustrated, with a detachable key or lever, for use where switches are likely to be tampered with. The General Electric Co. announce that they are now making oval tube "Union" conduit in three sizes, both close joint and brazed.

A pamphlet relating to the Brooke's "Positive Flow" hot-water system of heating buildings is issued by Messrs. Holden & Brooke, of West Gorton. This system is designed to provide a forced (positive) circulation of hot water at low pressure at an efficient and wholesome temperature, and at the same time to place the amount of heat supplied to each radiator under absolute control. It is claimed that the system ensures silent working and flexibility in the

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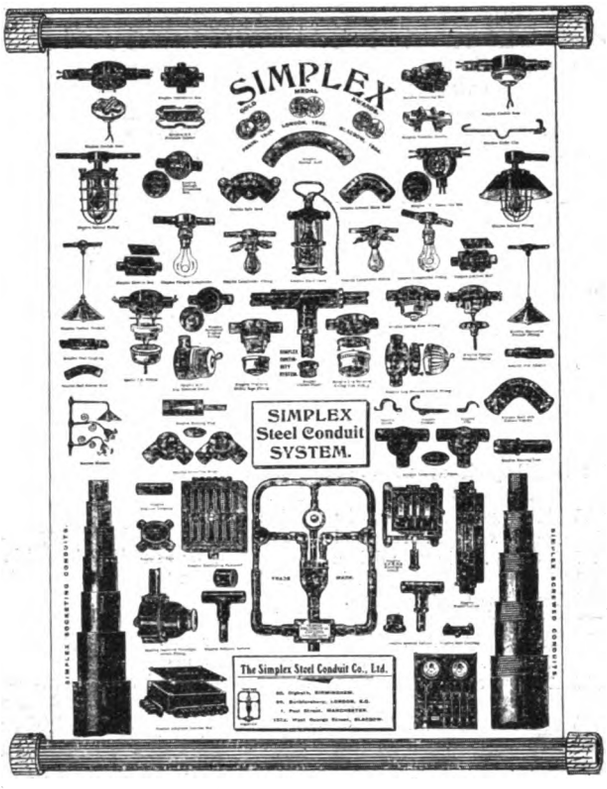
control of temperature throughout the service with a minimum of attention, maximum of reliability and economy in space required for the apparatus.

This is an age of showy advertisement tablets, and among the firms who are conspicuous in this class of advertising is the Simplex Steel Conduit Co., who have just prepared a bold trade showcard on metal rollers, illustrating a comprehensive assortment of the company's fittings, of which the accompanying figure is a reduced print.



The sheet is mounted on linen, and forms a serviceable and attractive showcard, which the trade can obtain, we understand, on application to the company at either the Birmingham, London or Manchester branches.

Royce Limited, Manchester, have ready a new dynamo and motor catalogue illustrating and describing the latest types of Royce machines, and giving tabulated information regarding outputs and speeds at various voltages.

A new list of "Miniature" arc lamps is about to be issued to the trade by the Union Electric Co., 151, Queen Victoria-street, London, E.C. It is claimed for these lamps that, although small, they embody all the good qualities of the company's larger forms of arc lamp, the mechanism alone being designed on a smaller scale. These lamps are suitable for many classes of interior and exterior illumination, and some of the lamps are provided with double enclosures to comply with rules enforced by some of the fire insurance companies.

A new price list of fusible cutouts and fuses, fuse blocks, &c., is published by the British Thomson-Houston Co.

The Dermatine Co. of Neate-street, Camberwell, London, S.E., have a new price list ready of "Dermatine" valves. The list contains a specially written article on pumping and condenser plant, and the application of valves, whether flexible or hard, to resist steam and oil.

The Electric & Ordnance Accessories Co., Stellite Works, Cheston-road, Aston, Birmingham, have ready an effective coloured poster advertising "Stellite" S.D. telephones. Telephone installers will find the card a business-bringer, and should apply to the company for a copy, which will be sent post free.

A well-illustrated catalogue of ships' telephones, watertight loud-speaking telephones and accessories is issued by Messrs. Alfred Graham & Co., of 4, Great Winchester-street, London, E.C. The goods listed are manufactured at the company's works, Peckham-park-road, and Culmore-road, London, S.E. A large range of instruments for a variety of uses is described.

A series of three pamphlets (Nos. 169, 170 and 171) are issued by the British Thomson-Houston Co., dealing respectively with single-phase induction motors, electrically-operated cranes and B.T.-H. meridian lamp. Illustrations and particulars are given in each case, and some fine examples of electrically-operated cranes are shown in list No. 170.

The British Aluminium Co., 9, Victoria-street, Westminster, London, S.W., have ready a number of new sheet price lists of aluminium goods.

Messrs. John Davis & Son, All Saints Works, Derby, have recently issued a pamphlet illustrating and describing the various coal cutters which they supply.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Aug. 17 to 23, with the ports of destination:—

Africa—Alexandria, £1,000; Cape Town, £650; Durban, £1,398; East London, £1,028; Port Elizabeth, £201. *Argentina*—Buenos Ayres, £161 and 116 tons tramway material. *Australasia*—Adelaide, £272; Auckland, £262; Fremantle, £121; Melbourne, £82; Otago, £76; Perth, £586; Sydney, £712; Wanganui, £55; Wellington, £75. *Belgium*—Antwerp, £275. *Burma*—Rangoon, £22. *Ceylon*—Colombo, £58. *China*—Shanghai, £481. *Cochin China*—Saigon, £33. *Germany*—Cologne, £35; Hamburg, £89. *Holland*—Amsterdam, £90; *Hong Kong*, £436 (including £233 telegraph material). *India*—Bombay, £159 (including £138 telegraph material); Calcutta, £1,392; Madras, £218. *Japan*.—Tokyo, £5,856 (including £367 telegraph material); Yokohama, £46. *Portugal*.—Lisbon, £65 (telegraph instruments). *Seychelles*, £65 (telegraph apparatus). *Siam*.—Bangkok, £100. *Straits Settlements*—Penang, £21; Singapore, £19. *Sweden*—Gothenburg, £9. *United States*—New York, £20. Total £16,169, against £10,514 in the corresponding week last year (Aug. 19 to 25).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

June 10, 1904.

13,107 ELECTRIC & ORDNANCE ACCESSORIES CO. and R. F. HALL. Birmingham. Switch mechanism for use with intercommunication telephone instruments.
13,158 A. GEIPEL. Plastic composition suitable for insulating material.
13,160 B.T.-H. Co. (G.E. Co., U.S.). Driving of machine tools.
13,161 E. A. CAROLAN (G.E. Co., U.S.). Filaments for incandescent lamps.
13,169 H. LEA. Electric light fittings.
13,170 C. HULSMEYER. Hertzian wave projecting and receiving apparatus adapted to indicate the presence of a metallic body, such as a ship or a train in the line of projection of such waves.
13,173 J. C. MERRYWEATHER. Providing telephonic communication for use at fires.
13,180 H. J. DOWSING. Electric radiators.

June 11, 1904.

13,216 W. AITKEN. Telephone exchange systems*
13,223 S. H. HOLDEN and CHAMBERLAIN & HOOKHAM (LTD.) Birmingham. Electrolytic meters.
13,253 J. R. CRAWFORD. Manufacture of filaments for electric lamps.
13,264 L. TORDA. Continuous-current motors and generators.
13,274 C. W. G. LITTLE. Controlling the trolleys of electric vehicles.
13,275 B.T.-H. Co. (G.E. Co., U.S.). Rail bonds.
13,276 B.T.-H. Co. (G.E. Co., U.S.). Protective devices for electric generating and distribution systems and apparatus.
13,277 B.T.-H. Co. (G.E. Co., U.S.). Coil-winding apparatus.
13,278 B.T.-H. Co. (G.E. Co., U.S.). Electric transformers, reactances and the like.
13,283 UNION ELEKTRICITÄTS-GESELLSCHAFT. Supplying or cutting off current in connection with single or polyphase alternating-current motors. (Date applied for, June 30, 1903, date of application in Germany.)*
13,284 UNION ELEKTRICITÄTS-GESELLSCHAFT. Starting and controlling alternating-current motors. (Date applied for, June 30, 1903, date of application in Germany)*

June 13, 1904.

13,297 J. JENNETT. Belfast. Railway crossing, fog, fire and burglar alarm.
13,332 C. J. BEAVER and E. A. CLAREMONT. Electric cables.*
13,343 LA SOCIÉTÉ ANONYME WESTINGHOUSE. Obtaining unidirectional currents of high voltage. (Date applied for, June 17, 1903, date of application in France.)*
13,353 R. J. C. COLLINS. Electrically-propelled vehicles.
13,360 B.T.-H. Co. (G.E. Co., U.S.). Electrical measuring apparatus.
13,369 C. W. HIGGS, R. J. H. FOX and T. B. HOPKINSON. Electric ignition apparatus of internal combustion engines.
13,370 SIEMENS BROTHERS & Co. and G. E. KERSS. Casing for electric leads.*
13,379 H. I. W. SCHWEDLER. Mercury current interrupters.*

June 14, 1904.

13,399 A. ECKSTEIN and A. E. ANGOLD. Manchester. Arc lamps.
13,426 W. FAIRWEATHER (Brown Hoisting Machinery Co., U.S.). Switching turntable.*

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13,427 W. FAIRWEATHER (Brown Hoisting Machinery Co., U.S.). Brake for overhead electrically-driven locomotives.*
13,428 W. FAIRWEATHER (Brown Hoisting Machinery Co., U.S.). Electric locomotives.*
13,429 W. FAIRWEATHER (Brown Hoisting Machinery Co., U.S.). Bucket rotating trolley.*
13,430 W. FAIRWEATHER (Brown Hoisting Machinery Co., U.S.). Operating overhead trolleys.*
13,433 H. HICKING. Process and apparatus for cleaning out accumulators.*
13,434 D. MARTIN. Arc lamp standards.
13,463 L. C. WERNER. Electric block signal system.*
13,466 H. PLANSON. Incandescent lamps.
13,468 W. M. SCOTT. Switches. (Date applied for, July 31, 1903, date of application in U.S.)*
13,470 W. H. KELSEY. Electric plug and socket extensions.
13,483 E. FAUVIN, E. AMIOT and E. CHENEAUX. Electric regulating apparatus of variable resistance and for direct reading. (Date applied for, Nov. 28, 1903, date of application in France.)*
13,489 F. O. SCHNELLE. Electrical separation. (Date applied for, June 15, 1903, date of application in Germany.)*

June 15, 1904.

13,516 W. E. TAYLOR. Blackpool. Mechanical ear for suspension of trolley wire.
13,527 G. HUGHES. Dublin. Electric measuring and indicating devices.
13,532 J. MORGAN. Prevention of accidents from breaking of overhead wire.
13,543 A. P. LUNDBERG and G. C. LUNDBERG. Switches.
13,564 JOHNSON-LUNDELL ELECTRIC TRACTION Co. (J. G. V. Lang, Germany). Regulation of electric motors.*
13,567 E. WEINTRAUB. Envelopes for vapour electric conductors. (Date applied for, June 15, 1903, date of application in U.S.)*
13,568 B.T.-H. Co. (G.E. Co., U.S.). Bearings for shafts of measuring instruments.
13,569 B.T.-H. Co. (G.E. Co., U.S.). Electric controllers.
13,570 B.T.-H. Co. (G.E. Co., U.S.). Controlling switches for electric circuits.
13,585 M. LATOUR. Electric motors. (Date applied for, June 19, 1903, date of application in France.)*

June 16, 1904.

13,596 F. W. BAYNES. Devon. Electric alarm clocks.
13,624 J. MACLEAN. Glasgow. Brush gear specially applicable to commutators of the internal ring type.
13,640 P. GOODIER, J. MURPHY and J. MURPHY. Liverpool. Regulating trolley head to work at an angle of 95deg. right and left.
13,643 H. OPPENHEIMER. (A.G. Mix & Genest, Germany). Signals in telephone exchange.
13,686 F. W. HOWORTH (firm Magneta Fabrik Electr. Uhren., Switzerland). Clocks controlled by reversals of electric current.

June 17, 1904.

13,698 U. HORSFALL, J. CROWTHER and A. G. BROWN. Manchester. Electrical motor starting switches.
13,703 H. E. T. VALE and F. L. MONKHOUSE. Liverpool. Electrical relays.
13,706 A. W. TOMKINS. Manchester. Apparatus for winding coils for continuous-current dynamo and motor electric machines.
13,709 A. H. BINYON. Automatic electrical signalling for railways.
13,720 C. A. SCHIERWATER. Liverpool. Overhead conductor equipment.
13,724 W. O. DUNTLEY. Electric drills.*
13,726 A. L. POCOCK. Terminal.
13,728 S. G. PRINCE. Outside protector for terminals of storage batteries.
13,732 A. N. V. DE CHRISTIANI (*née* Nicolaïdis). Phonic and telephonic correspondence.
13,733 W. T. PIPER. Beckenham. Electric plug adapter.
13,736 J. A. FLEMING. Apparatus for measuring wave lengths in wireless telegraphy.
13,758 H. C. HUBBELL. Portable electric lamps. (Date applied for, July 2, date of application in U.S.)*
13,759 W. BORCHERS and W. HUPPERTZ. Production of titanium from its oxygen compounds electrolytically. (Date applied for, June 18, 1903, date of application in Germany.)*
13,777 E. HAEFELY. Manufacture of insulating pipes.
13,778 E. HAEFELY. Apparatus for manufacturing insulating sockets.
13,779 G. S. DUNN. System of electrical distribution. (Date applied for, June 18, 1903, date of application in U.S.)*

June 18, 1904.

13,806 F. W. ASTON. Birmingham. Electric ignition for internal combustion engines.
13,862 B.T.-H. Co. (A.E.G., Germany). Electric arc lighting systems.
13,864 B.T.-H. Co. (A.E.G., Germany). Construction of dynamo-electric machines.
13,865 E. WEINTRAUB. Transforming the energy of alternating currents. (Date applied for, June 18, 1903, date of application in U.S.)*

June, 20, 1904.

13,902 W. AITKEN. Liverpool. Terminal insulators.
13,908 E. WEINTRAUB. Producing electric arcs from alternating currents, also applicable for rectifying alternating currents. (Date applied for, June 20, 1903, date of application in U.S.)*
13,925 G. W. MATTHEW. Arc lamps.
13,927 A. P. JONES (Long Arm System Co., U.S.). Electrically-operating bulkhead doors, hatches, &c.
13,928 A. P. JONES (Long Arm System Co., U.S.). Automatic electric cutout mechanism.
13,933 A. J. BOULT (Norman Dodge, U.S.). Storage battery separators.*
13,937 E. F. J. MODESSE. Installation of electric apparatus for traction in mines or other places containing explosive gas.*
13,947 G. SMITH. Tumbler switch.
13,952 O. IMRAY (Société Anonyme d'Etudes Electro-Chimiques, Switzerland). Apparatus operating with automatic regulation for submitting gases and vapours to the action of electric arcs.
13,979 E. A. CAROLAN (G.E. Co., U.S.). Electric lamps.
13,984 G. M. PINKERTON. Fuse boards and fuses.

June 21, 1904.

14,020 E. W. MARCHANT and G. W. WORRALL. Liverpool. Electrostatic apparatus for measuring potential differences.*
14,032 W. E. GRAY. Miners' and other portable electric lamps.
14,058 L. POTTHOFF. Solutions for the electro-deposition of metals.*
14,059 L. POTTHOFF. Apparatus for electro-galvanising.*
14,060 A. BOLZANO. Conductor and collector devices for electric railways and tramways.*
14,066 L. DE GOURNAY. High-voltage battery.*
14,071 H. H. BERRY and E. SKINNER. Raising and lowering arc lamps.
14,072 R. J. WHITE. Transmission of vibrating or wave sounds.*

June 22, 1904.

14,087 A. A. SMETHURST and T. H. BISHOP. Southampton. Lid for accumulators on ships, motor cars and the like.
14,105 E. WICHMANN. Germany. Electric cells.*
14,111 J. H. GOLDING. Self-locking contact maker.
14,117 R. O. SULLIVAN. Newcastle-on-Tyne. Protected conductor rail for electric railways.
14,128 H. LEITNER. Byfleet. Preliminary treatment of accumulator plates.
14,135 T. L. KOLKIN. Supplying current to electric vehicles.
14,136 W. H. FOOT. Brush holders for electrical machines. (Date applied for, June 24, 1903, date of application in U.S.)*
14,139 F. DE ZEA BERMUDEZ. Arc lamps.

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1903.

23,863 HALLBERG. Electric distribution systems.
24,581 MARGOWSKI. Portable electric fan.
26,247 D'OLIER. Electric driving mechanism for centrifugal machines.
26,271 PETERS. Cohering receivers used in space telegraphy.
28,401 PERDRISAT. Arc lamps.

1904.

455 and 550 RITCHIE. Telautograph apparatus.
707 WERNER. Electric block signalling systems.
1,314 ROPIQUET and DAVELUY. Electric igniters for explosion motors. (Date applied for May 30, 1903).
3,426 MACDIARMID and BATES. Switches.
4,394 DEUTSCH. Brush-holders for dynamo-electric generators.
6,873 DALE. "Clusters" for incandescent lamps.
6,889 WOODBRIDGE. Electrical distribution.
7,129 BURKE. Telegraphic signal systems.
8,235 PECK. Systems of electrical distribution. (Date applied for, May 1, 1903.)
8,612 RICHMOND. Transmission of electrica impulses.
8,986 SOC. ANON. L'ELECTRIQUE. Electrically-propelled road vehicles. (Date applied for Jan. 14, 1904.)
9,683 CHURCHILL-OTTON. Sanitary rotating diaphragm for telephones.
10,058 GENERAL CONTRACTS Co., COOK and CHIPPERFIELD. Switches.
10,142 MCGEORGE. Electrical conductors.
10,393 SCHWEDLER. Electric bath.
11,471 SIEMENS BROTHERS & Co. (Siemens & Halske A.G.) Dynamo-electric machines.
11,848 SANDER. Electric igniters for explosion motors.
11,862 HADDAN (Allgemeine Beleuchtungs und Heizindustrie A.G.) Electric lamps.

NEW COMPANIES, STATUTORY RETURNS, LIENS, REGISTERED, &c.

NEW COMPANY.

EVANS BROS. (LTD.) (81,840.)—Reg. Aug. 16, capital £30,000 in £1 shares (10,000 preference), to acquire business of ironmongers, &c., of Evans Bros., and to carry on the said business and that of electrical engineers and contractors, manufacturers of and dealers in electrical fittings, engineers, iron, brass and copper smiths, &c. First directors, D. Evans, J. Evans and S. Crapper. Reg. office, Woodfield-street, Morriston, Glam.

STATUTORY RETURN.

WEST AFRICAN TELEGRAPH CO. (LTD.)—The return to June 30 gives the capital as £400,000 in 40,000 shares of £10 each, of which 23,109 have been taken up. £231,090 has been received. No mortgages or charges.

MORTGAGES AND CHARGES.

BATH ELECTRIC MFG. CO. (LTD.)—Issue on Aug. 15 of £300 debentures, part of series created July 19, 1904, to secure £1,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

ELECTRICAL FITTINGS CO. (LTD.)—£2,400 debentures, created Aug. 15, 1904, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

ELECTROMOBILE CO. (LTD.)—A mortgage dated Aug. 10, 1904, to secure £3,500 and further advances up to £10,000, has been registered. Property charged, 15 per cent. of moneys payable to company under

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contracts for sale of automobiles or for garage, supply of electricity or other services (not including moneys payable exclusively for tyre maintenance. Holders, North of England Trustee, Debenture & Assets Corp.

FLEETWOOD & DISTRICT ELECTRIC LIGHT & POWER CO. (LTD.)—A charge dated Aug. 10, 1904, to secure £500 and further advances up to £700 (created under authority of High Court by W. Cash, receiver appointed by Court), has been registered. Property charged: All company's undertaking and assets (in priority to trust deed dated Oct. 1, 1899, and certain subsequent debentures created or issued thereunder). Holder, W. C. Johnson, London.

NATIONAL ELECTRIC CONSTRUCTION CO. (LTD.)—A mortgage or charge dated Aug. 4, 1904, to secure £20,000, has been registered. Property charged, company's undertaking and property, present and future. Holders, R. H. Benson and H. A. Vernet.

TELEPHONE CO. OF EGYPT (LTD.)—A trust deed dated July 27, 1904, to secure £60,000 debenture stock, has been registered. Property charged, company's undertaking and property, present and future, except uncalled property (as floating security). Trustees, Sir A. Colvin and G. F. Braithwaite.

URBAN ELECTRIC SUPPLY CO. (LTD.)—A trust deed dated July 28, 1904, and a disposition of even date, to secure £200,000 first mortgage debenture stock, have been registered. Property charged (by trust deed), electric lighting and tramway undertakings, certain freehold and leasehold hereditaments and company's undertaking and property, present and future, including uncalled capital; (by disposition), freehold property at Hawick. Trustees, Merchants' Trust.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26 5/8d. per oz. (Aug. 25). Consols 87 1/16—87 1/16 for money, 87 1/16 – 87 1/16 for account; 2½ per cent. annuities 87½. Consols Pay Day, Sept. 1; Stocks and Shares Continuation Days, Aug. 29 and Sept. 13; Ticket Days, Aug. 30 and Sept. 14; Pay Days, Aug. 31 and Sept. 15; Mining Share Carry-over Days, Aug. 26 and Sept. 12.

ALTERATION OF TITLE.—The name of the County of Surrey Electrical Power Distribution Co., Ltd., has been changed to the South Metropolitan Electric Tramways and Lighting Co., Ltd.

BRITISH INSULATED AND HELSBY CABLES (LTD.)—An interim dividend at the rate of 8 per cent. per annum on the ordinary shares for the half-year ended June 30 has been declared.

CHATHAM & DISTRICT LIGHT RAILWAYS CO.—The report for the half-year ended June 30 states that the receipts were £14,972. 17s. 2d., expenses £11,215. 8s. 4d. After adding balance from December (£556. 16s. 9d.), the available balance was £4,313. 15s. 7d. Interest, &c., absorbed £1,488. 6s. 6d. and interim 5 per cent. preference dividend £1,875. The receipts continue to show progress. The doubling of the track at Chatham Hill has been completed. Rochester Corporation having decided to proceed with the construction of certain of their lines, the company are placing orders for construction of a further section of their authorised route.

CHILIAN ELECTRIC TRAMWAY & LIGHT CO. (LTD.)—The directors' report for 1903 states that the credit balance was £1,946. 1s. 5d., and after deducting the debit balance from the previous year (£324. 10s. 6d.), the net balance (£1,621. 10s. 11d.) has been carried forward. No further construction has been carried on, and the only line not operated by electrical power is the short Nuñoa line, still being worked by mules. 52,427,358 passengers were carried, against 45,175,916 in 1902. The electric lighting department earned a net profit of $179,723·74, against $113,390·87 in 1902.

KALGOORLIE ELECTRIC POWER & LIGHTING CORP. (LTD.)—The chairman (Mr. Roger W. Wallace, K.C.) stated at the meeting on Tuesday that the financial position of the company had very much improved. The increase of business during the year amounted to 95 per cent. over the corresponding period of last year.

LANARKSHIRE TRAMWAYS CO.—A dividend at the rate of 4½ per cent. per annum has been declared.

LONDON UNITED TRAMWAYS (1901) (LTD.)—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 6 per cent. per annum on the ordinary shares. The traffic receipts for the half-year were £139,452, against £132,932 last year, an increase of £6,520, with an increase in expenses of only £779.

MATHER & PLATT (LTD.)—At the meeting on Wednesday the report (abstracted in our last issue) was adopted. Dr. E. Hopkinson, who presided, said the result of the company's trading for the past year showed a considerable increase in the profits earned. In addition to their home trade, which no engineering firm could safely neglect, they had ramifications in every country in the world, and he was glad to say the British colonies and dependencies gave them a full share of their trade. The liquid assets of the company were of considerably greater value than the whole of the preference capital, and during their 5½ years of existence a reserve fund of £200,000 had been created, which was equal to half the preference capital. They had no debts and no loan capital of any description.

PRETORIA LIGHTING CO. (LTD.)—The six per cent. mortgage debentures will be redeemed at par, or may be exchanged for shares at the head office (Pretoria) on and after Sept. 27.

STOCK EXCHANGE NOTICE.—Application has been made to the Stock Exchange committee to appoint a special settling-day in 34,100 £5 shares (£4 paid) of the *North Wales Power & Traction Co. (Ltd.)*.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 20	1,835	+ 292	12	19,668	+ 3,694
Airdrie	,, 12	201	...	27	5,339	...
Ayr Corporation	,, 20	466	+ 2	14	5,946	+ 186
Barnsley	,, 12	184	- 12	32	5,369	- 387
Barrow	,, 12	255	...	27	5,052	...
Bath Electric Trams, Ltd.	,, 17	758	...	33	20,661	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 21	1,034	- 68	...	...	...
Birmingham Corporation	,, 20	342	...	...	...	...
Birmingham Tramways Co.	,, 20	5,180	- 9	7	38,991	+ 2,784
Blackburn Corporation	,, 19	861	+ 102	21	20,549	+ 1,860
Blackpool Corporation	,, 18	2,499	+ 402	20	25,888	+ 2,740
Blackpool and Fleetwood	,, 20	1,606	- 350	7	10,780	- 551
Blackp'l, St. Anne's & Lytham	,, 18	975	+ 129	42	14,707	+ 6,276
Bolton Corporation	,, 21	1,988	- 295	21	39,708	- 17
Bournemouth Corporation	,, 17	1,440	- 78	‡20	28,615	+ 1,890
Bradford Corporation	,, 18	5,116	+ 1,170	¶20	96,884	+ 17,026
	,, 20	4,951	+ 839			
Brighton Corporation	,, 21	1,836	+ 255	20	22,527	+ 2,023
Brisbane Tramways	July 6	2,164	- 218	1	2,164	- 218
Bristol Trams & Carriage	Aug. 19	5,029	+ 178	13	71,290	+ 887
Buenos Ayres & Belgrano	July 24	2,955	+ 62	14	46,088	+ 2,165
Burnley Corporation	Aug. 20	1,128	+ 223	21	22,446	+ 5,180
Burton Corporation	,, 21	375	- 10	¶20	7,536	...
Calcutta Tramways Co.	,, 20	a36,967	+ a4,606	8	a248,237	+ a30,075
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	,, 20	2,190	+ 101	20	43,447	+ 1,358
Carlisle Tramways Co.	,, 20	201	- 26	33	6,615	+ 275
Central London Railway	,, 20	5,420	- 25	7	41,100	- 2,047
Chatham & Dist. Lt. Rys.	,, 18	614	- 29	33	19,455	+ 2,210
City & South London Rly.	,, 21	2,235	- 17	8	18,510	- 945
Colchester Corporation	,, 18	335	...	3	1,271	...
Cork Electric Trams Co.	,, 18	541	- 122	33	15,895	- 1,928
Darwen Corporation	,, 19	288	+ 10	20	4,738	- 98
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 12	613	+ 128	32	17,081	+ 2,771
Dover Corporation	,, 20	310	+ 6	21	5,080	- 186
Dublin & Lucan Railway	,, 19	134	- 29	7	1,058	+ 29
Dublin Southern District	,, 19	1,171	+ 42	7	39,578	- 3,748
Dublin United	,, 19	4,206	+ 100			
Dudley—Stourbridge	,, 12	952	+ 12	32	27,848	+ 1,076
Dundee Corporation	,, 17	841	- 2	...	...	...
East Ham Council	,, 20	749	- 12	20	15,980	+ 1,858
Gateshead & Dist. Trams	,, 12	918	+ 7	32	28,965	+ 1,321
Glasgow Corporation	,, 14	14,111	+ 468	†12	166,762	+ 10,911
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 12	300	+ 8	32	8,811	+ 813
Gt. Northern & City Rly.	,, 20	991	...	27	25,604	...
Greenock & Port Glasgow	,, 12	631	+ 86	32	18,231	+ 974
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 12	355	+ 7	32	9,507	+ 928
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 20	2,186	+ 358	20	44,270	+ 5,857
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	,, 17	145	- 42	‡0	3,037	+ 70
Ipswich Corporation	,, 20	609	...	20	10,918	...
Isle of Thanet Co.	,, 20	2,099	+ 277	¶47	27,225	+ 578
Kidderminster & District	,, 12	159	+ 12	32	4,207	- 28
Kirkcaldy Corporation	,, 10	239	- 88	32	7,278	...
Lanarkshire Trams Co.	,, 18	671	+ 88	33	20,893	...
Leeds Corporation	,, 20	6,038	+ 401	22	125,770	+ 7,809
Leicester Corporation	,, 20	1,851	...	...	...	...
Liverpool Corporation	,, 13	10,907	+ 724	33	341,017	+ 11,806
Liverpool Overhead Rly.	,, 21	1,641	- 75	18	18,781	- 163
*London County Council	,, 13	13,740	+ 3,908	§20	243,645	+ 48,872
Lowestoft	,, 20	441	+ 71	...	...	...
Maidstone Corporation	,, 11	184	...	4	814	...
Manchester Corporation	,, 20	12,407	+ 571	20	251,312	+ 9,578
Mersey Railway	,, 20	1,406	+ 83	7	10,091	+ 588
Merthyr	,, 12	199	- 4	32	6,502	+ 188
Metropolitan Elec. Trams	,, 19	1,894	+ 461	7	13,224	+ 2,196
Middleton	,, 12	362	- 47	32	10,470	+ 181
Nelson Corporation	,, 22	135	+ 22	21	2,518	+ 940
Newcastle-on-Tyne Corp.	,, 20	3,573	+ 63	7	26,222	+ 1,999
Newport (Mon.)	,, 10	538	+ 38	20	10,848	+ 2,060
Oldham, Ashton & Hyde	,, 12	559	- 179	32	17,496	- 957
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams	,, 19	1,154	+ 83	33	43,548	+ 5,601
Peterborough	,, 12	197	+ 7	32	4,907	- 97
Poole and District	,, 12	433	+ 11	32	9,561	- 2
Portsmouth Corporation	,, 20	2,506	+ 116	†20	44,480	+ 3,988
Potteries	,, 12	1,953	+ 620	32	54,202	+ 4,908
Reading Corporation	,, 18	691	+ 32	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 12	84?	- 6	32	4 738	- 97
Salford Corporation	,, 22	3,926	+ 70	21	85,778	+ 6,809
Sheerness	,, 10	99	- 14	32	1,984	- 450
Sheffield Corporation	,, 21	4,580	- 37	§21	100,549	+ 2,310
Southampton Corporation	...	...	...	...	...	...
Southend Corporation	,, 17	611	+ 52	20	8,275	+ 991
Southport Tramways	,, 12	448	- 48	32	10,502	+ 583
S. Staffordshire Trams.	,, 12	691	- 307	32	24,873	- 3,290
Stockport Corporation	,, 19	696	+ 353	20	12,601	+ 5,409
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	,, 12	655	- 8	32	17,611	+ 984
Taunton Trams	,, 12	92	- 10	32	1,802	- 170
Tynemouth and District	,, 12	425	- 70	32	9,561	- 598
Tyneside Trams Co.	,, 17	403	- 31	33	12,711	+ 2,072
Wallasey District Council	,, 20	855	+ 20	§20	16,383	+ 997
Walsall	,, 20	522	...	32	16,112	...
Warrington Corporation	,, 18	324	+ 27	20	6,578	+ 217
West Ham Corporation	,, 18	1,15?	...	25	21,509	...
Weston-super-Mare	,, 10	384	+ 9	32	3,873	+ 224
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 12	394	+ 12	31	12,554	- 104
Worcester	,, 12	385	+ 206	27	8,640	+ 3,976
Wrexham	,, 12	120	- 26	32	3,592	- 502
Yorkshire Woollen District	,, 12	644	+ 120	32	19,218	- 7,914

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 8 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Aug. 24.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 24. High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	..	Anglo-Argentine Ordinary Shares	6⅛—6⅜	..	April, Oct	6⅜	6⅞
5	2/6	Do. 5% Cum. Pref.	5⅜—5⅝	4 8 10	..	5⅜	5⅝
St.	6%	Do. Permanent 6% Deb. Stock	137 —141	4 5 0	..	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	99 —101	4 19 9	..	99¾	99¼
10	6%	Barcelona Tramways Ord.	9 —10	3 0 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 0	..	..	..
100	5%	Do. 5 per Cent. Debs.	96 —99	5 1 0	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	1 1/16—1 3/16	..	..	..	..
1	..	Do. 5% Cum. Pref.	1—1 1/16	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅜—4½	5 17 8	..	3 15/16	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96 —101	4 9 3	..	..	..
10	8%	†Bristol Tramways and Carriage Ord.	19 —20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107 —109	3 13 4	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	97 —100	6 2 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	99 —102	4 18 6	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝—105⅞	4 6 2	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 —100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	8⅞—9½	6 9 9	..	9⅜	8⅞
10	6/0	† Do. 6 per Cent. Cum. Pref.	10½—11	5 9 1	Feb, Aug	10 15/16	10⅜
St.	5/0	Do. 5 per Cent. Perpetual Debs	116 —119	4 5 1	..	118⅜	117½
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	94 —97	..	..	95½	94½
5	3/0	Buenos Ayres and Belgrano Ord.	2⅞—3⅛	4 16 0	..	3 3/32	3 1/16
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼—5⅝	5 4 4	..	..	..
5	3/0	Do. "B"	5 —5⅛	5 9 1	..	5 5/16	..
St.	5%	Do. 5 per Cent. Debs.	105 —108	4 12 8	..	106	105½
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	101 —104	4 16 6	..	104½	..
5	3/6	Calcutta Tramways	7¼—7⅜	3 17 6	..	7 5/16	7¼
100	4½%	Do. 4½% 1st Deb. Stock (red.)	104 —107	4 4 6	..	104⅜	..
1	1/0	Cape Electric Tram Shares	1¾—2	5 0 0	..	1 15/16	..
St.	4%	†Central London Ordinary Stock	87 —89	4 9 11	June, Dec	87⅞	87¼
St.	4%	† Do. 4 per Cent. Pref. Stock	100 —102	3 18 3	..	101½	..
St.	4%	Do. Deferred Stock	80 —82	4 17 7	..	80¼	..
100	4%	Do. 4 per Cent. Debs.	106 —109	3 13 5	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—5	5 0 0	..	5	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2½%	†City and South London Rly. Con. Ord.	39 —41	5 9 9	Feb, Aug	41½	40¼
St.	5%	† Do. 5 per Cent. Perp. Pref. (1891)	121 —124	4 0 8	Feb, Aug	..	..
St.	5%	† Do. (1896)	118 —121	4 2 8	..	..	..
St.	5%	† Do. (1901)	117 —120	4 3 4	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	105 —108	3 14 9	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 10	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 8 11	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	1/8¾	Gt. Northern & City Rly. Prf. Ord. (4%)	4¼—4¾	..	..	4½	..
10	4/0	†Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19½—20½	4 17 7	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 9	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	3¾	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 —91	4 7 11	..	..	..
10	1¾%	†Liverpool Overhead Railway Ord	3 1/16—3 1/8	3 9 9	Feb, Aug	..	..
10	5%	† Do. 5 per Cent. Pref.	9¾—10¼	4 17 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Debs.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10⅛—10¾	4 13 0	..	10 1/16	10⅜
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —105	3 16 4	..	103¼	..
St.	..	Madras Elec. Trams 5% Deb. Stk.	100 —103	..	Jan, July	102½	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
1	..	Metropolitan Electric Trams Def	7/8—1 1/16	..	..	..	..
1	0/6	† Do. 5% Cum. Pref.	1—1	5 0 0	..	1 1/16	..
St.	13/7	Do. 4½% Deb. Stock	98 —100	..	..	18¾	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 —105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 —2	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 —102	4 18 1	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	† Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	..	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	April, Oct	..	..
St.	3%	†Waterloo and City Ord.	86 —89	3 7 5	Jan, July	..	..
					June, Dec	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	†Alliance Elec. Co. 5% Cum. Pref.	⅜—½	8 0 0	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	1/16—⅛	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾—6¼	6 8 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¾—6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 7	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	2¾—3¼	9 4 6	..	3⅜	3 5/16
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	85 —88	4 10 11	..	..	..
2	..	Brush Electrical Engineering	½—1	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1 —1½	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	70 —75	6 0 9	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½—10¼	5 14 3	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	101 —105	4 5 8	Nov, May	102⅝	..
1	9d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 16 10	..	..	..
1	1/2½	Chadburn's (Ship) Telegraph Ord.	¾—1⅛	8 0 0	..	..	..
3	1/6	†Crompton and Co. (Nos. 1 to 54,000)	1½—2	3 15 0	Jan, July	1¾	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	94 —97	5 3 6	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7½—8	..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5¼—5¾	5 4 4	..	5¼	..
St.	4½%	Do. 4½% Deb. Stock	102—105	4 6 0	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅛—¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 —82	4 18 1	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 —83	6 3 8	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6 —6¼	5 12 0	H'lf-yearly	6⅛	6 1/16
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6¼	4 16 0	..	6⅛	6
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 4 0	..	105½	105
2	1/7½	Electric Construction Co.	1 —1½	6 8 0	July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2 —2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	96 —99	4 0 9	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 8	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 —9½	5 5 8	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	11 —12	6 5 0	Feb, Aug	11	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 6	Feb, Aug	..	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 —103	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	35 —38	6 6 2	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 6	Jan, July	102¾	..
5	..	Willans and Robinson Ord.	2 —3	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3 —4	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	75 —80	5 1 0	May Nov	..	..

Share.	Last Dividend	Name.	Price Wed., Aug. 24.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 24. High-est.	Low-est.
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord. (f.p.)	¾—1	..	..	..	1/16
1	0/8½	Do. 7% Cum. Pref.	1⅛—1⅜	5 1 9	..	..	..
St.	..	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	102 —107	4 4 6	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	..	..
10	4/6	† Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	† Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 —105	4 6 3	..	103⅜	102⅛
5	..	Bromley (Kent) El. Lt. & Power Shares	5½—6	..	..	..	..
St.	4½%	Do. Do. 1st Debs	100 —103	4 7 5	..	..	..
5	4/6	†Brompton & Kensington Elec. Sup. Ord.	10⅜—11½	4 8 11	..	..	..
5	3/6	† Do. 7 per Cent. Pref.	10¼—10⅜	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7½—7⅝	4 10 5	..	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 —109	3 13 11	..	..	..
5	4/0	†Charing Cross & Strand Electric Sup.	7½—8	5 0 0	Feb, Aug	7⅞	7⅝
5	2/3	† Do. 4½ per Cent. Pref.	5⅝—5⅞	4 3 7	Feb, Aug	5⅝	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	..	4 15/16	4 13/16
5	2/3	Do. Do. (1903)	4½—5	..	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 0	..	102½	..
5	3/6	Chelsea Electric Supply Ord.	6½—7	4 2 2	March ..	6 13/16	6 11/16
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 2 6	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10¼—10⅞	4 13 0	Feb, Aug	10½	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅜	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	120 —125	4 0 0	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 5 9	..	..	..
10	4/0	†County of London Elec. Supply Ord.	7½—8⅛	4 14 3	..	8⅛	..
10	6/0	† Do. 6 per Cent. Cum. Pref.	11½—12	5 0 0	Mar, Sept	11⅝	11½
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	105 —108	4 3 6	..	107⅛	106⅞
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —104	4 7 10	..	101½	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 —93	5 7 6	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5¾—6¼	4 8 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 —102	4 8 9	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
5	5/0	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
St.	4½%	I. of W. Elec Lt. & Power 4½% Db. St. (red.)	101 —103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅜—⅞	..	..	..	..
5	5/0	Kensingtn & Knghtsbdge Ord.	12 —13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	..	..
3	..	London Electric Supply Ord.	1½—1⅝	..	..	..	..
5	3/0	Do. 6 per Cent. Pref.	5 —5½	5 9 1	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 —99	4 1 6	Mr, Jn, S, D	..	..
10	9/0	†Metropolitan Electric Sup. Ord.	15½—16½	5 9 0	April, Oct	16⅜	15⅞
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½—5⅝	4 0 0	Jan. July	5⅝	5½
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	4 0 0	Jn, Dec ..	111	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 —99	3 10 6	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93 —96	4 13 9	..	..	..
10	6/0	Notting Hill Electric Ord.	14 —15	4 0 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	100 —103	3 18 3	..	..	..
5	4/0	Oxford Electric Ord.	5⅞—6½	5 4 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	97 —100	4 0 0	..	..	..
1	..	Rand Electric	1 —1½	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 —103	4 7 9	April, Oct	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	14⅝	..
5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 2	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2⅜—3½	6 3 1	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 —88	4 10 11	..	..	..
5	3/0	South London Electric Supply Ord.	3⅜—4½	3 10 7	..	..	..
5	2/6	Urban Electric Supply Ord.	4½ 5	5 0 0	..	4½	..
5	2/6	Do. 5% Cum. Pref.	4⅝—5½	4 15 3	..	..	..
5	6/6	Westminster Electric Supply Ord.	12½—13½	5 0 0	Mar, Sept	12⅞	12 7/8
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	..	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	97 —101	3 19 2	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..
St.	12/6	Anglo-American	46 —49	5 18 9	F, My, Ag, N	..	..
St.	25/0	Do. Preferred	90 —92	6 0 8	F, My, Ag, N	91½	91
St.	2/0	Do. Deferred	7¼—7⅝	1 6 2	F, My Ag, N	7 5/16	7 1/16
100	£2	Commercial Cable Capital Stock	170 —190	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 —96	4 3 6	Jn Ap, Jy, O	95¾	94½
10	5/0	Cuba Submarine Ord.	7 —8	7 10 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98¾—101⅛	4 9 2	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10¼	5 14 3	Ja, Ap, Jy, O	10¼	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 —101	4 9 2	Jn, Dec ..	..	..
St.	65/0	Eastern Ordinary	126 —131	5 6 9	Ja, Ap, Jy, O	129	127
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —90	3 18 6	Ja Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 6	May, Nov	107	106½
10	2/6	Eastern Extension	12 —12½	5 12 0	Ja, Ap, Jy, O	12⅜	12
St.	4%	Do. 4 per Cent. Deb. Stock	103 —106	3 15 6	Feb, Aug	103	104½
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	99 —102	3 18 9	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100⅞—103⅞	3 18 6	May, Nov	..	..
10	5/0	Gt. Nrthn. (of Copenhagen)	25½—26½	5 13 2	Jan, July	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 —101	4 9 2	June, Dec	..	..
25	37/6	Indo-European	43 —46	5 8 9	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..
10	6/0	West African Telegraph Shares	6 —7	5 14 3	..	..	..
2½	..	West Coast of America	1/16—⅛	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 6	Jan, July	..	..
10	..	West India and Panama	⅜—½	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6¼—6⅜	8 17 9	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	..	..
*	Do.	5 per Cent. Debs.	99 —102	4 18 1	Jan, July	..	..
10	3/C	Western Telegraph	12 —12½	5 12 0	Mr, Jn, O, D	12⅝	12
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 16 3	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99 —102	8 18 5	..	101½	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid,	5 —5½	6 7 3	August ..	5¼	5 3/16
1	7½	Monte Video Telephone Ord.	7/16—9/16	..	..	..	..
St.	6%	National Co. Pref. Stock	104 —106	5 13 9	..	105½	104½
St.	5%	Do. Def. Stock	89 —92	5 8 9	..	90⅝	88¼
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 8	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5¼—5⅝	4 13 0	Feb, Aug	5¼	5 3/16
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 —99	3 10 8	June, Dec	98¼	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104 —106	3 15 9	..	105½	.04⅜
..	5/9	Do. Do. Prov. Certs. 35% to be pd.	65 —67	..	..	66½	65½
1	0/8½	Oriental	1⅛—1 1/16	6 6 8	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	6 4 6	..	..	..
5	5/0	United River Plate	6 —6½	6 3 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¼—5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 —106	4 14 4	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 14 4	..	5⅛	5
10	2/0	Globe Telegraph and Trust	8¾—9¼	5 19 0	Ja Ap, Jy O	8⅞	8¾
10	3/0	Do. 6 per Cent. Pref.	13½—14	4 5 8	Ja Ap, Jy, O	13¾	13⅝
100	6%	Submarine Cables Trust (Cert.)	118 —123	4 18 9	April, Oct	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

IN a Paper read before the Institution of Electrical Engineers this year, and published in *The Electrician* last April, Mr. M. B. FIELD estimated the losses in cables due to eddy currents in the lead-covering. We suggested at the time that experimental investigation was required to put the matter clearly before engineers and to ascertain the real significance of Mr. FIELD'S calculations. Mr. J. T. MORRIS has fallen in with this suggestion, and has carried out a series of tests by an elegant and ingenious method. His results, which are recorded in another column, show that in ordinary circumstances the losses in question are not serious—in fact, in the example chosen by Mr. MORRIS as an illustration they would amount to no more than one-third per cent. of the C^2R losses. Like the latter, they vary as the square of the current and the length of the cable, but they also increase with the square of the frequency. An augmentation of the thickness of the sheath also adds to the losses in it, but in this case the losses only vary with the 0·7th power. Armed with this information, the power distribution engineer will be able to finish his summer holiday in peace, without dreaming at night of enormous quantities of energy being dissipated by the sheathing of his cables only to increase still more the already abnormal temperature of the streets.

WHILE the question is still being discussed by engineers in this country whether rotary converters or motor-generators are to be preferred for converting alternating current into continuous current, the story of the troubles experienced by the Seattle Electric Co. with rotary converters and the means employed to overcome these difficulties, will be read with benefit by engineers whose patience is sorely tried by similar troubles. The tale is told by Mr. S. C. LINDSAY and will be found on another page of this issue. Hunting, or "pumping" as the author prefers to call it, may be set up by various causes, but in this particular case it was evidently chiefly due to excessive line drop resulting in an interchange of balancing currents between the various converters. This trouble was overcome by doubling the voltage, strengthening the line conductors and re-arranging the transformers, and it would appear from the author's article that these 60-cycle rotary converters now operate perfectly satisfactorily. It may be regretted that Mr. LINDSAY contents himself with stating the conditions in a general manner, instead of giving definite figures with respect to the length of line, its resistance and so on, which might serve as a basis for others to build upon.

WIRELESS telegraphy has been filling an important part in the Russo-Japanese war. Although Port Arthur has been for some weeks past totally surrounded by the Japanese forces, occasional reports from Gen. STOESSEL—somewhat belated, it is true—have been published in St. Petersburg, and the CZAR has even sent a telegram back to him to congratulate the defenders on their bravery. It is not unlikely that these messages have been sent via the Russian Consulate at Chifu, to whose wireless telegraph plant the Japanese have taken such objection. Why they object, however, is not quite apparent, even if technically the employment of this means of communicating with Port Arthur from the Consulate is a "breach of neutrality." If the messages that pass are not sent in code, the Japanese can easily read them, and they are probably doing so in any case, for by now these wily people have probably been able to obtain possession of the code, or, at all events, t

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piece together an approximation to the meaning of the messages. If, on the other hand, the signals are unintelligible to the Japanese, nothing prevents them from erecting a noisy transmitting station at or near Chifu, and "queering" the Russian signals, just as the Russians tried to do with regard to the Japanese signals during the first naval battle outside Port Arthur. On this point, the article written by the "wireless" correspondent of *The Times* (reviewed on another page) is instructive.

In the meantime, a demonstration has been made of a useful application of wireless telegraphy to report, not the wars between nations, but the wars of the elements. By the enterprise of the *Daily Telegraph*, and with the assistance of the Marconi Company and several Atlantic liners, weather reports are being received from distances up to 900 miles from the shore. If this application is properly systematised, doubtless considerable advance may be made in the science of weather forecasting. In the United States the Weather Bureau took the matter up some time ago, and commenced the organisation of a wireless telegraph department. Trouble has already arisen, however, between this department and the Navy, with the result that the control of wireless telegraphy around the coast of the United States will now, probably, be vested in the Navy Department, who will furnish the requisite meteorological reports to the Weather Bureau.

An interesting point has recently been raised in a dispute between the Hove Electric Lighting Co., who are supplying electrical energy in Hove under a Provisional Electric Lighting Order, and the Brighton Corporation. It appears that a house in the Hove area is being supplied with electric current by Brighton Corporation. A portion of the garden at the back of the house is in Brighton, and the Corporation have run their supply mains into this garden, and have fixed the meters in a wooden box within their own area. The Hove Company contend that, as not a single lamp or any portion of the house is in the Brighton area, the Brighton Corporation are not justified by their own Provisional Order in giving a supply to the house; but the Corporation maintain that the supply was given upon "premises" situate within the borough of Brighton, and deny that their action is illegal. The Hove Corporation, who will ultimately become owners of the Hove Company's undertaking, have decided to support the Company in their contention, and now await a reply from the Brighton authorities. It may be noted that the question raised is on parallel lines with the case of "Gas Light and Coke Co. *v.* South Metropolitan Gas Co.," in which the House of Lords held that the sale and delivery of gas takes place at the actual place of consumption. The most reasonable solution of the problem, however, would be to allow the consumer the full advantage of his geographical position, and to let him buy his electrical energy from the undertaker who can supply him at the cheapest rate. A somewhat similar dispute occurred a short while ago between the Willesden Urban District Council and the Metropolitan Electric Supply Co., and as nothing more has been heard of it for several weeks, we should not be surprised to learn that it has been settled in this manner.

Those central station engineers who are not in the habit of making daily or weekly tests of the insulation of their mains networks, will be well-advised to make a thorough test of these during the next few weeks. After a long spell of hot and dry weather, the first series of heavy rains will find out all the weak spots, but these may easily be discovered and repaired before they have endangered the continuity of supply. If these small faults are left too long undetected, moisture will continue to penetrate at the spots where the mains and boxes are not watertight, and the result will be a continuous succession of short circuits and similar troubles during the late autumn and winter.

New Cable Steamer.—The new cable steamer "Magnet," equipped for the Far Eastern service of the Eastern Extension Australasia and China Telegraph Co., left the Thames yesterday (Thursday) for her station at Singapore.

The Electrical Equipment of the District Railway.—In order that the electrical equipment of the District Railway might proceed more rapidly, the Earl's Court section was closed for traffic from Saturday night to Monday morning.

Society of Engineers.—The present year being the jubilee of the Society, the council have decided that this epoch in the society's history shall be celebrated by a conversazione. Arrangements are, therefore, being made for a conversazione, on the evening of November 16th next, at the Royal United Service Institution, where the Society's ordinary meetings are held.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Cayenne—Paramaribo	July 13, 1904
Cap Haitien—Mole St. Nicholas	Aug. 20, 1904
Bundaberg—Gomen (New Caledonia)	Aug. 30, 1904

Car-lighting Resistances.—The A.E.G. English Mfg. Co. inform us that they are introducing some new car-lighting resistances composed of iron, the high temperature coefficient of which makes it possible to keep the current nearly constant within a certain range of voltage. In principle, a battery of, say, 30 cells, is charged from a dynamo on the locomotive, no cell switches are employed and all regulation of pressure is effected by the resistances only, of which there is one in series with every incandescent lamp. The highest pressure obtainable in this case is $30 \times 2{\cdot}5 = 75$ volts, and the lowest $30 \times 1{\cdot}85 = 55$ volts; the resistances, therefore, have to regulate between 55 and 75 volts. At 55 volts each absorbs 10 volts, and therefore 45-volt lamps are employed; but at 75 volts the resistance of the iron increases so much as to absorb nearly 30 volts, and therefore the pressure across the lamp terminals is kept almost constant. The actual variation of current through the lamp is said to be only 4 per cent. on each side of the mean between these limits. Higher voltage resistances are made for use on tramways, and we are informed that they are very successful.

Single-phase Railways in Sweden.—Some time ago (*The Electrician*, Vol. LII., pp. 359 and 866) we were able to announce that the Administrative Board of the Swedish Railways had recommended the Government to adopt single-phase electric traction on the Swedish State railways. According to *Elektrische Bahnen* the Government has sanctioned an experimental line, and a power station is now being built at Tomteboda and locomotives and motor cars have been ordered. The station at Tomteboda is to be equipped with two De Laval steam turbines directly coupled to single-phase alternators, which are to generate current at frequencies varying between 15 and 25 cycles per second, according to the speed at which the prime movers are run. Step-up transformers are used, wound in such a manner that current at any voltage between 3,000 and 20,000 volts may be supplied to the line. Two electric locomotives have been ordered, one from the Westinghouse Company of America, the other from the Siemens-Schuckert Co. The former has two axles, each driven by a single-phase series

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motor, while the latter has three axles operated by three similar motors. Both locomotives are equipped with transformers and means for varying the speed by altering the voltage applied to the motors. In addition to these locomotives, a local passenger train, consisting of four cars with two bogies each, is to be worked electrically. It is to be equipped by the Allgemeine Elektricitäts Gesellschaft. Two of the four cars will be equipped with 6,000 volt 25 ~ single-phase motors on the Winter-Eichberg system, two motors being carried by each motor car. The cars are to be lighted and heated electrically, and are to be fitted with vacuum brakes. So far no decision as to the design of the current-collecting device has been come to, but this question is hoped to be settled in time to allow the experimental runs to be commenced early next year.

The Arnold Single-phase Traction System.—It is announced by the *Electrical World* of New York that a trial trip was made on August 3rd over the Michigan Suburban Railway at Lansing, Mich., with a car fitted with the Arnold electro-pneumatic motor system. In this system, it will be remembered, a single-phase motor is used, the armature of which is always in motion. In starting, stopping or at any speed short of that corresponding to the synchronous speed of the motor, the field also revolves and drives, or is driven, by a compressed air engine. In the former case energy is stored as compressed air in a tank, and in the latter case is given out. The trial was made with the car equipment which was partly destroyed last winter in a fire. In spite of the fact that the machinery had been partly repaired, a complete demonstration of the system was not possible owing to cracked castings. The car at times attained a speed of 25 miles per hour, and no difficulty at all was experienced in taking current at 6,000 volts from the trolley line. The control enabled speeds from the lowest to synchronism to be maintained and was satisfactory in retarding and accelerating. The system was completed about two years ago, and was described in *The Electrician*, Vol. LII., p. 600. The trial trip was back and forth over 8 miles of line.

Wireless Telegraphy in the United States.—The United States Navy Department has published the full report of the special Board appointed to investigate the subject of wireless telegraphy. It was unanimously recommended that the Navy should have control of all the wireless systems along the coasts of the United States, the island possessions and the Panama Canal zone, and the President adopted the recommendation. The following principal conclusions are given by the *Electrical World* of New York :—

That wireless telegraphy is of necessity to the Government through the Navy Department, and that its use by the Signal Corps of the army in communication between military posts of the army and other necessary links will be necessary both in peace and in war, and that such use shall be unrestricted. When interference seems probable between stations of the Navy and War Departments the question involved shall be mutually settled by representatives of the two departments.

That coastwise wireless telegraphy is not a necessity for the work of the Weather Bureau, provided that the necessary meteorological data for that department can be collected by the stations of the Navy Department from ships at sea, and sent by them to the Weather Bureau.

That the maintenance of a complete coastwise system of wireless telegraphy by the Navy Department is necessary for an efficient and economical management of the fleets of the United States in time of peace and their efficient manœuvering in time of war.

That the Signal Corps of the army be authorised under its chief to establish from time to time such wireless stations as he may deem necessary, and that they do not interfere with the coastwise telegraph system of the Government under control of the Navy Department.

That the necessary steps be taken to have the Weather Bureau turn over to the Navy Department all coastwise wireless telegraph apparatus now under its control, and such material as it may have in its possession, which can be utilised by the Bureau of Equipment, and the proper transfers of funds for this purpose be made.

That the Weather Bureau furnish to the Hydrographic Office, and to naval wireless telegraph stations and to other portions of the public service, such meteorological data as it, or they, may desire at no cost to them.

That the Department of Agriculture shall continue the work of its meteorological vessel reporting and storm-warning stations, as now constituted and provided for by law, and continue the control of sea-coast telegraph systems, except wireless systems.

That the necessary steps be taken that the Navy Department may equip and instal a complete coastwise telegraph system covering the entire coasts of the United States, its insular possessions, and canal zone in Panama.

That the wireless stations of the Navy Department shall, without charge to the Agricultural Department, receive and promptly transmit to the ocean or to islands, or to other places where the information can be useful, the storm warnings of the Weather Bureau.

That the Navy Department shall request all vessels having the use of its wireless stations for the receipt of messages to take daily meteorological observations of the weather when within connecting range, and to transmit such observations to the Weather Bureau through naval wireless stations at least once daily, and transmit observations oftener when there is a marked change in the barometer, and that there shall be no charge against the Agricultural Department for these observations or for the transmission thereof.

As fast as the naval wireless telegraph stations are in operation the Navy Department shall receive and transmit through these stations free of charge all wireless messages to and from ships, providing such stations do not come in competition with commercial stations, until such time as Congress may enact the necessary legislation governing this subject.

In asking for legislation on this point the board invites attention to the fact that where wireless stations are needed for the merchant marine, as a rule, the navy will also require them. The board believes it to be in the interest not only of governmental but of public economy and efficiency to permit the naval stations to handle the public service, for in the present state of the art but one station is desirable for the public interest in such places. It is admitted that there may be special cases where private stations can serve a useful purpose, and the board believes that the Department of Commerce and Labour should have the duty of issuing licences in such cases under such regulations as will prevent interference with stations necessary to the national defence. All private stations in the interior of the country should also be under the supervision of the Department of Commerce and Labour.

Maidstone Corporation Tramways.—On July 14th the Maidstone Corporation light railways were opened for public traffic by the mayor, Ald. Morling. An unusual feature in the history of the venture is that the undertaking, which is wholly within the borough, was sanctioned under the Light Railway procedure, thus upsetting the views generally held regarding the Taunton decision of the Light Railway Commissioners. Including the overhead equipment, the total cost of the 2 miles of line, six cars, car shed and all necessary appliances, cables, switchboards, &c., will not, it is anticipated, exceed the sum of £20,000. The route is of single track throughout, with passing places, the gauge being 3ft. 6in. That portion of the track within the town proper is paved with 9in. by 3in. hard wood blocks, and for a part of the length, where the gradient approaches 1 in 15, the track has been paved with 5in. by 4in. granite setts. In the outlying portion of the town, where the traffic is slight, the remainder of the track, amounting to about 1 mile, has been paved with a serration of granite on either side of the rails with macadam filling in between, this form of construction lending itself particularly well to roads subjected to light traffic, and is, of course, particularly favourable upon grounds of economy. The points are in accordance with the latest practice, and are 13ft. long overall, of the extended-leg type, the tongues, which are 8ft. 6in. in length, being specially spiralised in order to give the cars easy entrance to the loops. In connection with the granite serration and macadam paving, the concrete bed has been put in to the full width of the tramway formation to provide for paving the track throughout at a later date should the Corporation decide to do so. Rails are the British standard No. 2 section, weighing 95lb. per yard, having joints of the "Dicker" type fixed by 6in. bolts fitted with the "Eureka" lock. Tie-bars are spaced at 6ft. centres, and are of the patent rolled weldless type. The track has been bonded throughout with 4/0 Neptune bonds. In addition to the track work, widenings had to be carried out at three points, amounting in all to 700yds. of route. The overhead equipment is on the span-wire system, and the cars, of which there are six, are double deck, single-truck, built to run on a gauge of 3ft. 6in. Each has a seating capacity of 48 persons, 22 inside and 26 outside, and is supplied with a complete electrical equipment. The motors are Messrs. Dick, Kerr's standard type for 500 volts, and will deliver approximately 28 H.P. at the armature shaft; this is based upon the standard rating—*i.e.*, a rise in temperature of not more than 75°C. in various parts after running at full load for one hour. The equipments are mounted on Brill trucks. Dick-Kerr standard controllers are fitted, and are specially arranged with resistances for rheostatic braking, operated by the driving handle, which may be utilised either when the car is proceeding backwards or forwards. Accommodation is provided in the car shed for six double-deck cars, and provision is made for rapid and economical extension. Power for the undertaking is supplied from the Corporation electricity works, which has undergone some few necessary alterations under the directions of Mr. E. E. Hoadley, the borough electrical engineer. Mr. Stephen Sellon is consulting engineer, and the work was executed by Messrs. Dick, Kerr & Co.

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EXPERIMENTS ON SHEATH LOSSES OF THREE-CORE CABLES.

BY J. T. MORRIS.

Attention has recently been drawn to the fact, that, when a three-core cable is conveying a polyphase current certain losses occur in the lead sheath, or in any of the conductors which surround it. Mr. M. B. Field, in a most interesting Paper before the Institution of Electrical Engineers,* has discussed this subject from a mathematical point of view, and has shown on what quantities these losses depend, making certain assumptions.

The following article is an account of some experiments which the author has carried out in order to determine experimentally the magnitude of some of these losses. It occurred to him that the matter might be put to the test for any particular case in a fairly simple way and without the use of great lengths of cable by means of the following arrangement: Consider the case of a three-core cable conveying a balanced three-phase current. It is clear (as is well shown by diagrams in the Paper above referred to) that a magnetic field is rotating about the axis of the cable, which makes one revolution for each cycle of the alternating current; further, that this field does not move forward perfectly steadily, but revolves in rather a jerky manner. If the field induces eddy currents in any neighbouring conductors as it revolves, it will tend to drag those conductors round in the direction in which the field rotates. Hence, in the case of an ordinary three-core cable carrying current there is a very slight tendency for the sheath to slip round on the insulation in the same direction as that in which the magnetic field rotates.

Method.—Now, in order to determine the magnitude of this effect, the sheath can be supported in its normal position with reference to the conductors in the cable, having its axis vertical and with some of the insulation removed between the sheath and the conductors. The sheath is then free to move, and on sending a three-phase current through the conductors this sheath will turn round, and the force with which it tends to rotate will be a measure of the torque; and this torque multiplied by the angular velocity of the magnetic field (2π frequency) will give a measure of the work which is being done on the lead sheath, due to the rotating component of the magnetic field. This method has the distinct advantage over wattmeter methods and others which have been suggested, that it uses the whole of the power to measure the loss, and hence it becomes possible to measure with an accuracy, of certainly 1 per cent., the rate of expenditure of energy of one-thousandth part of a watt.

Standardising.—In all cases a single manganin wire was used for suspension purposes—generally about 10in. in length. To the lower end of this was attached, by means of a wire cradle (made of non-magnetic metal of high resistance), the piece of lead sheathing, which in the majority of cases was 6in. in length. Then, on passing a three-phase current through the three-core cable fixed independently inside the lead sheathing, a torque is produced which twists the lead sheathing through a small angle—the angle of twist being observed by means of a beam of light shining on a concave mirror attached to the cradle and reflected back on to a scale placed about 8ft. off. In order to determine the magnitude of this torque the suspension was standardised in the usual way by taking the time of oscillation of the lead sheathing and then adding a known moment of inertia and again taking the time of oscillation of the system, making use of the following relation:

$$\left.\begin{array}{l}\text{Time of one complete}\\ \text{oscillation in seconds}\end{array}\right\} = 2\pi\sqrt{\frac{\text{Moment of inertia}}{\text{Restoring force for unit angle}}} \quad (1)$$

The following example will serve to illustrate the method:—

Angular deflection in radians	+0·0163
On interchanging two of the leads, angular deflection in radians	−0·0165
Mean angle.....	0·0164,

when 50 amperes in each phase is flowing, frequency being 60 ∽ per second:

Time of oscillation of lead sheathing alone	8·44 seconds
Time of oscillation with moment of inertia of 22,580 added	17·18 seconds

Then from equation (1) we obtain, as the restoring force for unit angle, 3,980 dyne cm.; and hence restoring force and, therefore, deflecting force in this experiment is

$$3{,}980 \times 0{\cdot}0164 = 65{\cdot}3 \text{ dyne cm.}$$

This torque multiplied by the angular velocity of the field (2π frequency) gives $65{\cdot}3 \times 2\pi 60 = 24{,}600$ dyne cm. per second, or ergs per second, as the rate at which work is being done on the lead sheath; and, dividing by 10^7 to convert into watts, we get 0·00246 watts as the rate at which electrical energy is being dissipated in this particular length of lead sheathing with 50 amperes passing in the cable at a frequency of 60∽.

Particulars of Cable used.—The cable used in most of the experiments was a piece of high-tension three-core cable suitable for a current of about 50 amperes per phase, the thickness of insulation between each conductor being 0·35in. Resistance per mile of each core 0·71 ohm. A section is shown in Fig. 1. In the section, part of the insulation is shaded; this indicates that portion of the insulation which was removed in order that the sheath might swing quite clear of the cable.

Connections.—In all the experiments the piece of three-phase cable under test was arranged with its axis vertical, and the upper ends of the three cores were electrically connected together by a stout Y-shaped piece of copper, thereby forming the centre-point of the three-phase system. This arrangement has certain advantages, the main being that it enables the space above the cable to be kept quite clear for suspension purposes, and it also ensures that the potential of the three cores shall be practically identical. Hence any dielectric losses which might be supposed to affect the result are reduced to a vanishing quantity. It should be stated that the ends of the cable projected above and below the lead sheath in all cases by a length of at least 6in. (in many of the experiments by a much greater length), in order to eliminate as nearly as possible the disturbance produced by the ends of the cable. The currents were adjusted, by means of water resistances in the three branches of the star-connected three phase circuit, to approximately equal values in the three phases, and the current wave was practically sinusoidal, but slightly more pointed. The frequency, except where otherwise stated, was always adjusted to 60∽ per second.

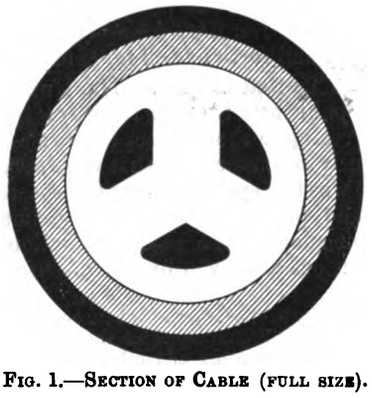

Fig. 1.—Section of Cable (full size).

Dependence of Loss on Length.—The next question which arises is: What relation exists between the loss on a short length obtained in this way and that on, say, a mile's length of cable? In carrying out these experiments it became at once clear that the loss, as one might expect, is not proportional to the length so long as such short lengths as 3in. to 6in. specimens are being dealt with. From a consideration of the distribution of the magnetic field and the way in which it rotates, the distribution of eddy currents in the lead sheath will be found to be as follows:—The eddy currents which are induced in the lead sheath flow up on one side of the sheath parallel with the axis of the cable (except for a slight slope due to the lay), and divide into two streams, passing near to the end of the piece of sheathing. They unite again on the opposite side of the sheath and stream down that side, dividing into two near the bottom, and uniting at the point first started from, and so on. It will be understood that the eddy currents are not flowing parallel with the axis of the cable for

* See *The Electrician*, Vol. LII., p. 1,017, and Vol. LIII., pp. 12 and 56, "A Theoretical Consideration of the Currents Induced in Cable Sheaths and the Losses occasioned thereby," by M. B. Field.

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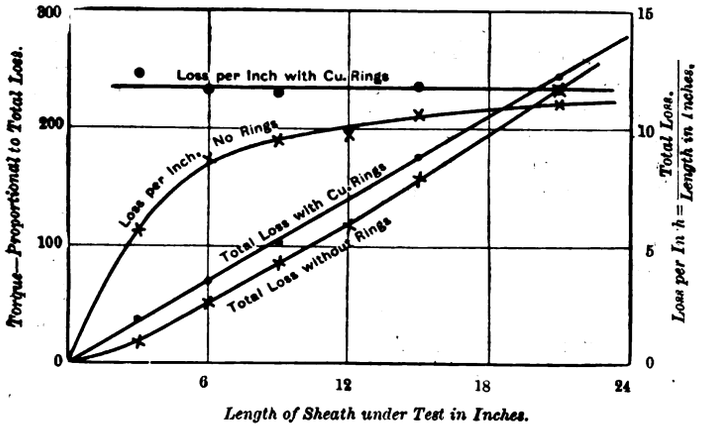
the whole of this short length of the sheath as they would do if this piece of sheathing were under normal working conditions, forming part of a long length of cable in actual work. To remedy this defect stout rings of high-conductivity copper, made from rod ¼in. diameter, were carefully soldered on to the two ends of the sheathing. As the conductivity of lead is only 6 per cent. of that of copper it was assumed that these copper rings might fairly be considered as conductors of relatively perfect conducting power when compared with the sheath. In order, however, to test the matter conclusively, a piece of cable 1 yd. long was taken, and experiments were carried out on the lead sheathing of the cable from 21in. downwards. The results are given below (see Table I.), and are shown graphically in curve A:—

Table I.—*Effect of Length of Sheath on Losses at a Current of 50 amperes and 60 ∼.*

Length of sheath in inches.	Deflection of sheath with two Curings.		Deflection of sheath alone.
	—	Corrected for loss in copper rings.	
21	248·5	245·5	233·0
15	180·0	177·0	159·5
12	..	..	117·0
9	107·0	104·0	86·0
6	73·0	70·0	52·0
3	40·0	37·0	17·0
0	3·0*	0·0	..

* Note.—This figure is a measure of the small loss which occurs in the copper rings themselves, and was determined by sweating the two rings together with no lead cylinder in between, and then observing the torque. This being deducted gives the figures in the next column.



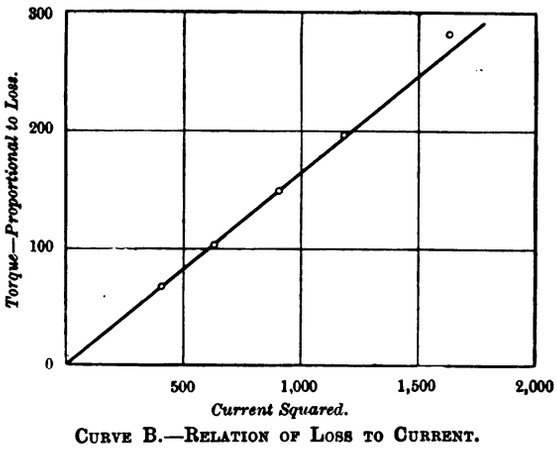
Curve A.

These experiments show that, with the addition of the copper rings, the results are practically proportional to the length, within experimental errors, down to as short a length as 4in. or even 3in. Whilst, if no rings are attached, in order to obtain as correct results, it would be necessary to experiment with lengths of 2ft. or more. The experimental difficulties then become rather considerable, principally owing to the great difficulty of getting the lead sheath to swing clear over such a length, but also because the time of oscillation is then so excessively slow—approximately three-quarters of a minute.

Dependence of Loss on Current Strength.—Ample evidence has been obtained during the course of this investigation to show that the loss in the lead sheath is rigidly proportional to the square of the current strength. Two examples are given, one in curve B (Table II.), the other in curve E (lower curve). In both these cases the torque has been plotted against the square of the current, and it will be seen that, within experimental errors, the curve is a straight line, the current being the same in the three phases. If the current in two cores is reversed, the direction of the torque is also reversed, but its magnitude remains unaltered. This was done in every experiment, and the mean taken in order to eliminate any zero errors. When the current in one of the phases was broken, there was, in no case, any torque observed.

Table II.—*Current varied. Frequency constant at 60∼.*

Amps.	(Amps.)².	Deflection of sheath.
20·25	410	67·5
25·15	633	103·5
30·15	909	148·0
34·4	1,183	196·5
40·4	1,632	282·5



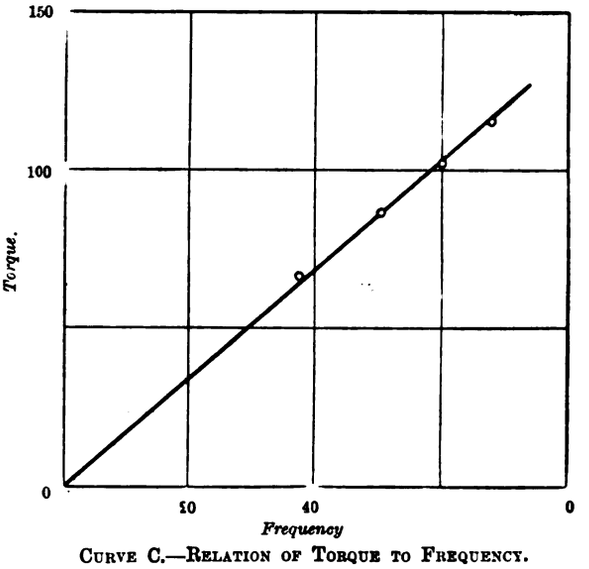
Curve B.—Relation of Loss to Current.

Dependence of Loss on Frequency.—In the experiments bearing on this subject, the current was maintained constant in each of the three phases at 25 amperes, and the frequency varied from 37 to 68∼ per second. The torque was found to be practically proportional to the frequency over this range. See Table III. and curve C.

Table III.—*Frequency varied. Current constant at 25 amperes.*

Frequency.	Torque.	Sheath loss proportional to Torque × Frequency.
37·2	66·5	248
50·3	86·8	438
60·0	102·2	613
67·8	115·5	785

Note.—Thickness of sheath about 0·13in.



Curve C.—Relation of Torque to Frequency.

In order to obtain the loss, the torque, as shown above, has to be multiplied by a constant × frequency, and hence the loss for constant current is approximately proportional to the square of the frequency. A reduction of 5 per cent. in proportionality will be noted between the lowest and highest frequency for this thickness of sheath.

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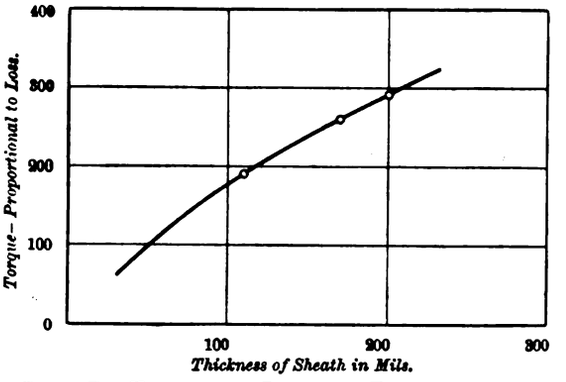
Dependence of Loss on Thickness of Sheath.—To put this matter to the test a piece of lead sheathing was obtained $\frac{1}{8}$in. in thickness. It was cut into 6in. lengths. Two of these pieces were turned down to thicknesses of 170 and 110 mils respectively, and the tests were made on three samples measuring 200, 170 and 110 mils. Copper rings were, as usual, sweated on to the two ends of each portion. The following results were obtained. They are shown graphically in curve D.

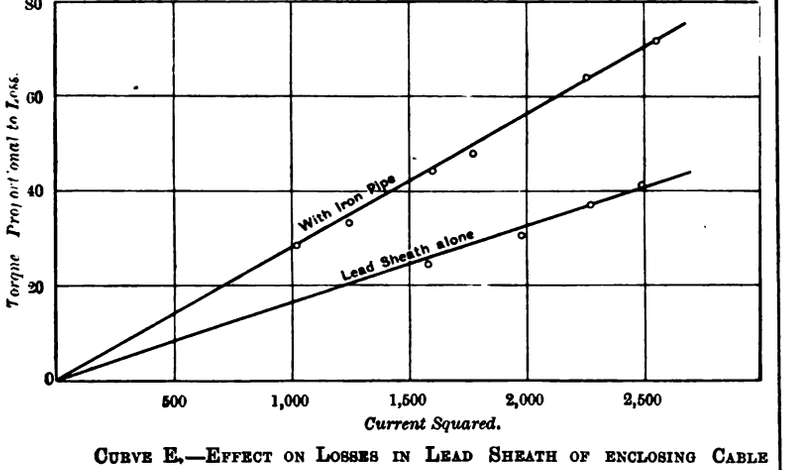
Thickness of sheath in mils.	Torque at 40 amperes, 60 ∼.
110	191
170	260
200	292



CURVE D.—VARIATION OF LOSS WITH THICKNESS OF SHEATH.

Hence for a frequency of 60 ∼ the loss varies as the thickness raised to the 0·7th power.

Effect due to Iron Pipe.—Three-core cables for polyphase work are occasionally placed in iron pipes or have steel armouring, though this is not considered good practice at the present time. As the method employed in these experiments is well adapted for the investigation of such matters, the experiments with a 9in. length of lead sheathing were repeated with a piece of 3in. wrought-iron pipe about 20in. in length (thickness $\frac{1}{4}$in.) slipped up outside the lead sheath and fixed in position. The lead sheath was left free to turn round without touching the pipe, and the torque on the lead sheath was again measured. It was found to have increased the lead loss by 70 to 75 per cent. throughout the whole range of current for which tests



CURVE E.—EFFECT ON LOSSES IN LEAD SHEATH OF ENCLOSING CABLE IN A WROUGHT IRON PIPE.

were made (see curve E). The losses in the iron pipe were not measured, but could easily be determined by the same method.

Conclusions.—Within the limits examined, the experiments show that the loss varies directly as the square of the current, as the square of the frequency and directly as the length. For the section of cable shown in Fig. 1 (within moderate limits of frequency), the loss in watts can be expressed by the following relation: Sheath watts $= c^2 f^2 l t^{0.7} \times 37 \times 10^{-12}$; where c = current in amperes, f = frequency, l = length of cable in yards, t = thickness of sheath in mils. This gives a loss of 17·3 watts per mile at a current of 50 amperes per phase and frequency of 60 ∼. Comparing this with the C^2R loss in the copper conductors for the same current (resistance per core 0·713 ohm). Total copper loss = 5,346 watts; Lead sheath loss = 17 watts. Hence the sheath loss is only one-third per cent. of the copper loss, and produces no greater effect than the increase in copper loss brought about by a rise of 1°C. of the cable. Though the loss is insignificant in this case, yet when greater distances separate the conductors and larger currents are employed the loss may become serious, as Mr. Field has shown in his Paper referred to above. If these experimental results are compared with the case calculated by Mr. Field, they will be found to be in fairly close agreement, when due allowance is made for the increased size of conductors, thickness of sheath and increase of current from 50 to 200 amperes.

In a short time the author hopes to be able to put the method described in this Paper to a practical test, by comparing the results obtained by this method on a 6in. length of cable with those obtained by a different method on upwards of 1 mile of the same cable when laid in position. In conclusion, the author desires to express his thanks to Messrs. W. T. Henley & Co. for their kindness in supplying some of the cable tested, and also to Mr. F. T. Fawcett for useful suggestions and much patient help during the course of the experimental work.

East London Technical College, Aug., 1904.

POWER SUPPLY TO TRAMWAYS IN NORTH LONDON.

(*Concluded from p. 746.*)

In our article on the electric tramways in North London (*The Electrician*, July 29th, p. 591), for which the Brimsdown station generates the necessary electrical power, the extensive nature of this undertaking was pointed out and well illustrated by a map. For such large traction schemes it is becoming the practice to transmit power in the form of high-tension alternating current, generally three-phase, from one or more central stations to a number of sub-stations, conveniently situated with regard to the lines to be operated, and the high-tension currents are then converted into continuous current at working pressure. In the case of the North London tramways, high-tension current from Brimsdown is conveyed by three-core feeders to sub-stations, of which in the near future there will be four, situated at Wood Green, Edmonton, Hendon, and Finchley respectively. At present the first sub-station is in operation, the second is already completed, the third is rapidly nearing completion, while the buildings of the fourth station have been commenced. The high-tension feeder network to all four sub-stations is fairly complete, and the gaps still existing are gradually diminishing in number and length. As will be remembered from our former article, the North Metropolitan Electrical Power Supply Co. also owns a generating station at Willesden, which supplies both alternating and continuous current by means of double-current generators. Unfortunately, however, the alternating current has a frequency of 25 ∼ per second only, and cannot, therefore, be used for supplying the high-tension network of the tramway system. In order to enable both power stations to work in parallel inverted rotaries have lately been installed at Willesden, and these will supply three-phase current at the same frequency as that of Brimsdown.

All sub-stations are equipped similarly, the only difference being with regard to arrangement and size. Fig. 8 is a plan and cross-section of Wood Green sub-station, and shows very well how the plant has been laid out. The car sheds are not shown on Fig. 8, but it may be mentioned that these sheds accommodate some 60 cars, and extensions will be carried out shortly. The high-tension underground cables emerge into the sub-station in the high-tension chamber shown in Fig. 8. Connection between the incoming cables and the cables in the station is made by means of cable bells, the construction of which is indicated in Fig. 10. The cables are first led to the B.T.-H. oil-break switches (see diagram of connections, Fig. 9) mechanically operated from the high-tension switchboard, each

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switch being situated in a separate brick cell, fitted with slate covers and iron doors. In general construction they are very similar to those installed at Brimsdown. It will be noticed from the diagram that they are automatically opened when the load exceeds a pre-determined value. From the oil switches, the incoming feeders, of which there are two, are connected to the high-tension 'bus bars, the position of which is clearly indicated in Fig. 8. Two outgoing feeders branch off from the 'bus bars, passing through oil switches, mechanically controlled from the feeder panels on the high-tension switchboard. As is seen in the diagram of connections, a section switch allows one incoming and one outgoing feeder to be entirely disconnected from the rest of the high-tension system in the station. This, of course, has been arranged so that the energy conveyed by that feeder may be directly passed on to another sub-station, if required. On the high tension 'bus bars there are also three sets of three-phase connections, one belonging to each of the three rotary circuits. These connections pass through oil switches of the same type as described above, and are then led to the transformers, which are of the core type and oil-cooled. Three single-phase transformers, connected together in delta fashion, form one three-phase set. There are three such sets, and one single-phase transformer, kept as a reserve near by, may be brought on a low lying trolley to any of these sets, and thus substituted for a defective element in a short time. For aiding the removal and replacing of the transformers, suitable hooks are fixed to the ceiling above them. Each single-phase transformer has a capacity of 92kw. and an efficiency at full load of 97·2 per cent. Its voltage variation is specified to be not more than 1·4 per cent. Including oil, the weight of one element comes to about 5,400lb., the floor space covered being 27in. by 45in., and the height 72in. The primary voltage is as near as possible 10,000 volts, the secondary pressure being 340 volts. Radiation from the outer cast-iron shell is depended upon to keep the oil cool. An earth shield is provided between the low and high-pressure windings, the latter being sectioned up into a number of coils. During continuous running at full load the temperature rise, as measured by the increase in resistance of the windings, was not to exceed 50°C., and it was specified, moreover, that the transformer should be capable of withstanding a 25 per cent. overload for two hours and a 100 per cent. overload momentarily. After leaving the transformers the low-tension leads pass through three-phase oil-cooled reactance coils, designed for a voltage of 18 volts per phase and a current of 465 amperes per phase. The reactance consists of a three-legged core with a short air-gap in each leg, in order to obtain the required reluctance. These reactance coils have been inserted in the circuit for steadying purposes. They absorb, of course, some power, but it is specified that this shall be less than 1 per cent. when full-load current is passing. After having become steady in temperature when running fully loaded, the temperature rise is not to exceed 45°C. The cables now pass, by way of knife switches on the low-pressure alternating-current panel, to the rotaries. The principal data of the rotary converters, three of which have been installed, are: Normal capacity 250kw., number of poles eight, speed 750 revs. per min., voltage on the alternating-current side 335 volts and on continuous current side 550 volts. In order to obtain greater freedom from hunting, the rotaries are compound-wound, the pole-pieces being of cast steel. After a 24 hours' run at full load the temperature at no part of the rotary is more than 40°C. above that of the surrounding air. The machines are amply dimensioned, being capable of carrying an overload of 25 per cent. for two hours and an overload of 100 per cent. for a short time without flashing or injurious sparking. At full load and half-load the commercial efficiencies are stated to be 92·5 and 87 per cent. respectively. For starting the rotaries a 10 H.P. induction motor has been keyed to the shaft of each. This plan of starting has been adopted because it allows the rotaries to be brought up to speed very quickly. To this end the induction motor has been designed for a very large starting torque. In consequence, the internal resistance of the motor is exceptionally high, but this, again, allows a starting resistance to be dispensed with. Alternating current from the low-pressure side may be switched on to this induction motor by a small switch of the knife-blade type mounted on the high-tension board. The rotor of the motor is permanently short-circuited. When speeding up a rotary, a variable loading resistance is inserted into one of its phases, as shown in the diagram of connections. This has the effect

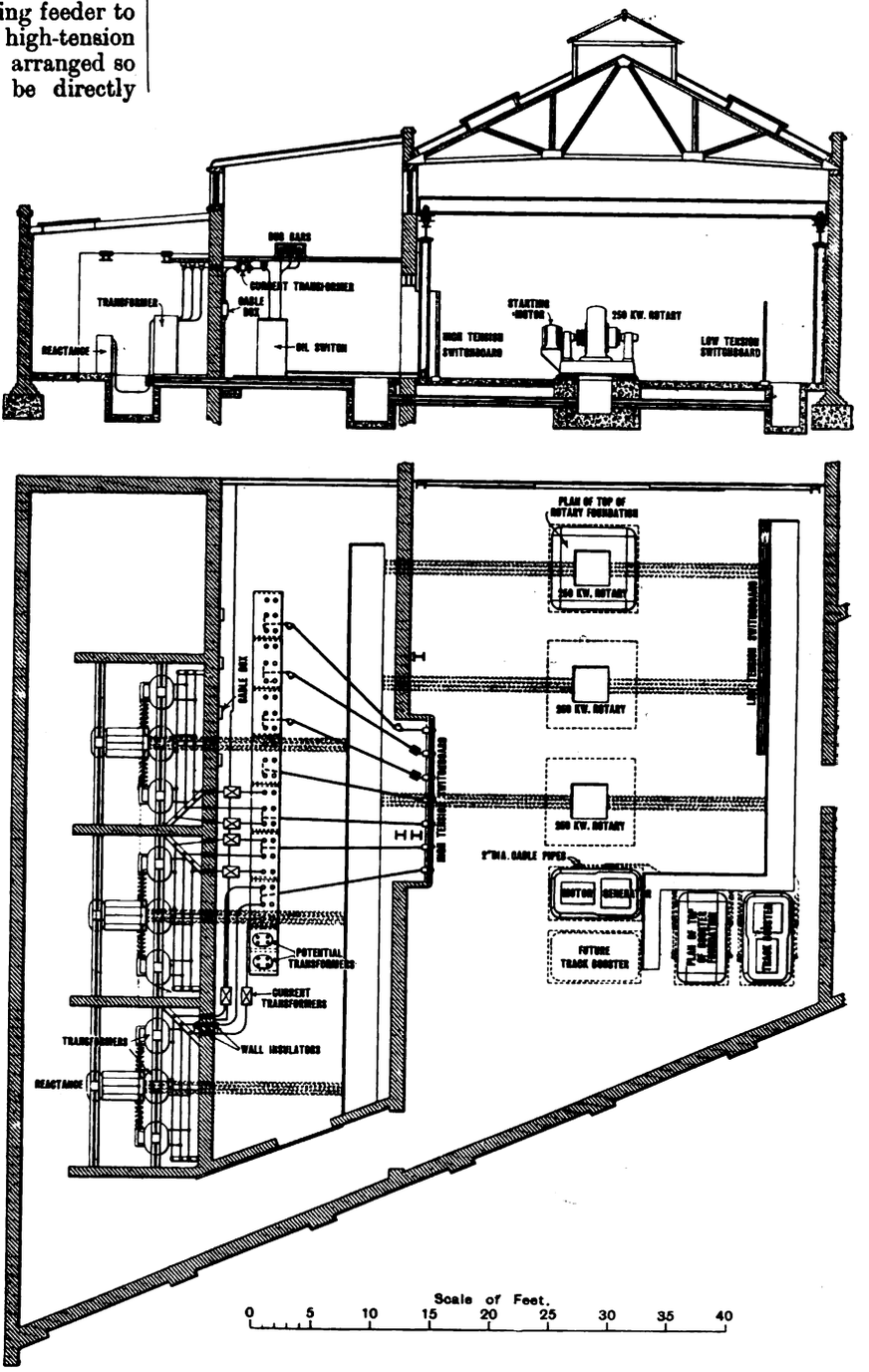

FIG. 8.– PLAN AND CROSS-SECTION OF WOOD GREEN SUB-STATION, SHOWING GENERAL ARRANGEMENT OF PLANT.

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of steadying the motion, and allows the speed of the rotary in question to be adjusted to a nicety. After the converter has been brought up to synchronism, both the motor and the loading resistance are switched off. The current from the rotaries is now led to the continuous-current switchboard and to the 'bus bars. Since the field of the rotaries may be varied in strength by field rheostats, regulation of the voltage of the continuous-current supply is possible by altering the phase

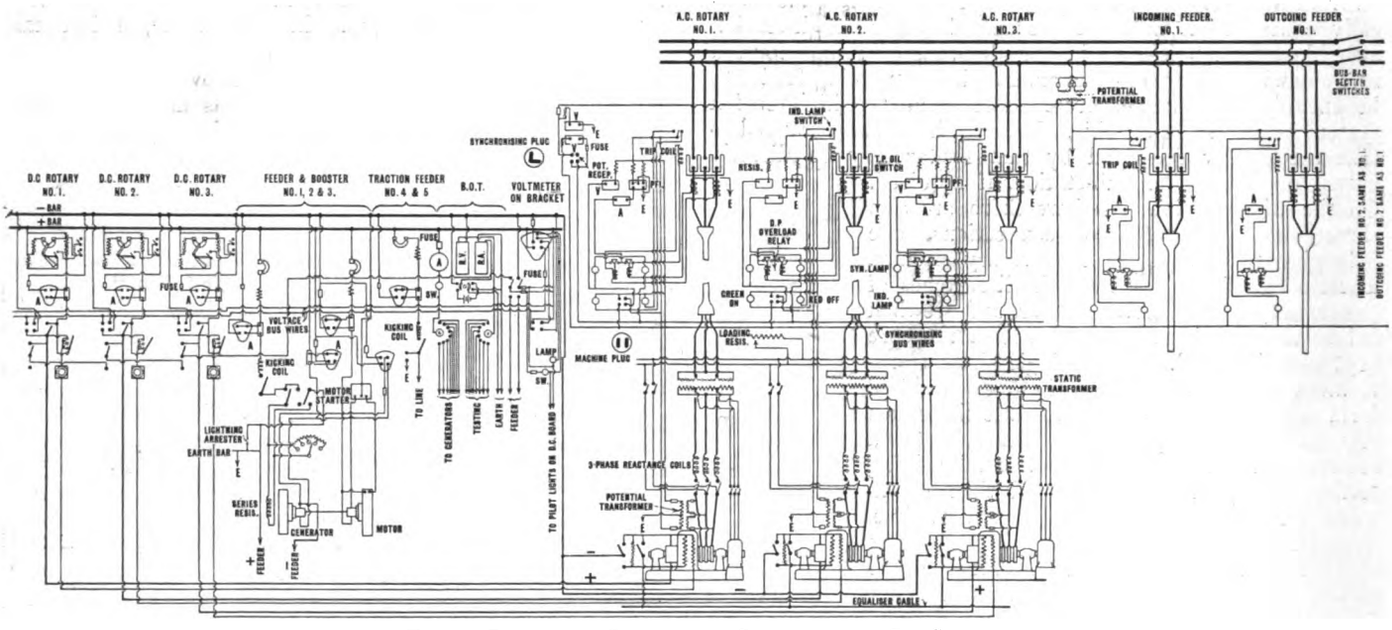

FIG. 9.—DIAGRAM OF SWITCHBOARD CONNECTIONS AT SUB-STATION.

relations between voltage and current on the alternating-current side of the converter. However, the conductors for conveying both alternating and continuous current are so amply dimensioned that for the present at any rate the fluctuations in voltage on the continuous-current side are but slight. There are four line feeders and two track feeders. In the circuit of the latter are two negative boosters, consisting of a shunt-wound motor driving a series-wound generator, both mounted on the same bed-plate, and a diverter rheostat is connected in shunt with the booster field. The normal output of the generator is 400 amperes at 50 volts, the speed at which it is driven being about 1,025 revs. per min. The shunt motor is supplied with current from the 550-volt supply. Momentary overloads not exceeding 50 per cent. are dealt with by the set without injury, and an overload of 25 per cent. can be

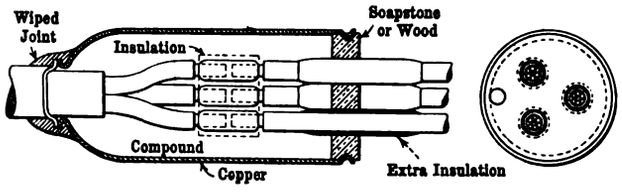

FIG. 10.—SECTION OF A CABLE BELL.

carried for one hour. After a 10 hours' run, when loaded with 20kw., the temperature of the set does not exceed 45°C. above that of the surrounding air. The combined efficiency is guaranteed to be 79·25 per cent. at full load, falling to 71·25 per cent. at half load. In the construction of the set there is nothing which calls for special mention. The set is started by a rheostat on the motor side.

There are two switchboards, both of white marble 2in. thick. One, placed on the side of the rotaries next to the transformers, contains all the apparatus for controlling and measuring the alternating currents, while the other, built of the same material, is on the opposite side of the converters, and controls the continuous-current circuits. In general construction, the board itself is nearly identical with the boards at Brimsdown. All instruments, we are told, are guaranteed to be accurate to 1 per cent. The alternating-current board consists of the following panels:—Three rotary panels, two panels for the incoming high-tension feeders, two panels for the outgoing feeders and one voltmeter equipment. No high-tension instruments or connections are fitted to the switchboard, all measuring instruments being worked from current and potential transformers.

The continuous-current switchboard consists of the following panels:—Five for the traction feeders, one Board of Trade panel, three negative equaliser and field switch panels, three rotary converter panels, three track booster panels and one voltmeter equipment. At a future date when a battery has been put down, battery and battery booster panels will be erected also. For this purpose ample room for later extensions to the board has been left. So far, current is supplied to the

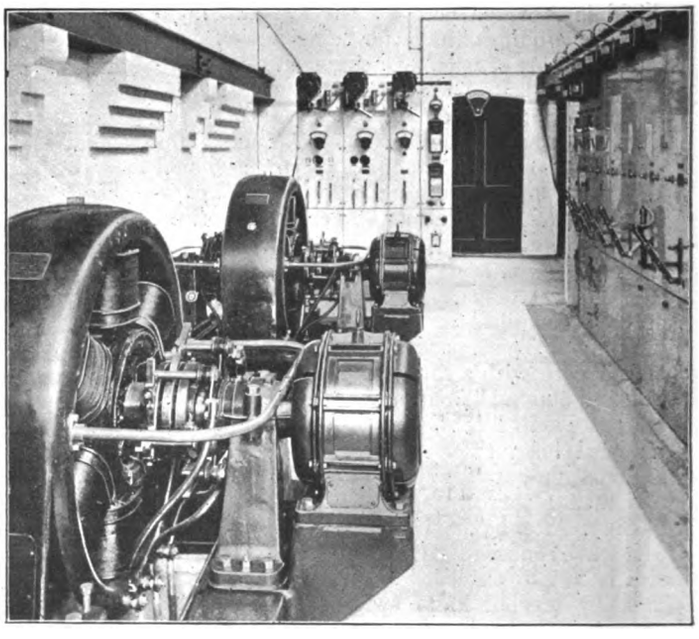

FIG. 11.—INTERIOR OF EDMONTON SUB-STATION.

tramway system from this sub-station by three line feeders only. The quick-break switches and lightning arresters are of the B.T.-H. type. A kicking coil is provided in the line feeder circuit. The circuit-breakers are of the B.T.-H. magnetic blow-out type, adjustable to open the circuit at any predetermined current within their range. The voltmeters and ammeters are of the moving-coil type.

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A view of the interior of the sub-station at Edmonton is given in Fig. 11. It is built on the same lines as that at Wood Green, but is equipped with two 100kw. rotaries only. Hendon, again, will have 250kw. sets, like Wood Green. The buildings are now completed, and the converting plant has been put down but not yet tested. Adjoining the sub station are about 8½ acres of land bought up by the company for future extensions of the car shed and car repairing shops. The station at Finchley is the least advanced, but the buildings are rapidly being pushed forward. These four sub-stations are to be interconnected by cables in duplicate, the network thus formed being fed with high-tension current from Brimsdown and Willesden, situated at the extreme ends of the system. The cables are B.I.W. three-core, paper-insulated and lead-covered, the insulation being specially thick on account of the neutral point of the three-phase system not being earthed. Measured over the lead covering, the diameter is 2·2in., and each copper core has a section of 0·1 sq. in. The capacity per mile is stated to be 0·35mfd. Mr. Sydney G. Smith, chief assistant to Mr. A. H. Pott, ably superintended the erection of the overhead equipment of the tramways and the cable laying for the whole scheme.

As mentioned earlier, the power station at Willesden has recently been equipped with auxiliary plant for enabling it to work in parallel with the station at Brimsdown. This auxiliary equipment consists of two 250kw. rotary converters, receiving current at about 550 volts from the continuous-current side of the double current generators and supplying three-phase current at about 340 volts and at a frequency of 50 ∼ per second. These inverted rotaries are similar to those installed at the sub-stations with the following differences:—Instead of the small induction motor on the converter shaft, there is a pulley from which a small exciter is driven by a belt. A governor has also been provided, which cuts the rotary out of circuit should the latter's speed exceed a predetermined limit. The current from the inverted rotaries is stepped-up to about 10,000 volts and transmitted to the high tension network. Since the network is yet incomplete only the Hendon sub-station will be operated from Willesden for the present.

Our thanks are due to Mr. A. H. Pott, chief engineer of the Metropolitan Electric Tramways, for conducting our representative over the whole system and for placing at our disposal information with which to compile this article. The erection of the plant at the Brimsdown power station was superintended on behalf of the Brush Company by Mr. H. H. Perry, who will subsequently take over the running of the station for the Company.

"THE TIMES" AND "WIRELESS" WAR CORRESPONDENCE.

The Times of August 27th contains a long and interesting article from their correspondent who has been on board their dispatch steamer "Haimun" in the Far East, and who has been utilising wireless telegraphy as a means of expediting the transmission of his news. After detailing the circumstances which led to the decision to employ a wireless telegraph system, the writer relates graphically the difficulties which were encountered in finding a suitable vessel and in fitting up the high mast required for the transmitting station. The De Forest Company had undertaken that the system would operate with certainty over distances of 200 miles if a mast 180ft. high could be erected both at the sending and receiving stations. The site chosen for the land station was the island of Liu-kung-tau which practically forms the Wei-hai-wei harbour, being about 3 miles from Port Edward, which is the official residence of the Commissioner. Most of the material had to be brought from the mainland, and it was most difficult to find spars of large enough dimensions for the mast, so that the mast had eventually to be 170ft. high instead of 180ft. In addition, a house had to be built for the operating room, and another shed for use as an engine room. Finally, after a 1 H.P. gas engine was got to run smoothly it was found that an important part of the electrical plant—namely, the exciter, had been lost in transit. The fitting of the boat was not so difficult as she was an electrically-lighted ship, and while the land station was being completed she was already making constant passages between Wei-hai-wei and Chemulpo, which was then one of the most interesting centres of the theatre of the war. The Wei-hai-wei station was in order 26 days after the plant had arrived in Wei-hai-wei, and on March 14th the first wireless message was exchanged across 20 miles of sea. From that date until April 18th a continuous service was maintained between the stations.

Some trouble was occasioned in the first instance by the omission to secure a good earth connection, the land station being situated on a rock nearly 100ft. above the level of the sea, but later on a better connection was made by placing copper plates in the sea and leading a wire to them over the face of the cliffs. The first serious accident was the carrying away of the topmast of the land station by a strong north-west gale. Fortunately 90ft. of the mast was left, and it was found possible to work with this length of mast over 100 miles while the repairs were being executed. The height of the mast on the ship was 102ft. It was during this period that the message from *The Times* Naval Correspondent describing the destroyer fight at sea was sent, and it was subsequently found that, although the message contained nearly 1,000 words, there was not one that had been received incorrectly. A visit of *The Times* Special Naval Correspondent soon after this enabled the mast of the land station to be properly fitted and stayed, as this correspondent fortunately possessed experience in such matters. From this time forward it was no longer necessary for the correspondent on board the dispatch boat to return to Wei-hai-wei in order to transmit his news, and the dispatch boat could remain in the vicinity of Port Arthur for long periods at a time:—

> We would leave Wei-hai-wei late at night and make Round Island, 44 miles east-south-east of Port Arthur, at daybreak. We would then steer due west in order to make Liau-tie-shan promonotory about 10 o'clock in the morning. After hovering in the vicinity of Port Arthur for some hours, we would steer south and anchor, weather permitting, in 12 fathoms, off Hwang-ching Island. Here we were within 25 miles of Port Arthur, and all through the night we could see the searchlights as the Russians swept the narrow approaches to their stronghold. It is strange that, although during this period we were so constantly in the vicinity of the Russians, we rarely saw a Russian vessel, and at night never, although, of course, we anchored with all our lights showing. At daybreak we would steer back within 10 miles of Port Arthur until we made Round Island in the afternoon. A fortnight of cruising in this manner gave us opportunities of seeing the rival fleets. On one occasion—namely, March 26th and March 27th—we were able to see the rival squadrons on two consecutive days. On March 26th, at 11 a.m., we reported the Russian fleet at sea to Wei-hai-wei for transmission to London. This message was despatched 70 miles north-west of Wei-hai-wei. On the following morning we reported from 65 miles north-west the fact that on the preceding night Togo had made another attemp to block up Port Arthur.

The boat was not only able to receive signals from the land station, but also Russian and Japanese messages. With regard to these, *The Times* correspondent says:—

> These messages, of course, came in cypher, and as we possessed no key it was impossible for us to make any improper uses of messages thus received, but we could easily recognise the difference in the systems employed, and by this means—and here another very important thing in favour of our system was proved—we were able approximately to tell the distance we were from the various ships. Moreover, our operator, who was extremely expert, began to recognise the notes of various ships—that is to say, he could tell if a Russian ship was at sea by listening for the answering communication from the shore. He could also detect whether the Japanese messages were being transmitted by relay to the naval base or whether the fleet itself was at sea. This, of course, was to us possibly of more value than if we had been able to decipher the actual messages sent, and during the period that the "Haimun" was in operation during April our most successful issues resulted from a careful listening for the wireless telegraphy of the opposing fleets. We listened, and came to conclusions which invariably correctly guided us in our movements. For instance, if for a space of six hours on end the Japanese were absolutely silent, we knew that Togo had taken to the sea, for invariably when he entered upon some enterprise for the time being all wireless communication ceased. This being the case, we knew exactly what course to steer, but even at this period we had not fully realised how successfully our system had been installed.

On April 9th the "Haimun" had to go to Chemulpo with *The Times* correspondent detailed to join Kuroki's army. On the way there, messages were sent from Bundegi to Wei-hai-wei, a distance of 80 sea-miles. Between Chemulpo and Chinampo news was heard which pointed to the probability of an important naval engagement at Port Arthur, and after

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strenuous exertions, attended by considerable risk, the vessel arrived in time to witness the first great naval engagement to be reported by wireless telegraphy. The article continues:—

It may be readily understood that we were very careful not to use our wireless telegraphy until the battleships themselves were engaged with the Port Arthur batteries. The reason for this is obvious. If we had commenced to send news of the position of the rival fleets, we should have at once interfered with the wireless telegraphy of both belligerents. This would certainly have been an unfriendly act, but, although we did not use our own instruments for sending, we listened attentively. The Russians were hard at work. They were just repeating the alphabet over and over again in order to "queer" the Japanese recording instruments. In fact, I am not sure it was not the constant use made by the Russians of their shore stations that prevented Togo from coming up in time to catch Makaroff's squadron outside. There is some discrepancy in the times given when the Japanese decoy squadron sent its messages to Togo and when Makaroff decided that he was too far out at sea and reshaped his course towards Port Arthur. It was only when the Russians stopped their "queering" process in order to receive a message from the "Bayan" that the Japanese second-class cruiser squadron was able to get an interval in which to send its all-important message. We received both messages, the Japanese, of course, being in their own private cipher, that from the "Bayan" being half in cipher, with a few words in French, and signed "B. A." But when once Togo had hoisted his fighting flags and sailed in under the guns of Port Arthur we felt that we were justified in sending just a short message, and so at 9:15 we sent a brief report from within 7 miles of Port Arthur, which furnishes the first record of a wireless message reporting a naval engagement being sent direct from the scene of operations to the office of the journal which was to give it to the public. . . . Later in the evening, when the Japanese had finished sending messages, we were able to send fuller reports of the day's fighting as we steered a course for Chinampo.

Returning again from Chinampo, the "Haimun" could still hold easy communication with Wei-hai-wei, a distance of over 200 sea-miles. Soon after this, however, a message was received from Wei-hai-wei giving the contents of Admiral Alexeieff's proclamation that wireless telegraphists would be treated as spies. Following this came the unwelcome announcement that the Japanese Government had seen fit to pass limitations on the free movements of the "Haimun," and this resulted in the wireless service being discontinued. The article closes with an account of some long-distance records obtained between the two wireless telegraph stations:

When ultimately it was worth my while to go north from Nagasaki on May 15th, in latitude 125° 10′ east, longitude 36° 15′ north, 155 miles from our land station, we sent a long message explaining the reason of the temporary suspension of the wireless system. Since the message had to cross 30 miles of the mountainous corner of the Shan-tung promontory, the hills of which vary from 200ft. to 1,860ft., its receipt may be considered the greatest triumph of the De Forest system in the Far East. On the following day we effected our longest distance. We sent and received an answer from just outside Chemulpo. This was over 210 sea-miles, and part of the distance was broken by the islands of the Prince Imperial Archipelago. A small portion of this message was not intelligible, but this was due to the fact that at the moment of sending a British war vessel was entering Chemulpo, and was using its wireless arrangements actually as it was passing within a cable's length of our shore station. The near proximity of this rival machine destroyed for a moment one of the most sensitive parts of our receiving apparatus, and some 25 words of the message were bungled.

SOME RECENT LONG-DISTANCE SUBMARINE TELEPHONE CABLES.*

BY F. BREISIG.

The submarine telephone cable from Fehmarn to Lolland is a connecting link in the Berlin-Copenhagen telephone line. It has a length of 12 statute miles, and was ordered conjointly by the German and Danish telegraph authorities. Subsequently the cables Greetsiel-Borkum (18·3 miles) and Cuxhaven-Heligoland (45 miles) were put down. These cables were made and laid by Messrs. Felten and Guillaume.

The damping per kilometre of cable is a function of the expression $e^{\sqrt{(a+imc)(w+iml)}s}$, wherein a = leakance, c = capacity, w = resistance, l = inductance per kilometre, m = frequency in 2π seconds and s = length of line in kilometres. This expression is now generally written in the form $e^{(ai+\beta)s}$, wherein $e^{\beta s}$ denotes a constant and e^{ais} a phase difference. The latter depends on the wave-length, and is important in connection with the theory of lines on the Pupin system. In the case under discussion, however, a need not be further discussed. If we assume—as is customary, especially when discussing cables—that the leakance is very small so as to be practically negligible—*i.e.*, that the insulation resistance is very large, we get by simple transformation: $\beta^2 = \frac{mc}{2}(\sqrt{m^2l^2+w^2} - ml)$.

The value of β is easily determined by means of this equation, and, since the limits of $e^{\beta s}$ for satisfactory telephonic speaking are known for other lines, it is possible either to examine an existing line as to its efficiency with regard to communication or to determine the necessary value of β for a new line of given length.

Pupin has termed β the "damping constant." If the self-induction is very large, then the damping is practically the same for any frequency, and the speech transmitted over such lines will be clear but weak. If, on the other hand, the self-induction of the cable be zero, then the waves of high frequency will be much weakened and telephonic communications will sound loud but dull and toneless.

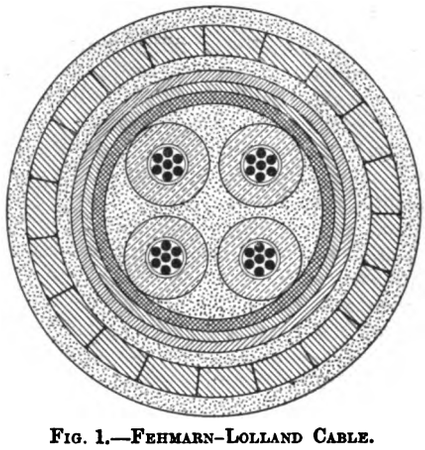

FIG. 1.—FEHMARN–LOLLAND CABLE.

From Fig. 1, representing a section of the Fehmarn–Lolland cable, it will be seen that four cores have been used, each consisting of seven copper strands, 1·35mm. in diameter. To increase the inductance, each of the four conductors is wound with a bare iron wire, having a diameter of 0·3mm., and then insulated by several layers of paper tape, the diameter over the insulation being 11mm. The four cores are then grouped around a jute core, the whole being subsequently wound with paper and tape. This unfinished cable is now 32mm. in diameter. It is then impregnated and covered with two lead sheathings (each about 1·5mm. thick), the lead containing 3 per cent zinc. Upon this there are two layers of bituminous paper and compound. The armouring consists of 19 galvanised iron wires of a trapezoidal section. On top of this there are two layers of compound. One shore end of the cable has for a length of 1·24 miles an additional protection in the form of an armouring of 32 iron wires of the form shown in Fig. 2. The final covering of this portion of the cable consists of two layers of compound. The outside diameter of the cable is 55mm. and 69mm. respectively, the corresponding weights per mile being 17 and 32 tons. There are no joints, the cable being made in one piece. Both before the cable was laid in January,

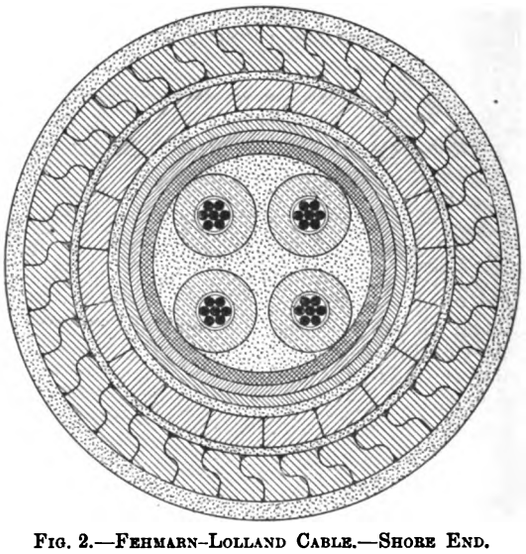

FIG. 2.—FEHMARN–LOLLAND CABLE.—SHORE END.

* Abstract of a Paper read before the Elektrotechnischer Verein of Berlin.

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1903, and subsequently, various experiments were carried out, and they proved that telephonic communication could be carried on very satisfactorily. The two other submarine cables mentioned were laid in the same year.

If, instead of using an insulation of bituminous paper, dry paper, loosely applied, is used for this purpose, the cable would gain in capacity, and a given damping might be obtained with a lighter cable. For the new cables, therefore, air insulated lead-covered cables were decided upon. In order to prevent long lengths of the cable becoming moist in the case of damage to the sheathing, short lengths of about 5ft. have been impregnated and are distributed over the cable at intervals of about one-third of a mile. Fig. 3 represents the section of the Greetsiel-Borkum cable, which is 18·35 miles long, and consists of one piece. The four conductors, consisting each of

Fig. 3.
Greetsiel–Borkum Cable.

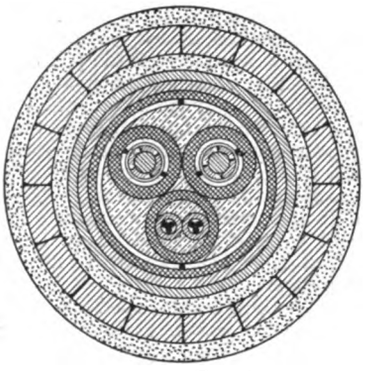

Fig. 4.
Cuxhaven–Heligoland Cable.

seven copper wires 0·8mm. in diameter, are wound with a bare iron wire 0·8mm. thick. Each core is then wound with several layers of paper tape until the diameter has increased to 3·7mm. These four cores, together with four paper wormings (see Fig. 3) are then stranded around a twisted paper core of a section as indicated in the figure, the lay of the eight cores being opposite to that of the paper core. A spiral of paper cord follows, and over this a layer of paper and tape, the diameter being now 19mm. After being dried, this cable core is provided with two lead sheathings (each 1·3mm. thick), the lead containing 3 per cent. of zinc. After this, there is a double layer of bituminous paper and one layer of bituminous tape (compound). The armouring consists of 23 iron wires of the shape shown in the drawing. Two layers of compound complete the insulation. The outside diameter of the cable is approximately 42mm., the weight per mile being about 10·8 tons.

Fig. 5.—Cuxhaven–Heligoland Cable.—Shore End.

In considering the best construction for the cable to Heligoland (46·5 miles), it had to be borne in mind that it had to work satisfactorily with an overhead telephone line, 373 miles long, and constructed of bronze wire 4mm. in diameter. The damping of the other cables would have been too large in this case, and a reduction of the damping to a value of about 0·007 had to be aimed at.

Fig. 4 shows the section of the cable decided upon. The cable contains four conductors, two of which are stranded and intended for telegraphic communication, the other pair, separated from one another, serving for telephonic purposes. The latter consist of a round copper wire (2·6mm.), around which four wires are stranded. These four wires have an approximate rectangular cross-section with sides 2·4mm. and 7mm. long. A bare iron wire, 0·3mm. in diameter, is wound closely around the copper conductor. On this follows an open spiral of paper cord and a layer of paper tape, the diameter over this being 9·6mm. Each telegraph wire, consisting of three strands of copper wire (0·89mm. in diameter), is wound with paper to a diameter of 3·5mm. These cores are then stranded and rounded off with paper, and the whole is wound with paper to a diameter of 9·6mm. The two telephone cores and the telegraph core are then stranded together and the whole rounded off with paper, the diameter being about 21mm. A distance of about 9·6mm. separates the two telephone cores. An open spiral of paper cord follows, and then there is a layer of paper and tape, the outside diameter being about 24·5mm. After drying, the cable is provided with two lead sheathings (each 1·4mm. thick), the lead containing 3 per cent zinc. Then there are two layers of bituminous paper and tape. An armouring of 16 galvanised iron wires follows, the final protection consisting of two layers of compound. The outside diameter of the cable is 47mm. the weight per mile being 13·5 tons. A length of about half-a-mile of the Heligoland end of the cable is provided with a second armouring (Fig. 5). Experiments on the finished cable have proved that telegraphic communication does not disturb telephonic conversation in the least. The transmission of speech is very good both over the cable alone as also over the cable and the overhead lines in connection with it. All the different waves are sufficiently damped to an equal degree, and the speech transmitted sounds like on an overhead system.

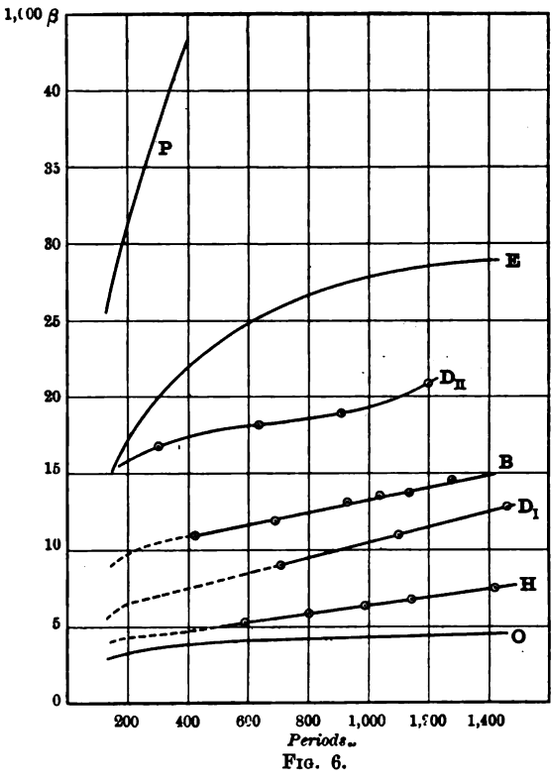

Fig. 6.

For comparison with these cables we will consider the cables between England and Belgium (54·6 miles) and Denmark and Sweden (3·3 miles). Both are gutta-percha cables. The English-Belgian cable (see *The Electrician*, Vol. LI., p. 323) has a conductor consisting of seven strands and weighing 160lbs. per naut. Each conductor is insulated with gutta-percha to a diameter of 10mm., this insulating material weighing 300lbs. per naut. Four such cores are stranded and armoured together. The Danish-Swedish (Elsinore-Helsingborg) cable has one conductor consisting of seven strands of a diameter of 0·8mm. each. This conductor is wound with an iron wire (0·2mm. in diameter) and then insulated with gutta-percha to a diameter of 8·2mm. The electric properties of these cables (calculated for one branch of the symmetrically used double line) per kilometre and at a temperature of 15°C. are tabulated below:—

Designation.	Cable.	Resistance. Ohms per km.	Capacity. Mfd. per km.	Self-induction. Henry per km.
D_I	Fehmarn–Lolland	1·71	0·1624	0·00250
B	Greetsiel–Borkum	4·86	0·0742	0·00399
H	Cuxhaven–Heligoland .	1·36	0·0914	0·00214
D_{II}	Elsinore–Helsingborg .	4·76	0·1745	0·00265
E	England–Belgium	3·83	0·144	0·00055

Fig. 6 represents the damping of these various cables as also of a cable of ordinary construction, P, containing a wire 1mm. in

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diameter, and of an overhead line, O, consisting of a bronze wire 3mm. in diameter. The damping of the three lead cables and of the Danish-Swedish cable are from tests of the complete cable, that of the English-Belgium cable being calculated from its dimensions. If it be assumed that satisfactory communication can be carried on over a cable, the damping exponent of which is 2·5 (calculated for a frequency of 1,000), then the distance over which satisfactory conversation can be carried out is, for the various cables, as follows :—

	H	D_I	B	D_{II}	E
Distance in miles..	244	153	117	80	56

The advantages of the new construction are thus clearly shown. As regards a few details of the cables, the following remarks may be of interest .—

The values for the capacity and self-induction of the cables as given in the table above apply to each branch of the double line. For the double line as a whole, the self-induction and the resistance are double and the capacity is half. The capacity of a cable with loose and dried insulation corresponds to a dielectric constant of 1·6, whereas that of an impregnated cable corresponds to a constant of 3·54. Since the Elsinore-Helsingborg cable has demonstrated that gutta-percha insulated cables with iron covering may be made and laid without difficulty, it would seem that lead-covered cables with impregnated insulation are no more to be seriously considered.

The capacity of both the impregnated cable and of the gutta-percha cable is smaller when measured with alternating current than when determined with continuous current, as is indicated by the following figures :—

Cable.	Capacity in microfarads, measured with	
	Continuous current.	Alternating current.
Fehmarn-Lolland	0·1624	0·1435
Elsinore-Helsingborg ..	0·1745	0·1632

No law connecting the capacity with the frequency was discernible from the measurements made, the greatest discrepancies from the mean being 2 per cent. It is not possible to decide from the few measurements taken whether the decrease in capacity with alternating currents actually ameliorates the cable with regard to its damping effect or whether the advantage so gained is not counterbalanced by losses in the dielectric. The following table gives the self-inductions of the cables per kilometre length with and without iron :—

Cable.	Self-induction.	
	With iron.	Without iron.
H	0·00214	0·00032
B	0·00389	0·00067
D_I	0·00250	0 00046
D_{II}	0·00265	0·00059

From these figures the mean permeability of the iron is calculated to be 101. By reason of the magnetisation and eddy current losses, the self-induction of the cable decreases somewhat with increasing frequencies. The figures given refer to frequencies below 100 ~ per second. In the following table the apparent resistances of three cables at various frequencies are given, the resistances obtained with continuous current being taken as unity :—

Frequency.	H.	B.	D_I.
400	1·45	5·15	2·04
600	1·58	5·46	2·26
800	1·75	5·80	2·49
1,000	1·90	6·15	2·67
1,200	2·06	6·43	2·85
1,400	2·22	6·85	2·94

Since the increase in self-induction does not keep step with the increase of the diameter of the iron-covered conductor, the limits obtainable in practice are soon reached, and any further increase in the self-induction must be obtained by other means, such as those proposed by Pupin.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Supplement to Vol. LXV. of the 'Journal' of the Iron and Steel Institute. Relations between the Effects of Stresses Slowly Applied and of Stresses Suddenly Applied in the Case of Iron and Steel. Comparative Tests with Notched and Plain Bars." By Pierre Breuil. (London : E. & F. N. Spon)

"Proceedings of the Cambridge Philosophical Society." Vol. XII. Part 6. (Cambridge : The University Press) 2s. 6d.

ENERGY LOSSES IN MAGNETISING IRON.*

BY W. M. MORDEY AND A. G. HANSARD.

That this subject has a good claim to the consideration of the engineering section of the British Association, will be admitted when it is pointed out that not less than 25,000 tons, perhaps as much as 50,000 tons, of coal are burnt every year in this country to keep alternate current transformers magnetised.† This waste must be multipled by at least three or four, if it is to include the alternating magnetising losses in dynamos and motors. The magnetising loss is partly due to hysteresis and partly to eddy currents. When testing iron for electrical purposes, many engineers are satisfied to measure the hysteresis only, and for this purpose Ewing's well-known tester is generally used. This ingenious instrument, introduced by Prof. Ewing to avoid the slow and laborious test by the ballistic method, directly compares the torque produced by revolving a small sample between the poles of a permanent magnet with that produced by samples, the hysteresis loss in which has been tested by a ballistic galvanometer. This instrument gives a result for one magnetic density only, and must, therefore, be used for other densities by reference to results otherwise obtained. These methods aim only at measuring hysteresis, which, as a cause of loss, is not more important than eddy currents. The determination of hysteresis is of great interest to physicists, but for engineering purposes what we want to know is the sum of the two losses at various densities and periodicities; how this total is made up is usually of minor importance.

These considerations led one of the authors in 1890, when faced with the necessity of getting iron for transformers of definite quality, to adopt the plan, previously advocated by Mr. Swinburne, of measurement of the total loss by a wattmeter, if possible under the actual conditions of working. For workshop convenience a fixed point of comparison was chosen, at which all iron was tested. This was stated as follows:—"The loss in iron sheets or stampings 0·014in. thick made up in the form of a transformer and tested by a wattmeter should be 0·38 watt per pound at a magnetisation of 2,500 **B** and at 100 ∿ per second."‡ At that time the custom was to order "best soft Swedish charcoal iron carefully annealed," but such iron varied in its losses under the defined conditions from little more than 0·3 watt per pound up to about 0·6, causing serious engineering difficulties.

Although further lamination was recognised as desirable, it was found to be difficult to get sheets thinner than 0·014in. (0·35mm.), so that was adopted for all purposes. The low magnetisation of 2,500 **B** was chosen as a point for comparison, because it was desired to keep down the no-load losses and the heating of 100 ∿ transformers. For lower periodicities, higher densities may, of course, be used.

The only manufacturers to take up this specification energetically were Messrs. Sankey & Sons, of Bilston, with whom an arrangement was made by which the price paid them was increased or reduced as the iron showed less or more than the standard loss. A few pounds of iron were tested in this way out of each delivery, and the corresponding bonus or penalty ascertained. The result was that within a year large variations of loss had ceased, and it soon became possible to design transformers with something like certainty as to what the magnetising losses would be. This improvement in quality and regularity which affected the whole industry is mentioned here, because it is not generally known how much is due to the efforts of these manufacturers.

We have continued to use the wattmeter method as the only one that tells us what we want to know, and we advocate its advantages over any other plan. It has only one drawback, that it is necessary, or, at least, desirable, to use a rather large quantity of iron for the tests.§ The curve I. (Fig. 1) is an average from the results of a

* Paper read before Section G of the British Association.

† Estimated as follows:—Transformers in use, fully 300,000 kw.; average magnetising loss, 1·5 per cent. for 12 hours a day = 19,700,000 Board of Trade units a year, at 5lb. of coal per unit = 43,750 tons. Or, to put it another way: at 0·5 watt magnetising loss per pound of iron—a moderate estimate—each ton of transformer iron continuously used consumes 9,811 Board of Trade units a year, which at 5lb. a unit involves the consumption of 22 tons of coal.

‡ Watts per pound at 100∿ may be converted to ergs per cubic centimeter per cycle by multiplying by 1,700.

§ These tests and those of the curves given in Figs. 2 and 4 have been made with a wattmeter designed some years ago by Prof. J. A. Fleming for the special purpose of such measurements. In this instrument, of the dynamometer type, every care has been taken to avoid the presence of any metal likely to cause eddies, and to avoid errors due to self-induction or capacity in the circuit of the pressure coil, which consists of few turns, and is used in conjunction with a non-inductive resistance and a separate variable-ratio transformer. In order to increase the range of the instrument, the current in the pressure coil is varied, and is read by a separate Siemens dynamometer. This not only largely increases the range of the instrument, but also enables the same reading to be taken under two or more instrumental conditions. The E.M.F. was read by a Kelvin multicellular electrostatic reflecting voltmeter. The alternator used had practically a sine curve.

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great number of wattmeter tests made before 1898 in carrying out this arrangement. Better iron is now obtainable. Fig. 2 shows the total losses at 50 and 100 ∿ for good 0·014in. iron that can be got regularly. It will be seen that it loses about 1 watt per pound at 5,000 B, 100 ∿, and 0·32 watt at 2,500 B. At 50 ∿ it loses 1 watt per pound at about 8,500 B. It is not safe to rely on getting better iron than this for large quantities, although occasionally better results are got in small quantities.*

The separation of hysteresis and eddy losses by calculation is based on the assumption that hysteresis varies directly as the periodicity, and as $B^{1.6}$, the latter or Steinmetz ratio being the value which Mr. Steinmetz, working from Prof. Ewing's results and from observations of his own, found to express the relation between hysteresis and density. The eddy currents are always assumed to vary as the square of the magnetisation, the square of the periodicity, the square of the thickness, and inversely as the resistance of the iron. As the eddies in ordinary thicknesses of plates are by no means negligible, it becomes a matter of some difficulty to reconcile these assumptions with the facts, especially when the total loss curve is found to be a $B^{1.6}$ curve, as often happens. For example, the curve I. in Fig. 1 within its very limited range seems to show that the total loss increases with the density in a less ratio than $B^{1.6}$. The dotted curves II. and III. represent $B^{1.6}$ values drawn through 1,000 B and 2,000 B respectively. Curve I. is inconsistent with the above assumptions, for if eddies varying as B^2 have to be added, the total losses should rise more steeply than the $B^{1.6}$ curve, instead of less steeply, as shown.

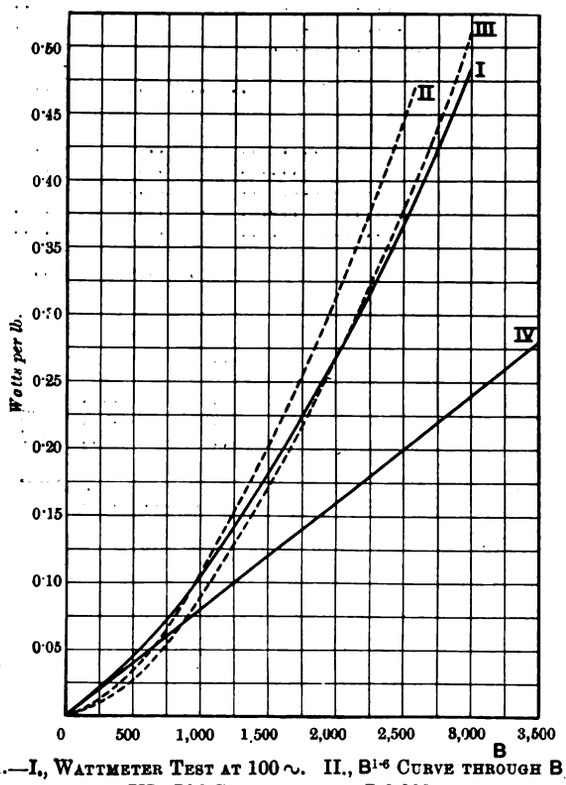

FIG. 1.—I., WATTMETER TEST AT 100 ∿. II., $B^{1.6}$ CURVE THROUGH B 1,000. III., $B^{1.6}$ CURVE THROUGH B 2,000.

The curves of Fig. 2 afford another illustration of this difficulty. The round points on these two curves are the wattmeter readings. The points thus × are $B^{1.6}$ values calculated from 4,000 B. It will be seen that these $B^{1.6}$ values correspond almost exactly with the total loss curves, and therefore no room is left for eddies on the ordinary assumptions for hysteresis and eddies. That eddies are present in a considerable amount is shown by reference to numerous ballistic tests of hysteresis of similar iron which are always much lower than the total losses of these curves. Further, the 50 and 100 ∿ curves are not in the ratio of 1 to 2, as they would be if there were no eddies, and if hysteresis were proportional to the periodicity. In such cases as this, if we admit that the hysteresis is proportional to $B^{1.6}$, the eddies also must follow nearly the same law.

The authors find that the curves given in Kapp's "Transformers" (1896, p. 23), which are carried up to between 6,500 and 7,000 B, have the same characteristics with regard to $B^{1.6}$ curves as the authors' (Curve I., Fig. 1). Whilst we are all prepared for considerable differences in the amount of the losses in iron, even of the same thickness and make, it is disturbing to find such difference not only in the amount, but in the character of the curves; and it shows how necessary it is, with such a material as iron, to base conclusions only on a large number of different observations.

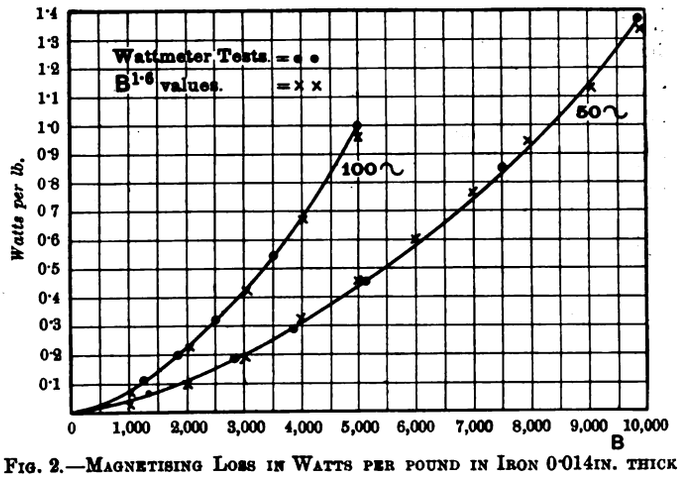

FIG. 2.—MAGNETISING LOSS IN WATTS PER POUND IN IRON 0·014IN. THICK AT 50 ∿ AND 100 ∿.

In order to examine the effect of increase of thickness of iron sheets, the authors have tested some transformer stampings made from sheets of three different thicknesses of the same quality of iron kindly supplied by Messrs. Sankey & Sons. The thickness of the three samples, A, B and C, calculated from the weight, is given below. Gauging with a micrometer showed a variation of about 0·001in. in the actual thickness of the plates. Samples of these plates were tested on a Ewing hysterisis tester by a very experienced experimenter, who obtained the results 0·39, 0·38 and 0·40. Another

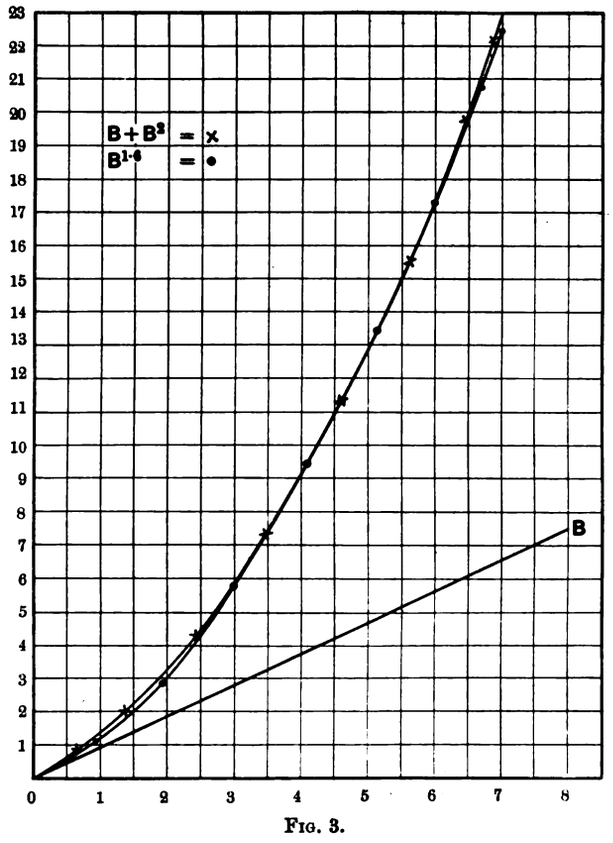

FIG. 3.

* It is often convenient to use an empirical rule even if it has no relation to physical realities. This may excuse our pointing out that most curves of total magnetising loss in iron are very closely satisfied by a division into two portions, one directly proportional to B, the other proportional to B^2. The curve I. in Fig. 1 may be so divided by the straight line IV. It is only necessary to remember that this line cuts the total loss of 0·48 watt per pound at 3,000 B into two equal parts to construct the whole curve. A similar division will be found to apply to the curves of Fig. 2, which go through a much longer range. The points of equality in the two portions being 2,500 B for the 50 ∿ and 4,000 B for the 100 ∿, in both cases the point corresponding to a loss of 0·32 watt per pound. In order to show the similarity of a $B^{1.6}$ curve and a $B+B^2$ curve, Fig. 3 has been drawn, in which the curve marked with round dots is a $B^{1.6}$ curve, and that with crosses is a $B+B^2$ curve drawn through two points on the other curve (having abscissæ 3 and 6). The straight line is the B component of the $B+B^2$ curve.

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experienced experimenter, on a different Ewing instrument, made the loss 0·44 in each of the three samples. We have adopted the former figures for purposes of comparison :—

	Thickness. In.	Mm.	Watts per lb. at 100 ∿ 4,000 B.
A	0·0136	0·34	0·39
B	0·0189	0·47	0·38
C	0·0254	0·61	0·40

The stampings were made up in transformer form, about 11·7lb. being used in each case, and wattmeter tests of the total loss were made at 50 and 100 ∿, at six values of B in each case. After deducting the losses in the winding, the iron losses were found to be as shown

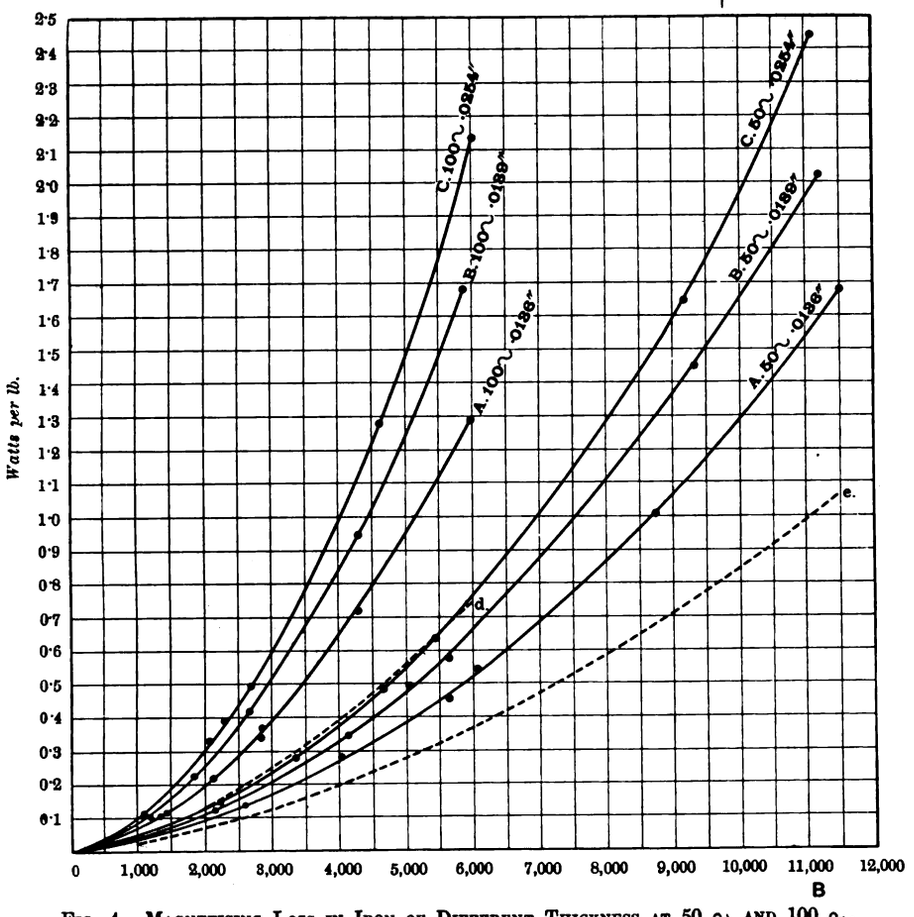

FIG. 4.—MAGNETISING LOSS IN IRON OF DIFFERENT THICKNESS AT 50 ∿ AND 100 ∿. d, HYSTERESIS AT 100 ∿. e, HYSTERESIS AT 50 ∿.

in the six curves of Fig. 4, which, unlike those of Figs. 1 and 2, are all steeper than $B^{1·6}$ curves, and, therefore, do not present the same difficulty.

The following table, based on these curves, gives results for eddies and hysteresis at various densities. The hysteresis is based on the values 0·39, 0·38, and 0·40 at 4,000 B, 100 ∿ by the Ewing tester, the other values of hysteresis being calculated as proportional to $B^{1·6}$ and directly proportional to periodicity.* This procedure seems

Losses in Watts per Pound of Iron at 50 and 100 ∿.

Thickness.	Hysteresis. 100	50	Total loss. 100	50	Difference due to eddies. 100	50	Percentage of eddies. 100	50	B.
A 0·0136in.	0·183	..	0·285	..	0·102	..	35·8	..	2,500
B 0·0189in.	0·179	..	0·37	..	0·191	..	51·5	..	
C 0·0254in.	0·188	..	0·44	..	0·252	..	57·2	..	
A 0·0136in.	0·39	0·195	0·635	0·26	0·245	0·065	38·6	25·0	4,000
B 0·0189in.	0·38	0·19	0·83	0·322	0·45	0·132	54·2	29·8	
C 0·0254in.	0·40	0·20	0·99	0·37	0·59	0·17	59·5	46·0	
A 0·0136in.	0·746	0·373	1·30	0·52	0 554	0·147	42·6	28·3	6,000
B 0·0189in.	0·727	0·363	1·76	0·67	1·03	0·307	54·5	45·8	
C 0·0254in.	0·766	0·383	2·12	0·76	1·35	0·377	63·7	49·6	
A 0·0136in.	..	0·845	..	1·33	..	0·475	..	35·8	10,000
B 0·0189in.	..	0·822	..	1·64	..	0·818	..	50·0	
C 0·0254in.	..	0·867	..	1·95	..	1·083	..	55·5	

* The two dotted curves in Fig. 4, *d* and *e*, show the hysteresis loss, assumed to vary as $B^{1·6}$, for 100 and 50 ∿ respectively, taken from the mean of these three values—viz., 0·39 watt per pound at 100 ∿.

justified by the form of these six curves. The total losses are by the wattmeter readings. The 10,000 B results are only for 50 ∿, the 100 ∿ tests not having been carried higher than 6,000 B.* Results at 2,500 B are worked out only for 100 ∿. Judging from the thinnest sheets the iron is of excellent quality.

These results show very clearly that, even with these thin sheets and moderate densities, the eddy loss is of the same order of importance as the hysteresis.

Examining the result to find what light they throw on the assumptions that eddies are proportional to the square of the thickness, the square of B, and the square of the periodicity, we get the following values :—

Eddies and Thickness.

		A.	B.	C.
(Thickness)²		1	1·93	3·5
	B.			
100 ∿	2,500	1	1·87	2·47
	4,000	1	1·84	2·4
	6,000	1	1·86	2·44
50 ∿	4,000	1	2·04	2·52
	6,000	1	2·09	2·56
	10,000	1	1·72	2·28
Average			1·903	2·445

Eddies and Magnetisation (B). *At 100 ∿.*

	B 2,500	4,000	6,000
B^2	1	2·56	5·76
A	1	2·40	5·43
B	1	2·36	5·40
C	1	2·34	5·36
Average		2·37	5·40

At 50 ∿.

	B 4,000	6,000	10,000
B^2	1	2·25	6·25
A	1	2·26	7·31
B	1	2·32	6·20
C	1	2·24	6·37
Average		2·27	6·62

Eddies and Periodicity. (*50^2 and 100^2 ∿ = 1 : 4.*)

	B	50 ∿	100 ∿
A	4,000	1	3·77
	6,000	1	3·77
B	4,000	1	3·40
	6,000	1	3·36
C	4,000	1	3·47
	6,000	1	3·58
Average			3·46

These three comparisons lead to the following conclusions :—For the 0·0136 and 0·0189 sheets the increase is practically proportional to (thickness)²—that is, the loss with the latter is nearly double that with the former. But as between 0·0136 and 0·0254 the average increase is less than (thickness)² by about 30 per cent. It is about 2·5 instead of 3·5 times greater.

As regards the relation between B and eddies, the tests on the whole do not indicate any marked departure from the B^2 assumption. As regards periodicity, the averages show that the increase is as 1 to 3·46, instead of 1 to 4.

We suggest that the result showing that eddies increase less quickly than (thickness)² and (periodicity)² may be reasonably explained by assuming that the eddy circuits have self-induction. If this is so, it prevents the possibility of dealing with them simply by Ohm's law, as hitherto seems to have been the practice.

Effect of Temperature on Eddies.—It might be possible to ascertain the total eddies, and to separate eddies from hysteresis, by measuring the total loss at two temperatures, assuming hysteresis to be constant within the range of the temperatures, and comparing the result with the assistance of the ascertained temperature coefficient. Fig. 5 shows a wattmeter test made of some 0·0124in. transformer iron (by Sankey) at 40°F. and 167°F. for this purpose, together with a ballistic galvanometer determination of the hysteresis of the same iron. The latter test was made without special reference to temperature, which, however, is believed to have been about 70°F. The iron was found to have a temperature

* An objection may be made to this analysis that the results obtained with the Ewing tester—namely, 0·39, 0·38 and 0·40—on samples weighing only about ½oz. each are possibly not representative of the average of each of the 11·7lb. samples tested by the wattmeter. We admit this, but that is one of the uncertainties inseparable from the small scale of the operation. It may also be objected that the higher and uniform value of 0·44 got on the same three test pieces by another experimenter would alter the figures somewhat. That is true, but the main broad results and conclusions would not be appreciably affected.

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coefficient of 0·248 per cent. per 1°F. (reckoning from 32°F.) based on observation taken at 72°F. and 154°F.

The ballistic test was made at three points, respectively: 8,000, 5,000 and 2,000 **B**. It is important to note that these points lie on a $B^{1.6}$ curve, as do also the wattmeter curves of this figure. As in Fig. 4, the eddies bear a very large ratio to the hysteresis, being about 50 per cent. of the total loss at the higher values of **B**. The effect of change in temperature is very marked, the increase of 127°F. giving a reduction of total loss—at 7,500 **B**, for example—of 0·28 watt per pound = 14·4 per cent. of the total loss, or 27·3 per cent. of the eddy loss.

An examination of the curves at 40°F. and 167°F. shows that the eddy currents, at least at the higher densities, apparently increase rather more rapidly than the fall of the resistance, suggesting the possibility that the hysteresis decreases under working conditions at these higher values of **B**. The authors, however, only wish to put the experiment forward as a further proof of the importance of the eddies, and as possibly affording a means of useful investigation of the relation of eddies to hysteresis. The considerable decrease in the total loss with rise of temperature must not be taken as a reason for working transformers hot—the increase of copper resistance would do much to counterbalance any saving in the iron. At one time the effect of continued heating at such a temperature as 167°F. would have been to cause a slow increase in the hysteresis, but this effect has now been overcome in this quality of iron, at least for such temperatures as this.

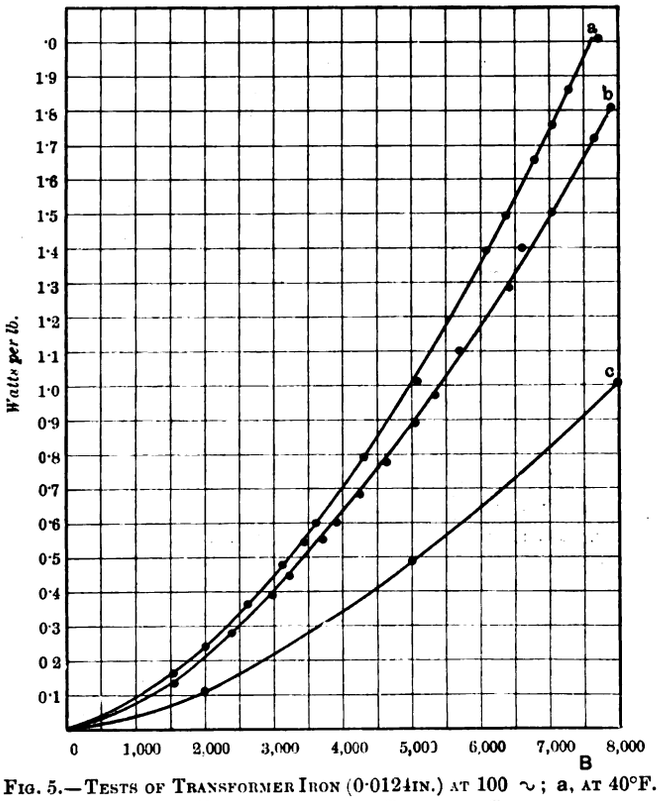

FIG. 5.—TESTS OF TRANSFORMER IRON (0·0124IN.) AT 100 ∿; **a**, AT 40°F. AND **b** AT 167°F. BY WATTMETER; **c** BY BALLISTIC GALVANOMETER AT ABOUT 70°F.

It may be thought that there is a remote possibility of explaining the increase of eddies—as judged by the curves of total loss—being less than the received theories would require, by assuming that there may be a decrease in hysteresis with **B**, as has been shown to take place under certain conditions by Prof. Bailey's very interesting experiment, which lent support to Prof. Ewing's magnetic theory and confirmed a prediction of Mr. Swinburne.* Such an explanation, however, would receive no support from our analysis, in which, on the whole, the eddy loss appears to be nearly proportional to B^2.

Although these results refer particularly to transformer conditions, they are applicable to a good deal of dynamo, alternator and motor work, in much of which the periodicities are as high as for transformers, even for direct-current work—for instance, turbine driven dynamos; a four-pole machine at 1,500 revs. per min. works at 50 ∿ per second. With such machines it is very necessary to work at as high **B** as possible, and under such circumstances the eddy losses are very large—especially as there is probably a greater tendency to eddies in dynamos than in transformers on account of the less even magnetic distribution in the former. Even in ordinary dynamos working at 8 to 16 ∿, with about 15,000 or 16,000 **B** in the core and 20,000 **B** or more in the teeth, the eddy loss will be found to account for an appreciable proportion of the total loss. As to the practical aspect of the question of thickness, it has been already stated that it is difficult to get iron thinner than 0·014in. (0·35mm.). Perhaps a practical limit will be reached at 0·01in. (0·25mm.). This would save nearly half the eddies, as compared with 0·014, and in some cases this would justify a considerable increase in the price of the iron. For example, the saving in 1 ton of 0·01in. iron used continuously at 15,000 **B** 50 ∿, as compared with 0·014in., would be more than 10,000 Board of Trade units a year. There is, however, some ground for believing that on the average the hysteresis loss with a given iron is rather higher when it is rolled very thin. The difference, however, is not likely to be so much as to counterbalance the considerable saving in eddy loss under many practical working conditions. Until some iron or steel has been discovered having a higher specific resistance combined with high magnetic qualities, the only way to reduce eddies is to use as thin iron as possible.

The authors would summarise their conclusions as follows:—(1) in determining the magnetic quality of iron sheets, eddy-current losses, though often neglected, are by no means negligible, and are often as important as hysteresis; (2) the simple laws generally assumed to be followed by hysteresis and eddies are found, as often as not, to be rather widely departed from; and (3) consequently, with such a variable material as iron, the only satisfactory method of predicting losses is to make wattmeter tests of samples, as nearly as possible, under the working conditions.

The authors wish to thank Mr. L. W. Wild, of the Westminster Electrical Testing Laboratory, for his able assistance in some of the experiments

* See Ewing's "Magnetic Induction in Iron and other Metals," 3rd edition, p. 327.

ELECTRICITY FROM WATER-POWER.*

BY A. A. CAMPBELL SWINTON.

It should be gratifying to our national pride to know that probably the very earliest example of the production of electricity by means of water-power on a practical scale and its transmission to a distance was the installation put up—for the purpose of lighting—at Cragside, Northumberland, by the late Lord Armstrong in the year 1882. This plant, which was still in daily use in the year 1884 when the author saw it in operation, consisted of a Siemens continuous-current dynamo which was driven by means of a belt off an 8 H.P. water turbine operating with a fall of 30ft., the electricity—which was delivered at 90 volts pressure—being carried by bare overhead wires attached to porcelain insulators on poles to the house about 1 mile distant. It is an interesting fact that when the installation was first put to work it was designed to operate with only a single wire, connection being made to the hydraulic power pipes at the one end and to the ordinary household water pipes at the other, the earth being expected to form a sufficient return in the manner employed in telegraphy. This plan, which was adopted on the advice of the late Sir William Siemens, was found to be quite ineffective, as, owing to the low voltage employed and the exceedingly rocky nature of the ground, no useful amount of electricity could be transmitted, until the earth return was done away with and a second metallic conductor substituted.

Though this 22-year-old English example of electricity developed by water-power and transmitted to a distance was, as already mentioned, probably the first such installation in existence in the world, the great development of such installations has, up to recently, taken place almost exclusively abroad. No doubt up and down this country a very considerable number of small electric plants operated by water-power have been put up for private house lighting and such like purposes, and there are even towns, such as, for instance, Salisbury and Keswick, where water-power has for long been employed to assist steam power for electrical production for public and private lighting, the water power being in these instances found of great value for the purpose, more especially of maintaining the supply during the periods of minimum load. A few hundred horse-power will, however, probably cover the whole of the plants of this character at present running in Great Britain, which is an altogether insignificant amount compared with the much larger corresponding figures for the Continent of Europe, America and other countries.

To obtain accurate statistics as to the amount of water horse-power at present employed for electrical production throughout the whole world is a very difficult matter, as in many countries no figures are available, while in others, such as are obtainable, are not up to date. The follow summary, giving an aggregate horse-power of nearly one and a-half millions, comprises all the hydraulic electricity works of which the author has been able to obtain particulars. He has, how-

* Paper read before Section G of the British Association, Cambridge.

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ever, no doubt that there must be many others in existence to which he has not been able to find any reference, while again, in the case of a number of the installations which have been included, the horse-power now employed is greater than that in use at the time that the statistics were made out.

Water-Power Electricity Installations.—United States of America 527,467 H P., Canada 228,225 H.P., Mexico 18,470 H.P., Venezuela 1,200 H.P., Brazil 800 H.P., Japan 3,450 H.P., Switzerland 133,302 H.P., France 161,343 H.P., Germany 81,077 H.P., Austria 16,000 H.P., Sweden 71,000 H.P., Russia 10,000 H.P., Italy 210,000 H.P., India 7,050 H.P., South Africa 2,100 H.P., Great Britain 11,906 H.P.—total 1,483,390 H.P.

It therefore seems reasonable to suppose that the total amount of water power actually used for electrical production throughout the world at the present time must exceed 2,000,000 H.P., which is about double the total steam power at present devoted in Great Britain and Ireland to the same purpose.

It is interesting to calculate what would be the amount of coal required to produce this large amount of horse-power were it generated by steam engines in the ordinary way; in other words, what is the saving of coal that the adoption of this amount of hydraulic power entails. Many of the hydraulic plants, particularly those which are used for chemical processes, operate at full power continuously night and day, but others work for shorter hours. Assuming, however, that the whole 2,000,000 H.P. is in use for 12 hours per diem, in other words, is employed on the average with what engineers call a 50 per cent. load-factor, and assuming, as is reasonable, that were the energy produced by means of coal, at least 3lb. of this fuel would be required on the average per horse-power-hour, we get 5·86 tons of coal per horse-power-year, or 11,720,000 tons of coal saved annually on account of the 2,000,000 water-horse-power utilised. Though this may appear a large figure, it amounts to less than 2 per cent. on the total output of coal in the world, which, on the average of the last five years, was 632,000,000 tons per annum. Assuming, however, an average cost of coal of 10s. per ton, this 11,720,000 tons represents £5,860,000 yearly, an amount which it would take over £100,000,000 of capital earning 5 per cent. per annum to provide.

Apart from mere magnitude, many of the more recent examples of hydro-electric engineering abroad, especially in America, are interesting by reason of the enormous distances over which the electric energy is being economically transmitted and the very high electric pressures that in numerous cases are being successfully employed. The longest distance over which transmission has so far been commercially effected is probably the 232 miles of line belonging to the California Gas and Electric Corporation, which stretches from the De Sabla power house via Cordelia to the town of Sausalito, which is situated on the opposite side of the Golden Gate Straits from the city of San Francisco. What this transmission means will be realised when it is stated that the distance covered is about equal to that which separates Cambridge from Newcastle-on-Tyne. The same Californian company also owns the Colegate and Oakland transmission line, which runs 142 miles from the Colegate power house, where 14,000 H.P. is developed from a head of water of 702ft.

Another very long line is that which reaches from the Electra power house via Stockton and Mission San José to San Franciso, a distance of 147 miles, over which 10,000 H.P. is being delivered regularly. This line belongs to the Standard Electric Co., who have 217 miles of power line with a capacity of 27,000 H.P. in operation. The voltages employed, as is to be expected having regard to the distance covered, are very high, ranging from 55,000 to 67,000 volts, 60,000 volts being apparently the standard figure for many recent installations, of which the following are some examples:—

*Plants recently installed by the Stanley Electric Mfg. Co., Pittsfield, Massachusetts.**

Name.	H.P. capacity.	Voltage.	Transmisson distance. Miles.	Head of water.
Quanajuato Power and Electric Co., Mexico	8,000	60,000	101	300ft.
Washington Water Power Co., Spokane	12,000	60,000	110	68ft.
Kern River Power Co., Los Angelos, California	16,000	67,500	110	..
Pierce Co.	26,000	55,000	40	..
Mexican Light and Power Co., Mexico	..	60,000	110	1,500ft.
Winnipeg General Power Co.	10,000	60,000	60	40ft.
Canadian Niagara Power Co.	..	60,000	93	..
Elec. Development Co. of Ontario	..	60,000	93	..

* For these particulars the author is indebted to Mr. C. C. Chesney, the chief engineer of the Stanley Electric Mfg. Co., who have recently installed these and numerous other similar plants.

Mention should also be made of the 50,000 H.P. and the 125,000 H.P. plants for the Canadian Niagara Power Co. and the Electrical Power Co. of Ontario, contracted for by the Canadian General Electric Co., both of which will employ pressures ranging up to 60,000 volts, while, to pass to another quarter of the globe, the Cauvery Falls electric power scheme in India has now been at work for over two years, and transmits 5,000 H.P. to the Mysore gold mines, a distance of 92 miles, using a pressure of 35,000 volts.

Turning now to the British Isles, the only large scale plant for the production of electricity by water power at present in operation in this country is the well-known installation of the British Aluminium Co. at Foyers. This installation, which was originally designed by the late Mr. Birch and carried out by Mr. W. Vaux-Graham, has been at work ever since the year 1896, and the whole of the power has been employed for electro-chemical purposes on the spot. A small percentage of the power is utilised for the production of calcium carbide, but the bulk is, and in the near future the whole of the power will be, used for making aluminium. At present the gross horse-power of the plant is 7,000 H.P., but plant for a further 2,000 H.P. is at the present moment being installed, and will be working in about a month's time.

The water is derived from the River Foyers, which has a catchment area of upwards of 100 sq. miles. Storage is effected by means of two lakes which have been joined together by the raising of dams and embankments, the result being a continuous lake of about 5½ miles long by about half a mile in width. The storage thus obtained is sufficient to run the entire plant continuously day and night for about 50 days. From the River Foyers the water is first passed through a tunnel 8½ft. in diameter, cut through the solid rock, to the renstock chamber, from which the water is delivered by separate cast-iron pipes to the turbines, which are installed on the shore of Loch Ness, and into which the water is finally discharged, the available head of water being 350ft.

The British Aluminium Co. have obtained Parliamentary powers for a further large water-power installation on Loch Leven. It is their intention to commence immediately the development of this scheme, which is capable of giving 17,000 gross horse-power. The reservoir is artificial and will contain about 150 days' storage of the full power, the head of water at the turbine being 964ft. It is anticipated that the whole of this power will also be taken up in the manufacture of aluminium on the spot, no distant transmission being, at present, at any rate, contemplated.

Another interesting water-power scheme of considerable dimensions is at the present moment being developed in Wales by the North Wales Electric Power Co., who have obtained Parliamentary powers for this purpose. Their first installation is at present being erected under the superintendence of Messrs. Harper Bros., the company's engineers, and derive its power from Lake Llydaw, on Snowdon. This lake, into which runs the water from Lake Glaslyn, is about 1⅛ mile in length and about a quarter to half a mile in width. Its area is 5½ million sq. ft., and it derives its water from a catchment area of about 1¾ sq. miles, including the summit of Snowdon. Being in the track of the Atlantic depressions, this area has one of the heaviest rainfalls in Europe, amounting on the average to 180in. per annum. In 1903 it reached the phenomenal figure of 250in. The prevailing winds are from the sea, and the atmospheric moisture is driven up the sloping side of the mountain, and on being condensed at the summit is discharged in the form of rain or snow on the eastern side over Lakes Glaslyn and Llydaw. The fall of the year gives the wettest months, and it happens that the quantity running from the lakes in spring is averaged up by the snow melting on the sheltered eastern side.

By means of a dam about 100ft. in length, the level of the lake is to be raised 20ft. The water will be drawn from the lake by means of a tunnel 600ft. in length at a point 30ft. below the present level, or 50ft. below the level when the dams are completed, with the result that there will be sufficient storage for meeting a 90 days' drought. The total fall utilised will be about 1,150ft., and the total horse power available, on the basis of a nine hours' working day, is calculated at 8,200. The first installation consists of two steel pipe lines and four 1,000kw. sets, each consisting of a double tangential water wheel coupled to a three-phase alternator giving 11,000 volts at 40 periods per second. The company will develop the full horse-power of Lake Llydaw before proceeding further, but they have also acquired a further water-power at Llyn Eigiau, in the Conway Valley, where a fall of 800ft. is obtainable, and where it is calculated there will be nearly twice as much horse-power available as there is at Llyn Llydaw.

One of the first objects of the North Wales Electric Power Co., as soon as their installation is completed, will be to supply energy for the working of certain light railways which they control in the district. It is, however, in addition, intended to supply electric energy throughout a large area comprising the whole of the counties of Carnarvon, Merioneth and Anglesea, and also a portion of the county of Denbigh. Three-phase currents are to be used, and the transmission lines will be of bare copper wires, 0·324in. in diameter, carried on insulators triangularly placed on wooden poles. A large

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proportion of the transmission lines will be carried along the track of the above-mentioned light railways. Lines are to be laid to the principal slate quarry districts of Nantlle, Llanberis, Penrhyn and Festiniog, where a considerable demand for power exists. The distances from the power station to these places ranges from 6 to 12 miles.

The latest water-power electric scheme in the United Kingdom is that of the Scotch Water-Power Syndicate, who have, by agreement, obtained from Lord Breadalbane and the Trustees of the Colquhoun Estate of Luss important water-power concessions. These agreements have been negotiated by Mr. E. Ristori, who, it may be mentioned, was one of the original founders of the Falls of Foyers installation, while the engineering and electrical details have been worked out by Mr. William Vaux-Graham and the author.

The first power that it is proposed to develop is one connected with Loch Sloy, which is situated some 5 miles north of Tarbet on the side of Ben Vorlich, between Loch Long and Loch Lomond. Loch Sloy, which is situated some 757ft. above Loch Lomond—which, in turn, is some 26ft. above the sea level—is fed from a catchment area of about 3,801 acres, which includes one side of Ben Vorlich, which, with its 3,092ft., is one of the highest mountains in Scotland. The district has the very heavy rainfall of some 74in. per annum, of which it is calculated that 60in. will be collectable.

A dam will be constructed at the eastern end of the loch, which will raise the height of the latter by some 60ft. This will impound some 240 million cubic ft. of water, capable, with a calculated net fall of 700ft. to Loch Lomond, of maintaining some 6,000 E.H.P. on a 25 per cent. load-factor for the maximum possible periods of drought, which are calculated at 100 days. From the loch the water will be taken in the first instance along an open conduit 3,650yds. in length, which will follow the contour line round Ben Vorlich till a point is reached almost immediately above the position where the power house will be constructed, on the shore of Loch Lomond, at a spot called Inveruglas. From the end of this conduit to the power house the water will be conveyed in steel pipes, the length of the pipe line being about 600yds. and the height of fall 700ft.

From the power house an overhead transmission line is to be constructed in duplicate for the purpose of conveying the electric energy to the industrial areas of the Vale of Leven and the Clyde, which comprise the towns of Dumbarton, Helensburgh, Renton, and Alexandria, and includes shipbuilding yards, engineering and dye works, calico printing works, and factories of various descriptions, many of whom have already intimated their desire to be supplied. The transmission line, for which private wayleaves have been obtained throughout, will be overhead on poles, starting from the generating station at Inveruglas, and continuing across country for a distance of 22 miles to a sub-station which will be situated at Renton, about midway between Dumbarton and the foot of Loch Lomond, in the centre of the Vale of Leven industrial area. At this sub-station the voltage will be reduced from the 40,000 volts, which it is proposed to employ for the long overhead transmission, to some 6,000 to 10,000 volts, it being the intention that the distribution from the sub-station to the various works shall be underground.

The following are the efficiencies which it is calculated will be obtained :—

	Full-load efficiency. Per cent.
Open conduit } Pipe line } Turbines }	75
Three-phase generators	94
Step-up transformers	97
High-tension transmission line	93
Step-down transformers	97
Underground distribution (say 6,000 volts average)	95
Total efficiency	58·6

This is on the assumption of the energy being delivered to customers at 6,000 volts. If, as is probable in most instances, it will be delivered at lower voltages, there will be a further transformation, the efficiency of which will be 95 per cent. in the case of transformation in pressure only, and 86 per cent. in the transformation to continuous current, making total overall efficiencies of 55·6 per cent. for three-phase current delivered and 50·3 per cent. for continuous current delivered.

So soon as a market has been found for the total power procurable from Loch Sloy it is intended to utilise a further water power, for which the rights have also been obtained, at Ardlui, about 2 miles further up Loch Lomond. This power is also fed by a small loch with an available fall of 800ft., the horse-power obtainable being about half that available at Loch Sloy. The Scotch Water-Power Sydicate have, in addition, obtained the rights to still further water powers on the Breadalbane estate that exist further north, and these will be utilised as soon as the demand for power justifies the capital expense. It is because of these additional powers (which will considerably extend the length of the transmission) that it is proposed from the start to employ so high a pressure as 40,000 volts.

It is estimated that the total cost of the Loch Sloy scheme, including the transmission line and the distribution to the various factories, will not exceed £200,000 which, on a basis of 5,000 H.P. delivered, works out at about £40 per horse-power—everything included. Seeing that many of the existing electric generating stations worked by steam have cost almost this amount for land, buildings and generating plant, this does not appear to be an excessive figure, and it may be pointed out as an interesting fact that the 20 miles of overhead transmission line only accounts for some £24,000, or about 12 per cent. of the total expenditure. This, coupled with the fact that the calculated loss on the transmission line at full load will only amount to about 7 per cent., and the step-up and step-down losses to another 6 per cent. making 13 per cent. in all, will give some idea of the extent to which the length of the transmission line is but a comparatively unimportant factor in schemes of this description. It may be pointed out further, that the above-mentioned line loss of 7 per cent. is upon the basis of only one of the two duplicate transmission lines being in use. When both are employed, the line loss will be reduced to 3½ per cent., and the total transmission loss at full load will be only a little over 10 per cent.

The main transmission will be on the three-phase system over two sets of three copper conductors each about $\frac{1}{10}$in. in diameter, the possibility of conveying as much as 5,000 H.P. over a distance as great as 22 miles with only 3½ per cent. loss by means of such comparatively small wires being, of course, due to the high pressure employed. Indeed, using pressure as high as 40,000 volts when it is a matter of transmitting comparatively small amounts of power, as, for instance, the 600 H.P. or thereabouts that under the present scheme it is expected will be required for the supply of the town of Helensburgh, the interesting point arises that the minimum size of conductor allowable is limited, not by electrical conditions, but by considerations of mechanical strength. On the main transmission line the conductors will be carried at a minimum height of 40ft. from the ground, while at all crossings over roads they will be enclosed in a wire cage to meet the Board of Trade requirements for insuring public safety.

The application of water-power in the United Kingdom can, of of course, never attain the dimensions that it has already reached in America and elsewhere, still, the above brief account of what is at present being done in Scotland and in Wales shows that there are possibilities even in this old country of which till recently but few were aware. As regards the economies of electrical generation by water-power, no general rule can, of course, be enunciated, and every case must be dealt with on its merits according to local circumstances. This notwithstanding, it is possible to give an indication of what is generally involved, having regard more especially to the fact that, with water-power as a rule, interest on capital plays a much greater part in determining the cost than do labour or upkeep.

Avoiding, on the one hand, small powers, where the costs are likely to be abnormally high, and, on the other, very large powers, such as we do not possess in this country, it may be taken generally that interest on capital, depreciation, upkeep and working expenses in this country will amount to about 12 per cent. on the capital expenditure.

On this basis it is easy to see that to be economically sound, the capital involved must not exceed 8½ times the annual price which can be got for the whole of the energy. For instance, if 5,000 H.P. is available for sale and £6 can be got for each horse-power on the average per annum, the capital involved must not exceed £52 per horse-power, or £260,000 in all.

To conclude, it has been said that the greatest benefactor to the human race is he who makes two blades of grass to sprout where only one grew before. On this principle the utilisation of natural water-power is obviously to the public advantage. When mechanical or electrical energy is generated by the burning of coal, it is a matter of the consumption not of interest but of capital. On the other hand, every water-horse-power that is put to use is something added, mundanely speaking, for all time, to the permanent resources of mankind.

Submarine Mines, the Morse Code and Searchlights.—The following note appears in the *South Wales Daily News*:—

The Submarine Miners' (Severn Division) men profited very much by their contact with the Engineers during their training at Plymouth, and, unlike the olden times, the Regulars seemed to be deeply interested in the work and play of the Volunteers. The latter in many things were able to give points to the Regulars, especially in electrical work, the Volunteers being able to discover and remedy defects with greater expedition than the Regular soldiers. . . . Artillery officers must insist upon training signallers in both semaphore and Morse systems, and not be dependent upon the Submarine Miners, who in time of war would have enough work to do. Then the omission of searchlight apparatus from the forts is a serious one, and should be supplied. At Barry the railway company could supply the necessary electric lighting, but at Lavernock this would be a more expensive matter. It was proved conclusively that the shore provides a great deal of protection for an attacking craft, and without searchlights these nooks and crannies could not be explored.

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SUBMARINE TELEPHONE CABLES.

In this issue we publish a description of some recent German submarine telephone cables, in which an effort has been made to put into practice the principles so long advocated by Mr. OLIVER HEAVISIDE. The essential difficulty in the laying of long submarine telephone lines is that for the same distance they possess greater capacity and smaller inductance than land-lines of corresponding length and resistance. To increase the inductance and decrease the capacity must, therefore, be the aim of the designer of submarine telephone cables, for it has been shown theoretically by HEAVISIDE in England, and experimentally by PUPIN in America and DOLZALEK and EBELING in Germany, that an increase of inductance is beneficial if it be sufficiently well distributed over the whole length of the line. The successful experiments made hitherto have been on long land-lines, and have consisted of inserting inductance coils at regular intervals, but naturally there are mechanical considerations which render it difficult to follow the same course in the case of submarine cables. While we will not admit that these difficulties are insuperable, it is evident that they are not unimportant, for the German engineers have preferred to confine their submarine experiments to modification in the construction of the cable.

Until recently it has been taken for granted that submarine cables must be insulated with either gutta-percha or vulcanised indiarubber, and preference has been given almost invariably to the former material in spite of its higher specific inductive capacity and greater cost. Yet rubber has been employed with considerable success in some instances, an example being some rubber core which has recently been taken up by the Great Northern Telegraph Co. and re-armoured after it had been in the sea for over 30 years. Perhaps we have lost the secret of manufacturing such good rubber now. Other insulating materials suitable for covering wire are not impervious to moisture, although their specific inductive capacities are far less than those of gutta-percha and rubber; consequently, if they are employed an outer covering which is absolutely waterproof must be added. In

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some of the German cables paper has been employed, with a double lead-covering. No particulars are given as to the increase in weight and the comparative price, but both of these are calculable. We still lack experimental data, however, to show whether lead-covered core can withstand the conditions of deep-sea working. Apparently, Herr BREISIG is not in favour of it, for he states: "Since . . . gutta-percha insulated cables with iron covering may be made and laid without difficulty, it would seem that lead-covered cables with impregnated insulation are no more to be seriously considered." Experiments may show—in fact, unpublished experiments may have proved already—that cable of this type is not suitable, but yet one more small additional point in favour of paper insulation may be mentioned. It is possible to adjust its insulation resistance over wide limits, and "leakance" is to some extent beneficial in the case of submarine telegraphy and telephony, if it can be kept strictly within bounds. The arrangement of the conductors in the Greetsiel–Borkum paper cable recalls the Willoughby Smith-Granville air-space cable, tried some years ago off the English coast. In this latter cable gutta-percha was employed, with an air-space of cross-shaped section; but, apparently, it was not successful for mechanical reasons, as no second cable like it was laid, and in the Anglo-Belgian telephone cable the solid construction of the Anglo-French telephone cable was reverted to.

Leaving the means by which the electrostatic capacity of the cable may be diminished, we will now turn again to what has been done in the direction of increasing the inductance. It is evident that nothing approaching the effect of the insertion of inductance coils at intervals has yet been achieved by any modification in cable construction. We appeal urgently to those who have the means at their disposal to devise a method of joining in inductances at definite equidistant intervals along a cable route; the result should be as beneficial to long-distance submarine telegraphy as to submarine telephony. The German investigators are apparently fairly well pleased with the result of surrounding the copper conductor with an iron wire, but it is really doubtful whether the advantages gained are sufficient to outweigh the disadvantage of increasing the diameter of the core and thereby increasing the capacity, weight and cost of the cable. Placing the conductors further apart, and not revolving them around one another, would also be a step in the right direction, and would at the same time diminish the capacity; but here, again, the question of cost comes in. A still more drastic method would be the employment of a single conductor instead of a metallic circuit in the submarine section of a long telephone cable. It should be possible, after some preliminary experimental work, to design a cable in which the conductor was first surrounded with a layer of paper, then with gutta-percha, and finally with the usual protection and armouring. The paper layer would diminish the capacity enormously, and it should not be impossible to place the gutta-percha around the paper-covered conductor in such a way as to render it waterproof. By bringing the earth connections sufficiently far out to sea, and employing at each end between the cable and the metallic circuit land-line an induction coil, or "translator," resembling those formerly employed for connecting together metallic-circuit and single-wire subscribers on "mixed-circuit" telephone exchanges, the difficulty of disturbance by outside induction effects might be avoided. Whether these effects could be entirely eliminated would, of course, be the main question; and it is conceivable that disturbances might be caused not only by the electric tramways near the shore stations, but also by the large-power wireless telegraph stations which are now being erected. Naturally, there is no inclination to lay a cable which may subsequently prove useless for the purpose for which it is intended, and those interested in the question must naturally move cautiously. The fact that a good single-core cable intended for telephony could, if ineffective for this service, be employed for telegraphy, is probably not sufficient encouragement Preliminary investigations as to induction effects might be made with one of the existing submarine telephone cables, however, by insulating the ends of three of the four cores, and carrying out tests on the remaining one.

Without entering into further detail, we earnestly invite the attention of the large telegraph and telephone administrations to these matters. The remarks which we have made above are offered merely as suggestions of some directions in which experiment would be valuable. Any step towards cheapening the design of telegraph cables, and extending the distances over which submarine telephony is possible, would be of such importance to the world at large that this field of research should not be neglected.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

The Indian Electricity Act, 1903. By J. W. MEARES, F.R.A.S., M.I.E.E. (Calcutta: Thacker, Spink & Co.; London: Thacker & Co.) Rs.6, or 10s. 6d. net.

Of the three parts into which this interesting little work is divided, the first consists of an introduction of 87 pages, the second gives the text of the Indian Electricity Act, 1903, together with some explanatory notes by the author, while the third is made up of a group of appendices containing the rules and forms prescribed by the Government of India, &c.

In the introduction, Mr. Meares, who is electrical adviser to the Government of Bengal, gives a brief, but clear and connected history of electrical legislation in India, including notes on the general and local acts which have been repealed by the 1903 Act, and on the licences, rules, &c., issued thereunder. This is followed by a useful summary of the main features of the new act, attention being called to points of difference between British and Indian procedure.

In the main, the new act is based upon the British statutes relating to electricity supply, but we must confess that in many respects the Indian act is more conducive to electrical progress and development than the British Electric Lighting Acts, while it is also more precise and accurate in draughtsmanship. The delicate tenderness shown towards local authorities in this country is not exhibited in the act, as the authorities possess no absolute veto on the granting of licences. This may, to some extent, be accounted for by the backward condition of municipal government in India. Many reforms which we have for years been agitating for are also embodied in the act—*e.g.*, provision for stand-by supply, the right to make differential charges, to attach brackets to houses, to employ overhead wires, to acquire land compulsorily, &c. In regard to the acquisition of land, the act gives more extensive powers than electricity undertakers in this country can hope to get from the Imperial Parliament, but it should be remembered that, in a country where the ownership of a plot of land may lie in a village community, or a group of families, it would be almost impossible to adopt the precautions and conditions usually insisted upon in this country when land is compulsorily taken for improvements. The permission to employ aerial lines should facilitate the development of power transmission schemes, and, owing to climatic and other reasons, it may prove extremely useful to electricity supply companies to be able to use these lines also for low-pressure distribution, especially in sparsely populated districts. We notice that where a licensee can prove (to the satisfaction of an officer appointed by the local government) that any distributing main is already loaded up to its full current-carrying capacity, or that, in case of a larger amount of current being

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transmitted by it, the loss of pressure would seriously affect the efficiency of the supply to other consumers in the vicinity, the licensee may postpone for six months the connecting-up of a new consumer, to allow time for an additional main to be laid. Since sometimes there is a totally unexpected demand for current from a district this is a reasonable provision, as is also that which renders a consumer liable to a fine for using energy off his power meter for lighting.

The act makes a noteworthy departure in providing for the formation of advisory boards for the Government of India and local governments to revise rules, &c.

As the Government of India leave the carrying out of the provisions of the act to the local governments there is a loophole left for the introduction of diversity of practice and laxity in enforcing regulations, &c. Some of the penal clauses are unnecessarily severe, while others are somewhat vague. For instance, a licensee who, without the previous sanction of the local government, "supplies energy or lays down or places any electric supply line or works outside the area of supply" renders himself liable to a fine. It would also appear that the Government attach more importance to the observance of their rules as to variation of pressure, &c., than to safeguards against injuries to persons, &c.

In conclusion, we would like to say that Mr. Meares has done his work very well, and he is to be complimented upon the success which has attended his efforts in improving electrical legislation in India. The utility of the book is greatly increased by a very full index. To electrical engineers, manufacturers and contractors who are interested in Indian electrical work it should prove invaluable.

Die Galvanoplastik. By Dr. W. Pfanhauser. (Halle-a-S.: Wilhelm Knapp.) 4m.

The author gives a full and up-to-date account of the various methods of electrolytic reproduction in copper, nickel, steel, silver and gold. The greatest attention is naturally paid to copper, which still holds the field as the most important electrolytic metal. Electro-deposition as such is not included, it being assumed that the electrolytic deposit is always to be detached from the surface upon which it has been deposited. The introductory work deals with the various methods of preparing matrices, whether in fusible metal, wax, plaster of paris, gutta-percha or gelatine. The methods of imparting electric conductivity to the surfaces thus obtained come under the heads of graphite, chemical methods, and burning-in methods. The composition of the copper bath recommended by the author for ordinary deposition is 1,000 grammes of water to 250 grammes of copper sulphate and 30 grammes of sulphuric acid. For rapid work, with over 3 amperes per square decimetre, he uses 250 grammes of copper sulphate, and only 7·5 grammes of sulphuric acid. The author goes exhaustively into the difficult question of the deposition of nickel, without, however, arriving at any altogether sasisfactory solution of the problem. The best result seems to be obtained with a bath containing 40 grammes of nickel sulphate and 35 grammes of nickel citrate to the litre of water. This requires about 18 days to give a deposit 1mm. thick. All the hard metals still suffer under the serious drawback that the deposits have a tendency to tear and roll up, owing to the absorption of hydrogen. Valuable features of the book are the statement of patent claims for the more modern improvements, and the provision of actual working estimates for large installations.

Molesworth's Pocket-book of Engineering Formulæ. 25th Edition. (London: E. & F. N. Spon.) 1904.

It would be difficult to give in a short space even a summary of the subjects treated in this handbook, but its scope will be readily conceived when it is mentioned that there is hardly any branch of civil, mechanical or marine engineering which is not dealt with. Of special interest to electrical engineers, however, is the chapter at the end of the book treating on electrical subjects. This part of the book contains in concise form a compilation of the more important laws, rules, constants and formulæ relating to the science of electricity, having been revised and re-written for the present edition by Mr. Walter H. Molesworth. Dynamo design is dealt with in its more general aspects, accumulators, rheostats, wiring and so on are referred to, and some pages are devoted to electric traction. Although containing a vast amount of matter, the publishers have succeeded in keeping its volume down to a convenient "pocket" size.

The Telephone Service. By H. L. Webb. (London: Whittaker & Co.) 1904. 1s. net.

A popular and non-technical description of the telephone service, as is afforded in the present volume, should be of considerable utility. A few well-chosen photographic views of the interior of telephone exchanges are bound in with the book. The author's energetic protest against the proposal that the Government should take over the telephone service of the country is out of place in a book of this character, however; and the telephone anecdotes which he has collected might also be omitted with advantage.

Rubber, Gutta Percha and Balata. By Franz Clouth. First English translation, with additions and emendations by the Author. (London: Maclaren & Sons.) 12s. 6d.

The formidable list of works of reference, the assistance of which the author acknowledges in the preface, should be a sufficient voucher for the correctness of the botanical and geographical part of this volume. The chapters relating to the extraction of the gum and the preparation of the raw product for the factory are also complete. On the other hand, in view of the author's experience as a manufacturer of rubber goods, the remaining parts of the book are disappointing. A general sketch is given of the methods of manufacture, but few details are included; for instance, the composition of the "mixtures" best adaptable for the various classes of rubber and ebonite goods is not given. To the insulation of wire and cable with gutta percha and rubber only a few sentences are devoted. A really good book on cable manufacture is still lacking.

The Elements of Plane Trigonometry. By R. Lachlan, Sc.D., and W. C. Fletcher, M.A. (London: Edward Arnold.) 2s.

As a school text-book and for use by elementary students of mathematics this is an excellent little work. It deals with the subject thoroughly, and takes the reader as far as De Moivre's theorem and hyperbolic functions.

FLAME TEMPERATURES IN INTERNAL COMBUSTION MOTORS.*

BY DUGALD CLERK.

(*Concluded from page 766.*)

Fig. 7 shows three diagrams with particulars marked under them taken from this engine under these circumstances. The upper diagram is the power diagram; the lower two diagrams show on a scale of one-fortieth and one of one-tenth the effect of adding the exhaust charge under pressure. In this case, comparing the best results obtained with the engine by Prof. Robinson in his test found at p. 254 of his book, we find an increase of 5 B.H.P, an improvement in indicated efficiency, increasing the indicated thermal efficiency from 28·7 to 32·5 per cent., and an improvement in the brake efficiency from 25 to 27·5 per cent. This improvement is obtained entirely by adding exhaust products under pressure to increase the weight of charge present, to increase the pressure before compression, and to diminish the flame temperature. This method of exhaust super-compression has the great advantage over air super-compression that no additional pumping is required. There are certain advantages, however, to be obtained from the use of air super-compression, notwithstanding the addition of a pump, and these advantages have induced the National Gas Engine Co. to build an engine (shown at Fig. 9) to carry out the fundamental idea of reducing flame temperatures while increasing mean pressures. This engine is intended to indicate 300 H P. when working with producer gas of about 150 B.Th.U. per cubic foot. The idea is to keep up mean pressures while keeping down flame temperatures in order to avoid the well-known liability of heavily loaded gas engines to overheating and pre-ignition. The engine is now at work with a weaker gas, and diagrams are shown at Fig. 8. In this engine the back end of the cylinder is arranged as a four-cycle motor of normal

* Paper read before the Cambridge meeting of the British Association, 1904.

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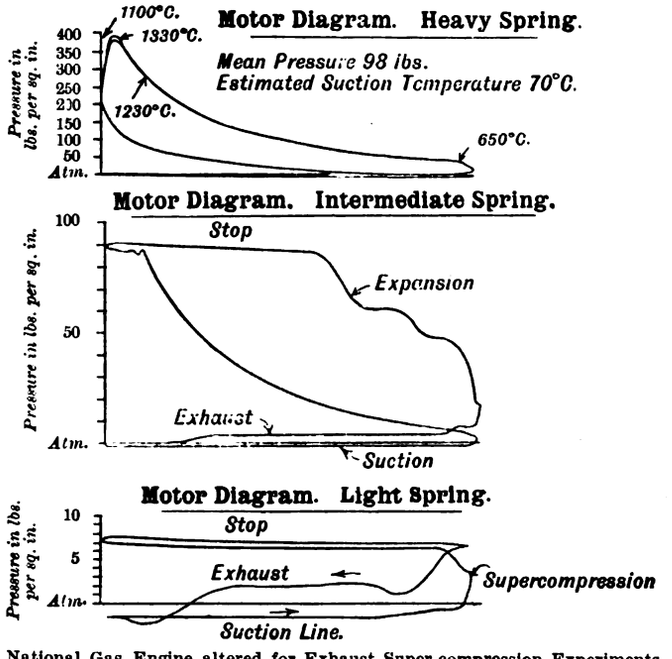
type; the front end is arranged as an air pump, and is closed with cylinder cover, through which a piston rod passes from a cross-head guide of usual construction. One air valve is operated at the pump end from the cam shaft. On one back stroke a charge of air is taken into the cylinder, the valve is closed, and on the out stroke this air charge is compressed into a reservoir forming the clearance space between the piston and the cylinder head. Ports over-run by the piston communicate with this clearance space, which is well water-jacketed, and the pressure causes the air to flow into the cylinder when the charging stroke is nearly complete. In this way the pressure of the charge is raised to about 7lb. per square inch.

The pressure in the front reservoir is raised to about 16lb. per square inch, as is shown upon the diagram, but the fall is only sufficient to raise the pressure within the cylinder to about 7lb. above atmosphere. The reservoir still contains some air at a little above 7lb. pressure, and this air is used on the next exhausting stroke to act as a scavenging air charge to displace the exhaust products from the cylinder and secure that no exhaust remains to form part of the further charge. The engine is thus not only a super-compression engine, but it is a scavenging engine. The pump side is arranged to draw air in on one stroke only —that is, the valve only opens once in two revolutions. One air charge is sufficient both for the purpose of super-compression and scavenging. Calculation from the diagrams proves clearly that a high mean pressure of over 100lb. per square inch is obtained with the very low maximum temperature of 1,200°C. The effect of this reduction of temperature in the smooth working of the engine

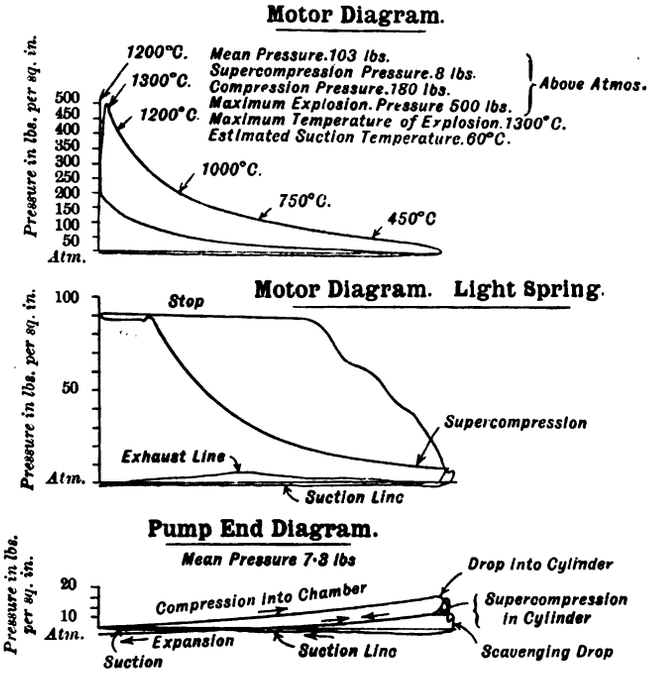


National Gas Engine altered for Exhaust Super-compression Experiments. Cylinder, 10in. diameter by 18in. stroke. Speed, 180 revs. per min. B.H.P., 28. Indicated thermal efficiency, 32·5 per cent. Brake thermal efficiency, 27·5 per cent. Test made by Author with Ashton gas; 566 B.Th.U. at 82°F. gas temperature, lower value. A later test with slightly diminished combustion space gives 27·2 B.H.P. Indicated thermal efficiency, 34 per cent. Brake thermal efficiency, 29 per cent.

FIGS. 7.

is most remarkable. The tendency to pre-ignition or overheating is found to be entirely absent. Notwithstanding the fact that no watered piston is employed, the engine runs with perfect certainty at full load, with consecutive ignitions, at 160 revs. per min. So far as my experience goes, no engine of these dimensions without a watered piston could run at an average pressure of over 100lb. per square inch without difficulty due to pre-ignitions. So far, my attempt to use higher atmospheric pressures has succeeded. It has allowed increased load for a given cylinder and permitted consecutive ignitions at full load and speed without requiring any water cooling of the piston. It appears probable that temperatures may be still further reduced with advantage, especially in operating large gas engines.

I need not inform the body of engineers before me that the difficulties with which the large gas-engine is at present struggling are in the main due to the high temperatures of the flame in the interior of the cylinder. So long as high-temperature flames are used within cylinders of relatively small dimensions, the difficulties due to unequal expansion of parts does not appear. The steam engineer is well aware of the care which has to be exercised in using large steam cylinders in such a way as to avoid cracking, and he can quite well imagine that the difficulties of allowing for free expansion in a gas-engine cylinder are much more serious than his own when he considers the relatively low temperature of his steam. Even with superheated steam, 300°C. is a fairly high temperature, while in existing gas engines of either large or small types it may be taken that the lower limit of maximum temperature at present is nearly 1,400°C. The water-jacketing of a moving piston is an admirable expedient most carefully and ably carried out by many Continental and English engineers; but it is an expedient which has never satisfied me, and is, I believe, regarded with distrust by a considerable number of English engineers. In my view, many of the troubles which have been experienced with large gas engines—cracking pistons, back cover, and the like—are due to the difficulties introduced of getting rid of very large heat flow through cylinder and piston walls, and it appears to me desirable, if possible, to reduce this flow to the lowest point consistent with maintaining the economy of the engines. In doing this, of course, it will not do to reduce the mean pressures of the engines. Large gas engines are at present undesirably heavy for the power as compared with steam engines, and it will not do to increase the weight in any way by reducing the temperatures. This plan of artificially raising atmospheric pressure, either by the addition of air under pressure or by the addition of cooled exhaust gases under pressure, appears to me to furnish a very promising solution of the problem. In gas engines operated with producer gas or blast-furnace gas the question of maximum possible economy is not at present a pressing one. The thermo-dynamic efficiency of all gas engines is now so much greater than any heat efficiency attained in steam engines that we can well afford to reduce economy, if need be, in order to make more certain of good practical results—that is, to make more certain of low cost for upkeep and repairs. In my



Diagrams taken from 21in. by 34in. National Engine illustrated at Fig. 9. Revs. at test, 160 per min.

FIGS. 8.

view, it would pay in large gas engines even to reduce fuel economy if by so doing entire immunity from breakdown was secured. So far the best means of limiting temperature in a simple way appears to be found in the addition of cooled exhaust gases to the charge before compression, and this method, although reducing flame temperature, has actually increased the efficiency instead of diminishing it. This is quite evident from the figures shown with reference to air and exhaust super-compression diagrams found at Figs. 6 and 7. The results obtained with the 10in. by 18in. engine are, so far as I am aware, the best heat efficiencies ever obtained from a gas engine of the dimensions. It will be noted that the exhaust super-compression indicated efficiency is 32½ per cent., while the air super-compression indicated efficiency is 34·4 per cent. The exhaust super-compression thus appears to give slightly lower results than the air super-compression in the same engine. Theoretically, under equal conditions, the efficiencies should be the same for either air or exhaust gas additions. No doubt the cause of difference is due to a somewhat smaller clearance space which was used in the engine while the air experiments were in progress. It would have been interesting to compare the heat efficiency of the large air super-compression engine with the smaller one, but unfortunately I have not been able yet to instal apparatus for making accurate measurements of the producer gas supplied to this

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large engine. The results obtained I will have pleasure in publishing later.

In bringing forward this question of flame temperature in gas-engines, both large and small, I must not be understood to depreciate in any way the efforts of those able Continental and English engineers who have made so brilliant an advance in the application of the large gas engines to producers and blast furnace gas within the last few years. The present position of the large gas engine in Britain is due to the work of Thwaites, Hamilton, Crossley, Atkinson, and Humphreys in England, and that of Delamere Debautteville, Krafts, Koerting, Oechelhauser and the Deutz Company on the Continent, while Westinghouse has contributed his share of work in America. The progress made in solving the large gas engine problem is a notable one, and most creditable to all these able engineers and firms. Nothing is to be gained, however, by over-estimating our present position either with regard to large or small gas engines. With small and moderate engines, no doubt, it may be considered with truth that all the problems have been solved, and that in these engines, not only on the point of heat efficiency, but also in all points of reliability and low cost of repairs, the gas engine more than holds its own with the steam engine. This pany, are producing large gas engines of British invention on British lines. Indeed, some of the Continental engines may also be said to be operated on British lines, because both the Koerting and the Oechelhauser engines are really modifications of the Clerk cycle invented and operated in this country over 20 years ago. From this it will be seen that British makers are no longer neglecting—if they can be said to have ever neglected—the large gas-engine problem. So far as small and moderate gas engines are concerned, British engineers have a very long lead. From information supplied me by many English firms, I estimate that there have been manufactured and sold from Britain alone some 100,000 stationary gas engines, the average power being something like 20 H.P. The present output of gas engines in Britain is very large. It at present amounts to at least 200 engines per week. This includes stationary gas and oil motors, but takes no account of petrol motors for cars. So far as these engines are concerned, the British position could not be improved upon. In the large gas engines, too, the problem is being seriously attacked. I had the pleasure of visiting the works of Messrs. Richardsons, Westgarth & Co. (Ltd.) a couple of weeks ago, and inspecting at Middlesbrough and Leeds a number of large engines built by them. They

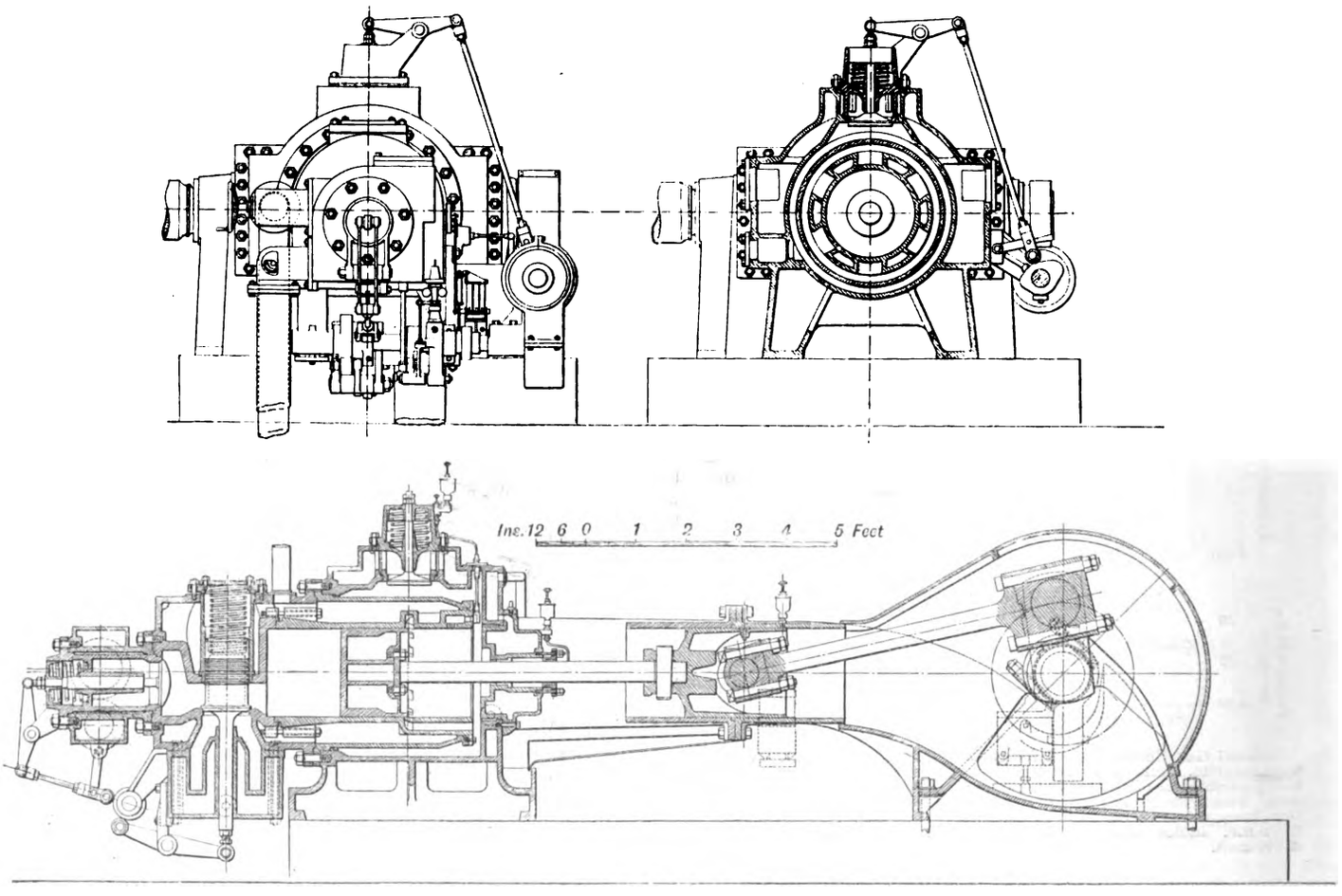

FIG. 9.

cannot yet be said, however, of the really large gas engine. At present these engines are in a state of somewhat rapid change, and the types upon the market are so numerous and varied that they are engaged in a struggle of which the fittest will survive. This question of flame temperature, however, affects them all, and much will be gained if engineers will frankly recognise flame temperature as a matter to be dealt with in itself instead of merely providing palliatives to neutralise the effects of high flame temperatures when generated. The advance in the knowledge of the theory of internal-combustion motors has made it quite clear that so long as flame temperatures are higher than temperature of adiabatic compression, so long will the full thermo-dynamic efficiency be attained for a given compression. This fact, however, arely requires restatement; it is so largely recognised by all gas ngineers.

In Britain at present we are fortunate in having before us examples of all the leading internal-combustion motors of the world, large or small. British makers are now occupied in building, among large gas engines, those of the Cockerill, Oechelhauser, Koerting and Westinghouse types, while other English firms, such as Crossley Bros., the National Company, and the Premier Com-

show a very interesting installation of seven Cockerill engines coupled to blowing cylinders in one engine house. These engines are rated at 600 H.P. each, so that this one engine house contains 4,200 H.P. of gas power for using blast-furnace gas. The engine installation is practically complete, and will be in operation when the scrubbing plant for the gas is finished fitting up. Messrs. Richardsons, Westgarth & Co. also showed me a tandem-cylinder double-acting gas engine of very interesting construction, from which the diagrams shown at Fig. 5 have been taken. This engine was shown to me in operation at the works of Messrs. Cochrane, of Middlesbrough, driving a dynamo. It worked with all the steadiness of a steam engine, and the governing was effected by varying the gas admission, keeping compression constant, so that two impulses were given to the crank at every revolution under all circumstances, light and loaded. This is a most interesting engine, which promises very well. I also inspected two single-cylinder single-acting Cockerill engines of 250 H.P. at the pits of the Yorkshire Coal and Iron Co., near Leeds, where they were driven by coke oven gas, also an interesting installation.

This question of flame temperature appears to me, perhaps, the most important and fundamental at present before engineers

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engaged in the design of these internal-combustion motors. It is fitting that this branch of the subject should be considered before the British Association, and assistance is particularly desirable from physicists who have interested themselves in temperature measurements, especially high-temperature measurements. The determination of these flame temperatures is one of great difficulty, and the data available are very incomplete. Certain assumptions have to be made, for example, as to the temperature of the total charge at the moment of filling the cylinder before compression begins. The only serious attempt to determine this charge temperature has been made by Prof. Burstall in the very able experiments conducted by him for the gas engine research committee of the Institution of Mechanical Engineers. In arriving at the flame temperature numbers given in this Paper, I have made free use of Prof. Burstall's results to enable me to assume some reasonable temperature for the "suction temperature," as Prof. Burstall calls it. The whole of this subject requires investigation, and new methods require to be discovered to enable the determination of the suction temperatures to be easily made for every experiment. I am glad to say that a committee of the Institution of Civil Engineers has been formed to attack the whole question of the thermo-dynamic standard for these engines; and, among other points, I hope that this point of flame temperature and its determination will be duly considered. There can be no doubt that in these times, when internal-combustion motors are being applied to every purpose of motive power both on land and sea, the scientific problems, which, after all, are fundamental and necessary to rapid progress, require much more serious consideration than has yet been given them.

In addition to the figures referred to, the Paper was illustrated by a large number of photographs and sections of large and small gas and oil engines.

OPERATION OF SYNCHRONOUS CONVERTERS.*

BY S. C. LINDSAY.

It is the purpose of this Paper to give a history of the experience we have had with 60-cycle synchronous converters in Seattle during the last 3½ years. As the Seattle Electric Co. has a greater capacity in 60-cycle synchronous converters in daily operation than any other company in the United States, and as they have been operated under a variety of conditions the writer thinks that his experiences might be of interest to others who are operating the same class of apparatus.

In the summer of 1900 we put into service two 550-volt compound-wound synchronous converters which were supplied with alternating current from the Snoqualmie Falls Power Co., the direct current from these synchronous converters being used to operate street cars and stationary motors. At that time the Snoqualmie Company was transmitting to Seattle at 15,000 volts over two lines, the conductors for each line being No. 2 solid aluminium wire. It was originally planned to use one line for power and the other line for lighting, and such power loads as were not subject to large and sudden changes. The current for the synchronous converters was transformed to 340 volts by three 500kw. transformers connected in Δ on both sides.

With 15,000 volts on the lines and the lines in multiple, one synchronous converter would operate satisfactorily up to full load; when the second synchronous converter was put in they would begin to pump immediately, although the load would not be increased beyond the capacity of one synchronous converter. If both machines were left in circuit the pumping would soon become so violent that the transmission line circuit-breakers at the power house would open. Various adjustments of the field strengths between maximum and minimum improved matters very little. It was tried a number of times to operate two machines under this condition, but without success. At times there would be several hundred horse-power of induction motors in Seattle operating from the same system. We tried to operate the synchronous converters both with and without the induction motors in service, but without success, the results being a little more favourable with the induction motors running. When the transmission lines were separated in Seattle, but still supplied from the same 'bus bar at the power house, we tried to operate a synchronous converter from one line and the induction-motor load and lights from the other line; with a very weak field a single synchronous converter would run comparatively steady without load, but would pump violently when loaded to one-third of its rated capacity, especially if it were a street-railway load. With the lines divided as above two synchronous converters were synchronised on the same transmission line, but were not loaded nor even paralleled on the direct-current side. After running under this condition for a few minutes they began to pump, and the pumping soon became so violent that they had to be shut down.

After these results, no further attempts were made to operate two machines at a time until the power company began to transmit at 30,000 volts, when it was found that both synchronous converters would operate entirely satisfactorily up to their full capacity with the transmission lines in parellel, and when the lines were separated one synchronous converter would operate perfectly up to full load and 50 per cent. of overload, but when the second machine was switched in pumping would commence unless the load was reduced. We could carry more load without any disturbance on one machine than we could on the two. It must be borne in mind that when these attempts were made to operate two synchronous converters from one line the line was loaded in almost every case with the induction motor and lighting load that was always carried when both lines were in parallel. In the spring of 1901 a third 550-volt synchronous converter was installed in the same sub-station with the other two machines, and connected to the same bank of step-down transformers. When the three synchronous converters were running at the same time they were, of course, in parallel on both their alternating-current and direct-current sides. A 250-volt shunt-wound 500kw. two-phase synchronous converter was also installed at the same time in another sub-station about one-quarter of a mile from the station where the 500-volt synchronous converters were installed, and was operated from the same system. The addition of these last synchronous converters caused no trouble whatever as long as both transmission lines were in parallel, but when it became necessary to place the entire Seattle load on one line it was found that the 250-volt synchronous converter and one 550-volt synchronous converter would operate satisfactorily, but that two 550-volt synchronous converters would not operate satisfactorily when the 250-volt synchronous converter was shut down.

When the transmission lines were multipled at Renton, and one line cut out between Seattle and Renton, all of the load in Seattle being carried by a single line between these two points and the two lines between Renton and the power house, all the 550-volt synchronous converters and the 250-volt synchronous converter could be operated at the same time; but when all of them were heavily loaded there was more or less pumping, but it was not serious enough to interfere with the lighting to any great extent. Within the last year the conductors in the transmission lines have been changed from No. 2 aluminium to 0000 aluminium between Renton and the power house, and to 00 aluminium between Renton and Seattle. Since this change two or more 550-volt synchronous converters can be run from a single line without any trouble. The trouble experienced when first trying to operate more than one synchronous converter from a single line must have been due to excessive line drop, which caused an interchange of current between the synchronous converters. While operating the three 550-volt synchronous converters from the same bank of transformers it was necessary to use great care in adjusting their field rheostats so as to keep the load equally divided between the synchronous converters. If one synchronous converter was given a weak field and the other two a strong field, pumping would commence and soon become serious if the proper adjustments were not made. We had all three synchronous converters thrown out of synchronism several times from improper adjustment of their field currents. While operating under this condition it was found that a dirty commutator or too much oil applied to a commutator for the purpose of lubrication would cause serious trouble, and on one or two occasions threw all machines out of synchronism. Shifting the brushes to find the neutral point was also a prolific source of trouble. After these causes of trouble had been discovered we got fairly good results, but only by the most careful attention to the machines.

Experience with these rotaries operating from one bank of transformers leads the writer to believe that a worse combination cannot be obtained, and it should never be employed except as a makeshift. After running under this condition for two months a separate bank of transformers was installed for each synchronous converter, each bank consisting of two 300kw. transformers transforming from 2,200 to 340 volts, these transformers in turn being connected to a single bank, transforming from 30,000 to 2,200 volts, both transformations being made on the Scott two-phase to three-phase system. This change in no way affected the results of an attempt to operate on a single transmission line, but the troubles experienced from operating the three synchronous converters from a single bank of transformers were entirely removed.

The one thing that has caused more trouble than any other in the operation of synchronous converters, and the thing that has been responsible directly and indirectly for over 90 per cent. of all the troubles we have had with them, has been the frequent breaking down of the transmission line. Almost every time the line would break, all of the 550-volt synchronous converters then running would flash over at the commutator, making a loud report very similar to the discharge of a cannon. The breaking of the line caused a rise of pressure at the commutator of the synchronous converters great enough to jump the space between the positive and negative brush holders of the machines. There were only two or three cases when the line broke down that the flashing over did not occur. On several occasions when the line broke armature coils were burned out simultaneously with the flash. The flashing did

* Paper read before the American Institute of Electrical Engineers.

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considerable damage each time it occurred by burning the commutator and brush holders and tearing away parts of the mica insulation between the copper segments, which left small pockets that soon filled up with particles of copper and carbon dust. Whether the rise of pressure at the commutators was caused by the sudden opening of the line or by a short-circuit between the broken wires and the other two-line wires is a matter that has never been determined, as no one qualified to make an intelligent report was ever present at the point of trouble when a break occurred. This trouble was finally stopped by grounding the neutral point of the two-phase windings of the step-down transformers. Although this was done primarily for another purpose, it produced an effect on the synchronous converters that we had long desired.

If the commutators are in first-class condition the damage done by a single flash has never been sufficient to cause serious trouble unless armature coils were burned out; the damage to the commutator being quickly removed by the use of a file and coarse sandpaper. When line troubles were quite frequent, say, three or four times a week, the damage done to the mica segments by one flash would not be removed before another flash would occur, and the result was that a number of mica segments in each commutator would be wasted away from $\frac{1}{32}$in. to $\frac{1}{16}$in. below the surface of the copper segment. These places would soon fill up with particles of carbon and copper dust, causing short circuits between segments. These short circuits would burn out, causing a flash and explosion at the commutators very similar to that caused by line troubles, the principal difference being that current did not disappear from the transmission line when trouble was caused by these short circuits. We experienced a great deal of difficulty from these short circuits before the cause of the trouble was determined. The difficulty in locating the trouble was due to the fact that when a flash-over would occur and throw the synchronous converter out of synchronism they could be immediately brought to voltage, synchronised, and loaded again without giving any evidence of the cause of the trouble. Sometimes the synchronous converters would be thrown out a number of times in a day from this cause, and again they would run for one or two days without any trouble. The cause of the trouble being determined, it was easily remedied by turning the commutators down until the mica and copper segments were even.

In the summer and fall of 1902 all of our synchronous converters were moved to the Post-street station, which had just been completed, and we now have in this station nine 500kw. synchronous converters, five of which are 550-volt, three-phase, the other four being 250-volt, two-phase, which are used on the three-wire lighting system. As stated previously, each synchronous converter is connected to its own bank of transformers, the transformers for the 500-volt synchronous converters being connected on the Scott system, transforming from two-phase to three-phase. The power purchased from the Snoqualmie Falls Power Co. is also delivered to this station, making it a combined generating and sub-station. The synchronous converters operate equally well from the steam-driven generators in this station without the use of special inductance coils as they do from the transmission lines, the only exception to this rule being when the steam-driven generators were operating considerably below their normal speed, say 114 revs. per min., their normal speed being 120 revs. per min. The action of the synchronous converters when run from the steam-driven generators at this reduced speed seems to be a tendency to slow down every time the engines pass their centres, which produces a very noticeable effect on all incandescent lights supplied from the generators and lighting synchronous converters. This trouble is caused by the irregular angular velocity of the prime movers and cannot be considered as synchronous converter trouble. In no case has this caused any trouble other than the effect on the incandescent lamps, even when the speed of the generators would fall as low as 110 and 112 revs. per min. This effect entirely disappears when the generators are running at their normal speed.

During the last 18 months the transmission line troubles have been very much less than they were before, and the troubles with the synchronous converters have practically disappeared. As the grounding of the neutral point of the secondary winding of the step-down transformers prevents the synchronous converters from flashing-over at the commutators when line trouble does occur, and various other improvements have been made in the transmission line, we have not had any more trouble with these synchronous converters than would be had with an equal number of direct-current generators of the same capacity. Having the two sources of supply in the same station, where all of the synchronous converters are situated, it has been necessary to operate some of the synchronous converters from the steam-driven generators and some of them from the power supplied by the Snoqualmie Falls Power Co., all synchronous converters being operated in parallel on the direct-current side. This combination is used with both types of synchronous converter, the pressure of each synchronous converter being controlled by Hartford regulators. This arrangement serves to steady the pressure variations caused by the fluctuations of the street-railway load, and the results are very much more satisfactory for smoothing out the load than when all synchronous converters are operated from the same source of supply.

As for care and attention necessary for synchronous converters, it is substantially the same as that required by direct-current generators of the same pressure and capacity. The commutators require sandpapering about once a week. Occasionally a commutator will require sandpapering twice in one week. No. 2½ sandpaper is used to bring the commutator to a smooth surface, and it is then finished with No. 1 sandpaper. A small amount of oil is used on each sheet of sandpaper to prevent the dust from flying. It is very bad practice to saturate sandpaper with oil for use on a commutator as the excess of oil will form a paste with the copper dust that will be forced into the mica, if the mica is as soft as commutator mica should be. The excessive use of oil is especially bad if there happens to be a number of mica segments in a commutator that are not uniformly even with the copper segments. Very good results are obtained by spreading the oil evenly over the sandpaper, then absorbing the greater portion of it with clean waste, leaving enough to prevent the copper dust from flying, but not enough to form a paste. We have tried for a long time to get a carbon brush that would be satisfactory, and we think that we have found one. In the meantime, we have found a great many that were not satisfactory, the average life of a set of carbon brushes being from three to six months. We have a set of brushes in a synchronous converter that were put in on May 28, 1903, and on April 14, 1904, they were about half worn out. The wear on this commutator has been very small also. We have a set of brushes in another machine that has been in use since February 23rd, and the wear on these brushes was found to be about $\frac{3}{16}$in. when measured in April. The brush just referred to is a medium-soft brush with a good deal of graphite in it. Pure graphite brushes are not at all satisfactory for synchronous converters.

THE NATIONAL PHYSICAL LABORATORY. RECENT RESEARCHES AND FUTURE WORK.*

BY R. T. GLAZEBROOK, F.R.S., DIRECTOR.

Researches Recently Completed.—Before any institution can standardise, it must possess standards, and accordingly much of our work has related to the construction of standards. Thus Dr. Harker has been concerned chiefly with the establishment of a scale of temperature. The thermometric scale in use for ordinary purposes in England is that of the Kew mercury thermometer; the scale of a mercury thermometer depends on the glass of which it is constructed, and the ordinary English crystal glass has some properties which detract from its suitability for thermometric purposes; a comparison between the Kew scale and that of the hydrogen thermometer is still in progress; meanwhile, for scientific work, the hydrogen scale, obtained through a number of Tonnelot thermometers, which have been studied at the Bureau International, is our standard. Above 100°C. the constant volume nitrogen thermometer has been accepted as standard. Dr. Harker and Dr. Chappuis at Sèvres had compared the nitrogen thermometer with the platinum resistance thermometer up to a temperature of about 500°C. Dr. Harker, in his recent work, has continued his comparison up to 1,000°C., including in his investigation a number of thermo-junctions. The table gives some of the results:—

Second Series of Comparisons. Compensated Furnace.

Gas thermometer, platinum thermometer BA_2, thermo-junction NPL_2.

No. of experiment.	Temperature. Gas thermometer.	Junction.	Pt. thermometer.	G—Pt.	G—Th.	P—Th.
5	523·1	524·3	524·39	−1·3	−1·2	+0·1
10	568·5	569·5	569·35	−0·9	−1·0	−0·2
8	598·5	597·8	597·62	+0·9	+0·7	−0·2
1	599·4	599·0	598·80	+0·6	+0·4	−0·2
3	641·1	641·1	641·75	+0·6	+0·0	−0·6
4	682·4	683·0	682·54	−0·1	−0·6	−0·5
2	776·7	775·5	775·13	+1·6	+1·2	−0·4
9	820·0	818·4	818·31	+1·7	+1·6	−0·1
11	831·4	832·2	831·86	−0·5	−0·8	−0·3
12	866·7	868·4	868·28	−1·6	−1·7	−0·1
6	875·0	875·4	875·24	−0·2	−0·4	−0·2
7	959·8	956·0	955·47	+4·3	+3·8	−0·5
13	1,005·0	1,004·4	1,004·37	+0·6	+0·6	−0·0

The thermo-junction was compared with one standardised at the Reichsanstalt by the kindness of Prof. Holborn, and the table indicates the accuracy with which the scale in use at the Reichsanstalt agrees with our standards at Bushy. It shows, moreover, that Callendar's parabolic formula for calculating the value of the temperature from the readings of the platinum thermometer is applicable over a range of temperature from −200°C. to 1,000°C. at least.

* Abstract of Paper read before Section A of the British Association.

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The chief difficulty in such comparisons is to secure that the instruments should all be at the same temperatuae. Dr. Harker attained this result by using a resistance furnace constructed by himself to produce his high temperature. In this he placed an auxiliary platinum thermometer connected to a Callendar recorder and only observed when the recorder indicated that the temperatures had been constant for a sufficiently long period.

Another research which has been brought to a successful termina tion this year is Mr. Smith's construction of a number of mercury standards of resistance. Such standards had only been constructed twice previously in England, both times at the Cavendish Laboratory; and though in 1894 the Electrical Standards Committee of the Board of Trade had recommended, "That a material standard constructed in solid metal should be adopted as the standard ohm and should from time to time be verified by a column of mercury of known dimensions," the establishment of the Laboratory afforded, 10 years later, the first opportunity for this verification. Mr. Smith measured and calibrated a series of eleven tubes. The resistance of each of these was determined in four different ways and each such measurement was repeated on three fillings of the tubes. The next table gives the results of two such series of measurements. It will be seen that the difference from the mean for any one tube is nowhere greater than six parts in a million. The unit of resistance employed is the ohm (10^9 C.G.S. units) derived through the standard coils of the Association from the experiments made in the Cavendish Laboratory by Lord Rayleigh and the present writer, 1886—1888.

Standard	Res. in ohms (Kelvin double bridge).	Res. in ohms (potentiometer).	Mean value of res.	Difference from mean, parts in 100,000.
M	1·001162	1·001167	1·001164	-0_2 $+0_3$
	1·001164	1 001162		$\pm 0_0$ -0_2
	1·001166	1·001165		$+0_2$ $+0_1$
P	1·000467	1·000468	1·000470	-0_3 -0_2
	1·000468	1·000472		-0_2 $+0_2$
	1·000472	1·000471		$+0_2$ $+0_1$
T	1·000277	1 000273	1·000278	-0_1 -0_5
	1·000281	1·000280		$+0_3$ $+0_2$
	1·000276	1·000281		-0_2 $+0_3$
U	1·000215	1·000213	1·000217	-0_2 -0_4
	1·000216	1·000216		-0_1 -0_1
	1·000222	1·000218		$+0_5$ $+0_1$
V	1·001462	1·001455	1·001462	$\pm 0_0$ -0_7
	1·001468	1·001462		$+0_6$ $\pm 0_0$
	1 001463	1·001465		$+0_1$ $+0_3$
W	1·000156	1·000161	1·000153	$+0_3$ $+0_8$
	1·000152	1·000151		-0_1 -0_2
	1·000146	1·000151		-0_7 -0_2
X	1·001147	1·001147	1·001151	-0_4 -0_4
	1·001154	1·001151		$+0_3$ $\pm 0_0$
	1·001155	1·001152		$+0_4$ $+0_1$
Y	1·000356	1·000354	1·000350	$+0_6$ $+0_4$
	1·000347	1·000350		-0_3 $\pm 0_0$
	1·000348	1·000346		-0_2 -0_4
Z	1·001387	1 001391	1·001389	-0_2 $+0_2$
	1·001389	1·001384		$\pm 0_0$ -0_5
	1·001392	1 001393		$+0_3$ $+0_4$
G	1·001130	1·001135	1·001135	-0_5 $\pm 0_0$
	1·001138	1·001135		$+0_3$ $\pm 0_0$
	1·001131	1·001132		-0_4 -0_3
S	1·001053	1·001054	1·001057	-0_4 -0_3
	1·001055	1·001061		-0_2 $+0_4$
	1·001061	1·001057		$+0_4$ $\pm 0_0$

In the next table are given the observed resistances of the tubes in this unit, and their calculated resistances, determined from their geometrical dimensions, in international ohms.

	Mode of erection I.			
Standard.	Observed resistance in ohms.	Theoretical resistance in international ohms.	Observed − theoretical value.	Difference from mean.
M	$1·00005_2$	$0·99994_6$	$0·00010_6$	$+0·00002_1$
P	$0·99938_4$	$0·99930_4$	$0·00008_0$	-0_5
T	$0·99912_1$	$0·99904_6$	$0·00007_5$	-1_0
U	$0·99912_9$	$0·99904_6$	$0·00008_3$	-0_2
V	$1·00043_3$	$1·00036_1$	$0·00007_2$	-1_3
W	$0·99915_2$	$0·99905_5$	$0·00009_7$	$+1_2$
X	$1·00006_3$	$0·99998_0$	$0·00008_3$	-0_2
Y	$0·99926_3$	$0·99915_5$	$0·00010_8$	$+2_3$
Z	$1·00032_5$	$1·00024_8$	$0·00007_7$	-0_8
G	$1·00034_2$	1·00027	0·00007	-1
S	$1·00025_4$	1·00016	0·00009	$+1$
		Mean	$0·00008_5$	

The mean difference between them is $0·00008_5$ ohm, and shows that the resistance of one international ohm as derived at the N.P.L. is less than 10^9 C.G.S. units as represented by the Association Standards by this amount. A further series of experiments have shown that the resistance of the unit employed as the international ohm at the Reichsanstalt is greater than the resistance of the international ohm as derived at the N.P.L. by $0·00002_0$ ohm. In other words, our unit and the German unit agree to two parts in 100,000. Thus we may claim to have established a scale of temperature up to 1,000°C. probably correct to a few tenths of a degree at that temperature, and a standard of resistance agreeing with that in use on the Continent and in America—where the Reichsanstalt standards are at present employed—to two parts in 100,000.

To turn now to Dr. Stanton's experiments on wind pressure. Dr. Stanton has endeavoured to attack the problem by measuring the distribution of pressure and the resultant thrust on small plane areas exposed to a uniform current of air. The current produced by a Blackman fan, is a vertical one some 2ft. in diameter. The surface on which the thrust is to be measured is exposed to the draught being carried at one end of a long lever and the thrust is measured by balancing it against weights at the other end of the lever. The distribution of pressure over the surface is measured by a series of Pitot tubes which are connected by very fine indiarubber tubes in a sensitive water gauge. The other limb of the gauge is connected to the "static pressure" tube of the Pitot tube arrangement. In this arrangement it can be shown that if v be the velocity of the current and h the difference of level in the two limbs of the gauge, then $v = k\sqrt{2gh}$, when k is a constant which theoretically is equal to unity. By means of an ingeniously devised anemometer Dr. Stanton verifies this law, obtaining for the constant k the value 1·08. From these experiments the important law was deduced that on similar structures the resultant force due to a uniform wind is simply proportional to the square of the linear dimension. The range of dimensions over which this law has been verified is, of course, extremely small; with a view of extending the law Dr. Stanton is now engaged in repeating the experiments on a large scale in the open air.

Substance.	Condition.	Disruptive voltage.	Ratio of max. diff. from mean to mean.	Thickness. Millimetre.	Volts per millimetre.	Punching pr'ss're. Lbs.	Bending test. Cylinder diameter
Press-spahn..	a	2,180	9 %	0·23	9,500	55·0	..
	b	2,330	6 ,,		10,000	57·0	$\frac{1}{16}$"; >10
	c	2,330	6 ,,		10,200	27·0	$\frac{3}{4}$"
Press-spahn..	a	2,920	13 ,,	0·56	5,200	106·0	..
	b	3,550	3 ,,		6,300	105·6	$\frac{1}{16}$"; 6
	c	3,670	7 ,,		6,550	79·0	1"
	d	3,330	3 ,,		5,950	40·0	$2\frac{1}{2}$"
Press-spahn..	a	6,650	2 ,,	1·61	4,150	>150·0	..
	b	>9,000	..		>5,600	>150·0	about 5"
	c	>9,000	..		>5,600	>150·0	,, 8"
Press-spahn & standard varnish ..	a	3,610	8 ,,	0 34	10,500	57·5	..
	b	7,120	12 ,,		21,000	74·0	$\frac{3}{8}$"
	c	>9,000	..		>26,000	67·0	1"
	d	>9,000	..		>26,000	60·0	$1\frac{3}{4}$"
Manila paper	a	1,540	8 ,,	0·28	5,500	62·0	..
	b	1,540	2 ,,		5,500	25·0	$\frac{1}{2}$"
	c	1,590	5 ,,		5,700	20 0	1"
Manila paper.	a	1,620	4 ,,	0·38	4,300	69·0	..
	b	1,920	4 ,,		5,100	41·0	$\frac{1}{16}$"; 4
	c	1,810	5 ,,		4,800	24 0	$1\frac{3}{4}$"
Manila paper & standard varnish	a	1,800	2 ,,	0·34	5,300	54·0	..
	b	3,400	8 ,,		10,000	47·0	1
	c	4,310	8 ,,		12,700	42 0	2
	d	4,180	9 ,,		12,300	37·0	$2\frac{1}{2}$
Waterproof board	a	2,420	2 ,,	0·29	8,300	62·5	..
	b	3,720	7 ,,		12,800	67·0	$\frac{1}{16}$"; >10
	c	3,630	11 ,,		12,500	34 0	1"
Waterproof board	a	3,300	4 ,,	0·44	7,500	94 0	..
	b	4,480	17 ,,		10,200	102·0	$\frac{1}{16}$"; >10
	c	5,200	10 ,,		11,800	57 0	1"
Oiled clo'h..	a	4,580	4 ,,	0 22	21,000	29·0	..
	b	5,110	20 ,,		23,000	27·0	$\frac{1}{4}$"
	c	4,650	14 ,,		21,000	24·5	$\frac{3}{8}$"
	d	3,940	12 ,,		18,000	19·0	1"
Red oiled paper	a	6,600	6 ,,	0·25	26,000	30·0	..
	b	6,850	11 ,,		27,000	34·0	$\frac{1}{2}$"
	c	7,900	13 ,,		31,000	37·0	$\frac{1}{2}$"
	d	6,940	8 ,,		28,000	28 0	$1\frac{1}{4}$"
Black oiled board	a	5,320	2 ,,	0·30	17,700	59 0	..
	b	5,460	8 ,,		18,200	61 0	1"
	c	6,170	3 ,,		20,600	55·5	2"
	d	4,870	4 ,,		16,200	33·0	$2\frac{1}{2}$

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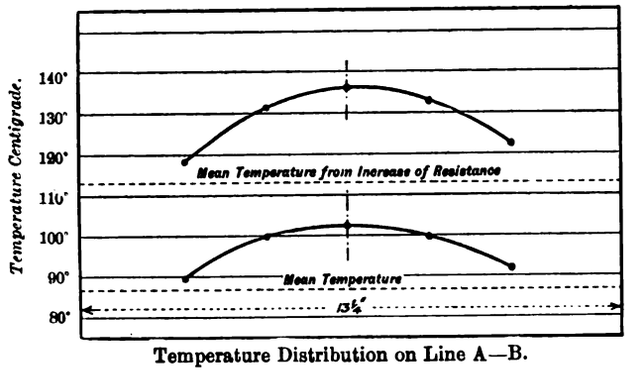
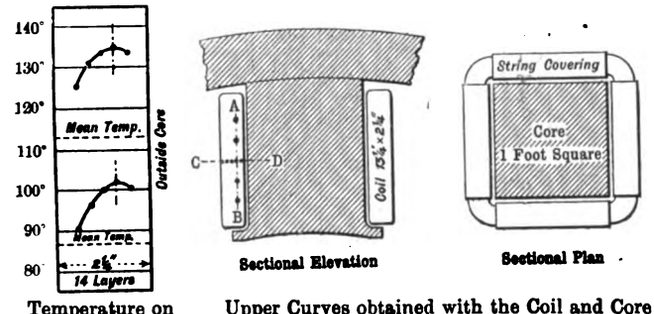
The value of the work now being done by the Engineering Standards Committee is well known and the Laboratory has been fortunate in being able to assist in this work in various ways. Thus it will be necessary for the Electrical Plant Committee to determine a maximum of temperature for the safe working of motors, dynamos and electrical machinery. But this will clearly depend on the electrical and mechanical properties of the materials, especially the insulators used in constructing the coils. Accordingly a large series of insulating materials were obtained and heated for some three months to temperatures of from 75°C. to 100°C., 100°C. to 125°C., and 125°C. to 150°C. in electric ovens. These were tested for resistance, electric strength as measured by the volts required to pierce them, mechanical strength as measured by resistance to shear—produced by a carefully made punch—and capacity to resist bending. This last was tested by bending the specimen round a series of cylinders of gradually decreasing diameters and noting the diameter of the cylinder at which the specimen broke. The table on the preceding page shows some of the results.

In the table *a* indicates that this specimen had not been heated, *b* indicates heating to about 75deg., *c* to about 100deg., *d* to about 125deg. Speaking generally, the properties improve by heating to 75deg., do not seriously deteriorate by further heating to 100deg.—in some cases they actually improve—but show a marked falling off on heating to 125deg.

The smallest cylinder used had a diameter of $\frac{1}{16}$in., and an entry like $\frac{1}{16}$>10 in the last column indicates that the specimen was



Temperature Distribution on Line A—B.



Temperature on Line C—D.
Temperature by External Thermometer 31°.
Machine running.

Upper Curves obtained with the Coil and Core alone.
Current 8·1 Amperes.
Lower Curves. Machine—500kw. running.
Current 8·2 Amperes.

FIG. 1.

bent 10 times without breaking round this cylinder. But in the endeavour to apply these results another difficulty occurred. The temperature of the coils used to be taken by means of a thermometer placed against them. I fear the method is too often employed now. The more modern practice is to determine it from the resistance of the copper. But this gives the average temperature of the coil, and the breaking down is probably determined by the maximum temperature. Very little was known about the distribution of temperature in the coil beyond that contained in a valuable Paper by Mr. Brown. Some eight or 10 makers gave their help, and wound a number of field coils of their ordinary pattern, but containing thermo-junctions of iron-eureka wire standardised at the Laboratory. The distribution of temperature in these coils was tested in the first place at the Laboratory by running the proper current through the coils and observing the temperatures as given by the 12 or 15 thermo-junctions. The resistance of the coil was also measured, and thus data were obtained for finding the mean temperature and the distribution of temperature. When this was done the coil was returned to the maker's works and the same observations made there during a test run of the machine. The experiments are still in progress, but Fig. 1 gives the result for one coil. The diagram explains itself. Thus, when the coil was at the Laboratory carrying a current of 8·1 amperes the mean temperature was 113°C. and the maximum 136°C., a difference of 23°C., while when used on a 500kw. machine, and carrying the same current, the mean temperature was 82°C. and the maximum about 103°C. The difference in these figures is due to the fanning action of the armature. I think the value of a series of experiments of this kind on eight or 10 different types of machine will be obvious to anyone interested in electrical machinery, while cordial thanks are due to those manufacturers who have helped in the investigations. These experiments have been carried out by Mr. Rayner.

So far I have dealt with the past; I will turn now for a few moments to the future. The opportunities for work are increasing fast, and the requests for our help are very numerous. Unfortunately we have to decline by far too many of these. Our equipment is incomplete, our staff insufficient to deal with all we have to do. We must work on a larger scale than is now possible. The demand for scientific assistance in many branches of industry has begun to grow; unless we are in a position to satisfy that demand, we shall check its growth and the results will be disastrous. We believe that science can do much to aid commerce and manufacture, but the attempt to do this must be on a fitting scale. Each time I reply to a genuine request for assistance "No equipment," I feel I have done serious harm to the cause the founders of the Laboratory had at heart when they pressed it on the Government.

At the invitation of the authorities of the Treasury a statement containing constructive proposals giving effect to these conclusions has been submitted to them by the Royal Society with the request that the Lords Commissioners of H.M. Treasury will carefully consider the work and organisation of the National Physical Laboratory, with a view to laying down the lines that ought to be followed in the future and to placing the Laboratory in a position to do its national work, and this has been followed by a further memorandum and letter calling attention to the urgency of the case and asking for inquiry. These documents are now under the consideration of the authorities. Let me conclude with a quotation from a letter just received from a surveyor in the Government service on the West Coast of Africa with whom I have been in communication about his apparatus.

The reason why this demand—for accurate surveying tapes—may not have come fully to the notice of the proper authorities in the mother country may, I think, be attributed to the fact that until quite recently there was no place in England where these standards could be obtained (indeed, as far as I am aware, there is no place now) and the colonies have been forced to procure them from foreigners, and the knowledge of the superiority of their workmanship in this direction leads the colonies to infer that they might be equally advanced in other kindred commodities. I feel I have no need to point out how disastrous this has proved from a national point of view.

A 100-MILE TRANSMISSION LINE.*

BY ROBERT HOWES.

The plant considered is that of the Washington Water Power Co., of Spokane, Washington. The power house is located at the foot of the lower falls of the Spokane river, in the very centre of the city of Spokane. The theoretical head on the water-wheels is about 71ft. That portion of the plant which furnishes the power for the transmission line is composed of two Y-connected 4,000-volt, 2,250kw., 60 cycle, 300 revs. per min., revolving-field alternators, each directly driven from a pair of 40½in. special turbines, made by the Stilwell-Bierce and Smith Vaile Co., and designed to develop 4,000 H.P. under 68ft. of effective head. The water is supplied to each unit through a steel flume 10ft. in diameter and over 500ft. long. The wheels are governed by Lombard governors, with compensating action modified to meet the demands occasioned by kinetic energy of the water moving in the long flumes. These governors can be relied upon to keep the speed from rising or falling over 3 per cent. from the normal with instantaneous changes of 600kw. at any position of the gates, and will care for small changes of load to within one-third of 1 per cent. of normal speed. The principal exciter is driven from a separate wheel, which is supplied with water from either of the two flumes. An induction motor, not yet in operation, is to be connected to the end of the exciter shaft opposite the water wheel, and driven from the transmission leads inside the oil circuit-breakers. It will serve the double purpose of governor and insurance against lack of power for the exciter if the chute case of the water wheel becomes partially chocked up. An indicating wattmeter on the induction motor will indicate the choking of the water wheel by showing that the motor takes more load. The exciter will then be started and the choked wheel cleaned out.

The plant is designed to furnish three-phase current at 4,000 volts for local power and 2,300-volt single-phase current for local lighting service in Spokane. Any lighting feeder can be thrown on either of the three legs of the Y-connected generator by means of oil switches

* Abstract of Paper read before the National Electric Light Association of America.

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and the load on the generators kept balanced. Hand voltage regulators are installed on the neutral or grounded side of each lighting feeder, the voltage being regulated with the aid of a voltmeter compensated for the line loss. The generator, transmission line and main city switches are motor controlled. Those on the transmission line and city have automatic overload tripping devices. The city feeders have automatic oil circuit-breaker switches, hand operated. The step-up transformers are 750kw. each and of the water-cooled type. They are connected in delta on the 4,000-volt side and in Y on the high-tension side, the neutral connection being grounded at the power house. The high-tension winding is for 34,700 volts, taps being brought out for 26,000 volts also, thus giving a choice of 60,000 or 45,000 volts line pressure. Two spare transformers are installed, and the switching arrangement is such that one of the spare ones can be cut in to replace either of the three in use without shutting down. The second spare one can be connected on any phase by shutting down about one minute. Three banks of lightning arresters are installed on the line; one at Spokane, one at the end of the line and one about 20 miles from the end of the line.

The main line is 98 miles long to the farthest sub-station, and has three short branches at present. Low-tension current is transmitted about 2 miles farther up the cañon, making the total transmission just 100 miles. On leaving the power house the line goes through the city streets for 3½ miles, the poles used being from 40ft. to 85ft. long, in order to get above everything that might be interfered with. Wherever it crosses other lines grounded wires are strung over them several feet below the transmission line. Leaving the city the line follows a county road for about 24·5 miles till it reaches the Cœur d'Alene Indian reservation. Across this, a distance of 24·8 miles, almost all in heavy timber, a private right of way was obtained and cleared of all trees and brush. All trees outside the right of way, liable in falling to reach the line, were also felled. At one point in this portion the line crosses the St. Joseph river, where it empties into the Cœur d'Alene lake. The river runs close to a bluff on the west, while on the east side there is a marsh and the neck of an inlet. At high water several feet of water stand from bluff to bluff. To span this would require a span of 3,300ft., so resort was had to setting the poles on a cluster of five piles. The centre one being driven about 6ft. lower than the others, a socket was formed in which the pole was firmly clamped with heavy iron bands. By this means the longest span was reduced to 474ft. across the river channel, the wires being far above the smoke-stacks of the steamers that navigate the river. No. 0 B. & S. hard-drawn copper wire was used here for further security against a wire breaking. A row of single piles with a plank walk was placed across the marsh under the line for patrolling purposes. Thus far this construction has proved most satisfactory.

Leaving the reservation the line follows up the valley of the Cœur d'Alene river and the south fork of the same to the mining region. It is largely on private right of way, but follows county roads in part and goes through a mixture of swamps and meadows—sometimes several feet under water—timber-covered mountains, steep rocky mountain sides and around rocky cliffs. As far as possible it was considered best to avoid proximity to towns, railroad tracks, &c., where the youth with a 22-calibre rifle likes to walk and practice shooting, for the insulators offer a tempting target to those of a mischievous nature. The poles of the present line are set 35ft. from the north or westerly side of the 100 foot right of way, leaving room for a duplicate line on the other side. The standard pole is 35ft. long, of winter-cut cedar, 12in. at the ground line and 8in. at the top. They are set 6ft. in the ground. Special lengths are used in hollows at bottom of ravines, &c., to avoid making too great a change in the slope of the wires on any one insulator, also at railroad crossings and in villages. The wires are of No. 2 B. & S. medium hard-drawn copper, and are placed to form an equilateral triangle 42in. on a side. The upper insulator is set on the top of the pole, the others at either end of the cross-arm. A complete set of three partial transpositions is made in each section where the condition varies in paralleling telegraph, telephone lines, &c., otherwise in every mile. A private telephone line is run on the side of the poles below the power line, and is transposed every few spans. The insulators used are of the double-petticoat type, 13in. size, and are mounted on a metal pin.

The sub-station buildings are of brick. The high-tension wires, entering near the top, go directly to knife-disconnecting switches set on a gallery, thence to the transformers on the ground floor. One transformer of the three-phase type is used. The secondaries pass from a transformer to a switchboard carrying oil circuit-breakers, recording wattmeters and indicating instruments, thence to the consumers' circuits. Half-voltage taps are taken off the transformers for starting the synchronous motors. There are eight of these sub-stations, six of which have been in continuous use since starting. Besides the above there is a sub-station recently built about 11 miles from Spokane, where power is taken from the transmission line and the voltage stepped down to 23,000 to supply the lines of an inter-urban railway 33 miles long. The railway company uses the power through rotaries to supply the trolley with 600-volt direct current. Several miles of long-distance telephone line parallel the transmission line at a distance of about 40ft., and one of the telephone company's engineers was much worried, fearing trouble with the operation of these lines. Three days after the transmission was in operation he asked when the current would be turned on, as he wished to notice how much the change was. Upon learning that the current was on, he admitted he could not detect it in the operation of the telephones. There is very little sound on the private telephone line from induction unless one wire becomes grounded, when it becomes almost impossible to understand a person at the other end.

A rather peculiar loss of from 1ft. to 6ft. of head in the draft tubes is encountered at the ordinary height of the river. The centre of shaft is then about 18ft. above tail water. Not far above the intake to the power house the river divides into several channels and falls over numerous small dams and cascades (composing the "upper falls") about 60ft., reaching this level a few hundred feet above the intake. There being no quiet water whatever, considerable quantities of air seem to be taken into the flumes with the water, and no doubt are held there under pressure as the water flows down the flumes, to be instantly released upon passing through the wheels into the partial vacuum. This, no doubt, explains a part of the loss of head. Another peculiar phenomenon is noticed every time one of the 4,000-H.P. wheels is started, of which the writer has found no satisfactory explanation, and would be glad to hear one. The following characteristic observations were recorded by him:—The pressure at the centre of shaft, according to gauge, being noted as 24lb. and the vacuum in draft tubes being zero, the gate of the wheel was opened slowly. Full speed was reached in about one minute, the gate baing 9 per cent. opened. The vacuum was noted as rising rapidly. The speed remained steady for two or three minutes and the vacuum increased to 10in. of mercury. Suddenly the wheel slowed down 20 per cent., the vacuum continuing to rise to about 18in. of mercury, where it remained practically stationary. The wheel continued to run at steady speed and 20 per cent. low until the gate was further opened, it requiring 16 per cent. gate opening to bring the wheel back to speed. The pressure gauge showed a loss not to exceed $\frac{1}{10}$lb., while the vacuum remained about the same.

The power house being ready before the line was completed, 77 miles of line were first tested. All switches were closed and the generators started slowly from rest. The speed was gradually increased, the connections having been made for 60,000 volts pressure. The pressure was brought up to 42,000 volts and then cut down slowly to zero without any indications of trouble. Next morning the machine was started again in the same manner, the voltage being raised to about 68,000 volts for a short time, and then lowered to about 58,000 or 60,000 volts, and held there all day while the entire line was patrolled and found to be in a good condition. Along the line a discharge could be heard at a large percentage of the insulators. With 58,000 volts on the line, the amperes shown on the generator were 230 in each leg, while the wattmeter indicated 25kw. per leg. This would show the charging current to be approximately 15 amperes, while, after the step-up transformer loss was deducted, the remaining energy lost in the line would not be over 10kw. per wire, or a total of less than 30kw. In this test only one set of lightning arresters was connected, they being at Spokane; each division of the set was composed of 24 General Electric 2,000-volt double-pole arresters connected in series, thus forming 96 spark-gaps from each wire to ground. A steady stream of sparks could be noticed through the first few air-gaps. These became less frequent as the number of gaps crossed became greater, and before reaching half-way down the arresters the sparks were no longer visible. The leading current exerted such an exciting effect on the generator that the exciter voltage had to be reduced to 85 volts and all the generator fields resistance cut in, giving an exciting current of about 50 amperes, whereas, with the generator half-loaded with non-inductive load, the exciter was run at 115 volts with the generator rheostat handle in about central position.

After this test the line was shut down for four days, the transformers were connected to 45,000 volts line pressure, and the first sub-station, 79 miles from Spokane, cut in. The voltage was brought up to 43,000 volts, and simultaneous volt readings were taken by means of telephone, the voltage being very steady. The voltage indicated at the sub-station was a little over 44,000. The voltmeters were new, but were not compared; however, the error should not have been 2 per cent. The ampere-meters in Spokane on the 4,000-volt side of the transformers indicated 120 amperes, giving about 10·5 amperes for charging current at this voltage, there having been two more miles of line cut in and also an unloaded transformer and bank of lightning arresters at the sub-station since the test at 58,000 volts. During the first test the neutral wire was not grounded at the power house, and the floating around of the neutral point was plainly noticed on the lightning arresters, the sets connected to the three wires showing considerable difference, sometimes one being most active and then another.

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Grounding the neutral wire stopped the greater part of this effect, althought a slight varying difference still seemed to exist. As induction motors were started, the amperes supplied to the step-up transformers decreased until a minimum reading of about 95 amperes was reached. The kilowatts were not observed, owing to the generator furnishing current to the city as well at this time, and the proportion of the total supplied to each could not be accurately obtained. After this time, adding more load increased the current, accordingly the minimum current is about $8\frac{1}{3}$ amperes for 79 miles of the line at 43,000 volts.

The work was rapidly pushed to completion, and the sub-stations were put in operation, each sub-station being put into service as soon as the line reached it. The power was cut off only long enough to make connections to each piece of new line. Accordingly, no opportunity to test the charging current and the kilowatts of the complete line was had; for one could never be sure that all the load was off at the various sub-stations. From two of these current is supplied for lighting purposes, the towns of Wardner and Kellogg being lighted from one. Unity power-factor is usually reached with a load of 1,450kw. The current in the line is then about 18·5 amperes per mile. Four 300 H.P. induction motors, one 240 H.P. synchronous motor and several induction motors of smaller sizes are in operation on the line. One of the 300 H.P. induction motors is supplied from the sub-station at the end of the line, and is directly connected to a hoist which is in almost constant use. During the first two months this had to be run entirely unbalanced. The effect of this hoist upon the regulation of the line was at first very serious. The motor is a three-phase General Electric, built for 514 revs. per min, 2,080 volts and 60 cycles. When the load on the line was light and this motor was started it would throw a heavy inductive current on the line, increasing the power-factor instantly, leaving the generator much under excited and causing the voltage to drop accordingly. To this had to be added a drop of about 1 or $1\frac{1}{2}$ per cent., due to drop in speed. The speed would be just about recovered when the load would come off again, restoring the power-factor and excitation to the generator, while the speed would rise about as much as it fell on starting the motor, causing the voltage to go slightly above normal. Ordinarily, the voltage at Spokane would fall about 10 or 12 per cent. and rise 2 per cent. from normal, while extreme cases were nearly twice as bad. The voltage at the end of the line would, in general, vary about 1·6 times as much as it did at the power house. This action continuing every two or three minutes, needless to say, made the power unsatisfactory for lighting purposes, while the speed variation of the induction motors was enough to bring forth severe complaint where they were used to run milling machinery requiring a very constant speed. Even the synchronous motor, judging from the attendant's account, would start to fall out of step, slip over a few poles, and again get in step, but causing much anxiety. After a day or two of this, a man was put in constant attendance on the generator rheostat, and the writer went to the end of the line to study conditions and see what could be done. He found that the motor as then handled took about 275 kilovolt-amperes for the first point on the controller. The operator would then move the handle rapidly, bringing the kilovolt amperes up to 400 or 500, make the run, and shut off quickly. The time of raising the car from the 300-foot level was 25 seconds, and from the 600-foot level was 45 seconds. It was noted by comparing recording voltmeter charts that the attendant at the switchboard in Spokane could do little to keep the voltage from falling, but would bring it back very quickly.

When the motor was cut out the voltage would rise nearly as much as it had dropped before. However, the general effect was much improved. It was found that the controlling rheostat of the motor was too small to stand regulating the speed of the motor for any considerable time, so, as a temporary makeshift, a resistance was made of iron wire and inserted in the circuit between the starting box and the rotor. This had the effect of cutting down the kilovolt-amperes taken at the first point to about 175, and the operator could then move the controller handle more slowly. The first instantaneous drop in voltage was much reduced, and the attendant at the power house had a chance to hold the voltage nearer normal. With this condition the voltage would usually fall at the power house about 6 or 7 per cent., and would rise nearly as much above normal. While this gave pretty poor lighting service, it did not seriously interfere with the motors. This arrangement, however, has the bad feature of running the motor at a slower speed, and so doing only the work of a smaller motor. This is not serious while operating from shallow shafts, but would be unsatisfactory for deeper workings, which will be worked in the future. Accordingly, the writer recommends for such requirements a rheostat large enough not to overheat when running with any part of it in use, the first point to give a current nearly as small as that taken by the motor with the rotor open-circuited. The second point would increase the current about 30 per cent., the next 30 more, the remaining ones to give more gradual changes. The motor would not start until the third or, if heavily loaded, perhaps the fifth point. The controller handle should also have a time relay device, making it necessary to consume about three seconds between the first and second points, two between the second and third, and one for the next, also a smaller time limit for cutting out these points. An emergency switch should be provided, so that the operator could cut off the current instantly if necessary. This would enable the power house to care for the small changes and keep the voltage near its standard there, the line-loss being the principal thing left to contend with.

A large water rheostat was installed at Spokane and used in connection with the transmission line, and was found to be of use on light loads; but when the power-factor reached 100 per cent. it did little good and could be cut out. It was hoped that a voltage regulator ordered would be installed in time to record the results herewith, but at time of writing the regulator had not arrived.

A suggestion made, but not tried as yet, is to instal a large synchronous motor at the end of the line, with no load except its own exciter, and instal one of these regulators to operate on the field of this motor. If the line voltage dropped, the regulator should strengthen the motor field and throw a leading current on the line. If the voltage rose, the field should be weakened to throw a lagging current on the line. The objection to using a motor installed for other purposes is that the motor would often be shut down, and would be largely out of the power company's control.

It may be of interest to note that while the line has been in continuous operation for over seven months, the circuit-breaker has been tripped only eight times, excepting when arrangement for a short shut-down has been made with all parties interested. Of these eight times, two were caused by accidental short-circuits on the line, made by the company's workmen; four were short-circuits on the secondaries of customers, and were severe enough to throw out the secondary breaker, the sub-station breaker and the power-house breaker all at once; the other two were from unknown causes. The total time the power has been off because of these troubles is 32 minutes.

STEAM TRIALS ON WILLANS ENGINES.

On April 6th steam trials were made at the Poplar Vestry electricity works (of which Mr. P. N. Hooper is the chief electrical engineer) on one of the 500kw. Willans engines recently installed, with a view of ascertaining the commercial efficiency of the Willans-Mather and Platt steam sets under working conditions. The trials were carried out, under the supervision of Mr. P. N. Hooper, by representatives of Messrs. Willans and Robinson (Ltd.) and Messrs. Mather and Platt, and are of considerable interest at the present time as showing the results obtainable with this type of engine under working conditions with only a moderate amount of superheat and with a comparatively poor vacuum. It will be noticed that, at full load with a vacuum of 25in. in the engine, and with 25deg. of superheat only, a total steam consumption of 18·64lb. per kilowatt was obtained on one trial and 19·52lb. of steam per kilowatt on a second trial. This means that the mean of the two trials was about 19lb. of steam per kilowatt, or about $11\frac{1}{2}$lb. of steam per indicated horse-power. These results are good considering the conditions. From curves which we have recently published it is evident that, with a higher degree of superheat, the steam consumption would have been considerably lower.

The exhaust steam from the engines was collected and condensed in a tank mounted on a weighbridge, which was measured at definite periods. The electrical instruments recording the output of the dynamo were of the Weston standard type, and were calibrated by an independent authority after the tests. The results in the tables herewith are corrected to allow for an error in the instruments, which were found on calibration to be reading rather high.

Tests of 500kw. Willans-Mather & Platt set at Poplar.

—	Steam press. Boiler.	Steam press. Steam chest.	Temp. in steam chest.	Degree of superheat.	Vacuum in engine.	Speed revs. per min.	Output. I.H.P.	Output. E.H.P.	Output. Kw.
			Fah.	Fah.	In.				
Full-load conditions	180	165	398	25·1	25	260·5	825·8	672·6	501
¾-load ditto	180	133	408.	51·0	25	266·0	653·2	512·0	381
½-load ditto	180	88	402	72 0	26	272·0	458·2	338·0	252

—	Guaranteed pounds.	Obtained pounds. Full load. 1st trial.	Full load. 2nd trial.	¾ load.	½ load.
Water per I.H.P.	..	11·33	11·80	12·1	12·46
Water per E.H.P.	16	13 90	14·56	15·46	16·88
Water per kw.	..	18·64	19·52	20·72	22·63

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On May 14, 1904, similar tests were carried out at the Blackburn Corporation electricity works, of which Mr. A. S. Giles is the chief electrical engineer. The tests were made with a view of ascertaining the commercial efficiency of the 750kw. Willans steam dynamos recently installed in conjunction with Messrs. Dick, Kerr & Co.'s 10-pole continuous-current machine giving an output of approximately 1,600 amperes at 500 volts when running at a speed of 180 revs. per min. The trial under consideration at the present time was made on engine 3,416 by representatives of Messrs. Willans and Robinson and Messrs. Dick, Kerr & Co., under the direct supervision of Mr. A. S. Giles. The steam consumption results which are given herewith are the mean results of three separate trials. Considering the poor vacuum prevailing (22in.) and the moderate degree of superheat (112°F.), the results obtained—viz., 18·34 lbs. per kilowatt (say, 11·05lbs. per indicated horse-power)—are distinctly good.

The steam consumption was obtained by measuring the water into the boilers, the tank used, which belonged to the station, being calibrated before the trial against a properly calibrated tank. The instruments were of the Weston type, calibrated against standards before and after the trial.

Tests of 750kw. Willans-Dick, Kerr set at Blackburn.

Steam pressure in boilers, 179·6lb.
Temperature of steam at boiler pressure, 379°F.
Ditto at stop valve, 491°F.
Degrees of superheat, 112°F.
Vacuum, 22in.
Mean kw. 775·2
Water per I.H.P. 11·05.
Ditto per E.H.P. 13·7.
Ditto per kw. 18·34.

THE ACTION OF LIGHTNING STROKES ON BUILDINGS.*

BY KILLINGWORTH HEDGES, M.INST.C.E.

In a Paper entitled "The Protection of Buildings from Lightning," which was read at the Glasgow meeting of the Association in 1901, the author mentioned the establishment of the Lightning Research committee, organised jointly by the Royal Institute of British Architects and the Surveyors' Institution, who have since investigated a very large number of occurrences from the reports furnished by their observers. It was decided after the first year to confine the committee's investigations to buildings which were fitted with conductors, and, following this course, the reports on about 40 protected buildings affected by lightning have been summarised by a sub-committee, and are having the attention of the general committee, who will in due course issue a report.

The principal causes of the failure of the usual style of lightning rod, as fitted on the buildings investigated, appear to be due to the following:—(1) Insufficient number of conductor and earth connections; (2) the absence of any system of connecting the metallic portions of the buildings to the lightning conductor, especially the interconnection of the finials, rain-water pipes and gutters. In the author's opinion the frequent damage by side-flash from the conductors might be lessened by running a horizontal conductor along the ridge or along the parapets of all the roofs, somewhat after the method which is almost universally adopted in central Europe.

The lightning strokes may be divided into three classes:—(1) Those where the conductor convey a portion of the flash to earth, but the side-flash to other unearthed metallic conductors damaged the building; the practice of running the conductor round the projecting masonry, often taking sharp bends, doubtless facilitated the deviation of the current from its direct path to the earth. (2) In several observations a metallic roof of large area received the flash, consequently became highly charged, and the single conductor failed to convey the whole of the stroke, a portion of which took a circuitous path—for instance, through a speaking-tube and an electric bell wire. (3) A flash struck the building at two points simultaneously, a lightning conductor taking one part of the stroke, but damage was caused by the other portion selecting an unprotected part of the roof.

Earth Connections.—With a few exceptions, these had the defect common to nearly all earth-plates which are simply buried in the ground close to the foundations of a building, and owing to drainage soon became dry, consequently are of very high resistance. Architects, as a rule, object to sufficiently deep holes being made near a structure; consequently, the permanently moist ground is not reached. The tubular earth designed by the author does away with this objection, and can be kept moist by leading a small tube to the nearest rain-water pipe.

Interconnection with the Metal Work of a Building.—Although the utility of the external metal was specially put forward in the report of the Lightning Rod Conference in 1882, their recommendation has been apparently disregarded in all the cases under review. The Cavendish Laboratory (No. 64) stroke, which was fortunately unattended with danger owing to the gas in the gas-pipe which formed the path of the current being turned off, would have not taken this circuitous path had the leaden roof been connected to the conductors which ran down the tower only, also to the rain-water gutters and pipes, which should have been interconnected at the bottom and properly earthed. Again, at Bedford (No. 88) last year, St. Paul's Church was seriously damaged by the flash leaving the single conductor on the tower by the water on the roof and passing thence to earth by means of the rain-water pipes. In this case it is interesting to note that the lead pipes were not fused, but their round section was changed into an oval one; the iron water pipes were broken. This incident and No. 68 (St. Pancras Church, Euston) show clearly that the damage was due not to direct stroke, but by a portion of the flash leaving the main conductor and taking a circuitous path round the unconnected metal work outside and inside the buildings.

Observation No. 2: Kea Church Truro.—The copper sheathing of the spire owing to its great capacity, could not discharge through the one excellent conductor to earth, consequently the flash divided, part going by the conductor and part by the alternative path formed by the copper covering of the spire to a rain-water pipe, thence sparking through a parapet wall to lead flashing down another pipe, and then along a very small copper wire used for training plants, to the main conductor. Similar effects were noted in Stoers Lighthouse (No. 54) and Devaar Lighthouse (No. 56), the divided flash in the former leaving the conductor for a telephone wire and in the latter for a speaking-tube. In these observations the conductors may be said to have acted to a certain extent, and if the structures had been entirely unprotected the damage would have been greater, but by proper attention to the necessities of each case, and increasing the number of the conductors, the risk would probably be nil, as there would be a definite path for the lightning to take.

Quite the most interesting case is that at Possingworth House (No. 67), struck in June and again in August, 1902, although the roof fairly bristled with air terminals, every chimney being protected, mostly with its own conductor and earth connection. It is probable that on the second occasion the flash divided, one part selecting a chimney stack, which it damaged, bending the air terminal to an angle of 45deg., while the other, neglecting the many points, fell on an unprotected statue much lower than the chimney and went to earth by the iron frame of a conservatory, showing the unreliability of a number of independent conductors which should have been interconnected by means of a horizontal wire led along the ridge. This would, in all probability, prevent any serious damage.

Sir Oliver Lodge has shown by an interesting experiment that a column of hot air is often selected by a flash although a lightning rod may be affixed to the side of the chimney. Most of our large stacks have a band of metal to which the air terminals are fitted, and from these two conductors should be led to earth. The method adopted in Germany appears to be simpler, and consists of a heavy iron frame rising to a sufficient height above the stack and continued at the apex so as to form an aigrette. That lightning may prefer the smoke issuing from a chimney was shown by the stroke at the East London Waterworks, Sunbury, last year, the flash doing some damage to the capping before it arrived at the standpipe inside, which was a perfect earth, in that it was in direct connection with the company's mains.

The general conclusions arrived at by the author are that there is very little advantage in placing isolated rods on an ordinary building without it has a high tower. A church, for instance, with a spire should have at least two conductors from top to earth. Even then, if any other part of the structure happens to be in the path of a discharge from a cloud to the ground, the stroke may disregard the protected towers or spire and fall on the building, choosing some lower point. If the suggestion put forward by Sir Oliver Lodge at the Bath meeting in 1888 were more closely followed, and the conductors so arranged that they form a protective network over all the roofs, a flash would in all probability be received by some portion of the system and pass without harm to the ground by one of the numerous earths to which the network would be connected.

The insurance offices appear to disregard the question of adequate protection, and are quite content if the single conductor which has not prevented serious damage, for instance, to a church is replaced, and, moreover, take no steps to have the earth connection tested periodically; also, the few unconnected lightning rods erected on our national museums, picture galleries and other public buildings contrast most unfavourably with the more scientific methods adopted on the Continent, more especially in Germany, where, in some districts, the local authorities have issued rules as to the erection and testing of lightning conductors, to which the various public bodies have to conform, and in some cities householders are subject to penalties if the system is allowed to get out of order.

* Paper read before Section G of the British Association.

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CORRESPONDENCE.

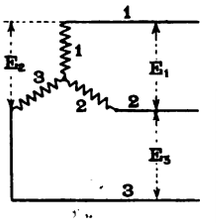
POWER SUPPLY TO TRAMWAYS IN NORTH LONDON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your issue of August 19th contains an instalment of an article on "Power Supply to Tramways in North London." In dealing with the turbo-alternators you give what appears to be an extract of the specification, and also some calculated characteristic curves of the 1,000kw. alternators. It seems to be of general interest to call attention to the clauses dealing with the regulation on unbalanced load, as they contain figures which, from theoretical and practical reasons, are inconsistent, and which it ought to be impossible to meet—at least with a generator of the given characteristics. The paragraph in question reads as follows:—

With two phases equally and fully loaded and a power-factor unity, the third phase being on open circuit, 7 per cent. The difference in voltage between one of the loaded phases and the phase on open circuit was not to exceed 4 per cent. With one phase loaded, the power-factor being unity and the other phases on open circuit, 6 per cent. The difference between the loaded phase and the phases on open circuit was not to exceed 5 per cent.

Here it apparently has been overlooked that in a three-phase star-connected generator, even if the current is in phase with the terminal E.M.F., it will necessarily be lagging in regard to one phase of the winding and leading in regard to the other, and, consequently, its effect on the voltage will be such as to cause a drop in the first and a rise in the second phase, and thus produce a difference in voltage between the various phases which very often is even larger than the regulation on balanced load; besides, all three voltages will be different, and, therefore, each phase has its own regulation. Of course, in a star-connected generator it is impossible to load only one phase of the generator, as any load between two terminals will affect two phases of the generator, and any load on two phases outside of the machine will affect all three phases of the generator. It is extremely difficult to predict to any degree of accuracy the resultant voltages under the specified conditions, as the higher harmonics—specially the third—superimpose effects which cannot readily be predetermined.



To illustrate the aforesaid I am giving corresponding values obtained in test on a 200kw. three-phase generator for 2,300 volts.

Balanced Load.

Full load.	No load.	Regulation.
E_1 = 2,300	2,415	5 per cent.
E_2 = 2,300	2,415	5 ,,
E_3 = 2,300	2,415	5 ,,

Unbalanced Load. Load between phases 1 and 2.

Full load.	No load.	Regulation.
E_1 = 2,300	2,420	5¼ per cent.
E_2 = 2,220	2,420	9 ,,
E_3 = 2,650	2,420	8¾ ,, (drop)

Unbalanced Load. Load between phases 1 and 2 and 1 and 3.

Full load.	No load.	Regulation.
E_1 = 2,050	2,400	17 per cent.
E_2 = 2,370	2,400	1¼ ,,
E_3 = 2,300	2,400	4½ ,,

As the generator on which the above tests were taken showed even a better regulation on balanced load than the turbo-alternator referred to above, it seems difficult to see how these machines can come anywhere near the specification. It would certainly be of interest to know what the actual tests will show.

Incidentally, I may refer to an apparent error in the article referred to. Here the regulation from no load to full load on 85 per cent. power-factor is given as 18 per cent., while the characteristic curves show about 30 per cent. I suppose it was meant to refer to regulation from full load to no load, which, however, according to the characteristic curves, should also come out larger than 18 per cent.—Yours, &c.,

Rugby, Aug. 24. H. S. MEYER.

MR. BALFOUR'S ADDRESS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the presidential address delivered by the Right Hon. A. J. Balfour at the seventy-fourth meeting of the British Association I find the following sentence:—

Whether this vehement sentiment in favour of a simple universe has any theoretical justification I will not venture to pronounce.

This sentiment really has a justification in the unconscious labour of our intellect. In dealing with physics our intellect meets reasons in favour of the unity of matter, and more or less unconsciously stores them in our brain or memory. These unconsciously-stored reasons are strong enough to produce satisfaction over any attempt to unify physical nature.

Further I read:—

The point to which I desire to call attention is not to be sought in the great divergence between matter as thus conceived by the physicist and matter as the ordinary man supposes himself to know it, between matter as it is perceived and matter as it really is, but to the fact that the first of these two quite inconsistent views is wholly based on the second.

There I see only two different more or less perfect ways of conceiving matter. The difference is similar to that between the conception of matter formed by a blind creature and that formed by one who sees, or between perceiving matter by means of seeing it with a simple eye and an eye armed with a microscope. The first step towards more perfect perception of matter was the use of the microscope. The further step was the division of matter into molecules and atoms. The third step, the division of atoms into monads moving in ether. The fourth step, let the monads be a modification (knots) of ether. What is ether?

Let ether be *a medium* inextensible, incompressible, and continuous. What have we herewith explained altogether? We have only changed the question, "What is matter?" for the question, "What is this medium?" From the aforesaid lines we see that not only "down to five years ago our race has, without exception, lived and died in a world of illusions," but that our race will still further, and I suppose for ever and ever, live and die in the same world of illusions, only that these illusions will be of a different kind.—Yours, &c., JOSEF DONÁT.

Brno (Brünn), Aug. 25.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A lecturer and demonstrator in physics is required at University College, Nottingham. Commencing salary £130, rising by increments to £180 per annum. Applications (on forms to be supplied by the registrar) by Sept. 20. See advertisement.

Loughborough Electricity committee require a shift engineer and also a good fitter-driver for their electricity works. Applications to the town clerk (Mr. Harry Perkins), Town Hall, Loughborough, by 2 p.m. Sept. 9. See also advertisements.

A firm of engineers and machinery importers in India require a qualified engineer to take charge of, travel and push their electrical department. See advertisement.

Applications are invited for the position of lecturer in electrical engineering in the University of Sydney. Salary £500 per annum, with permission to carry on certain consulting practice subject to approval of Senate. Further particulars from the Acting Agent-General for New South Wales, 9, Victoria-street, London, S.W., to whom applications by Sept. 10.

Willesden District Council are prepared to receive applications for the position of resident electrical engineer, to take charge of the distribution of electricity within the district. Salary £250 per annum. Particulars and forms of application from the consulting engineer (Mr. E. T. Ruthven-Murray), electricity office, Salusbury-road, Kilburn, London, N.W., to whom applications by Sept. 17.

The Electric Supply committee of St. Marylebone (London) Borough Council invite applications for the position of resident engineer and manager of their electricity undertaking. Salary £600 per annum. Applications to the town clerk (Mr. James Wilson), Town Hall, Marylebone-lane, London, W., by Sept. 5.

The Council of the Durham College of Science are ready to receive applications for the Principalship. Salary £1,000 per annum. Applications to secretary by Sept. 30.

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The committee of the City and Guilds of London Institute are about to appoint a professor of Mechanical Engineering and Applied Mathematics at Finsbury Technical College. Salary £600 per annum. Applications to the hon. sec., Gresham College, London, E.C., by Sept. 15.

The Joint Committee of Management of Clonmel (Ireland) Asylum require an electrical engineer to report upon electric lighting. Fee not to exceed 10 guineas. Applications to resident medical superintendent by Sept. 7.

Assistant lecturers in physics and mathematics (salary £130 each) are required at the Hartley University College, Southamption. Applications to Principal by Sept. 10.

An assistant science master is required at the Limerick municipal technical schools. Salary £150. Applications to principal by Sept. 5.

Mr. R. H. Wilkinson, manager of the Oldham Corporation tramways, has been appointed to a similar position at Huddersfield, in succession to Mr. H. N. Thomas, at a salary of £350 per annum.

Mr. Andrew Nance, manager of the Belfast Street Tramways Co., has been appointed manager of Belfast Corporation tramways.

EDUCATIONAL NOTICES.

Birkbeck College, London.—The new session begins on Monday, Oct. 3. There are day and evening classes and systematic courses of instruction (lectures and laboratory) for the degrees of Science and Engineering of the University of London. Further information can be obtained from the Principal.

Durham College of Science (Newcastle-on-Tyne).—Courses are provided at this college for students proceeding to the degrees in Science or Letters or the diploma in the Theory and Practice of Teaching, and special facilities are offered for the study of agriculture, chemistry, mining, engineering and naval architecture. Matriculation and exhibition examinations begin Sept. 26, and lectures Oct. 4. Prospectuses from the secretary.

Glasgow and West of Scotland Technical College.—The next session begins on Sept. 27. The diploma of the college is granted in civil, mechanical and electrical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics, and architecture. The courses of study usually extend over three sessions, and special courses for individual students are arranged as required. The laboratories in the departments of physics, chemistry, metallurgy, mechanical and electrical engineering are equipped with the most approved apparatus. The preliminary examination of candidates for the diploma begins on Sept. 19. Prospectuses from the secretary, 38, Bath-street, Glasgow.

Northampton Institute.—Full day courses in the theory and practice of mechanical, electrical and horological engineering will commence on Oct. 3. Entrance examination, Sept. 28 and 29. The courses for mechanical and electrical engineering include periods spent in commercial workshops and extend over four years. Students also prepare for the degree of B.Sc. in engineering at the University of London. Particulars as to fees, &c., can be obtained at the Institute, St. John Street-road, London, E.C., or on application to the principal (Dr. R. Mullineux Walmsley). The evening technical classes in all branches of electrical and mechanical engineering commence Sept 26. There are well equipped laboratories for all kinds of electrical testing.

Victoria University of Manchester.—The session commences on Oct. 4. Complete theoretical and practical training is given in this university to students preparing for responsible positions in electrical works, and a certificate is granted on the successful completion of the course, which extends over three years. Suitably prepared students are, however, admitted for shorter courses. The John Hopkinson Electrotechnical laboratory is fitted up with powerful modern machinery. Prospectuses from the Registrar.

College Calendars.—The calendar of the Glasgow and West of Scotland Technical College for the 1904-5 session (which commences on the 27th inst.) contains very full particulars of the courses of instruction, together with the fees payable, lists of the professors and teaching staff, bursaries (including the Sir John Pender gold medal), scholarships, examinations, &c. There are both day and evening classes, and the diploma of the College is granted in civil, mechanical and electrical engineering, mathematics and physics, mining, metallurgy, chemistry and naval architecture. There are well-equipped engineering laboratories for practical and special research work. Students holding the College diploma may be admitted to the examinations for degrees in science in engineering in Glasgow University, and the regulations for these examinations are set out in full. Copies of the calendar may be obtained from the College, price 1s.

We have received the calendar of the Durham College of Science for the year 1904-5 session, which contains particulars of the courses of instruction, fees, exhibitions, scholarships, examinations, &c. Students in electrical, civil or mechanical engineering, mining or metallurgy may, after following a prescribed course extending over three years, and passing the several examinations, proceed to the degree of B.Sc. There are well equipped laboratories, and all classes (day and evening) are open to both sexes. The catalogue is published by Andrew Reid & Co., Newcastle-on-Tyne. Price 1s., post free 1s. 4d.

Tuition by Correspondence.—Electrical and mechanical engineering is taught by correspondence by Prof. A. Jamieson, M.Inst.C.E. Kelvinside, Glasgow, and students are prepared for examinations and situations.

Aberdeen.—The revenue of the electricity department for the year ended July 31 was £38,209. 12s. 6d.

This sum includes £24,394. 18s. 9d. from private lighting, £2,782. 7s. 2d. for public lighting, £9,617. 19s. 8d. for traction and £109. 6s. 5d. from the Suburban Tramway Co. Expenditure was £17,135. 17s. 4d., leaving a balance of £21,073. 15s. 2d. Interest required £7,398. £6,319. 13s. 11d. was applied to depreciation, £4,003 to sinking fund and a surplus of £3,631. 5s. 2d. was carried to reserve. Capital expenditure to July 31 was £220,742. 17s. 11d., after writing off £25,138. 13s. 11d. for depreciation.

The charge for current for private lighting has been reduced to 6d. per unit for the first hour and 1½d. after.

Alsace-Lorraine.—It is stated that a Belgian company has obtained a concession, in accordance with an understanding between the French and German Governments, to construct an electric railway from Moyeuvre la Grande to Joeuf and Homecourt.

Barking.—The capital expended upon the Council's electricity undertaking at March 31 was £45,324. 4s. 6d., an increase of £4,876. 6s. 8d. for the year.

The total receipts were £6,919. 9s. including £4,103. 19s. 3d. from sale of current for private lighting and £2,443 from public lighting. Expenses were £4,019. 1s. 6d., including cost of generation (£2,492. 3s. 7d.), distribution (£177. 7s. 10d.), public lighting (£602. 3s. 8d.) and management (£505. 5s. 10.). Gross profit was £2,900. 7s. 6d. After paying interest (£1,371. 13s. 3d.) and sinking fund instalments (£1,487. 3s. 6d.), &c., the net profit was £26. 8s. 4¾d. The estimated profit for the year was £200, but the chief electrical engineer (Mr. A. Hugh Seabrook) explains that the diminution is mainly due to the bulk of their loans having been taken up on the instalment system of repayment. If these had been taken up on the annuity principle, the capital repayments would have been £200 less.

In connection with the surcharge made by the district auditor (Mr. Dolby) at the audit for the year to March 31, 1903, of sums amounting to £2,223. 6s. 8d. (representing the loss to the general district rate account occasioned by the failure of the Council to provide for the deficiency of income on their electric lighting undertaking as required by the Barking Electric Lighting Order), the Local Government Board have (as stated in our issue of Aug. 12) allowed the appeal of the members of Council affected. The Board state that they—

Are empowered by sec. 4 of the Poor Law Audit Act, 1848, as applied by sec. 247 (8) of the Public Health Act, 1875, and sec. 53 (2) of the Local Government Act, 1894, to determine any appeal that may be made to them against any surcharge made by a district auditor in the accounts of a district council, according to the merits of the case. The Board have taken into consideration the facts of the present case, and have decided to deal with the matter upon the merits in the exercise of their power under the above-mentioned enactment. The Board accordingly decide that the surcharge should be discharged and hereby discharge the same.

Barnsley.—An inquiry will be held here to-day into the application of the Council to borrow £6,868 for electric lighting extensions.

On the recommendation of the Electricity and Lighting committee it has been decided to supply incandescent lamps from the electricity works at cost price.

Barton (Lancs.)—The Council have declined to consent to the proposed application of the Lancashire Electric Power Co. for a provisional order.

Buenos Ayres.—The Anglo-Argentine Tramways Co. having acquired the undertaking of the City of Buenos Ayres Tramways Co. have let the contract for the electrical equipment of the lines to the Allgemeine Elektricitäts Gesellschaft, Berlin.

Costa Rica.—The San José Electric Light & Traction Co. are engaged in supplying current for lighting in San José and are also owners of the tramway service in that city. The company have acquired an important water-power source called El Brazil, with a view of extending the company's operations to the outlying districts of San José.

The public lighting of Limon is now almost entirely effected by electricity, both incandescents and arcs being employed. The extensive wharves are also lighted electrically.

The United Fruit Co. are engaged in important commercial operations along the coast of Costa Rica, especially in connection with the shipments of bananas. The company has established a wireless telegraph service on the De Forest system at Limon in conjunction with their station at Bocas del Toro, 60 miles distant.

Customs Decisions.—It is notified that the increase to 15 per cent. ad val. of the duty upon all electric dynamos, motors, transformers and engines, or parts thereof, imported into Sweden, came into effect on May 16 last.

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Derby.—Last week the contractors for the municipal electric tramways (Messrs. J. G. White & Co.) entertained the members of the Tramways committee, their wives and several of the leading Corporation officials.

The mayoress (Mrs. Boam) and Mrs. Duesbury were presented by the contractors with silver flower vases.

Mr. A. N. Connett occupied the chair, and Mr. G. Balfour was vice-chairman. After the loyal toasts, Mr. Connett proposed "The Derby Corporation Tramways Committee," and, on behalf of the contractors, disclaimed responsibility for the delay in the completion of the works, which was due to several unforeseen circumstances, including the determination of the Corporation to have English rails after having first agreed to the use of Belgian rails.

Ald. F. Duesbury, J.P. (chairman of the Tramways committee), who replied, thought the contractors had executed their contract very well. He also paid a tribute to the watchfulness of the borough surveyor (Mr. J. Ward).

The official inspection of additional tramway routes, which are ready for opening, will take place on Tuesday.

Durham.—A conference of public authorities and others interested in the proposed scheme of electricity supply for the county will be held at the Miners' Hall, Durham, on 10th inst.

Electric Driving.—At the meeting of John Abbot & Co. (Ltd.), Gateshead, on Tuesday, the chairman (Mr. L. W. Adamson) said electric power plant had been put in for driving a portion of their works. He considered electrification was a step in the right direction.

Electric driving has also been adopted at the works of James Oakes & Co., Alfreton. The generating plant consists of a continuous-current dynamo (giving current at 220 volts) coupled direct to Belliss engine and a Babcock-Wilcox boiler, capable of evaporating 10,000lb. of water per hour.

Fatality.—An inquest was held at Liverpool on Wednesday into the death of a child caused by an electric tramcar on Monday evening.

It appeared that deceased, when crossing the road, fell across the metals, and the driver of an approaching car had not time to bring his vehicle to a standstill before striking the boy, who was pushed along about 3yds. The boy, whose leg was caught underneath the guard, was recovered by raising the car with planks and blocks. The car was going at a speed of 4 to 5 miles an hour. After extrication the boy died the same night from shock. The general manager of the tramways (Mr. C. R. Bellamy) said the liberation of the child should have been accomplished by splitting the board of the car with the crowbar carried by every car. That was the first accident of the kind which had occurred since 1901. In regard to the suggested provision of a jack to each car, he had seen serious accidents happen in jacking up a heavy weight such as a car, even when operated by experienced men. He would suggest the advisability in future of fixing the guard in such a way that it might easily be removed with a spanner. A verdict of accidental death was returned.

Faversham.—In the report by the consulting engineers (Messrs. Talbot & Stevenson) the approximate cost of street lighting is put at £17. 15s. per arc lamp per annum, and £5. 10s. for each Nernst lamp. The estimate for the half-year ended March 31 next shows total expenses, including interest and sinking fund £964. 8s. 4d., estimated receipts £521. 8s. 4d.

Fires.—A small fire occurred on 25th ult. at the works of J. J. Statter & Co., Birmingham. The damage done was slight and was covered by insurance.

A fire broke out on Wednesday in the store rooms of the National Telephone Co. at Willersley-street, Nottingham. Considerable damage was done.

Fleetwood.—Mr. T. L. Miller, who has been appointed electrical inspector under the Fleetwood Electric Lighting Order, in succession to Mr. C. H. Wordingham, has prepared a report for the Electric Lighting sub-committee on the electric lighting of certain thoroughfares. The Council offer to guarantee payment of interest at 4 per cent. per annum for three years upon the capital outlay by the local electric lighting company in laying cables, erecting lamps, &c.

Heckmondwike.—In consequence of disagreement between the Yorkshire (Woollen District) Electric Tramways and the District Council as to to the price to be paid by the company to the Council for current, the Hightown and Batley cars no longer enter Heckmondwike, stopping at the boundary.

Heston and Isleworth.—The Council offer to supply electric current for lighting at 5d. per unit, subject to discounts ranging from 5 to 20 per cent., according to consumption. For power the charge will be 3d. per unit up to 750 units per quarter and 2d. beyond this amount. The Council have adopted a system of wiring premises on the "free" wiring system, and in this case the charge will be 5½d. per unit. The Council offer owners of houses which they do not themselves occupy to wire and fit up their premises on the instalment system.

Heywood.—The tramway deadlock continues. A conference was held on Wednesday between representatives of the Tramways committees of Heywood, Bury and Rochdale, when the amended proposals made by Bury and Rochdale for working the tramways in Heywood were considered. Heywood suggested a 21-year lease of the lines, while the neighbouring corporations asked for a 30-year lease. The latter authorities now suggest a 21 years' lease, and offer to construct and maintain the track and at the end of the term hand it over in good condition to Heywood. The question of which authority should supply electric power was also argued. A further conference will be held to discuss the matter.

Holyhead.—Sept. 14 has been provisionally fixed for the inauguration of electricity supply.

Huddersfield.—On Monday the Tramways committee passed a vote of thanks for his services to the manager of the Corporation tramways (Mr. H. N. Thomas), who has been appointed manager of the Durban (Natal) tramways The mayor (Ald. Inman), who conveyed the vote of thanks to Mr. Thomas, also presented him with a piece of plate.

Import Duties on Trade Catalogues, Price Lists, &c.—The London Chamber of Commerce have for some time past been in communication with representatives of the Commonwealth of Australia, with the Government of India and the Canadian Government relative to the levying of duty upon price lists and catalogues sent to Australasia, India and Canada. The Government of India considerable it desirable to afford all possible facilities for the development of trade, and have issued instructions that all trade catalogues and circulars imported into India by packet, book or parcel post shall in future be admitted free of duty. Canada has decided that bona fide trade catalogues and price lists of goods for wholesale, not exceeding three to one person, shall be admitted into Canada without payment of Customs duties. Australasia, on the other hand, it is to be regretted, have not favourably considered the Chamber of Commerce proposals. It is officially stated that the primary object of the duty is not for the purpose of revenue, but for the encouragement of local printing, and that, therefore, the Commonwealth Government has no present intention of altering the law, which provides for the payment of a duty of 3d. per lb. upon such catalogues and price lists entering the States of the Commonwealth after Aug. 1, 1904.

Inner Temple.—The Library is to be wired for the electric light, and is to be closed from Sept. 5 until Oct. 1 inclusive.

Leeds.—The Lighting committee have decided to light all the tramway routes within a mile of the junction of Briggate and Boarlane by arc lamps.

Light Railways.—The Board of Trade have confirmed the Axminster and Lyme Regis Light Railway (Further Capital Powers) Order.

The Blackpool and Fylde Light Railway (Change of Name, &c.) Order has been submitted to the Board for confirmation.

The Snowdon and Bettws-y-Coed Light Railway Order has been submitted to the Board of Trade for confirmation.

Llanwrtyd Wells.—Mr. Penry Lloyd proposes to form a small company for erecting a turbine-driven electricity station for supplying current for lighting the village and for working a proposed electric tramway between the village and Wells, a distance of about half a mile.

London County Council Tramways.—The road-widening work on the projected Brockley–Forest Hill electric tramway route was begun on Monday, and active preparations for the construction of the Camberwell Green–Lordship-lane (Dulwich) line will be commenced shortly.

Llanelly.—The Board of Trade have been inquiring as to the steps taken to carry out the provisions of the Llanelly Electric Lighting Order, 1891, and the matter, as well as the dispute with the British Insulated & Helsby Cables (Ltd.) as to the transfer of the order, were discussed by the Council in committee last week. The company have, it will be remembered, appealed against the judgment in the action brought by the Llanelly Tramway Co. against themselves and the Llanelly & District Electric Traction Co.

Llantrisant.—The Council will not oppose the application of Mr. G. Vaughan Fowler for a provisional electric lighting order.

Lucknow (India).—Messrs. Kincaid & Co. have accepted the conditions of the Municipal Board for the electric lighting concession.

Madrid.—The Sociedad Tranvia del Este has submitted to the authorities an application for a concession for the working of certain lines of tramway in Madrid by electricity. The lines are intended as an extension of the existing railway system.

Maidstone.—The annual report of the borough electrical engineer (Mr. E. E. Hoadley) states that

The total capital expended during 1903 was £54,070. 8s. 8d., compared with £45,241. 15s. 11d. in the preceding 15 months. The revenue was £6,288. 4s. (including £5,961. 2s. 8d. for private and public lighting) against £4,661. 14s. 6d. for the previous 15 months, an increase of £1,256. 12s. 9d. Total costs were £3,779. 19s. 4d., leaving a gross profit of £2,508. 4s. 8d. (equal to a dividend of just over 5 per cent.), against £1,472. 6s. 4d., or a dividend of 3½ per cent. Interest required £1,619. 5s. 11d. and sinking fund instalment £2,028. 6s. 5d., making the deficiency £1,275. 0s. 10d., against £3,162. 16s. 11d. Total works costs (inclusive of interest and principal) had been £8,563. 4s. 10d., or £368. 16s. 9d. more than the amount last year. The number of units sold was 474,723, against 305,688, and the number of 8 c.p. lamps con-

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nected 27,327, against 22,503. The number of consumers had risen from 224 to 331. The works costs were 1·695d. per unit, against 2·428d. The demand for current, especially for power, is increasing in a satisfactory manner. Last year 124,273 units were supplied for power, or 21·6 per cent. of the total output, against 8·6 per cent. in the previous year.

The report was presented to and adopted by the Council last week.

The chairman of the Electricity committee (Mr. E. Vaughan) said that although they had only completed their second year of working, he had hoped their profit would have been enough to meet the charges for interest and repayment of principal, but they still had a deficiency of £1,275. He thought they should be allowed three years before commencing repayment of principal.

Manchester.—The Tramways department have introduced a system of payment of fares by tokens. Some are of the value of a penny and others of a halfpenny, the former coloured red and the latter blue.

Municipal Tramways Association.—The annual conference of this Association will take place at Liverpool between the 27th and 29th inst.

Municipal Tramways Football League.—On Wednesday a meeting was held at Liverpool of some of the leading officials of North country municipal tramway systems, and it was decided to form a football league.

Mr. C. R. Bellamy (Liverpool) presided, and among those present were Messrs. C. W. Mallins (Liverpool), W. Wyld (Birkenhead), C. Trotter (Sheffield), J. Mason (Manchester), J. Downes, J. Hatton and J. Woods (Wigan), J. Green (Wallasey), J. T. Anderson (Birkenhead), J. Tomlinson (Southport), E. S. Llewellyn (Liverpool) and W. R. Meikle, hon. sec. and treasurer. It was decided to provide a silver challenge shield for competition, and also medals. A list of fixtures was also arranged for the coming season.

Preston.—There was a temporary failure of electricity supply on Thursday evening last week.

Radcliffe.—The market hall was lighted electrically on the 28th ult. There are 100 25 c.p. incandescent lamps in groups of five.

Rangoon.—A concession for the erection of electricity works has been granted to a local firm, Messrs. Darwood & Co.

Salford.—In the annual report of the general manager of the Corporation tramways (Mr. E. Hatton) it is stated that the total length of tramways now worked by the Corporation is 59½ miles (single track).

All the 150 tramcars are provided with life-guards of the gate and cradle type. There are 100 double-deck single-truck and 50 double-deck bogie cars, all with staircases of the reversed type. Successful experiments have been made during the year with outer-deck coverings, and 20 single-truck cars have been provided with covers. It is proposed to increase the number of cars, as the present stock is insufficient to meet traffic requirements. The number of passengers carried was 36,956,405, an increase of 8,805,730 compared with the preceding year. The receipts were £198,422. 7s. 6d., against £144,486. 2s. 6d. The gross profit was £60,106. 14s. 11d., plus £242. 2s. 9d. for interest on investments. This sum has been dealt with as follows:—Payment to local authorities for running powers, &c., £10,903. 4s. 5d., interest and sinking fund charges £34,005. 14s. 2d., relief of rates £12,000, reserve and renewals fund £3,449. 19s. 1d.

Sheffield.—Some stallholders in the Sheaf Market complain that the fine dust emitted from the chimney of the electricity works seriously damages their goods, and one stallholder has commenced proceedings in the local county court for the recovery of £2. 10s. for damage alleged to have been caused by this means.

South Africa.—The "British and South African Export Gazette" states that

It has been found that road construction work is necessary in connection with the Johannesburg electric tramway project which will entail an additional expenditure of £145,000.

A beginning has been made of the construction work of the extension of the East London electric tramways, for which the cars and material were obtained some time ago.

The King Electric Power Co., King William's Town, have acquired land for extending their electricity works.

Negotiations are proceeding for a supply of electricity in bulk by the De Beers Co. for lighting Beaconsfield, a suburb of Kimberley. The local authority require that the charge for current shall be the same as that paid by Kimberley Council to the same company (6d. per unit).

Gibson Bros., owners of the Kimberley-Beaconsfield tramway, have received a 10 years' extension of their concession and authority to convert their line to electric traction on the overhead system, and to extend it to Alexandersfontein, about 4 miles beyond their present terminus. Current is to be taken from the De Beers Co.

Although the European population of Lourenço Marques is only about 5,000, the traffic receipts on the Delagoa Bay Development Co.'s short electric tramway at that place were £1,005 in July. It has been decided to extend the line to Marracuene. About 15 miles of streets in Lourenço Marques are lighted electrically.

The borough electrical engineer of Durban (Mr. John Roberts) has recently been in England negotiating for the supply of additional electrical plant which the Corporation have found necessary. There is a brisk demand for current for power, and recently orders for 102½ H.P. in motors were received.

The members of the Potchefstroom Town Council are agreed upon the desirability of acquiring and extending the undertaking of the Potchefstroom Electric Light & Power Co. Efforts are being made to raise a loan for the purpose.

Mr. W. Oliver, M.Inst.C.E., and Mr. E. G. Clifford Jones, M.I.E.E., of Cape Town, have been appointed consulting engineers in connection with the Umtata combined electricity and water supply scheme. It is proposed to utilise the power of the falls on the Umtata river 3½ miles from the town for the generation of electric energy to be used during the day for pumping and at night for lighting.

At a recent public meeting of Cape Town ratepayers, the whole of the projects for which the Corporation propose to raise £2,000,000 (including £100,000 for electricity supply) were disapproved. It is expected, however, that a poll about to be taken will result in approval of the Council's proposals.

Stockton-on-Tees.—The income of the electricity department from the sale of current for the past year was £5,331. 8s. 4d., an increase of £441. 8s. 5d., over the previous year. Expenses were £3,149. 4s. 3d., leaving a gross profit of £2,320. 6s. 5d. Interest and redemption of capital required £3,227. 14s. 1d., leaving a deficit of £957. 13s. 8d. Capital expenditure for the year was £2,176. 12s. 8d., bringing the total to £49,856. 8s. 7d.

Stourbridge.—The Council have referred back a recommendation of the Electric Powers committee to obtain a provisional order for Pedmore, Hagley, Clent and Belbroughton.

Thanet.—The Isle of Thanet Electric Tramways & Lighting Co. have adopted a uniform rate of 5d. per unit for electric current, instead of the maximum demand system (6d. for first hour and 3d. after) hitherto in use.

Tiverton.—An inquiry was held here last week into the application of the Council to borrow £13,000 for electricity works.

The town clerk (Mr. Marshall Hole) said it had originally been proposed to use water-power for generating current, but owing to difficulties raised by the Fisheries Department of the Board of Trade the scheme had been abandoned. Eventually an agreement was entered into with Messrs. Frank Suter & Co. for erecting and maintaining the works.

The consulting engineer (Mr. J. Enright) supplied technical details.

There was some opposition by ratepayers.

Transvaal Imports.—The value of electric cables, wires and fittings imported into the Transvaal during the five months ended May 31 last was £33,000, compared with £27,000 for the corresponding period of 1903. Tramway material stands for £34,000 only, compared with £44,000.

Wellingborough.—Plans and estimates are being prepared for the proposed application for sanction to a loan for electric lighting.

West Ham.—The capital expenditure of the electricity department at March 31 was £268,511. 9s. 5d., an increase of £83,342. 6s. 1d. during the year.

The total income for the year was £30,363. 18s. 4d., including £3,096. 8s. 11d. for public lighting, £25,000. 12s. 4d. for private lighting, £1,514. 8s. 7d. for power, £210. 0s. 10d. for traction, £246. 4s. 7d. for lighting artizan's dwellings, £72, 17s. 10d. for interest on hire-purchase of wiring installations and motors, £110. 8s. 6d. for hire of motors, and £103. 1s. 7d. for supervising wiring and fitting work for various departments. The expenditure of £20,547. 2s. 3d. comprised £14,314. 15s. 6d. for cost of generation, £1,293. 15s. 8d. for distribution, £852. 6s. 10d. for public lamp maintenance, £616. 3s. 4d. for rent, rates and taxes, and £2,164. 6s. 6d. for establishment charges and management. The gross profit (£9,186. 16s. 1d.) was applied in payment of interest on mortgage loans (£2,608. 16s. 5d.) on bank overdraft (£2,019. 12s. 4d.), repayment of loans (£3,168. 6s. 9d.), first half-year's contribution to consolidated loans fund for redemption and extinction of Corporation stock (£1,807. 14s. 9d.), and interest (£4,045. 4s. 2d.). The net deficiency for the year was £3,788. 6s. 10d., but the unappropriated balance from 1903 reduces this figure to £2,098. 18s. 11d.

Whitehaven.—The Harbour Commissioners, who have adopted electric lighting at the harbour and docks, are taking electric energy from the Corporation.

Wimbledon.—The following revised scale of charges, which will come into force on Oct. 1, has been adopted by the Council:—

For private lighting (including all religious and charitable institutions, &c.), up to 400 units per quarter, 4½d. per unit; 400 to 800 units per quarter, 4d.; exceeding 800 units per quarter, 3½d. The charge for electrical energy supplied to public buildings and for street lighting will be 2¾d. per unit, and for power, cooking and heating, &c., 2d. per unit. Where small motors, cookers, &c., are installed and require less than 1 ampere at 220 volts, these are to be supplied only at lighting rates unless there are more than one on the same installation with an aggregate demand greater than that specified above.

Wisbech.—An inquiry will be held here on Tuesday into the application of the Council for permission to borrow £25,000 for electricity supply.

Workhouse Lighting.—Ormskirk Guardians are considering the question of putting down electric lighting plant at the workhouse at an estimated cost of £4,750.

Wrexham.—The amended scheme for the extension of the public electric lighting (prepared by the engineer, Mr. Wm. Sillery) was adopted by the Council on Monday. It provides for the substitution of incandescents, supplemented by some enclosed arc lamps, for arc lamps. In this way a saving on the original estimate of about £1,400 to £1,500 per annum is to be effected.

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Yorkshire Electric Power Scheme.—Yorkshire Electric Power Co. announce that electric power will be available from their Thornhill station in December.

Outing.—A party of members of the Electrical Trades' Union spent a pleasant day's outing at Broxbourne, Herts., on Saturday last. A substantial spread was provided at the Bull Hotel. Owing to the intense heat a severe leak (not directly to earth) was discovered in the cellar of the hostelry. The programme included a cricket match, Married v. Single, but it was found that the single members had not turned up in sufficient strength, consequently the teams were mixed.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Edmonton District Council are desirous of entering into an arrangement with a company for the exercise of their powers under their provisional order. Particulars and forms of tender of the clerk (Mr. W. F. Payne), Town Hall, Edmonton, to whom tenders by noon Sept. 27. See also advertisement.

Leyton District Council invite tenders for the electric wiring and fittings required at Newport-road School, Leyton. Specifications, &c. (after 12th inst.), from the architect (Mr. Wm. Jacques, A.R.I.B.A.), 2, Fen court, Fenchurch-street, London, E.C. Tenders to be delivered at the meeting of the Education committee at 7 p.m. Sept. 23. See also advertisement.

Aberdeen Tramways committee invite tenders for the supply and delivery of 20 top-deck car covers. Specifications from the city electrical engineer (Mr. J. Alex. Bell), electricity works, Millburn-street, Aberdeen, to whom tenders by Sept. 27. See also advertisement.

Johannesburg Town Council invite tenders for the supply of (*a*) 300 10-ampere a.-c. meters; (*b*) 250 10-ampere, 40 25-ampere and 10 50-ampere d.-c. meters; and (*c*) 500 concentric and 100 triple concentric service fuse boxes. Specifications, &c, from the consulting engineers (Messrs. Mordey & Dawbarn), 82, Victoria-street, Westminster, S W., to whom tenders by noon Sept. 12. See also advertisement.

The Council of the County Borough of *West Ham* invite tenders for the reconstruction of certain existing horse tramways of a route length of about 3 miles 3 fur. double track. Tenders to the town clerk, Mr. Fred. E. Hilleary, by 4 p.m. Sept. 7.

West Ham Corporation also require tenders by 4 p.m. 13th inst. for supply and erection of electrical equipment for 3 miles 3 furlongs of tramway track.

West Ham Guardians require tenders by 10 a m. 14th inst. for 12 months' supply of electrical fittings.

Tenders are invited by the *Postmaster-General* until noon of Sept. 26 for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles. Forms of tender from the controller of stores (Mr. S. C. Hooley), Stores Department, G.P.O., 17-19, Bedford-street, London, W.C.

Torquay Town Council invite tenders for the erection of a chimney shaft (260ft. high) at their proposed new electric light and power station. Tenders to the town clerk before noon Sept. 12.

Wallasey District Council require tenders by 14th inst. for supply and erection of high-tension switch gear of British manufacture.

The Secretary of State for *India* invites tenders by 2 p.m. Sept. 20 for electrical plant.

Swansea Corporation invite tenders for supply and delivery of two negative tramway boosters. Tenders to the town clerk (Mr. Jno. Thomas) by noon Sept. 7.

TENDERS RECEIVED AND ACCEPTED.

Wimbledon District Council have received the following tenders for two water-tube boilers (of not less than 4,000 sq. ft. of heating surface each) with Bennis stokers, economisers, feed pump and pipework:—

Babcock & Wilcox (*accepted*) (4,020 sq. ft. heating surface each)	£5,089	0	0
Ditto (3,654 sq. ft.)	4,870	0	0
Stirling Boiler Co. (4,100 sq. ft.)	5,385	0	0*
Stirling Co. (U.S.A.) (4,095 sq. ft.)	5,100	0	0
Ditto (3,678 sq. ft.)	4,975	0	0
Musgrave & Son (3,615 sq. ft.)	5,028	10	0
R. Hornsby & Son (3,615 sq. ft.)	5,023	10	0
Richardsons, Westgarth & Co. (4,000 sq. ft.)	5,083	0	0
Ditto (3,615 sq. ft.)	4,890	0	0
E. Le Bas & Co. (3,615 sq. ft.)	4,885	0	0

* This tender specifies another type of stoker than the Bennis.

Stoke-on-Trent Guardians have accepted the tenders of the Morley Electrical Engineering Co. for three electric motors (two 13 H P. and one 2 H.P.) for driving, pumping and laundry machinery at the workhouse at £147, for cable at £98. 7s., and for tubing at £32. 7s. The contract for junction boxes, inspection frames and covers has been given to Dean & Lowe at £15. 16s.

Redditch District Council have accepted the following tenders:—Mr. F. Newbould, chimney shaft, £649; Geo. Huins & Son, boiler house and coal bunkers, £500; Edward White, iron principals, £125; Babcock & Wilcox, piping and valves, £633.

Redditch Council have authorised the engineer and works manager (Mr. W. J. Ferguson) to order the following instruments, stores, &c.:—Worthington Pumping Engine Co., two feed pumps; Electrical Co., five high-tension watt-hour meters (£90), five dead beat induction watt-meters, 8in. dials, with current transformers (£65. 10s.), two induction voltmeters (£17); Moul & Co, two high-tension double-pole switches (£12); Cowans Ltd., three current direction indicators (£45) and one synchronising panel (£27); Brush Co., three Bates fuses (£8. 5s) and two spare handles (£2. 5s.)

Erith District Council have accepted the following tenders:—Robt. W. Blackwell & Co., for rails, fish-plates and bolts (60ft. lengths), £8,391. 10s. 4d.; and also for permanent way construction, including 12,000 super. yds. Guernsey granite setts, and 25,800 super yds. Norway granite setts, £38,579. 14s. 7d.

Walthamstow Council have accepted the tender of Messrs. Oliver & Co. for supplying and fixing 132 arc lamps with double carbons; also the tender of W. T. Henley's Telegraph Works Co. for supplying cables during the next two years.

Dover Corporation have accepted the tender of C. A. Parsons & Co. for condensing plant at £1,450, and that of J. Wright for wiring Priory House, Dover College, at £43. 18s.

Mr. H. W. Hind has obtained a contract for wiring and fitting up of Middlesbrough town hall for the electric light. There will be the equivalent of 670 8 c.p. lights.

Aliwal North (Orange River Colony) Council have ordered a storage battery of 256 central station type cells from the Hart Accumulator Co., Stratford, London.

Ernest Scott & Mountain have received an order for a 112kw. three-phase generator for the Globe & Phœnix Mine, Rhodesia.

Davey, Paxman & Co., Colchester, are supplying the engines and boilers for driving the electricity generating plant at the forthcoming Cape Town Exhibition.

The Crown Agents for the Colonies have ordered from Mather & Platt an alternator, with direct-coupled exciter, for Lagos.

BANKRUPTCIES, LIQUIDATIONS, &c.

The liquidator (Mr. G. S. Barnes, 33, Carey-street) in the winding up of H. M. Salmony & Co. (Ltd.) has been released.

Mr. A. C. Bourner, Bush-lane House, London, E.C., has been appointed trustee in the failure of G. W. Warner and A. P. Bowen, electricians, &c., 12, Holbein-place, London, S.W.

A meeting of creditors of James William Hunter and Albert Clapham, electrical engineers and motor car dealers, trading as the Yorkshire Motor Car & Electrical Engineering Co., at Leeds, was held on Monday. Gross liabilities £4,396. 19s. 6d., of which £3,415 is expected to rank. Assets estimated to produce £2,047. 5s. 5d. Mr. W.H.Platts was appointed trustee, with committee of inspection.

Sale by Tender.—Messrs. Wheatley Kirk, Price & Co. have been instructed by the receiver of H. Sutton & Co., Ltd. (in liquidation) to sell by tender the goodwill and the whole of the stock upon the premises, 8, The Exchange, Muswell Hill, London, N., consisting of brass, copper and hammered iron electric light fittings, arc and incandescent lamps, flexible wire, telephones, &c. Catalogues and forms of tender from the auctioneers, 46, Watling-street, London, E.C., or Albert-chambers, Albert-square, Manchester. Additional particulars are given in an advertisement.

Sale by Auction.—Messrs. Brackett & Sons will sell by auction at "Broomhill," Woodside-lane, London, N., on Sept. 13, electric light plant, comprising three dynamos, switchboards, storage battery, three gas engines, &c., as set out in an advertisement. Private view on 12th inst., orders for which and catalogues may be obtained from the auctioneers, 34, Craven-street, Charing Cross, W.C., and Tunbridge Wells.

Plant for Sale.—A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 80, Birley-street, Blackpool.

Messrs. Neil McLean & Co., 227, Main-street, Gorbals, Glasgow, have for sale some electric lighting plant, including five Edison-Hopkinson, three Siemens, one Kapp and some Brush dynamos, and steam engines by Galloways, Marshall and other makers. See also advertisement.

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Mr. W. J. Crampton, 73, Queen Victoria-street, London, E.C., has for sale three electric motors. See advertisement.

Messrs. T. Sheldon & Co., Springfield Foundry, near Wolverhampton, advertise for sale a complete electric lighting plant, including a 7 H.P. Tangye oil engine, Parker dynamo, 53 E.P.S. cells, switchboard, &c.

A second-hand country house lighting plant (a 3½H.P. oil engine, dynamo, switchboad, storage battery, &c.), is advertised for sale. Applications to Mr. C. F. Mendham, 6, East India-avenue, London, E.C.

Factory Premises for Sale.—Mr. Frederick Warman (Highbury Corner, N., 66, Chancery-lane, W.C., and Crouch End, London, N.) will include in his sale at the Mart, Tokenhouse-yard, E.C., on Sept. 6, a well-built factory at 1A, Waterloo-terrace, Upper street, London, N.; also some freehold land adjoining. See advertisement.

Business for Sale.—An electrical contractor's business is advertised for sale in another column.

Catalogues, &c.—A new price list (catalogue No. 12) of Ferranti indicating wattmeters for single and multiphase alternating-current systems is ready, and can be obtained by the trade free on application to the company at Hollinwood, Lancs. The list deals with the 8in. round typo of wattmeter in cast-iron case.

On p. 774 of our last issue reference was made to the General Electric Co.'s "Progress Sheet" for August. We are asked to state that the remarks applied in the note to the "Quadrant" form of tumbler switch should read to apply to the "Link" form of switch.

Some excellent examples of telpher installations are shown in pamphlets issued by the United Telpherage Co., Westfield, New Jersey, U.S.A. A number of these installations have been put into gas works, where they have been found to be good labour savers.

Coney Island, the famous pleasure resort of the population of New York, and which possesses numerous places of entertainment, is described in a liberally-illustrated pamphlet issued by the Edison Electric Illuminating Co. of Brooklyn (N.Y.). Hundreds of thousands of Edison incandescent lamps are employed in the illumination of the various show places, this work being carried out on an unusually exhaustive scale.

The Boardman Electrical Patents Co., London, have ready a new catalogue of electric arc lamps for photographic, photo-process, stage, medical and similar purposes.

An illustrated circular describing worm-reducing gears, suitable for all descriptions of electric drives, is issued by Messrs. James Hawley (Ltd.), Carruthers-street, Liverpool, and can be obtained on application. These gears are made for right-angle or straight drives.

Messrs. Tinkers (Ltd.), Hyde, near Manchester, have ready a new specification of Tinkers' mild wrought-steel steam superheater and a leaflet illustrating and describing the apparatus.

Messrs. W. H. Bailey & Co. forward catalogue and particulars of Köster patent air compressors and vacuum pumps. This firm have the sole right to manufacture under Köster patents in the United Kingdom. The compressors are made on the single and multiple stage compound inter-cooling system, all machines being arranged either for belt, steam or direct electric driving. The catalogue contains a list of uses to which these machines may be put, and there are tables of standard sizes, as well as some excellent illustrations.

The Laidlaw-Dunn-Gordon Co., of Liberty-street, New York City, have prepared a well-got-up pamphlet describing the Meyer-gear pumping engines for small works and elevator service. These engines are built in the cross-compound and three-cylinder compound types and with fork frames. A large number are employed in feeding large boiler plants, &c., for which they are claimed to be well adapted.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Aug. 24 to 30, with the ports of destination:—

Africa—Alexandria, £517 (including £415 telegraph material); Cape Town, £1,236; Durban, £115 (including £75 telegraph material); East London, £1,324 (including £61 telegraph material); Port Elizabeth, £663 (including £264 telegraph material). *Argentina*—Buenos Ayres, £860. *Australasia*—Brisbane, £493; Fremantle, £570; Lyttelton, £150; Melbourne, £44; Otago, £106; Perth, £727; Sydney, £3,419; Wellington, £375. *Belgium*—Ostend, £20. *Brazil.*—Rio Janiero, £160. *Ceylon*—Colombo, £71. *China*—Shanghai, £97. *Denmark*—Copenhagen, £6. *Germany*—Hamburg, £12. *Gibraltar*, £151 (including £70 telegraph material). *Greece*—Piræus, £45. *Holland*—Amsterdam, £53; Flushing, £36; Rotterdam, £254 (including £215 telegraph cable). *Hong Kong*, £24. *India*—Bombay, £25; Calcutta, £966; Karachi, £250; Madras, £34. *Italy*—Genoa, £35 (telegraph material). *Japan*—Yokohama, £1,105. *Madeira*, £240. *North Atlantic*, £16,000 (telegraph cable). *Portugal*—Lisbon, £50. *Straits Settlements*—Penang, £154; Singapore, £273. Total £30,640, against £12,825 in the corresponding week last year (Aug. 26 to Sept. 1).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

June 22, 1904.

14,145 C. W. FISHER. Telephonic instruments.
14,147 S. O. COWPER-COLES and THE METALS CORP. Electrolytic deposition of metals.
14,148 O. O. KRUH. Vapour electric lamps. (Date applied for, June 22, 1903, date of application in U.S.)*
14,160 S. PALMER. Electric clocks and electromotive apparatus therefor and for other purposes.*
14,163 C. H. MEBZ and S. G. REDMAN. Movable overhead frogs and section insulators.

June 23, 1904.

14,170 T. RIGG. Birmingham. Accumulators.
14,176 T. F. JONES. Liverpool. Electrical collector rails.
14,195 W. J. A. WATKINS. Cricklewood. Electric conductors for tramways worked on the conduit system.
14,196 B.T.-H. Co. (G.E. Co., U.S.). Electrodes for arc lighting.
14,197 B.T.-H. Co. (G.E. Co., U.S.). Methods of making hollow articles.
14,221 R. DREIBHOLZ. Liverpool, Galvanic batteries.
14,227 M. BÜTTNER. Polarisation cells.
14,230 W. E. LAKE (Submarine Signal Co., U.S.). Submarine signalling and apparatus therefor.*
14,231 H. J. LA FORGE. Electric sparking plugs for internal combustion motors. (Date applied for, June 24, 1903, date of application in France.)*
14,239 C. DE KANDÓ. Electric traction engines.*
14,250 L. TORDA. Dynamo-electric machines and the like.

June 25, 1904.

14,276 F. PUNGA. Single-phase motors.
14,281 J. HAYDOCK and T. S JONES. Halifax. Supporting and connecting trolley wires and of insulating connections.
14,294 T. M. LYNCH. Liverpool. "Live-rails" of electric tramways.
14,309 B. M. DRAKE and DRAKE & GORHAM (LTD.). Arrangement of plant for generating stations.
14,336 W. STRICKLAND. Generation of electricity.
14,350 P. KRAUSE. Electric signalling and braking devices for trains.*
14,351 F. BITT. Thermopiles.
14,366 M. LATOUR. Starting resistances for collector motors. (Date applied for, June 27, 1903, date of application in France.)*
14,380 J. J. STANGER. Electro-medical baths.*

June 27, 1904.

14,433 I. MOLESWORTH DE HAVILLAND. Coventry. Electric ignition, lighting and battery charging systems, parts of which are applicable for other purposes.
14,442 J. S. ALEXANDER. Kingston-on-Thames. Electrically connecting rails or other conductors.
14,460 J. Y. JOHNSON (Badische Anilin and Soda Fabrik, Germany). Reduction of the difference of phase in electric circuits.
14,463 V. A. FYNN. Electro-magnetic apparatus for opening, closing or short-circuiting electric circuits.

June 28, 1904.

14,500 A. E. CARTER and C. C. FOWLER. Brighton. Chemically treating arc lamp carbons whereby wastage is stopped while lamp is burning.
14,504 J. HARGREAVES. Farnworth. Electrolytic cells.
14,510 F. NICHOLSON. Manchester. Trolley poles of electric tramcars.
14,519 H. SANDERSON. South Shields. Automatic electric rail protector.
14,520 F. EVERHART and J. J. DOSSERT. Branch connections for electric cables.*
14,523 W. FAIRWEATHER (American Electric Telephone Co., U.S.). Telephone systems.*
14,543, 14,544 and 14,545 W. H. BRISTOL. Thermo-electric couples.*
14,553 A. GETTO. Electric burglar alarms.*
14,567 I. O. REVILLOID. Electricity meters.
14,568 SIEMENS SCHUCKERT WERKE, G.M.B.H. Arrangement of cable working with high voltage. (Date applied for, June 29, 1903, date of application in Germany.)*
14,577 E. D. KNIGHTS. Liquid lift controllers or resistances.

June 29, 1904.

4,663A P. H. THOMAS. Breaking electric circuits. (Date applied for, June 27, 1903, date of application in U.S.) Comprised in application No. 4,663, Feb. 25, 1904.*
14,597 F. S. SMITH and J. H. SMITH. Derby. Time switches.
14,617 E. LYCETT. Birmingham. Contacts of electric wire connections.*
14,648 H. I. W. SCHWEDLER. Applying Röntgen rays to the human body.
14,663 C. S. DE FERRANTI. Electromotor driving.

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June 30, 1904.

14,648 H. O. FARRELL. Manchester. Dynamo-electric machines.
14,717 J. LEIGHTON and E. HACKING. Insulating electric conductors for firing plugs of internal combustion engines.
14,727 J. C. ANGUS. Electric railways.
14,728 W. J. STILL. Gravity-controlled electric current indicator with a long range of movement.
14,733, 14,734 and 14,735 E. A. CAROLAN (G.E. Co., U.S.). Arc lamps.
14,736 B.T.-H. Co. (G.E. Co., U.S.). Cutouts.
14,737 and 14,738 B.T.-H. Co. (G.E. Co., U.S.). Dynamo-electric machines.
14,739 B.T.-H. Co. (G.E. Co., U.S.). Brush holders for dynamo-electric machines.
14,740 B.T.-H. Co. (G.E. Co., U.S.). Electricity meters.
14,741 B.T.-H. Co. (G.E. Co., U.S.). Protection against reversal of energy.
14,743 J. E. NEALE. Electric or other railways.
14,761 H. J. HADDAN (Martin Becker, Germany). Driving gear for electric cranes, trolleys, travelling winches, &c.
14,762 H. J. HADDAN (Martin Becker, Germany.) Electromagnetic operating devices for levers, valves and other mechanism.

July 1, 1904.

14,767 H. HIRST and C. E. GUNNER. Nipple for conduit tubes and fittings.*
14,770 H. HIRST and J. H. COLLINGS. Electric light reflectors.
14,786 G. W. PEARD and A. M. MARTIN. Liverpool. Supply of current to "live" rail.
14,792 E. ROTHWELL. Manchester. Electric railway automatic feeding appliance.
14,806 R. D. COLE. Dublin. Books of memorandum forms for telephone messages and holders for same.
14,814 J. H. LUBY and W. HARRIS. Bristol. Clip for clamping trolley wires to fittings in overhead wire systems of electric traction.*
14,815 J. H. LUBY and W. HARRIS. Bristol. Section insulator for overhead wire systems of electric traction.*
14,821 J. T. ARMSTRONG and A. ORLING. Electro-capillary apparatus.
14,829 H. C. BRAUN. Electro medical apparatus.
14,841 A.E.G. Regulation of dynamo-electric machines. (Date applied for, July 2, 1903, date of application in Germany.)*
14,847 C. LYON. Electric fire alarms or thermo-indicators.*

July 2, 1904.

14,856 J. WESTAWAY. Liverpool. Tube railways.
14,879 H. W. HARRIS. Controlling electric switches at predetermined times.
14,911 A. BELLARDENT. Arc lamps. (Date applied for Sept. 5, 1903, date of application in France.)*
14,918 A. DAMASKINOS. Automatic telegraphic apparatus.*

July 4, 1904.

14,933 H. CURWEN. Newcastle-on-Tyne. Protection from the "live" rail.
14,940 A. J. PARSONS and H. MANDIFIELD. York. Electric time switch.
14,986 L. ZEIDLER. Magneto-electric ignition for explosion motors.

July 5, 1904.

15,011 F. RICHMOND. Burnley. Primary batteries.
15,034 CROMPTON & Co. and A. J. HODGSON. Chelmsford. Arc lamps.
15,035 K. EDGCUMBE and E. I. EVERETT. Instruments for measurement of electrical resistances.
15,041 G. ELLIS. Signalling to, and communicating with, telephone exchanges.
15,043 H. H. LAKE (Submarine Signal Co., U.S.). Electric transmitters.*
15,045 H. S. WILLIAMS. Recording number of telephone messages.
15,054 W. WALKER. Apparatus connected with telephones.
15,061 W. P. THOMPSON (Weatherby Electric & Mfg. Co., U.S.). Liverpool. Signalling apparatus.*
15,067 and 15,068 E. A. CAROLAN (G.E. Co., U.S.). Arc lamps.
15,070 B.T.-H. Co. (G.E. Co., U.S.). Control of electric motors.

July 6, 1904.

15,117 B.T.-H. Co. (G.E. Co., U.S.). Cutouts.
15,118 B.T.-H. Co. (G.E. Co., U.S.). Dynamo-electric machines.
15,131 W. F. GIBBS. Electric railways or tramways.
15,155 W. DWORZYNSKI. Automatic electric balance.*

July 7, 1904.

15,199 W. V. BIGGS. Apparatus for fixing electric lamps in electroliers, &c.
15,203 C. A. ALI. Electric burglar and fire alarm.*
15,226 D. W. TROY. Method of selecting electrical impulses. (Date applied for, July 11, 1903, date of application in U.S.)*
15,230 L. CALVERT and W. A. SNAPE. Arc lamps.

July 8, 1904.

15,253 W. R. V. MARSHALL. Glasgow. Dynamo-electric machines and motors.
15,255 H. ILLINGWORTH. Tadcaster. Electric cars.
15,258 P. ARNHEIM. Electromagnetic switch devices for telephone stations. (Date applied for, July 20, 1903, date of application in Germany.)*
15,261 W. A. KEB. Dynamo-electric machines.
15,267 J. G. IRVING. Nottingham. Electric light fittings.
15,283 R. S. MCLAREN. Charging accumulators for self-propelled vehicles.
15,288 H. D. BAILEY and P. O. BONNIWELL. Handles of tools used in electrical work.
15,289 C. C. GARRARD and FERRANTI LIMITED. Relays for direct current automatic circuit-breakers.
15,290 C. C. GARRARD and FERRANTI LIMITED. Electrical measuring instruments.
15,294 A. G. BETTS. Electro-depositing antimony.
15,296 R. E. PHILLIPS (E. H. Vogel, U.S.). Electric elevators.*
15,298 A. G. BETTS. Process of treating metal mixtures produced in electrolytic metal refining operations.

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1903.

15,212 HIEBLING. Manufacture of soda and caustic potash, chlorine and hydrochloric acid by electrolysis of aqueous solutions.
15,218 SWANTON. Electrical apparatus operated by the expansion and contraction of a controlling member.
15,403 GARRARD and FERRANTI LIMITED. Electric circuit-controlling apparatus.
15,599 POULSEN. Production of alternating currents.
15,817 DICKSON. Electrically-actuated musical instruments.
15,972 HUNT. Switches and rheostats for starting and controlling electric motors.
16,113 MASKELYNE. Producing and detecting Hertzian oscillations.
17,568 HUNTLEY. Electric heating devices.
21,088 OPPENHEIMER (A.G. Mix & Genest). Telephone connections on the party line system.

1904.

1,205 HÖFLINGER and WOLFFHARDT. Telephonic apparatus.
3,787 SHOBE and EMBLEY. Electric railway and tramway systems. (Date applied for, April 10, 1903.)
4,020 REYROLLE. Switches.
6,116 FIRM OF C. LORENZ. Electrical apparatus for aiming and shooting practice. (Date applied for, Dec. 21, 1903.)
6,833 SPAGNOLETTI. Electro-mechanical cut-outs.
6,834 SPAGNOLETTI. Means for automatically controlling the passage of electric currents.
7,021 KLEIN. Controlling electrically-operated elevators.
7,977 MÖLLER. Receiving devices for wireless telegraphy. (Date applied for, May 2, 1903.)
8,907 WHITEMAN (Henricks Novelty Co.). Friction gear for driving electrical generators.
11,651 COLLE. Portable insulated support for double-wire electric lines. (Date applied for, Aug. 4, 1903.)
12,087 CONRAD. Prepayment electric measuring instruments, (Date applied for, June 24, 1903.)
12,344 and 12,345 HEANY. Arc lamps and arc lighting.
12,585 ANDERSON. Ignition plugs for explosion engines.
12,841 LYLE. Burglar alarm device.
12,977 NYE and PECK. Telephones.
13,332 BEAVER and CLAREMONT. Manufacture of electric cables.
13,428 FAIRWEATHER (Brown Hoisting Machinery Co.). Electrical locomotive.

STATUTORY RETURNS, LIENS REGISTERED, &c.

STATUTORY RETURNS.

D.P. BATTERY CO. (LTD.)—The return to Aug. 3 gives capital as £10,000 in 4,996 A, 4,996 B and eight other shares of £1 each, all of which have been taken up and paid for in full. Mortgages and charges, £20,000.

EDMUNDSON'S ELECTRICITY CORP. (LTD.)—The return to Aug. 4 gives the capital as £800,000 in 70,000 ordinary, 70,000 preference and 20,000 reserve shares of £5 each, of which 70,000 ordinary and 70,000 preference have been taken up. £5 per share has been called up on 70,000 preference and 56,800 ordinary, and £634,000 has been received. £66,000 is considered as paid on 13,200 ordinary shares. Mortgages and charges, £305,772.

MEXICO ELECTRIC TRAMWAYS (LTD.)—In return to June 23 the capital is £1,000,000 in 500,000 ordinary and 500,000 preference shares of £1 each, all of which have been taken up. £500,000 has been received in respect of the preference shares, and £500,000 is considered as paid on the ordinary. Mortgages and charges, £400,000.

THOMAS PARKER (LTD.)—The return to July 18 gives capital as £75,000 in 7,500 shares of £10 each, all of which have been taken up. £10 per share has been called up on 5,750, and £57,500 has been received. £17,500 is considered as paid on 1,750. Mortgages and charges, £60,000.

MORTGAGES AND CHARGES.

BATH ELECTRIC MFG. CO. (LTD.)—Issue on Aug. 20 of £100 debentures, part of series created July 19, 1904, to secure £1,000, charged on company's undertaking and property, including uncalled capital. No trustees. Previously issued of same series, £450.

EDMUNDSON'S ELECTRICITY CORP. (LTD.)—An acknowledgment of indebtedness, dated Aug. 19, 1904 (supplemental to a trust deed dated July 10, 1899, and four deeds of acknowledgment dated respectively April 27, 1900, Aug. 1, 1901, Nov. 14, 1902, and Sept. 28, 1903, securing debenture stock to an amount not exceeding three-fifths of paid-up capital) has been registered. Property charged:—130 1st mortgage debentures of £100 each of Winchester Electric Light & Power Co., 150 similar debentures of High Wycombe (Borough) Electric Light & Power Co., 200 debentures of Salisbury Electric Light & Supply Co., 150 debentures of Ventnor Electric Light & Power Co., 100 debentures of Bromley (Kent) Electric Light & Power Co., 40 debentures of Woolwich District Electric Light Co., 50 debentures of Chislehurst Electric Supply Co., 40 debentures of Newmarket Electric Light Co., 50 debentures of Alderley & Wilmslow Electric Supply, and company's undertaking and general assets, present and future. Trustees: J. Bailey and Anglo-American Debenture Corporation. Total amount of debenture stock previously issued, £300,000. (Note.—The last return gives capital paid up in cash as £634,000, considered as paid £66,000.)

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—Issue on Aug. 10 of £40,000 5 per cent. mortgage debentures, part of series created Feb. 18, 1904, to secure £100,000. Property charged, company's under-

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taking and property, present and future, except uncalled capital. Holders, J. D. Milburn and York City & County Banking Co. No trustees. Previously issued of same series, £26,100.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26 5/8d. per oz. (Sept. 1). Consols 88⅛—88¼, xd., for money, 88 5/8—88 7/8, xd., for account; 2½ per cent. annuities 87¼—87¾, xd. Consols Pay Day, Oct. 5; Stocks and Shares Continuation Days, Sept. 13 and 27; Ticket Days, Sept. 14 and 28; Pay Days, Sept. 15 and 29; Mining Share Carry-over Day, Sept. 12.

ABERDEEN SUBURBAN TRAMWAYS CO.—The net profit for the half-year ended July 31 was £449. 5s. 3d. The Deeside line was opened on June 23, and the Donside line on July 7. The number of passengers carried on the two routes was 196,373. The directors regard the result of the half-year's operations as very satisfactory. The suburban lines have proved great feeders to the Corporation tramways.

ALTERATION OF TITLE.—At an extraordinary meeting of the Angus Electric Light & Power Co. (Ltd.) on Tuesday it was decided to change the name of the company to the North of Scotland Electric Light & Power Co. (Ltd.), to increase the ordinary share capital to £100,000 and to issue £25,000 debenture stock. Arrangements have been made for taking over the Inverness provisional electric lighting order.

BLACKPOOL & FLEETWOOD TRAMROAD CO.—At the meeting last week the chairman (Mr. Geo. Richardson) said the number of passengers carried in the past half-year was 779,060, traffic receipts were £9,934, against £10,550, and expenditure was £7,570, against £7,677. After paying debenture interest (£3,529) a dividend of 4 per cent. was declared.

BURY, ROCHDALE & OLDHAM TRAMWAY CO. (LTD.)—In the report for the half-year to July 31 the directors state that the Board of Trade arbitrator (Mr. H. Graham Harris) appointed to ascertain the value of the undertaking, had issued his award at £159,075, exclusive of £3,600 for street improvements, which point was reserved. The authorities had since intimated that they would pay the latter sum. The tramway in Whitefield, about which there was a difficulty, was included in the arbitration, and the £350 to be paid by the Council, added to the award, made a total of £163,025. This large sum is to carry interest at the rate of 5 per cent. per annum if the sale is not completed within three months.

FIRE RESISTING CORP. (LTD.)—At the statutory meeting on Tuesday the chairman (Mr. E. M. Fox) said that their works at Fulham were busy treating wood for the new electric railway carriages for the Metropolitan District Railway. They had sufficient work in that department at present to keep their works busy for several months.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—An interim dividend on the ordinary shares at the rate of 10 per cent. per annum (less tax) has been declared for the half-year ended June 30.

LANARKSHIRE TRAMWAYS CO.—At the meeting on Wednesday the chairman (Mr. A. R. Monks), in moving the adoption of the report, said the profit available for distribution, after deducting interest and contribution payable to local authorities, was £6,429, out of which a dividend was recommended on the issued capital for the half-year at the rate of 4½ per cent. per annum.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee have appointed Sept. 8 a special settling day in 34,100 £5 shares (£4 paid) of the *North Wales Power and Traction Co., Ltd.*

TYNESIDE TRAMWAYS & TRAMROADS CO.—This company is inviting applications for an issue of £40,000 5 per cent. mortgage debentures in multiples of £50.

WIRRAL RAILWAY CO.—The chairman (Mr. T. H. Jackson) stated at the meeting on Monday that the directors had not lost sight of the possibility of adopting electric traction, "but were waiting until greater proof of its perfect efficiency was given."

YORKSHIRE ELECTRIC POWER CO.—At the meeting on Tuesday the chairman (Mr. Arnold G. Lupton) said the administration expenses during the past half-year were large, and had been swelled by law charges of over £900, and a further sum under the same heading would have to go into their next balance-sheet. In spite of the ample protection afforded by their act for both local authorities and the company, several local authorities promoted last session bills to supply electricity outside their own areas. The directors opposed those bills, and in every case the Parliamentary committee had upheld their contention. They hoped that the local authorities would now make use of the facilities offered by the company rather than spend their money and that of the company in fighting them in that profitless manner. The more satisfactory side of their work was the progress that had been made at Thornhill with their supply station. The building was completed, and they would be able to carry out their promise to supply current this year. A scale of charges had been arranged. It was found impossible to arrange a scale which should meet every class of demand, and in the case of individual consumers, such as collieries and factories which wanted large supplies, the directors would negotiate for special charges. He referred to the agreement with Mirfield Council. The Council were to supply current for lighting and make the general distribution in their district, but the larger users of electric power would come direct to the company. By that arrangement the local authority of a comparatively small district obtained electricity at a very low cost, and would be able to supply it for lighting and other purposes at similar prices to those of large towns and cities, whilst manufacturers would not be hampered. Routes for 12 miles of cables had already been arranged for.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 27	1,825	+ 292	12	19,668	+ 3,694
Airdrie	,, 19	200	...	28	5,589	...
Ayr Corporation	,, 27	409	+ 25	15	6,856	+ 150
Barnsley	,, 19	205	- 7	33	5,574	- 894
Barrow	,, 19	238	...	28	5,290	...
Bath Electric Trams, Ltd.	,, 24	771	...	34	21,482	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 28	1,061	+ 8	...	...	...
Birmingham Corporation	...	...	...	...	...	...
Birmingham Tramways Co.	,, 27	4,870	- 168	8	43,661	+ 2,616
Blackburn Corporation	,, 26	1,011	+ 120	22	21,560	+ 1,988
Blackpool Corporation	,, 25	2,822	+ 832	21	28,651	+ 3,488
Blackpool and Fleetwood	,, 27	1,852	+ 416	8	12,582	- 136
Blackp'l, St. Anne's & Lytham	,, 25	1,137	+ 370	43	15,848	+ 6,646
Bolton Corporation	,, 28	2,095	+ 360	22	41,803	+ 843
Bournemouth Corporation	,, 24	1,497	+ 58	‡21	25,112	+ 1,448
Bradford Corporation	,, 27	4,458	+ 602	21	101,322	+ 17,629
Brighton Corporation	,, 28	1,875	+ 288	21	23,904	+ 2,806
Brisbane Tramways	July 18	2,152	- 22	2	4,316	- 240
Bristol Trams & Carriage	Aug. 26	4,981	- 49	14	76,271	+ 588
Buenos Ayres & Belgrano	July 31	2,735	- 164	15	48,823	+ 2,001
Burnley Corporation	Aug. 27	1,068	+ 183	22	23,499	+ 5,368
Burton Corporation	,, 28	434	...	¶21	11,381	+ 2,109
Calcutta Tramways Co.	,, 27	a36,484	+ a4,549	9	a284,721	+ a34,624
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	,, 27	2,194	+ 159	21	45,641	+ 1,517
Carlisle Tramways Co.	,, 27	222	- 8	34	6,887	+ 268
Central London Railway	,, 27	5,480	- 19	8	46,580	- 2,066
Chatham & Dist. Lt. Rys.	,, 25	672	+ 9	34	20,128	+ 2,220
City & South London Rly.	,, 28	2,257	- 146	9	20,767	- 1,091
Colchester Corporation	,, 25	353	...	4	1,623	...
Cork Electric Trams Co.	,, 25	490	- 130	34	15,825	- 2,057
Darwen Corporation	,, 26	268	+ 4	21	4,996	- 94
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	,, 19	599	+ 120	33	17,680	+ 2,891
Dover Corporation	,, 27	296	+ 7	22	5,876	- 129
Dublin & Lucan Railway	,, 26	141	+ 2	8	1,000	+ 32
Dublin Southern District	,, 26	1,953	+ 807	8	46,255	- 2,948
Dublin United	,, 26	4,429	- 24			
Dudley—Stourbridge	,, 19	964	+ 72	33	28,811	+ 1,148
Dundee Corporation	,, 24	977	+ 184	...	...	...
East Ham Council	,, 27	760	+ 25	21	16,639	+ 1,388
Gateshead & Dist. Trams.	,, 19	968	+ 52	33	29,938	+ 1,978
Glasgow Corporation	,, 27	18,982	- 1,803	†13	180,748	+ 11,108
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 19	286	- 10	33	8,597	+ 803
Gt. Northern & City Rly.	,, 27	1,010	...	28	26,814	...
Greenock & Port Glasgow	,, 19	688	- 92	33	18,920	+ 952
Halifax Corporation	,, 17	1,694	+ 91	21	33,655	+ 2,460
	,, 24	1,563	+ 83			
Hartlepool Tramways	,, 19	857	+ 10	33	9,564	+ 988
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 27	2,155	+ 341	21	46,423	+ 6,199
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	...	...	...	...	...	...
Ipswich Corporation	...	...	...	...	...	...
Isle of Thanet Co.	,, 27	618	...	21	11,586	...
Kidderminster & District	,, 27	1,912	+ 241	¶48	29,187	+ 819
Kirkcaldy Corporation	,, 19	152	+ 11	33	4,360	- 17
Lanarkshire Trams Co.	,, 24	276	- 42	34	7,852	...
Leeds Corporation	,, 25	698	+ 10	34	21,590	...
Leicester Corporation	,, 27	5,577	+ 85	28	131,847	+ 7,815
Liverpool Corporation	,, 27	1,378	...	15	20,139	...
Liverpool Overhead Rly.	,, 20	10,441	- 92	34	351,458	+ 11,774
*London County Council	,, 27	1,688	+ 12	‡9	15,869	- 151
Lowestoft	,, 20	13,429	+ 2,940	§21	257,074	+ 51,813
	,, 27	426	+ 44	...	...	...
Maidstone Corporation	,, 18	188	...	6	1,175	...
	,, 25	177				
Manchester Corporation	,, 27	12,485	+ 804	21	268,797	+ 10,377
Mersey Railway	,, 27	1,425	+ 113	8	11,516	+ 698
Merthyr	,, 19	191	- 8	33	6,698	+ 180
Metropolitan Elec. Trams	,, 26	2,126	+ 710	8	15,319	+ 2,909
Middleton	,, 19	359	- 71	33	10,829	+ 60
Nelson Corporation	,, 27	181	+ 17	22	2,649	+ 957
Newcastle-on-Tyne Corp.	,, 27	3,584	+ 74	8	29,806	+ 2,073
Newport (Mon.)	,, 27	533	+ 60	21	11,331	+ 2,109
Oldham, Ashton & Hyde	,, 19	634	- 30	33	18,120	- 977
Oldham Corporation	,, 14	1,216	...	24	28,056	...
	,, 21	1,164				
Perth (W. A.) Elec. Trams.	,, 26	1,158	+ 45	34	44,701	+ 5,646
Peterborough	,, 19	167	- 11	33	5,074	- 109
Poole and District	,, 19	425	- 7	33	9,986	- 9
Portsmouth Corporation	,, 27	2,578	+ 200	†21	47,053	+ 4,138
Potteries	,, 19	1,472	+ 13	33	56,274	+ 4,922
Reading Corporation	,, 25	699	+ 22	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rotherham	,, 19	394	- 23	33	5,132	- 120
Salford Corporation	,, 29	4,295	+ 460	22	90,078	+ 6,769
Sheerness	,, 17	95	- 8	33	2,079	- 452
Sheffield Corporation	,, 28	4,647	+ 258	§22	105,196	+ 2,568
Southampton Corporation	...	...	...	...	...	...
Southend Corporation	,, 24	633	+ 101	21	8,908	+ 1,065
Southport Tramways	,, 19	421	- 75	33	10,923	+ 508
S. Staffordshire Trams.	,, 19	711	- 337	33	25,684	- 3,858
Stockport Corporation	,, 26	591	+ 210	21	18,193	+ 5,620
Sunderland Corporation	,, 28	1,446	+ 211	21	28,894	+ 713
Swansea Trams	,, 19	617	+ 19	33	18,228	+ 1,003
Taunton Trams	,, 19	66	- 9	33	1,868	- 179
Tynemouth and District	,, 19	422	- 104	33	9,933	- 697
Tyneside Trams Co.	...	...	...	...	...	...
Wallasey District Council	,, 27	850	+ 33	§21	17,238	+ 1,050
Walsall	,, 27	463	...	34	16,575	...
Warrington Corporation	,, 25	326	+ 17	21	6,904	+ 233
West Ham Corporation	,, 25	1,147	...	26	22,657	...
Weston-super-Mare	,, 17	357	+ 20	33	4,230	+ 245
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 19	414	+ 17	33	12,968	- 88
Worcester	,, 19	366	+ 21	28	9,006	+ 4,186
Wrexham	,, 19	117	- 25	33	3,709	- 527
Yorkshire Woollen District	,, 19	622	+ 153	33	19,840	+ 3,067

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 8 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Aug. 31.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to Aug. 31. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	..	Anglo-Argentine Ordinary Shares	£⅛–£⅜	..	April, Oct	£⅛	£⅛
5	2/6	Do. 5% Cum. Pref.	5⅜–5⅝	4 8 10	..	5⅝	5⅜
St.	6%	Do. Permanent 6% Deb. Stock	137 –141	4 5 0	..	140	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	99 –101	4 19 9	..	100	..
10	6%	Barcelona Tramways Ord.	9 –10	3 0 0	..	9⅜	..
10	5/0	Do. 5% Cum. Pref.	9 –10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 –96	4 14 0	..	..	..
100	5%	Do. 5 per Cent. Debs.	96 –99	5 1 0	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	1⅛–1⅜	..	..	..	..
1	..	Do. 5% Cum. Pref.	1⅛–1⅜	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1⅞–2⅛	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½–4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs. ...	96 –101	4 9 3	..	..	..
10	8/	Bristol Tramways and Carriage Ord. ...	19 –20	4 0 0	Feb, Aug	..	..
10	4/	Do. Cum. Pref. (fully paid)	10 –10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107 –109	3 13 4	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	97 –100	6 2 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	99 –102	4 18 6	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10½	4 15 3	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103¾–105¾	4 6 2	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 –100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	8½–9⅛	6 9 9	..	9⅛	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10½–11	5 9 1	Feb, Aug	10⅞	10½
St.	5/0	Do. 5 per Cent. Perpetual Debs	116 –119	4 5 1	..	..	..
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock....	91 –97	..	..	95½	..
5	3/0	Buenos Ayres and Belgrano Ord.	2⅝–3⅛	4 16 0	..	..	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.....	5⅛–5⅜	5 4 4	..	5⅛	..
5	3/0	Do. "B"	5 –5⅛	5 9 1	..	..	..
St.	5%	Do. 5 per Cent. Debs.	105 –108	4 12 8	..	105⅛	106
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	101 –104	4 16 6	..	..	..
5	3/6	Calcutta Tramways	7⅛–7⅜	3 17 6	..	..	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	104 –107	4 4 6	..	..	..
1	1/0	Cape Electric Tram Shares	1⅝–2	5 0 0	..	1⅝	1⅝
St.	4%	Central London Ordinary Stock	87 –89	4 9 11	June, Dec	89	87
St.	4%	Do. 4 per Cent. Pref. Stock	100 –102	3 18 3	..	..	..
St.	4%	Do. Deferred Stock	80 –82	4 17 7	..	81	..
100	4%	Do. 4 per Cent. Debs.	106 –109	3 13 5	..	106¾	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½–5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 –101	3 19 2	..	100½	..
St.	2½%	City and South London Rly. Con. Ord.	40 –42	5 8 9	Feb, Aug	42	41½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891) ...	121 –124	4 0 8	Feb, Aug	122½	122½
St.	5%	Do. (1896)	117 –120	4 3 6	..	..	..
St.	5%	Do. (1901)	115 –118	4 5 0	..	117½	115
St.	4%	Do. 4 per Cent. Perpetual Debs	105 –108	3 14 9	May, Nov	107½	107
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 –103	4 17 10	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½–13½	4 8 11	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	..	..
10	4%	†St. Northern & City Rly. Prf. Ord. (4%)	4⅛–5	..	..	4⅛	4⅛
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 –10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 –20	4 10 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 –14½	4 2 9	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 –110	4 1 10	Jan, July	..	..
5	2/6	†Isle of Thanet Elec. Trams & Lt. 5% Pf.	3⅝–4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 –91	4 7 11	..	..	..
10	12½%	†Liverpool Overhead Railway Ord	3⅛–3⅜	3 9 9	Feb, Aug	..	..
10	5%	† Do. 5 per Cent. Pref.	10 –10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref..	10½–10¾	4 13 0	..	10¼	..
St.	4%	Do. 4% 1st Mort. Deb. Stock.....	103 –105	3 16 4	..	104½	103⅝
St.	..	Madras Elec. Trams 5% Deb. Stk.	100 –103	..	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock.....	6 –9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 –15	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅞–1	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞–1	5 0 0	..	⅞	..
St.	13/7	Do. 4½% Deb. Stock	98 –100	..	..	99½	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs.(1908)	102 –105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs.(1922).....	103 –105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 –2	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99–102	4 18 1	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 –9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8⅛–9½	5 5 3	Feb, Aug	9	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 –104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid).....	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	86 – 89	3 7 5	June, Dec	£6	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	⅞–1	8 0 0	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	⅛–⅜	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5½–6½	6 8 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5½–6	5 0 0	Jan, July	5⅝	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 –104	4 6 7	..	..	..
St.	4½%	†British Thoms'n-Houst'n 4½% 1st Mt. Db.	99 –101	4 9 1	..	..	..
5	3/0	British Westinghouse 6% Pref.	2⅝–3½	9 4 6	..	2⅞	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock ...	85 –88	4 10 11	..	..	..
2	..	Brush Electrical Engineering	⅛–⅜	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1 –1⅛	8 0 0	Mar, Sept	..	..
St.	4½%	† Do. 4½ per Cent. Perp. 1st Deb. Stock	94 –97	4 12 10	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	70 – 75	6 0 9	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½–10⅛	5 14 3	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	101 –105	4 5 8	Nov, May	102½	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	⅝–¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 –93	4 16 10	..	..	..
1	1/2½	Chadburn's (Ship) Telegraph Ord.	⅞–1⅛	8 0 0	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000) ...	1½–2	3 15 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	90 –95	5 6 5	Jan, July	92	..
5	..	Dick, Kerr & Co. Ord.	7⅛–8	..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5½–5⅝	5 4 4	..	..	..
St.	4½%	Do. 4½% Deb. Stock	102–105	4 6 0	..	104	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½–¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 –¼	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 –82	4 18 1	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 –83	6 8 8	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6 –6½	5 12 0	H'lf-yearly	6⅜	6⅛
5	3/0	Do. 6 per Cent. Cum. Pref.	6 –6½	4 16 0	..	6⅜	6⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 –107	4 4 0	..	..	..
2	1/7½	Electric Construction Co.	1 –1½	6 8 0	July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2 –2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	96 –99	4 0 9	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref...	9 –9½	5 5 3	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 –98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	11 –12	6 5 0	Feb, Aug	11½	11
5	2/3	† Do. 4½ per Cent. Pref.	5 –5½	4 1 10	Feb, Aug	5⅝	..
St.	4½%	† Do. 4½ per Cent. Mort. Deb. Stock (rd.	107 –111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½–19½	5 2 6	Feb, Aug	19½	19½
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 –103	3 18 5	Mar, Sept	..	..
10	5/0	†Mather & Platt 5 per Cent. Cum. Pref.	10½–11	4 10 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	85 –88	6 6 2	Mar, July	85	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909.....	101 –104	3 17 6	Jan, July	..	..
5	..	Willans and Robinson Ord.	2 –3	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3 –4	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	75 –80	5 1 0	May, Nov	..	..

Share.	Last Dividend.	Name.	Price Wed., Aug. 31.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to Aug. 31. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord. (f.p.)	¾–1	..	..	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅛–1⅜	5 1 9	..	..	..
St.	..	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	103 –107	4 4 6	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11⅛–12⅜	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9⅛–10⅜	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10⅜–11⅝	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.) ...	102 –105	4 6 3	..	..	..
5	..	Bromley (Kent) El. Lt. & Power Shares	5⅛– 6	..	..	..	..
St.	4½%	Do. Do. 1st Debs	100 –103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10⅜–11⅛	4 8 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10⅜–10⅝	3 5 1	Mar, Sept	10⅞	..
5	4/0	Calcutta Electric Supply Ord.	7⅛–7⅜	4 10 5	..	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 – 109	3 18 11	..	..	..
5	4/0	Charing Cross & Strand Electric Sup...	7⅜–8⅛	4 17 0	Feb, Aug	8	7⅜
5	2/3	Do. 4½ per Cent. Pref.	5⅛–5⅜	4 3 7	Feb, Aug	5⅜	5⅜
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅜–5	4 10 0	..	..	..
5	2/3	Do. Do. (1903).....	4⅜–5	..	..	4⅜	4⅛
St.	4%	Do. 4% Deb. Stock (red.).....	102 –104	3 17 0	..	..	..
5	3/6	Chelsea Electric Supply Ord.....	6½–7	4 2 2	March ..	6⅞	6⅝
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.) ...	106 –109	4 2 6	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10⅛–10⅜	4 18 0	Feb, Aug	10⅜	10⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.).....	120 –125	4 0 0	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 –105	4 5 9	..	103	..
10	4/0	County of London Elec. Supply Ord...	7⅛–8⅜	4 14 3	..	8⅛	8⅛
10	6/0	Do. 6 per Cent. Cum. Pref.....	11⅛–12	5 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	105 –108	4 3 6	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs..	101 –104	4 7 10	..	102	101½
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 –93	5 7 6	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅜–6⅛	4 8 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 9	..	..	..
10	..	Havana Electricity Co. Shares	9⅛–10⅜	..	..	..	..
5	5/0	Hove Electric Lighting Ord.....	7⅜–8⅝	5 0 0	..	8⅝	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St (red.)	101 –103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅜–⅝	..	..	..	..
5	5/0	Kensingtn & Knightsbdge Ord.....	12 –13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.....	6½–7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 –105	3 16 6	..	..	..
3	..	London Electric Supply Ord.	1½–2	..	..	..	..
5	3/0	† Do. 6 per Cent. Pref.	5 –5½	5 9 1	..	5⅞	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb,.....	96 –99	4 1 6	Mr, Jn, S, D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	15½–16½	5 9 0	April, Oct	16½	16⅛
5	2/3	Do. 4½ per Cent. Cum. Pref.....	5⅛–5⅜	4 0 0	Jan. July	5⅜	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	4 0 0	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 –99	3 10 6	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93 –96	4 13 9	..	..	..
10	6/0	Notting Hill Electric Ord.	14 –15	4 0 0	March.....	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	100 –103	3 18 3	..	..	..
5	4/0	Oxford Electric Ord.	5⅜–6⅛	5 4 0	March ..	5⅜	..
St.	4%	Do. 4% Deb. Stock	97 –100	4 0 0	..	..	..
1	..	Rand Electric.....	1 –1⅛	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 –103	4 7 9	April, Oct	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.....	14½–15½	4 13 7	Feb, Aug	14¼	14
5	3/6	Do. 7 per Cent. Pref.	8 –9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.) ...	97 –100	3 10 2	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord...	2⅜–3⅛	6 3 1	..	2⅜	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 –88	4 10 11	..	..	..
5	3/0	South London Electric Supply Ord.....	3⅜–4⅛	3 10 7	..	4⅛	..
5	2/6	Urban Electric Supply Ord.	4⅛–5¼	4 15 3	..	4⅜	..
5	2/6	Do. 5% Cum. Pref.	4⅛–5¼	4 15 3	..	..	..
5	6/6	Westminster Electric Supply Ord.	12½–13½	5 0 0	Mar, Sept	12⅞	12⅝
5	2/6	Do. 5 per Cent. Cum. Pref.	6 –6½	3 16 11	..	6⅜	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	£7 –101	3 19 2	Jan, July	..	..
10	..	Amazon Telegraph	2⅜–3⅛	..	Jn, Dec ..	..	..
St.	12/6	Anglo-American.....	47 –50	5 12 0	F, My, Ag, N	48	47½
St.	25/0	Do. Preferred.....	90 –92	6 0 8	F, My, Ag, N	92	91
St.	2/0	Do. Deferred	7⅜–8⅛	1 4 3	F, My Ag, N	8⅛	7⅞
100	£2	Commercial Cable Capital Stock	170 –190	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 –96	4 3 6	Jn Ap, Jy, O	96¼	94⅞
10	5/0	Cuba Submarine Ord.	7 –8	7 10 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15 –16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2⅜–3⅛	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.....	7 –8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98¾–101¾	4 9 2	Jan, July	..	..
20	3/0	Direct United States Cable	10 –10½	5 14 3	Ja, Ap, Jy, O	..	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 –101	4 9 2	Jn, Dec ..	..	..
St.	65/0	Eastern Ordinary	126 –131	5 6 9	Ja, Ap, Jy, O	130	128
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 –90	3 18 6	Ja Ap, Jy, O	89	88½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 –108	3 14 6	May, Nov	..	..
10	2/6	Eastern Extension	12 –12⅜	5 12 0	Ja, Ap, Jy, O	12⅜	12⅛
St.	4%	Do. 4 per Cent. Deb. Stock	103 –106	3 15 6	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	99 –102	3 18 9	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100% –103%	3 18 6	May, Nov	101	..
10	5/0	Gt. Nrthn. (of Copenhagen)	25½–26½	5 13 2	Jan, July	26	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 –101	4 9 2	June, Dec	..	..
25	87/6	Indo-European	43 –46	5 8 9	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 –100	4 0 0	June, Dec	..	..
10	6/0	West African Telegraph Shares	6 –7	5 14 3	..	..	..
2½	..	West Coast of America	⅛–⅜	..	..	..	..
100	4%	Do. 4 per Cent. Debs.....	97 –100	4 0 6	Jan, July	..	..
10	..	West India and Panama.....	⅝–¾	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½–8⅜	8 17 9	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	5 –6	..	May, Nov	5⅜	5
100	5%	* Do. 5 per Cent. Debs.	100 –103	4 17 10	Jan, July	..	..
10	3/0	Western Telegraph	12 –12⅜	5 12 0	Mr, Jn, O, D	12⅜	12⅛
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 –104	4 16 3	June, Dec	..	..
St.	4%	Do. 4% Deb Stock (red.)	100 –103	3 18 0	..	102	101
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid, ...	5 –5⅛	6 7 3	August ..	5⅛	5⅛
1	7½	Monte Video Teleph ne Ord.	⅛–¼	..	..	..	..
St.	6%	National Co. Pref. Stock	104 –106	5 13 9	..	106⅛	104½
St.	5%	Do. Def. Stock	89 –92	5 8 9	..	90½	89½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.....	12 –14	4 5 8	Feb, Aug	13	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 –13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref...	5⅛–5⅜	4 13 0	Feb, Aug	5⅛	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.) ...	97 –99	3 10 8	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.).....	104 –106	3 15 9	..	..	..
..	5/9	Dc. Do. Prov. Certs, 35% to be pd.	65 –67	..	..	66½	65½
1	0/8½	Oriental	⅛–1⅛	6 6 8	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 –1⅛	6 4 6	..	..	..
5	5/0	United River Plate	6 –6½	6 3 3	July.....	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅜–5⅛	4 15 3	June, Dec	5	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.).....	103 –106	4 14 4	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
£	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½–5⅛	5 14 4	..	..	..
£	2/0	Globe Telegraph and Trust	8½–9¼	5 19 0	Ja Ap, Jy O	9⅛	8⅞
£	3/0	Do. 6 per Cent. Pref.....	13½–14	4 5 8	Ja Ap, Jy, O	13⅝	13⅜
100	6%	Submarine Cables Trust (Cert.)	118 –123	4 18 9	April, Oct	..	..
..	36/7	Underground Elec. Rys. Co. of London 5% Apply Shares Secured Notes	97 –98	..	..	98⅛	..

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NOTES.

Although our cousins across the sea were rather slow in taking up the manufacture of single-phase traction motors on a commercial basis, they now seem to be applying their proverbial energy to the problem and rapidly making up leeway. In addition to the Westinghouse Company, we now find another big electrical firm, the General Electric Co., appearing before the public with what appears to be a technically successful single-phase railway motor. In principle, the motor, described elsewhere in this issue, possesses no novel features; it is rather an adaptation of the well-known series motor fitted with a compensating winding, as successfully experimented with for some years past by a number of inventors. But there is novelty, we believe, in the method employed by the General Electric Co. for rendering the motor equally satisfactory whether fed with continuous current or alternating current. The performance curves published leave no doubt that this end has been attained, and this is the more gratifying, since not very long ago the opinion was held, almost universally, that a good single-phase current motor could not at the same time be a successful continous-current motor, and vice versa. As will be gathered from the article referred to, the field winding is divided into two parts, which are connected in parallel or series according to the form of current to be employed. The alteration is quickly effected by a change-over switch, and the passage from one system to the other offers no difficulty. It is not quite clear why two trolleys are used on the car, one for the continuous current and one for the alternating current. Although the trolley wires for both kinds of current are differently situated relatively to the track, this difficulty could easily have been overcome by the use of trolleys of the Dickinson type. But it may be that the arrangement actually adopted was preferred, because, with the aid of the inter-locked switches, it is then impossible to run the motor with one kind of current while the field is connected up for working with the other.

From the curves included in the article it is satisfactory to note that the power-factor is high over a large range of the load. In face of the figures quoted, it cannot be disputed that the electrical energy expended to do a certain amount of work is considerably greater with alternating current than with continuous current. It would be of some importance to know, by the way, whether the figures given for alternating-current working include the transformation losses or not, as, if not, the advantage would be still more on the side of continuous-current working. Moreover, the excellent accelerating properties of the continuous-current motor are not possessed to the same degree by its alternating-current rival, but an exact comparison of this and of the current consumption at starting is rendered difficult by the different voltages in the two cases. Notwithstanding hese drawbacks, however, it is evident that, as the motor problem may soon be regarded as solved, single-phase traction has a future before it, especially in the case of main-line railways. Some independent tests on single-phase motors under working conditions must be the next step towards the practical realisation of the problem.

In another article this week, two single-phase motors, designed by the Oerlikon Company, are described. The first one is a 35 H.P. motor and has been tested connected up both

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as series motor and repulsion motor. The comparative characteristic curves obtained are most interesting, but they offer no conclusive evidence as to the superiority of either form of motor, as it has been generally considered impossible to design a motor so that it will perform equally well as series motor or as repulsion motor. The 200 H.P. Oerlikon single-phase series motor is of more interest, not only on account of its size, but also because in its design some novel ideas seem to have been introduced which have the effect of increasing the power-factor and eliminating sparking. It seems a pity that Dr. BEHN-ESCHENBURG has not divulged the nature of these improvements, but we hope to hear more about them later. It will be remembered by our readers that the Oerlikon Company, some time ago, was experimenting with single-phase traction on the Ward-Leonard system, and we published at the time a brief description of the electrical equipment of the car used in this connection. It was then already hinted that the system apparently did not give complete satisfaction, and that the Oerlikon people were developing a single-phase system of their own. The first fruits of their endeavours are no doubt represented by the motors alluded to above.

WHEN our Institution party arrives at St. Louis the members of it will doubtless be called upon to explain the poor representation of Great Britain at the Exhibition. When the advance catalogue of exhibits was published we commented on the fact that the number of English firms exhibiting was extremely small, undoubtedly owing to the preventive tariffs which impede the sale of English manufactures in the United States; now that the Exhibition is open this is being made still more apparent. For instance, in the second instalment of the special account of the Exhibition published in the *Daily Chronicle*, it is stated that in the whole Exhibition not more than ten firms have deemed it worth while to send out special representatives with their exhibits to watch their interests. If this be a fact—and the writer in the *Daily Chronicle* speaks confidently—it is, indeed, a remarkable state of affairs at one of the largest, if not the largest, international exhibitions that has ever been held. In the Transportation Building there are 30 to 35 locomotives, but all there is in the way of British locomotives are two models, one of them worked by a penny-in-the-slot device. The only other British railway or tramway exhibits of practical value are, it is stated, 60ft. of L. & N.W. Railway track, and a double-deck tramcar. The Machinery Building covers 12 acres and there are but two exhibits in it from Great Britain. "Electrical Appliances" occupy 9 acres, and, if the exhibit of the British Post Office and the model of the Behr mono-rail system were absent, "all the British exhibits could be displayed in a drawing room." In fact, the only section of the electrical engineering industries in which England is represented with any approach to adequacy is in electrical measuring instruments. A collective exhibit of the manufactures of a number of instrument-making firms has been put together by the Royal Commission and sent out under the charge of the Commission's representative.

PARIS is once again getting fidgetty about its electricity supply. The city is divided up into "secteurs," which are supplied by companies, but the concessions to these were only granted for a period of 18 years, and the majority of the concessions expire in 1907. Owing to the necessity of providing for the repayment of their capital in this short time, the companies have continued to charge a high price for electrical energy, and are now naturally showing a disinclination to extend their networks or to add to their generating plant. Moreover, the matter may be urgent for another reason—viz., that it is not evident that the companies can be compelled to sell their generating stations or the service lines on consumers' premises at the end of the period, although apparently the network actually under the streets will become the property of the city authorities. Continuity of supply must take precedence over everything, and, if the generating stations are not to be acquired by the municipality in 1907, arrangements for the erection of new ones must be commenced without delay.

THE matter has been under consideration once before—seven years ago. At that time there was much discontent as to the high price charged for current, and, moreover, it was feared that, unless the companies were given encouragement to extend their works, insufficient current would be available for the 1900 Exhibition. M. CHARLES BOS was commissioned to make a report on the subject, and recommended that the concessions should be extended to 1931 in exchange for considerable reductions in tariff. The municipality and the companies failed to come to terms, however, and electric light and power in the Exhibition was chiefly supplied by plant owned by exhibitors, only one of the Paris electricity supply companies being fortunate enough to obtain what should have been a much-coveted addition to the summer load. A technical committee has now been nominated by the municipal authorities to consider the question. Its constitution is as follows:—MM. MASCART, MAURICE LÉVY, POLLARD (President of the Société Internationale des Electriciens), P. JANET, BOUTY, HOSPITALIER, MONNIER, PICOU, BLONDEL and RABOUREL. The Committee, it is seen, is well representative of electrical science and engineering, and a number of leading business men have also been nominated to assist them in their deliberations.

IN this issue will be found a description of the electrical equipment at the Pinxton collieries, which are among the largest and most important in Great Britain. The installation itself is at present comparatively small, but its working has proved so satisfactary that there is no doubt as to the policy which will be pursued in the future. Unfortunately, however, additional capital expenditure is viewed with disfavour by other colliery managers, and, so far as innovations are concerned, they follow too literally the Cæsarian motto, *Festina lente*. The Pinxton collieries form an admirable model of what will undoubtedly be adopted as standard practice in electrical mining work, and the fact that there has been a total immunity from accident and breakdown since the system was inaugurated is striking testimony of its efficiency. Actual practice has proved the truth of our oft-repeated contention that three-phase working is immeasurably superior to continuous current for mines.

THE development of the manufacture of three-phase plant in this country has been considerably retarded owing to the

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uncertainty with regard to patent questions. The Westinghouse Company were owners of the Tesla patents of 1887 and 1888 and also of the notorious "split phase" patent of 1889. Since the expiry of these, there has been considerable advance in the output of three-phase machinery by British manufacturers, but there is one detail with regard to which makers of three-phase motors are still very cautious. This relates to the insertion of resistances into the rotor circuits of induction motors for starting purposes, the invention of which is claimed in a patent by DOLIVO VON DOBROWOLSKY, owned by the Allgemeine Elektricitäts-Gesellschaft, and expiring only next December. To be on the safe side, some makers have been paying a royalty to the German company for permission to use this device, while others have preferred to put up with the disadvantages of squirrel-cage rotors. One firm alone has bravely refused to believe in the validity of this patent as a master patent, and has consistently sold in this country motors and starting switches in which rotor resistances were employed. An action for infringement against this firm has been pending for some time, but we learn on good authority that it has now been abandoned, and, therefore, the way may now be considered quite clear for the manufacture and sale of all classes of three-phase plant in this country.

TWO Papers (printed in this week's issue) were read at the recent British Association meeting, dealing with the subject of testing induction motors. Dr. SUMPNER and Mr. R. W. WEEKES described a method by which the Hopkinson test can be applied to such motors. The principal feature to be noticed is that, in order to get the load to circulate between the two motors (which are belted together in the usual way), the diameter of the pulleys must be adjusted to give the requisite slips. On account of the somewhat low efficiency of such machines, the extra power developed by the motor, compared with the generator, is greater than in the case of a continuous-current test, so the authors use motors slightly differing in size—*e.g.*, a 30 H.P. to act as motor and a 25 H.P. as generator. It will be seen, therefore, that the results obtained can hardly be reckoned to be so trustworthy as in a continuous-current test, the separation of the losses between the two machines being more hypothetical. The method has another drawback somewhat lightly passed over by the authors: the "make-up" current has a very low power-factor, and may be even larger than the circulating current between the machines; so that, though there is a saving of power in making large tests, as in the continuous-current case, a generator has to be found capable of giving the same volt-amperes as the machine under test, or even more. Even with these disadvantages, however, the method will, we believe, be found useful by manufacturers. Mr. WILLIAM CRAMP describes a very different method of test, in which the separated losses are obtained by driving with a continuous-current motor whose efficiency has been predetermined, and exciting the stator with a continuous current. The advantage claimed for this test is that it "enables a very satisfactory test to be made, when alternating current of the right voltage and frequency is not available." We cannot help doubting, however, whether "satisfactory" is the right word to apply to a test made in circumstances absolutely unlike working conditions, and ignoring all the reactions which occur between the different causes of loss.

THE question of Clark cell *v.* Cadmium cell has been given on the other side of the Atlantic, an importance which we on this side would find it difficult to justify even if it were merely a choice between two cells, probably equally valuable in electrical measurement. But that is not the whole story. Following upon the proceedings of the Chicago Congress of 1893, certain countries, of which the U.S.A. was one, invested with legal authority the value then recognised for the E.M.F. of the Clark cell. Hence, to-day in St. Louis, 1·434 volts is the legal E.M.F. of the Clark cell, whereas all the world knows that the actual E.M.F. is about 1·433 volts, and very probably slightly less. But the proposal of our American friends, which is intended to redress this legal anomaly, and is praiseworthy to that extent, contains other propositions of a much less desirable character. It is suggested that the Clark cell be deposed from its acknowledged pre-eminence as a measuring appliance and the cadmium cell substituted; that the cadmium cell be adopted as a primary standard of electrical pressure; and, further, that this last suggestion be accepted as international. The mere statement of these three proposals is enough to condemn them. What need is there for deposing the Clark cell; surely two good and useful articles are equally worthy of respect? The determination of the E.M.F. for any cell involves an absolute measurement of a current; why not accept the basis of such current measurement as the current standard? The construction of an electric current dynamometer, suitable for such absolute measurement, is certainly not to be lightly entered upon, and a secondary standard would then be probably desirable. If so, we do not think there is much ground for hesitancy in preferring for this purpose the silver voltameter to any cell. Neither Germany nor Great Britain made the mistake of accepting the Clark cell as an absolute standard for E.M.F., and therefore the opinion of the B.A. Standards Committee to be presented at the St. Louis Congress (see report on another page) ignores the legal anomaly as a question for the U.S.A. alone. The opinion to be presented on behalf of Germany is not only in accord with the resolution of the B.A. Committee, but further quotes convincing arguments against any alteration from the ohm and ampere as absolute standards and the volt as deduced from them by Ohm's law.

American "Independent" Telephone Association.—The annual convention of the Independent Telephone Association of the United States will be held this year in St. Louis from September 21st to 23rd.

Personal.—The Postmaster-General has appointed Mr. A. Eden (first-class technical officer) to succeed Mr. A. W. Heaviside, I.S.O,, as superintending engineer of the Newcastle-on-Tyne district. Mr. Heaviside retires on reaching the age limit.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 18, 1902
Beissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Cayenne—Paramaribo	July 13, 1904
Cap Haitien—Mole St. Nicholas	Aug. 20, 1904
Bundaberg—Gomen (New Caledonia)	Aug. 30, 1904

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Fire.—The fire at the works of the Windsor Electrical Installation Co. last week, which was reported in the daily papers, was of a very trivial character. It appears to have started on a motor car standing in the stores, the electricity works being in no may interfered with. As a matter of fact, electricity is not used in the stores for any purpose.

McMillan Memorial Fund.—Further contributions have been received to the McMillan Memorial Fund in response to the appeal of the President and Council of the Institution of Electrical Engineers, and the amount received up to Monday last was £1,709. 16s. 10s., contributed as follows:—Members £923. 1s. 4d., Associate Members £265. 3s., Associates £262. 16s. 4d., Students £52. 1s. 3d., Foreign Members £24. 18s. Subscriptions from non-members £181. 16s. 11d. The fifth list of contributions appears in our advertisement columns.

Municipal Tramways Association of Great Britain.—The annual conference of the Municipal Tramways Association of Great Britain will be held in Liverpool on September 27th, 28th and 29th. Among the Papers down for reading are the following:—"How to Effect Economy in Current Consumption," by P. Fisher; "Arrangement of Men's Duties," by J. B. Hamilton; "Methods of Dealing with Mixed Systems of Traction," by A. L. C. Fell; "Cars: their Equipment and Maintenance," by J. Aldworth; and "Overhead Equipment, Construction and Maintenance," by J. M. McElroy. The following reports will also be submitted:—"The Standardisation of Tramway Accounts" and "Hours of Labour, &c., of Tramway Employees." On Tuesday, 27th inst., a dinner will be given by the Liverpool Corporation, on the following day (28th inst.) the Association dinner will take place, whilst Thursday (29th inst.) will be devoted to excursions. During the conference visits will be paid to the Lambeth-road works and Pumpfields power station of the Liverpool Corporation. The conference meets on Tuesday and Wednesday, 27th and 28th insts. at 11 a.m.

Rack and Pinion Tramway near Montreux.—*Elektrische Bahnen* publishes a description of the Trait-Planches rack and pinion line, which branches off the electric tramway system operating between Vevey, Montreux and Chillion. It is but short, some three-quarters of a mile in length, but the gradients are severe, the maximum being 15 per cent. This extension is of some interest on account of the fact that three motors are employed to drive the one and only motor car used. Two motors drive the ordinary running wheels, while the third motor actuates the toothed wheel which engages with the rack. The track is built with three rails of the Vignoles type, one side of the track consisting of two parallel rails close together, and the rack is fixed within the slot thus formed. The truck of the motor car consists of two frames of girder work, placed one above the other and held apart by springs. A 35 H.P. motor for working the pinion is attached to the lower frame, and this frame also carries the pinion bearing. The upper frame is equipped with two 35 H.P. motors for driving the running wheels. Current is conveyed to and from the car from two overhead lines by a pair of trolleys of the ordinary Dickinson type, the rails not being employed as a return.

Telegraph Service in Porto Rico.—The *Electrical Review* of New York states that the Porto Rico telegraph service has improved wonderfully since the United States Government has withdrawn its military force. The insular Government maintains the service, educating its own operators and transacting the telegraph business in both English and Spanish, operators being required to use both languages and the typewriter. When it is considered that during the régime of the Spanish Government the tape and register were used, and it sometimes took days to transmit messages, the improved conditions will be realised. There are 42 offices in paying operation on the island. The uniform rate is 25 cents for 10 words. In the school maintained at St. Juan for instructions, telegraphy is taught as well as the keeping of office accounts and rendering of reports. The lines are worked by 1,500 gravity cells, renewed every three months. About 100 miles of copper is in use, mostly No. 9 G.I. Poles are of native hard wood, some of them in use for over 30 years. Operators are paid from $40 to $100 per month, women being received on the same basis as men. For the last fiscal year the number of messages sent was 286,386, and the receipts $49,114.07, on which the profit was $13,914.46. Storage batteries with rotary transformers will soon be installed on the main circuits. The Morse code is used. The wires are all single, although it is expected that the duplex system will be used soon.

Wireless Telegraph Notes.—An article in the *Elektrotechnische Zeitschrift* of August 18th contains the results of a long series of experiments carried out by Prof. Slaby. The experiments deal with various important points connected with the tuning of transmitters, and afford a test of the value in practice of the formulæ available for the capacity and self-inductance of wires. The effect of neighbouring earthed objects on the capacity of a wire was investigated by measuring by a telephone bridge-method the capacity of a 10-metre (33ft.) length of wire held horizontally at varied distances above floors of different kinds. Thus at a height of 1 metre above a zinc-covered floor, or above a wooden floor, the measured capacity was some 20 per cent. greater than the value calculated by the simple formula for straight wires; but with a similar elevation above an asphalte pavement the error was only about 6 per cent. At heights greater than 2 metres the ordinary formula is, however, accurate enough; and a modified formula gives values for capacity and for wave-length agreeing well with all the experiments. In some of these observations the effect of damp weather was noticeable, since it increased the observed wave-length somewhat, probably because the capacity of the wire was increased by the presence of water in the dielectric. A different set of experiments was intended to decide whether the electric or magnetic portion of the electromagnetic wave plays the greater part in distance transmission. Here the apparatus was so arranged that either a potential loop or a current loop of the transmitter, as desired, could be put nearest the receiving circuit. Prof. Slaby found a difference approaching 40 per cent. in favour of the magnetic effect, but he used distances of only 3 metres (9·8ft.). From this the author draws the conclusion that in fixing a wireless telegraph station it is most important to give free play to the circles of magnetic force expanding from the current loop at the bottom of the air-wire. Still another group of experiments examines the effect on capacity and wave-length of using as a sender a bundle of wires arranged parallel to one another or in the form of a cone. With equal parallel wires, spaced at distances of a metre or more, the wave-length is practically the same as with one of the wires, while the energy of charging is increased in proportion to the number of wires; with a closer arrangement of the wires the energy of charging is greatly diminished. With the conical arrangement of wires the energy of charging was found to be smaller than with the corresponding parallel arrangement. Prof. Slaby has further investigated the effect on the rate of radiation from a given air-wire system of introducing inductance coils at the lower end of the air-wire for tuning purposes, the principal measurment being made by placing a hot-wire ammeter between the air-wire system and the added inductance. His results show, he says, that such a process of lengthening the wave is accompanied by diminution in the amount of energy radiated.

Reuter's correspondent at Tsing-Tau reported last week an interview with Admiral Matussevitch, who was wounded on board the "Cesarevitch" during the last naval engagement off Port Arthur, and is now in hospital at Tsing-Tau. Admiral Matussevitch spoke in the highest terms of the usefulness of wireless telegraphy. In the fight on August 10th the apparatus on board the "Cesarevitch" continued working until it was shot away. It had worked more surely and quickly than flags, and he believed that in the near future every boat of all Navies, even gunboats, would be fitted with wireless telegraph apparatus.

The United States Secretary of Agriculture has decided to instal a wireless telegraph system of fire alarms in all Government forest reserves throughout the country.

According to the *Electrical World* of New York, Gen. Greely, chief signal offices, U.S.A., received on August 9th the first wireless telegraphic message sent direct from Nome, Alaska. It marks the inauguration of the Government wireless line from Nome to St. Michaels, 107 miles.

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THE APPLICATIONS OF ELECTRICITY AT THE PINXTON COLLIERIES.

It is fitting that the Pinxton Collieries, which are, perhaps, the oldest in the country, should be amongst the first to adopt electricity as a means of transmitting energy, and that they should adopt it on a very extensive scale. These collieries are the property of the Pinxton Coal Co. and are situated on the borders of Nottinghamshire and Derbyshire, about one-third of the distance between Nottingham and Sheffield. There are nine pits, varying in depth from 120yds. to 450yds., and the total output is 3,000 to 4,000 tons of coal per day. For reaching the workings there are 11 shafts, two of which, however, are only used in emergency, and various qualities of coal are extracted and sent to all parts of the country. Five different seams are now being worked and they are all considered "safe," with the exception of one Silkstone seam, which is rather gassy. Special interest attaches to these collieries by reason of their age. It is not certain that they are the oldest in England, but it is known definitely that at least one pit—No. 1—was being worked as long ago as the 17th century. Their geographical position entitles them to be described as of considerable importance and they are served by three railways—viz, the Great Northern, the Midland and the Great Central. There is also a canal by which coal was conveyed from the pit's mouth before the advent of the railways, but the competition by the Midland Railway Co. became very serious, and the railway company subsequently bought up the canal and closed it for traffic, although it still remains in existence.

Of the nine pits, four are worked with three phase current and the remainder with continuous current, but the size of the continuous current plant is practically negligible as compared with the three-phase, and, therefore, we shall devote considerably less attention to it. When electrical working was first adopted at the Pinxton Collieries it was decided to make a start with continuous current, and plant to the extent of about 50kw. was put down. This, however, was not quite so satisfactory as might have been desired, and Mr. F. J. Milne, the electrical engineer, at once came to the conclusion that all future plant would have to be three-phase. Fortunately, his decision has been amply justified. As a rule, colliery owners are exceedingly conservative, and, therefore, electrical working is always viewed with considerable doubt, amounting almost to suspicion. Moreover, there is also the additional capital outlay involved, and, in view of the present depressed state of trade, which is keenly felt by the coal industry, it is not surprising that progress is hampered to a certain extent. Hence, it will be understood that the plant which we propose describing is but the nucleus of something very much larger, and is, after all, practically nothing beyond an experiment on a commercial scale. That the experiment has proved successful is beyond doubt, and extensions are being pushed forward with great rapidity.

The alternating-current plant supplies energy, for the purposes enumerated later, to pits Nos. 1, 2, 3 and 6. On the top, or "bank," as it is termed technically, of No. 1 pit there are 10 Lancashire boilers by Messrs. Danks & Co. Eight of these are employed for ventilating, pumping and winding purposes, while the remaining two are set apart specially for the electrical plant. Each is 30ft. by 8ft., has an evaporative capacity of 8,000lb. of water per hour, is hand-fired, and works at a pressure of 160lb. per square inch. One Cameron feed pump has been installed, but each of the boilers is also fitted with an injector. A single 6in. steam pipe, supported overhead on iron trestles 12ft. in height, conveys steam from the boilers, which are situated in the open, devoid of all covering, to the engine room. The distance from the boilers to the engine room is about 40yds. No special expansion bends are provided, and a Royle steam trap is fitted near the engine room for draining the pipe. The whole arrangement is, in fact, quite an ordinary one, and very little trouble has been taken to secure economical working, seeing that fuel is so cheap.

In the engine room there are two engines, one by Messrs. John Fowler & Co. and the other by Messrs. Willans & Robinson. The Fowler engine is of the horizontal compound condensing type, with the air pump carried on the low-pressure piston tail rod. Hartnell's patent expansion valve gear is fitted, and the following are the principal dimensions of the engine:—Stroke, 2ft. 6in.; diameter of high-pressure cylinder, 14in.; diameter of low-pressure cylinder, 25in.; speed, 107 revs. per min. The main shaft carries a grooved flywheel 14ft. in diameter between the cylinders, and the alternator is driven from this by means of 10 1¼in. cotton ropes. The alternator itself is an E.C.C. machine running at 420 revs. per min. when working at 150kw. three-phase and 50 ∿ per second. Its main shaft carries a pulley to receive the ropes from the engine flywheel, and another grooved pulley taking four 1in. ropes for driving the exciter. It is a revolving-field machine with water-cooled bearings. Originally, the complete set was installed in the Corporation of Leeds electric lighting station, but it was replaced there by a vertical directly-coupled set, and the Pinxton Coal Co. bought it because it was to be obtained at a low price and because economical working and space are only secondary considerations in the generating station of a colliery. As far as the engine is concerned, no alteration has been made, with the exception of replacing the stuffing boxes by metallic packing, which appears to be answering the purpose admirably. In the case of the alternator, however, considerable alterations had to be made, as it was originally a single-phase machine. The Electric Construction Co. undertook the task of re-winding it, and, instead of generating single phase current at 2,000 volts and 83 ∿ per second, it is now a three-phase machine generating 1,100 volts between the phases at 50 ∿ per second. This conversion has been most satisfactory in every respect, and the machine has worked quite smoothly ever since. The exciter is also an E.C.C. machine, and generates 35 amperes at 160 volts when driven at 750 revs. per min.

At one end of the engine room is a Willans central valve triple-expansion 250 H.P. engine, fitted with automatic expansion gear, and directly coupled to it is a 150kw. three-phase Witting-Eborall alternator. This machine runs at 375 revs. per min., and generates current at 1,100 volts between the phases and at 50 ∿ per second. It is of the revolving field type, and carries on its shaft a four-pole 40-ampere 110-volt exciter. Both alternators are star-connected, but the centres are not earthed. On actual test, the combined efficiency of the Willans set when running non-condensing was 82 per cent, and of the Fowler set 76 per cent. A consumption of 24lb. of water per indicated horse-power was recorded when both sets were running, the water being measured into the boilers.

The switchboard is situated at one side of the engine room on a platform 10ft. above the floor level, and rubber mats are employed. It consists of 12 white marble panels, supported on channel iron, efficiently earthed. There are two generator panels, to which two sets of three separate 19/16 cables are brought from each machine. These cables are drawn into iron pipes laid under the station floor. On reaching the switchboard the cables are led directly to porcelain clip fuses situated near the bottom of the board and well protected from accidental or intentional contact by means of an iron screen. From the fuses the cables run to three-pole oil-break switches, from the live side of which leads are taken to the voltmeter and synchroniser transformers. Ammeters are then inserted in the circuit, and the cables are finally attached to 'bus bars carried on oil insulators at the back of the board. Recording voltmeters and ammeters of the moving coil type are employed. Two additional shunt transformers are used for hot-wire and edgewise voltmeters, and these also supply current for actuating the Everett-Edgcumbe rotary synchroniser. The six high-tension distributing panels are similar to the generator panels, and the exciter panels carry the usual instruments. Regulation is effected by varying the alternator field in one case and the exciter field in the other, but it is possible, by means of resistances in both alternator fields, to adopt the former method in both cases. One high-tension distributing panel is used solely for workshop power and surface lighting. Cables are taken from it to the primary of a 65kw. three-phase Oerlikon transformer which steps down from 1,100 to 400 volts and is air-cooled. The neutral of the secondary is brought

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out for lighting purposes, and 230-volt lamps are inserted between it and any phase. The three phases from the low-tension side of the transformer go up to two panels on the main switchboard, through ammeters, oil switches and fuses, to two groups of workshops. At the point where the cables are tapped for the first machine in each shop a three-pole switch is inserted, and they end at the last machine in the shop. A fuse, but no switch, is inserted in the neutral wire, and all four wires are carried on insulators.

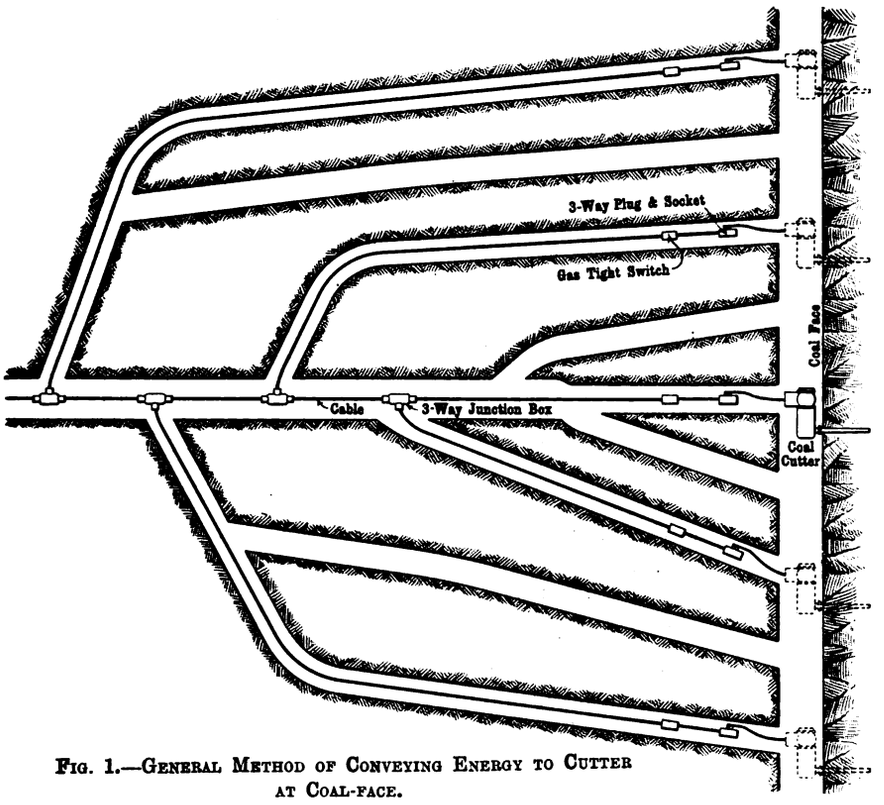

FIG. 1.—GENERAL METHOD OF CONVEYING ENERGY TO CUTTER AT COAL-FACE.

The workshops themselves contain some interesting specimens of labour-saving machines which are nearly all separately driven by means of induction motors situated quite out of the way and having an excellent reputation for never giving trouble. One of the most ingenious tools is an electric power hammer driven by a slipping belt. When it is desired to use the hammer the belt is caused to grip the pulley which actuates a crankshaft operating the hammer. Normally, the belt slips over the pulley, but it grips the latter on being stretched by a jockey pulley fixed on one end of a bell-crank lever. The strength of the blow struck may be regulated to a nicety, the working speed being 375 revs. per min., and the hammer is in many respects superior to a similar machine driven by steam. It is an American device, the English agents being Messrs. Buck and Hickman. In the saddler's shop there is a sewing machine, also driven by an induction motor, and the machine for cleaning miners' lamps is similarly driven. Nearly all the induction motors in the workshops were supplied by The Electrical Co. The fitting shops are lighted by four Stewart enclosed arc lamps in series, with each of which is a choking coil.

Returning to the switchboard, there are five remaining panels, which feed Nos. 1, 2 and 3 pits, the managing director's residence and the general offices respectively. Current is supplied to No. 1 pit at 1,100 volts, and the tension is not reduced until the sub-station, situated about ¾ mile from the pit bottom, is reached. The high-tension cable was manufactured by Messrs. Glover & Co. and is three-core, each core being composed of 19/16. It is paper-insulated, lead-covered, served with jute, then armoured with double-steel tape, and finally given a serving of jute over all. Messrs. Glover also supplied a large amount of other types of cable, including nearly ½ mile of 4-coil cable, three of the cores being 7/22 and the others 3/22. This is used for low-tension work and is insulated and protected in a similar fashion to the high-tension cables.

From the switchboard to the pit mouth it is laid direct in the ground, and then taken down the shaft in pitch-pine casing. This casing is screwed to wooden plugs driven into the brick wall of the shaft, and it has a single groove running throughout its length, slightly less in diameter than the cable which it is to receive. By hammering the cable into the groove its weight is equally distributed for the entire depth of the shaft, and there is, consequently, far less danger of rupture than if it were simply cleated to the shaft wall at intervals. After the cable has been driven into the casing, a pine covering is screwed on, and the whole forms a very serviceable and effective piece of work.

Immediately at the pit bottom there is a 3kw. single-phase oil-cooled transformer for lighting pit bottoms Nos. 1 and 6, which are adjacent. This transformer steps down from 1,100 to 230 volts, and is fitted with oil switches and fuses in both primary and secondary circuits. After the single-phase transformer there is a three-pole high-tension oil switch, by means of which all supply beyond the pit bottom can be entirely cut off. Owing, however, to the lighting transformer being on the live side of this switch, light is always available even though power be cut off. From this point the cable runs direct to a sub-station about ¾ mile distant. In no case are there any bare wires, and the cables are all laid beneath the surface at the side of the roads. An exception to this practice is made in damp situations, when the cable is laid solid in wood troughing; or, in exceptionally damp places it is drawn into iron pipe, bridging the damp ground and terminating in wooden boxes filled with bitumen. At the sub-station the cable passes through high-tension fuses and is then connected to the primary terminals of two three-phase Oerlikon transformers, one of which has a capacity of 60kw. and the other 45kw. These transformers are in parallel and may be isolated on either high or low-tension side. They are air-cooled, star-connected, and the neutral is brought out on the secondary side for lighting, three 100-volt lamps being wired in series, and the leads carried in iron gas pipes, screwed and earthed. The primary voltage is 1,100 and the secondary 520, the latter being connected to the 'bus bars of a small switchboard through oil switches. The distributors are also controlled by oil switches.

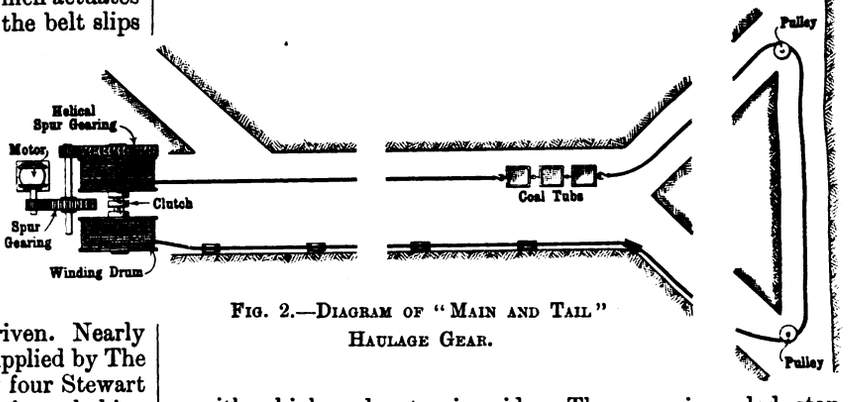

FIG. 2.—DIAGRAM OF "MAIN AND TAIL" HAULAGE GEAR.

Fig. 1 is not intended to represent any particular working of the Pinxton Collieries, but is merely a diagram showing the general method of working. A three-core cable is taken from the distributing centre along a road, in the direction of the coal face. At some convenient point, a three-way dividing

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box is put in and the cable divided up as shown. Some distance further on another dividing box may be interposed and thus the cable is eventually split up into numerous ramifications the actual number depending, of course, on the capacity of the main cable. The branches off the main road are termed "gates" and these lead direct to the working face. They are so constructed that their ends are just about 100yds. apart. Near the end of every other gate is placed a gas-tight or "gate end" switch, and a few feet further on there is a three-pole socket, which receives a three-pole plug attached to the end of a flexible cable. All work as far as the three-way dividing boxes is considered permanent; but from these points to the gate end switches the work is more of a temporary nature, although, if the coal face advances, even this work may become permanent. In some collieries it is customary to combine the socket with the gas-tight switch, special switches being made for this purpose. Those at Pinxton are, however, separate, the switches having been made by Messrs. Johnson & Phillips. They are of the triple-pole quick-break knife pattern, designed to break 50 amperes at 750 volts, and provided with fuse terminals. Each pole is mounted on a separate enamelled slate base, the bases being separated from each other by means of stout insulating non-inflammable fillets. The fuses are of the standard terminal type, the fuse wire being clamped between stout gunmetal blocks and enclosed in asbestos tubes. Stout iron crossbars hold the three poles of the switch rigidly in position. The switch and fuse is fitted into a cast-iron box lined with asbestos throughout and having a hinged cover. When closed, the cover is secured by means of two fly-bolts and nuts, a rubber joint making the entire switch gas and watertight The handle for operating the switch is fixed on the outside of the case, the spindle being taken through a suitable stuffing box and connected to the insulated crossbar mentioned above. Highly insulating and practically unbreakable material is employed in the construction of the switch handle, thus ensuring that the switch is doubly insulated from the operator. Cables are taken through insulated stuffing boxes to suitable cable thimbles clamped on heavy gunmetal terminal blocks mounted on the front of the slate. The cast-iron case is complete with holding down lugs.

One of the most fruitful sources of trouble in electric coal cutting is the flexible cable, which conveys energy from the gas-tight switch or three-pole socket to the cutter itself. This cable has to undergo very rough treatment at the hands of unskilled workmen, and it is by no means unusual for picks and shovels to be dropped upon it. The three-core trailer cable employed at Pinxton was manufactured by the St. Helens Cable Co., and each core is of 7/18 copper wire. It is insulated with vulcanised rubber, which is covered with jute compound, and the whole is drawn into spiral armoured rubber tube. Owing to the fact that a distance of 100yds. separates adjacent gate ends and that cables are only taken down alternate gates, it is obvious that the trailer, or flexible cable, must be 100yds. in length in order that the cutter may be fed continuously.

The cutter is of the Hurd bar type driven by a 20 H.P. three-phase induction motor manufactured by Messrs. Mavor & Coulson. It is started by means of an auto-transformer. Considering the nature of their work and the constitution of the "dirt" under the coal, it is extraordinary that the machine runs so quietly and creates so little dust. It should not be inferred from this statement that there is an entire absence of noise and dirt, but there is surprisingly little of either. The bar, having a revolving and reciprocating motion, holes out the dirt to a depth of 6ft. under the coal, and makes an exceedingly clean cut. Four men attend the machine, and it is maintained by the Pinxton authorities that it performs as much work in a given time as 20 men, and does the work more thoroughly. Two men clean out the dirt which the cutter has taken out, and at the same time they put in position struts and supports to prevent the undercut coal from falling. The cutter, which was supplied by Messrs. Cowlishaw, Walker & Co., hauls itself along automatically by means of a wire rope passed round a pulley some yards away. It runs on small rails, and as soon as it has advanced over one length the rails are taken up from behind the cutter and laid down in front of it. Thus there never need be more than two pairs of rails in use for one cutter at the same time. The rate of working varies within very wide limits according to the nature of the soil, but it is not at all an uncommon occurrence to cut as much as 80yds. a day at Pinxton. As with every other machine, there are occasional mishaps and breakdowns, but these are extremely rare and are due chiefly to dust getting in bearings. The motor is, of course, amply dimensioned and keeps very cool. Practically the only attention required by the machine is lubrication and sharpening of the cutters.

The advantages of electric haulage was early recognised at Pinxton, and three haulage motors have been installed. Two of these are "main and tail" gears, and the other is a "tail" gear. Each is equipped with a 20 H.P. A.E.G. motor, running at 1,000 revs. per min. and having a wound rotor, with resistances in series, by which the speed can be regulated In addition, there is a device for short-circuiting the slip-rings when required. The end of the motor shaft carries a raw hide pinion geared into a cast-iron spur wheel driving a countershaft, the gear ratio being 60 to 13. On the other extremity of the countershaft is a helical pinion geared into a helical spur-wheel fixed on the drum shaft, the gear ratio in this case being 78 to 17. The drum shaft carries two drums, each having a diameter of 2ft. 8in.; one has a $\frac{3}{4}$in. wire rope, and the other a $\frac{5}{8}$in. wire rope. By means of a claw clutch on the shaft between the drums either, but not both, can be made fast to the shaft. Each drum is equipped with a band brake. The method of operating a "main and tail" haulage gear is illustrated in Fig. 2. In the case of a "tail" haulage there is a single winding drum, and a train of empty trucks descending a gradient is caused to unwind the rope. The rope is then attached to a train of loaded trucks, which are hauled up the gradient. These 20 H.P. motors frequently haul as much as 400 tons up a gradient of 1 in 3 during the course of a single day. This means that they are often overloaded; but, in spite of this fact, there has never been a breakdown since they were installed, over two years ago.

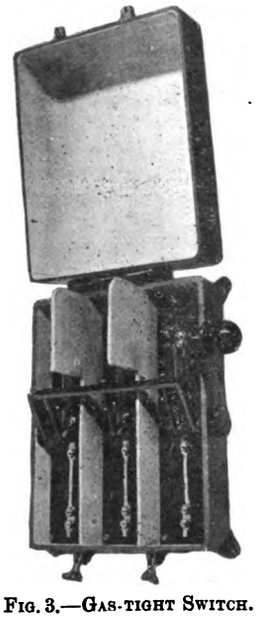

FIG. 3.—GAS-TIGHT SWITCH.

The lighting of the underground part of the collieries is almost a negligible quantity, as very few lamps are required, except at sub-stations and hauling stations.

We have to express our indebtedness to Mr. F. J. Milne, electrical engineer to the Pinxton Collieries, to whose specifications all the work has been carried out, for his courtesy and kindness in affording us facilities for inspecting the work and in giving us much of the information contained in this article.

Telephony in Abyssinia.—The *Telephone Magazine* of Chicago, quoting from the *Washington Post*, says that nearly 800 miles of telephone wire have already been put up in Abyssinia, and 1,000 more are in process of construction. The work is being done for the Abyssinian Government, and the contractor has had almost every imaginable trouble to contend with. Tremendous rainfalls were the first source of damage, washing out many miles of pole line. Scarcely had this damage been made good when the poles again began to fall. This time the cause was termites, or white ants. The destruction was stopped by erecting iron poles, but the latter proved very attractive to the natives, who tore them out and converted them into tools. To put a stop to this, messengers were sent throughout the country, proclaiming that extreme punishment awaited any who touched the telephone lines. The principal trouble encountered now is due to elephants, who use the poles as scratching posts, thus knocking them down, and monkeys who find the wires delightful swings. The rapid growth of the jungle also gives some trouble and makes it necessary to keep a party of men constantly employed cutting away the young growth.

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A NEW SUB-STATION ON THE CENTRAL LONDON RAILWAY.

Experience in the past has proved that it is most desirable to provide an arrangement whereby the tunnels and stations of "tube" electric railways may remain efficiently lighted in the event of a breakdown of the main power plant. It is, of course, comparatively easy to arrange for this in the case of a new undertaking, but the problem is rather more difficult when dealing with railways which have been running for some time. However, it has been effected in a very ingenious manner by Mr. H. F. Parshall in connection with the Central London Railway, as may be seen from the following description.

A new sub station has been built at the Bond-street station of the railway, and it is equipped with two 900kw. rotary converters, each of which is worked from a separate bank of three transformers. These machines are in every respect similar to those already running in the company's other sub-stations, but there is, in addition, a 100kw. rotary converter, whose armature is wave-wound. This wave-winding simplifies the end connections considerably, only three connections being required to the slip-rings instead of two per pair of poles, as is usual. The sub-station itself is supplied from the generating station through two three-core lead-covered cables, each core having a sectional area of 0·15 sq. in. It will be seen from Fig. 1, which is a diagram of connections at the generating station main switchboard, that a separate high-tension switchboard has been provided for the Bond-street sub station, and that it is possible to supply this board either from the main high-tension 'bus bars, through a large motor-driven oil switch, or from one or both of two separate generators which are situated at extreme ends of the station. This enables Bond-street either to run in parallel with the other sub-stations, on the high-tension side, or to work quite independently.

At present, supply for lifts, lighting and traction is derived from sub-stations at Notting Hill, Marble Arch, Bond-street and the Post Office, but it is intended to discontinue the lift and light supply from Marble Arch, using Bond-street instead, When, however, Bond-street is shut down, the lift and lighting panels there will be supplied from Marble Arch as required.

The lift and lighting boards at Notting Hill and the Post Office are outside the sub-stations, so that in case of injury to the sub-station boards the lift and lighting boards will remain unharmed. These boards are provided with throw-over main switches, which enable them to derive their supply either from their own sub-station or from Bond-street, the cables in each case being in duplicate. Thus it will be seen that not only is the Bond-street sub-station able to derive its supply from the ordinary high-tension power 'bus bars or from a separate high-tension switchboard, but the lighting supply at Notting Hill, Bond-street and the Post Office may be obtained from Bond-street or from the power supply on the low-tension side.

A double-ended booster is provided at Bond-street in order to compensate for drop in volts in the cable from there to the lift and lighting boards at Notting Hill. In ordinary circumstances all the lighting current will be supplied through Bond-street from a single generator at the power house, so that the lighting will be absolutely independent of the traction supply. In case of emergency it will then be necessary simply to throw over the lift switches at Notting Hill and the Post Office to supply them also from Bond-street. If, on the other hand, for any reason it should be necessary to do so, the lighting switches at Notting Hill and the Post Office can be thrown over to take supply from the adjacent sub-stations, or both lighting and lift switches may be thrown over so as to be supplied from Marble Arch.

The traction feeder arrangements at Bond-street are the same as at other sub-stations, but the traction 'bus bars are, of course, independent of the 'bus bars supplying lifts and boosters. In all cases, the lighting switches are connected to the live side of the main circuit breakers. There is a lift distributor in each tunnel and any lift in any station can be

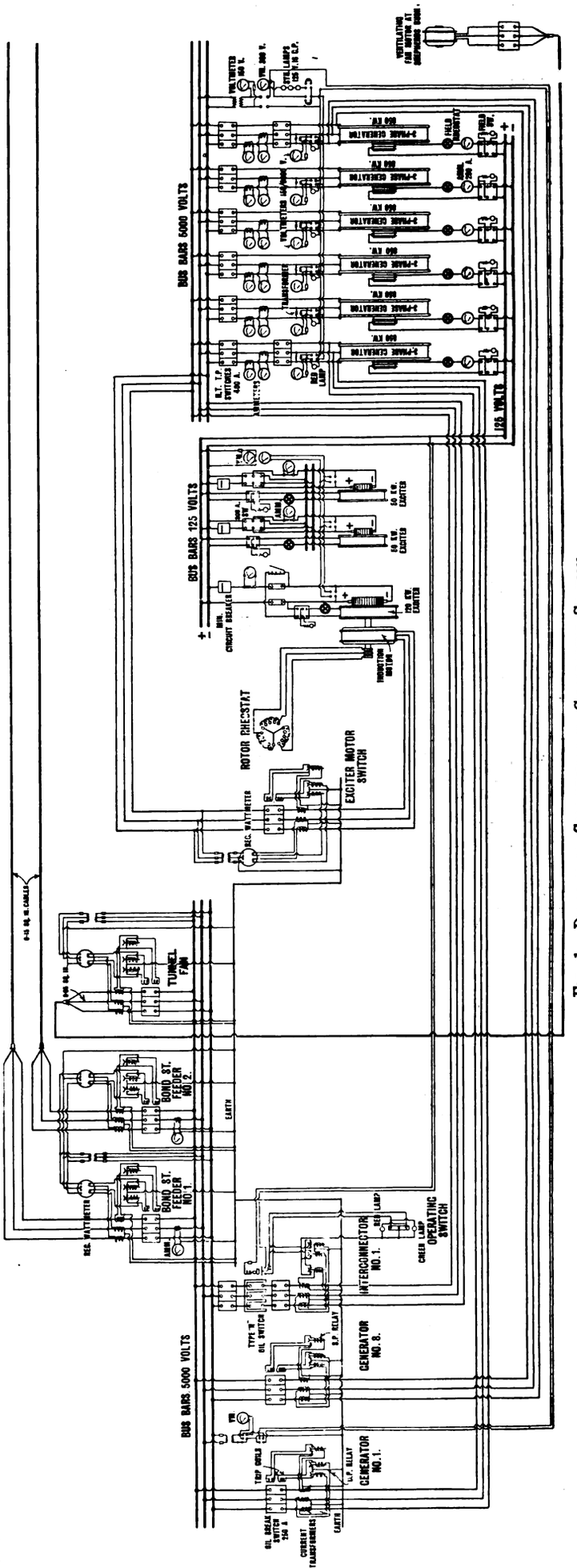

FIG. 1.—DIAGRAM OF CONNECTIONS IN GENERATING STATION.

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worked off either distributor. In each station alternate lights are taken off separate distributors and the lighting distributors are kept quite separate from those working the lifts. Recently, all rubber cables have been replaced by single paper lead-covered cables of large section, and practically all of them are run in iron pipes.

The transformers at Bond-street have a capacity of 300kw. each and step down from 5,000 to 330 volts. The chief point cases consist of riveted boiler plates, while the bases and tops are of cast iron. They are situated in a separate room from the rotary converters and switch gear, the two rooms being divided by a brick party wall and iron doors. The wall, however, is not continued quite up to the roof, and, therefore, it is possible for the travelling crane to be used for work in either room. It was originally intended to have the sub-station at the bottom of the lift shaft, as has been done in the case

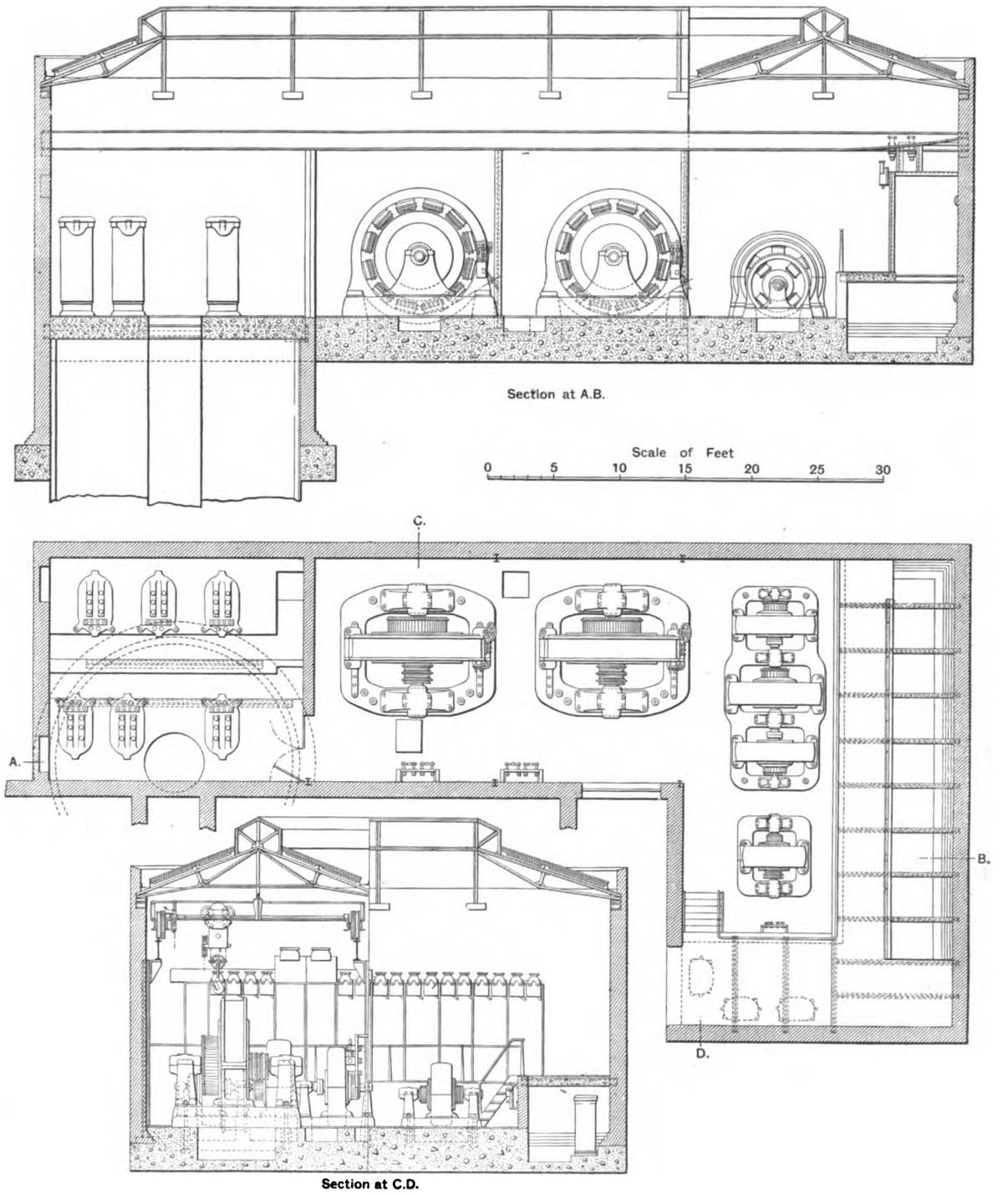

FIG. 2.—PLAN AND SECTIONS OF BOND STREET SUB-STATION, SHOWING GENERAL ARRANGEMENT OF PLANT.

of interest in connection with them is that they are water-cooled. After a 12 hours' run at normal load the temperature is guaranteed not to exceed 30°C. with the surrounding air at 25°C., nor is more than 2½ gallons of water at 16°C. required every minute. The drop in E.M.F. does not exceed 1¼ per cent. from no load to full load. Their efficiency at full load is 97·7 per cent. and at half load 97·2 per cent. The transformer of the other sub-stations, but this project was subsequently abandoned and a much lighter and cooler site was found on the ground level.

For starting up the rotary converters the intermediate tap method has been adopted, and several advantages are gained thereby. Before the Bond-street plant was put in, it used to be the custom, in starting up in the morning, for one converter

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in a sub station to be run up by connecting it on to the full voltage, and thus making the whole continuous-current system alive. The other sub stations would then run up their rotaries on the continuous-current side. This practice of course, put double load on the first converter started up, and for this reason it was usual for the sub-stations to start up the system in turn, so as to distribute the duty. Now, however, Bond-street is always got under weigh first, as there is not the least difficulty in starting the rotaries by means of the intermediate taps on the transformers. The other sub-stations then start on the continuous-current side.

We are indebted to Mr. H. F. Parshall, consulting engineer to the Central London Railway, for his courtesy in enabling us to obtain the above information and in lending us the drawings from which to make the illustrations accompanying this article.

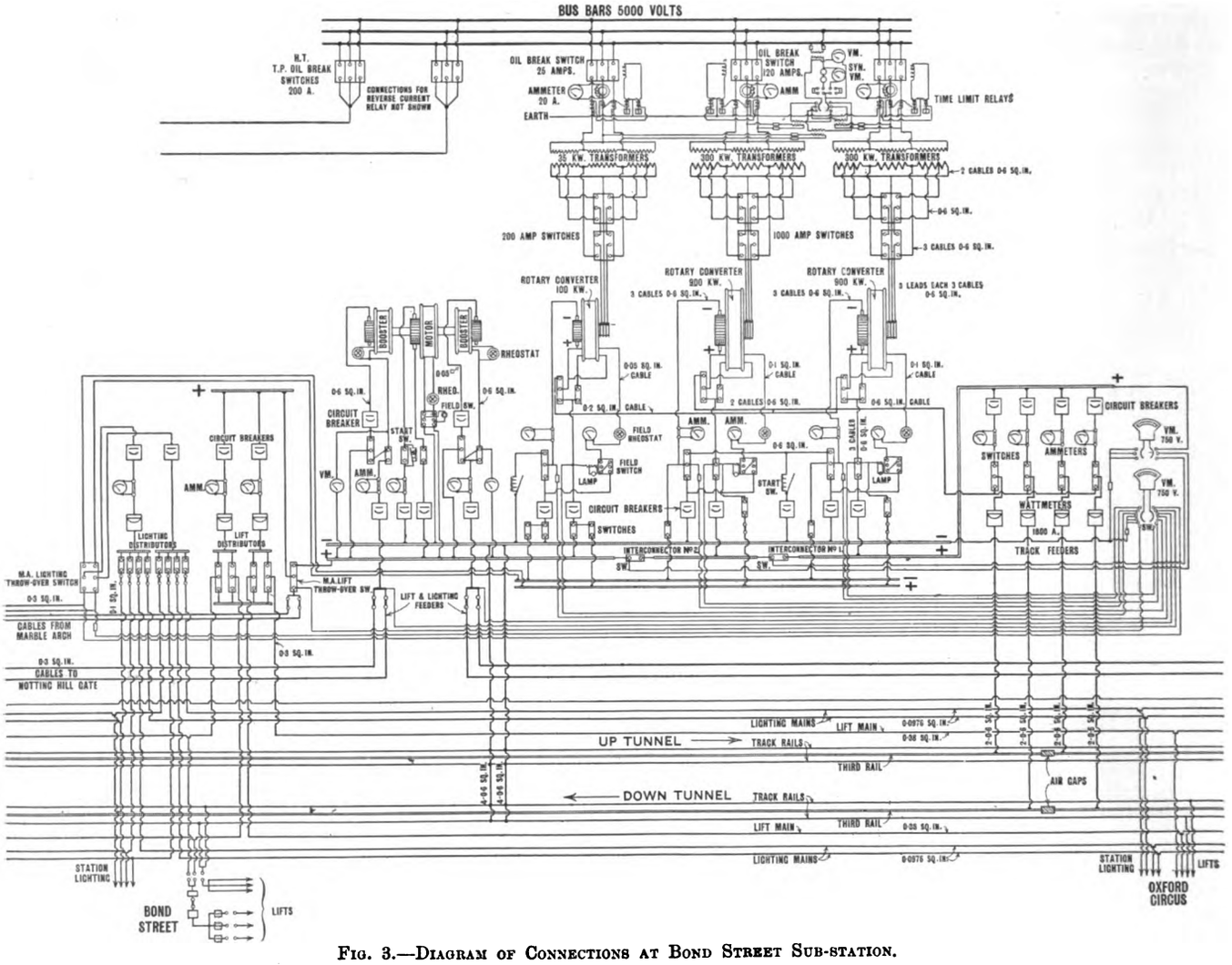

Fig. 3.—Diagram of Connections at Bond Street Sub-station.

A NEW AMERICAN SINGLE-PHASE MOTOR.

Our American contemporaries contain descriptions of a compensated single-phase railway motor developed by the General Electric Co., and also particulars of trial trips with it undertaken on August 19th on the Ballston division of the Schenectady Railway.

Fig. 1 is a diagrammatic representation of the motor, C being the compensating winding which opposes the magnetomotive forces of the armature winding. If left unbalanced, or at least substantially so, the armature field conduces to sparking and to bad power-factors. The motor consists of an annular laminated field with a distributed winding similar to that of an induction motor. As the motor is to operate both with alternating current and continuous current, and since the field strength has to be different for each case, the distributed field winding is split up into two parts which may be connected either in parallel or in series. These two portions of the winding have different number of turns, the arrangement being such that the motor runs at practically the same speed whether fed with continuous current at 250 volts or single-phase current at 200 volts. Fig. 2 shows plainly the way in which the armature, compensating coil and field coils are connected up for both forms of current. The power equipment of the car consists of four motors, and it will be noticed by reference to Fig. 2, that two motors are always in series and are treated as a unit. It is also seen from the diagram that the compensating coils are always in series with their armatures. The latter are in construction identical with ordinary continuous-current armatures, having a four-polar wave winding, and the two brushes are permanently fixed in the neutral positions. The air-gap is relatively large, being about twice that of stationary induction motors of corresponding size. Actual tests have demonstrated, it appears, that the commutation is perfect for continuous-current working and satisfactory when the motors are run with single-phase current. For grouping the field windings, suitable for either working with alternating or continuous currents, a change-over switch is provided on the car. The car is also equipped with two main line oil switches in the alternating and continuous-current circuits, and these various switches are mechanically interlocked in such a manner that the

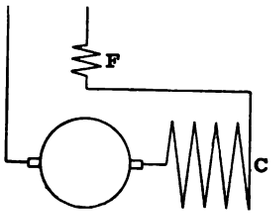

Fig. 1.—Diagrammatic Sketch of the Compensated Single-Phase Motor.

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change-over switch can only be operated when the main switches are open, and, further, that one main switch only can be closed at a time.

As will be learned from the diagram of connections, Fig. 2, the speed control of the car is effected on the well-known series-parallel system, two motors being treated, as already mentioned, as one unit. To this end, the car equipment also includes two K 28 controllers of the standard continuous-current type. Although a variation in the speed by means of transformers with variable ratios of transformation would be somewhat more economical in power, as far as working with alternating currents is concerned, nevertheless the speed control by means of resistances was preferred in this particular case, the reason being that the former method would necessitate a double set of speed controlling devices on the car, one in connection with the continuous-current supply, the other relating to the single-phase supply. Since, moreover, alternating current is supplied to the system on the outlying districts only, where stops are comparatively few, a costly and heavy auxiliary speed equipment for governing the motor speed by varying the voltage of the single-phase current supplied to the motors could all the more be dispensed with.

The car weighs complete, but without passengers, 30·4 tons, and is geared for a maximum speed of 43 miles on the level. Accommodation is provided for 44 passengers, the body measuring 43ft. over all. The body is supported by two Brill No. 27 trucks, having a wheel base of 6ft. and carrying two motors each. These are equivalent to 50 H.P. continuous-current motors at "standard railway rating." Current is picked up from the wires by two trolleys

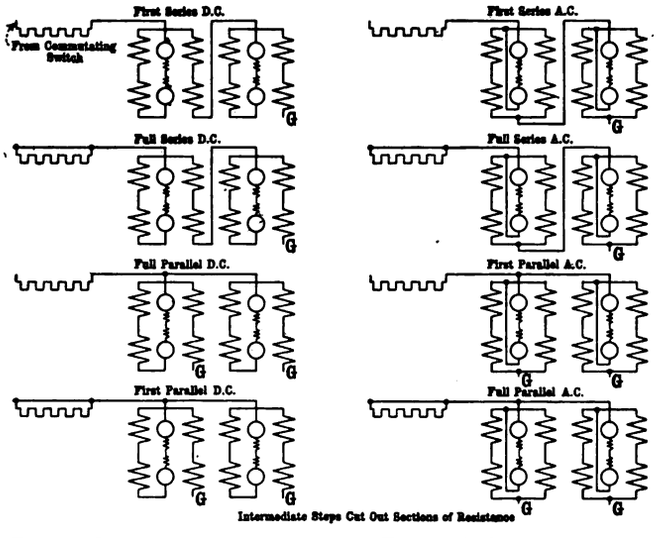
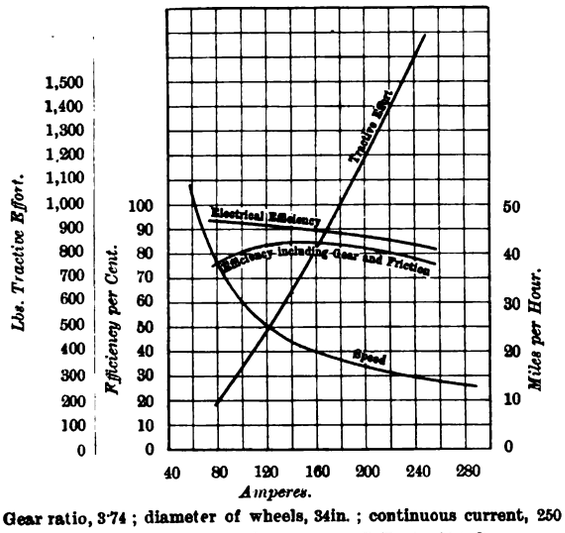


FIG. 2.—DIAGRAM OF CONNECTIONS FOR FOUR A.C. MOTORS USED ON BOTH ALTERNATING AND CONTINUOUS-CURRENT SERVICE.

of ordinary construction, one being used for the continuous-current supply, the other serving for conveying the alternating current from the wires to the car. The base of the alternating-current trolley is insulated from the car body by composition insulators Compressed air for operating the brakes and the whistle is obtained from an air compressor driven by a small compensated series motor, which, like the car motors, may be run off the continuous-current or single-phase current supply.

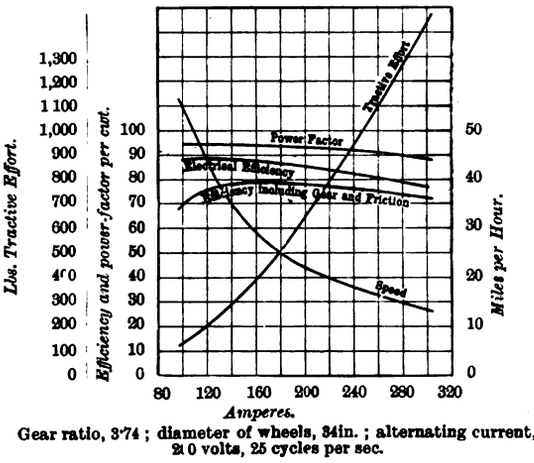
Continuous current at about 500 volts is used for operating the cars within the present boundaries of the continuous-current traction system. Outside this area, however, alternating current at 2,000 volts is employed. This voltage is reduced on the car by an 80kw. transformer to 400 volts, suitable for directly working the motors. The transformer is hung from the car body, and is effectively cooled by having its corrugated case exposed to the current of air which is set up when the car is in motion. Figs. 3 and 4 represent the characteristics of the motors when working with both kinds of current.

The line upon which the trials were carried out has a total length of 15·5 miles, 3·9 of which, lying in the city of Schenectady, are worked with continuous current. The interurban section is laid with 75lb. T-rails, gravel ballast, and has a maximum gradient of 1·8 per cent. and no curves exceeding 4½deg. As the Ballston extension has been worked for some time past with continuous current—and this method of operation is to be continued in parts—it was necessary to construct an additional set of trolley wires for conveying the single-phase current. The continuous-current wires are carried on centre-pole brackets, and a cross-arm was subsequently fixed to the poles, which are spaced 100ft. apart, for supporting the alternating-current trolley wires also. In connection with the continuous-current supply, a 500,000 circular mils (about 0·4 sq. in.) feeder is employed, but for the alternating-current system no feeder is used. The trolley wires for the alternating and continuous-current service are identical in size, being of No. 0000 size and having a grooved section. On the wooden cross-arms, mentioned above, are porcelain insulators of a standard type which support a steel wire of a diameter of ⅜in., running parallel to the track, and the trolley wire for the single-phase current is hung from this catenary by means of suitable clips fixed midway between the poles.



Gear ratio, 3·74 ; diameter of wheels, 34in. ; continuous current, 250 volts.

FIG. 3.—CHARACTERISTIC CURVES OF G.E. A. 604 COMPENSATED RAILWAY MOTOR.



Gear ratio, 3·74 ; diameter of wheels, 34in. ; alternating current, 210 volts, 25 cycles per sec.

FIG. 4.—CHARACTERISTIC CURVES OF G.E. A. 604 COMPENSATED RAILWAY MOTOR.

In order to determine the increase in resistance due to induction effects when using alternating current at 25 ∿ per second, comparative resistance tests were made on 1 mile of circuit, the results being tabulated in the following table:—

Comparative A.C. and D.C. Resistance, Trolley and Track, per Mile of Circuit.

——	D.C. Resistance.	A.C. Resis. 25 cycles.	Ratio A.C./D.C.
	ohms.	ohms.	
Two trolleys in series	0·318	0·417	1·31
One trolley and double track ..	0·167	0·259	1·55
Two trolleys and double track..	0·088	0·155	1·76
Double track alone	0·0174	0·114	6·55

The alternating-current wires are 5ft. apart and 16·5ft. above the track, and the four track rails (the line is double) are bonded every 1,500ft. At present, single-phase current is generated at 2,200 volts and 25 ∿ per second by an inverted converter situated at a temporary sub-station at Ballston Lake. This sub-station is supplied with alternating current at 40 ∿ per second from the distributing system of the Hudson River Power Co., but, as a frequency of 40 ∿ per second was too high for working the railway satisfactorily, an inverted converter, fed from the continuous-current side of the

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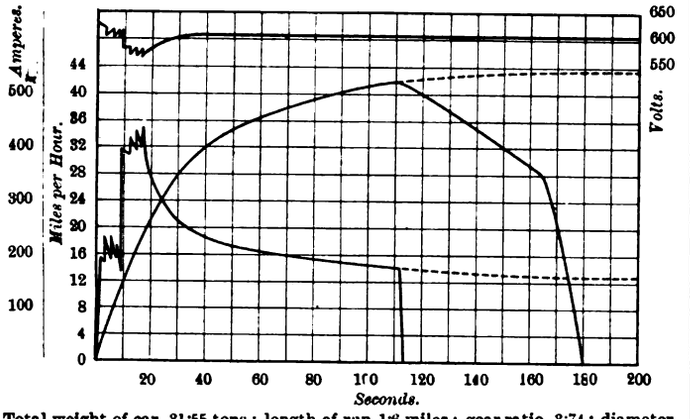
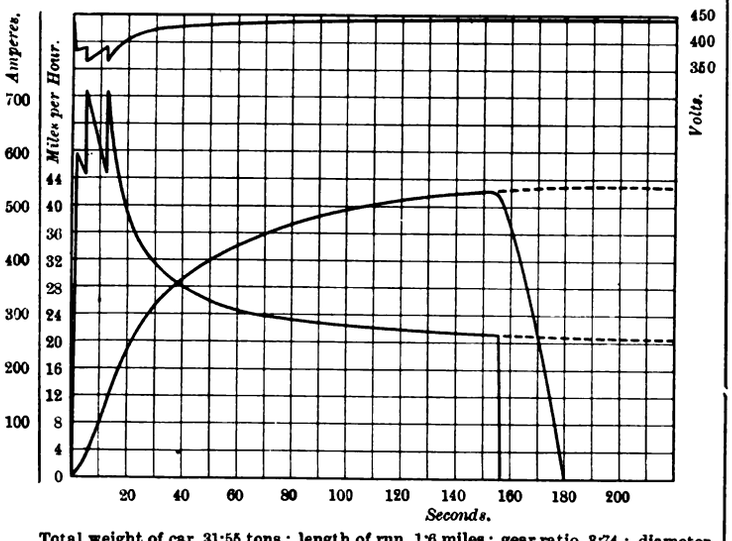
sub-station, had to be reverted to as mentioned. Later on, a permanent sub-station is to be erected at Ballston, and the inverted converter is to be replaced by a motor-generator.



Total weight of car, 31·55 tons; length of run, 1·6 miles; gear ratio, 3·74; diameter of wheels, 34in.

FIG. 5.—SPEED TIME CURVE (CONTINUOUS CURRENT) OF 4 G.E.A. 604 COMPENSATED RAILWAY MOTORS.



Total weight of car, 31·55 tons; length of run, 1·6 miles; gear ratio, 3·74; diameter of wheels, 34in.

FIG. 6.—SPEED TIME CURVE (ALTERNATING CURRENT) OF 4 G.E.A. 604 COMPENSATED RAILWAY MOTORS.

The performance curves in Figs. 5 and 6 and the data given in the table below are interesting, as showing the relative merits of continuous current and single-phase current working :—

Comparative Runs with Continuous and Alternating Current.

	D.C.	A.C.
Length of run ..... miles	1·6	1·6
Weight of car ..... tons	31·55	31·55
Time ..... seconds	180	180
Average current on ..... amperes	229	346
Average voltage	606	425
Volt-amperes full speed on level	96	110
Volt-ampere-hours, per ton-mile of given run	86·3	125·5
Average speed ..... m.p.h.	32	32
Schedule speed, including 15-second stop	29·5	29·5

A Large Automatic Telephone Exchange.—The *Western Electrician* (Chicago) of August 13th publishes a detailed description of a 10,000-line automatic telephone exchange which has now been in operation for some months in a business district in Chicago covering about 2 sq. miles. At present there are 8,287 lines connected to it. It is stated that the average number of switch and instrument "troubles" reported per day are 26, and that for the operation and maintenance of the exchange only one man is required for every 2,000 lines. The automatic switching is done by means of the apparatus described in *The Electrician*, Vol. L., p. 13, and Vol. XLI., pp. 52 and 522. So far as distributing frames, power plant, &c., are concerned, the equipment of the exchange follows more or less the ordinary practice.

MAGNETIC DOUBLE REFRACTION OF COLLOIDAL IRON HYDRATE.*

BY A. D. DENNING, M.SC., PH.D.

The magnetic double refraction of iron salts has often been looked for, but up to the present only observed by J. Kerr ("Brush Grating Experiments," Brit. Assoc. *Report*, 1901), and by Qu. Majorana (*Rendic. Acc. dei Lincei*, 1902), and Schmaus (*Ann. der Physik*, 1903), with old specimens of "Bravais's Iron." These experimenters found very transient results and give no absolute values for the same. Having found very remarkable results for the viscosity of the colloidal $Fe(OH)_3$ from Merck, it was deemed desirable to examine if solution would show properties of magnetic double refraction. But although the author made many (more than 80) different experiments under various conditions—*i.e.*, after repeated dialysis, frequent heating and cooling, by varying concentrations and various magnetic field strengths in differently shaped polarisation tubes—he has only been able to find traces of such properties.

Only on one occasion have really measurable results with this solution from Merck been obtained. This was after slowly evaporating a portion until it contained approximately 20 per cent. Fe. Then, by placing a few drops between thin glass strips on the poles of the electromagnet, a displacement of the interference bands of a Babinet's compensator $= \frac{1}{10}$th wave-length with a field strength ($=H$) of 24,300 C.G.S. units was obtained. After 1½ hours the displacement had decreased by 50 per cent.; on the next day no traces of phenomenon were to be found. Much more remunerative results were obtained with a solution of "Bravais's Iron" obtained from a Heidelberg apothecary—*e.g.*, with a solution ($\sigma = 1{\cdot}0041$) containing 0·295 per cent. Fe ($=c$). A displacement ($=\beta$) of $\frac{3}{4}\lambda$ with a field strength ($=H$) of 4,460 C.G.S. units was obtained in a polarisation-tube length ($=l$) $= 5{\cdot}5$cm.—a value which gave a specific magnetic double refraction (k) $= 0{\cdot}89 \times 10^{-6}$.

Further, the author was able to confirm Majorana's results that the phenomenon obeys the law $\beta = kH^2lc$. He found, further, that k decreased with the time—*e.g.*, the last value given above was 12 per cent. smaller after a lapse of 10 days. He could not find that shape of trough or previous shaking of solution had an influence on the result.

Apparently the Merck ferric hydrate and the "Bravais's Iron" have not the same chemical constitution. Oddly enough, no solution of $Fe(OH)_3$ that was in the Heidelberg Physics Institute during the course of above experiments showed traces of double refraction, when subjected to a sudden and quick motion as previously found by Prof. Quincke (*Ann. der Physic*, 1902). Schmaus' explanation of the suspension character of the solution is nothing more than Quincke's "Schaum-Theorie."

SINGLE-PHASE RAILWAY MOTORS OF THE OERLIKON COMPANY.

Dr. Hans Behn-Eschenburg, in an article which appeared recently in the *Schweizerische Elektrotechnische Zeitschrift*, described two new single-phase commutator motors, manufactured by the Oerlikon Company. One of them is a 35 H.P. motor, capable of working with continuous current or with alternating current at frequencies between 20 and 40 ∿ per second, while the second is designed for 200 H.P. and a frequency of 15 ∿ per second.

The 35 H.P. motor, to commence with, runs normally at about 1,000 revs. per min. and is designed so that it may be run: (1) as an ordinary continuous-current series motor from a 200-volt supply; (2) as a series motor for single-phase currents at 200 volts and frequencies from 0 to 25 ∼; (3) as a repulsion motor when fed with single-phase currents of from 40 to 50 ∼ per second and at a pressure of 230 volts, or (4) as a compensated series motor of the Latour type, being fed in this case with single-phase current at 250 volts.

The rotor and stator are each equipped with a six-polar, distributed winding, embedded in slots and in appearance resembling very much the ordinary winding of a continuous-current armature. No resistance is inserted between the armature coils and the respective commutator segments. In the first three cases, six brush spindles are required, but in the fourth case 12 brush spindles are necessary. The carbon brushes are 8mm. wide in all cases. When the motor is used for the purposes (1) and (2), the brushes are fixed at the neutral points and the stator winding is split up into two identical parts, the magnetic axes of which are shifted relatively to each other by one-half of the pole pitch. One part serves for producing the field and corresponds, therefore, to the field winding of the ordinary continuous-current series motor, while the other part—

* Abstract of a Paper read before Section A of the British Association.

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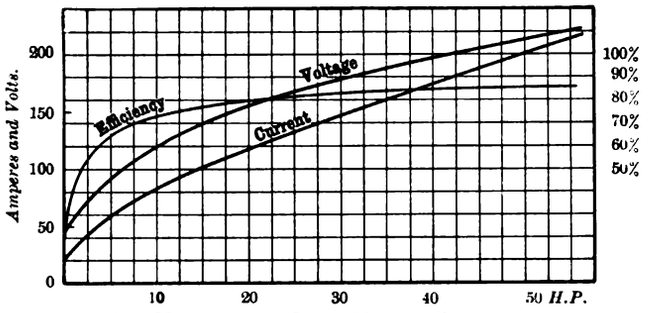
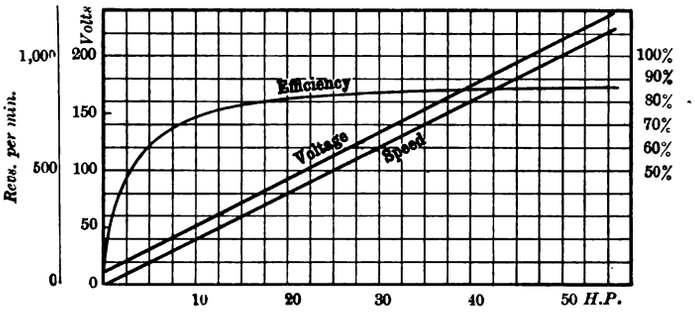
the compensating winding—nullifies the detrimental effect of the field emanating from the loaded armature. It would be possible, of course, to replace these two windings by one only, shifted one quarter of the pole pitch from the centre line of the brushes.

Exhaustive tests (see Figs. 1 to 4) were made with the motor when working in the four ways indicated, and the normal load, defined as the maximum load compatible with good commutation, was kept up in every case for four hours. The temperature rise at the end of the full load run of four hours, it is stated, did not exceed 45°C. (81°F.) on any part of the machine.

The motor was loaded by taking current from a generator directly driven by the motor. In order to obtain best results in all cases,

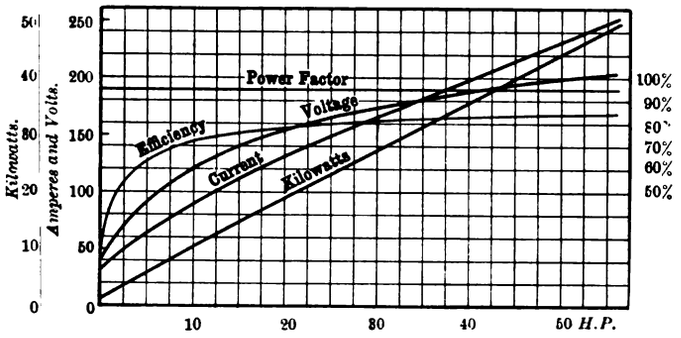


35 H.P. Oerlikon Motor run as Series Motor with Continuous Current. Speed 1,000 revs. per min.

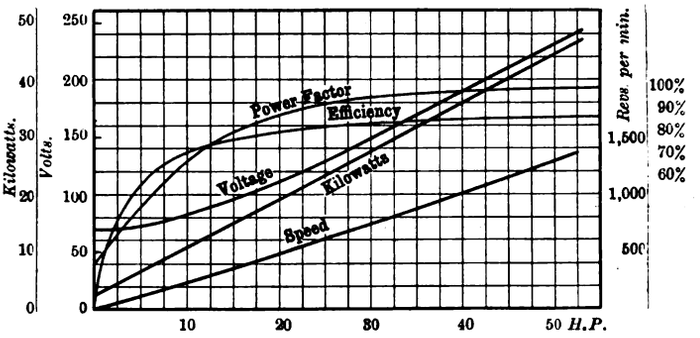


35 H.P. Oerlikon Motor run as Series Motor with Continuous Current, the Current being kept constant at 200 amps.

FIG. 1.

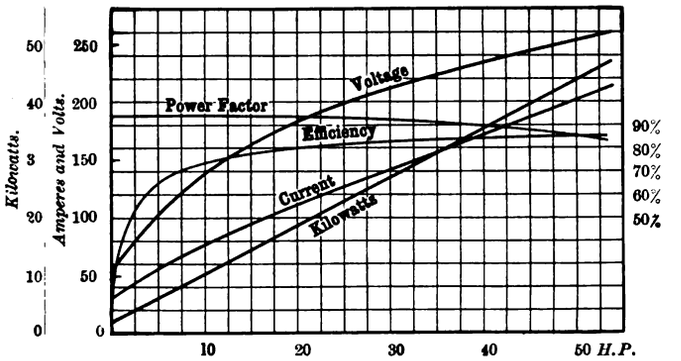


35 H.P. Oerlikon Motor run as Single-phase Series Motor. Frequency 22∼ per sec. Speed 1,000 revs. per min.

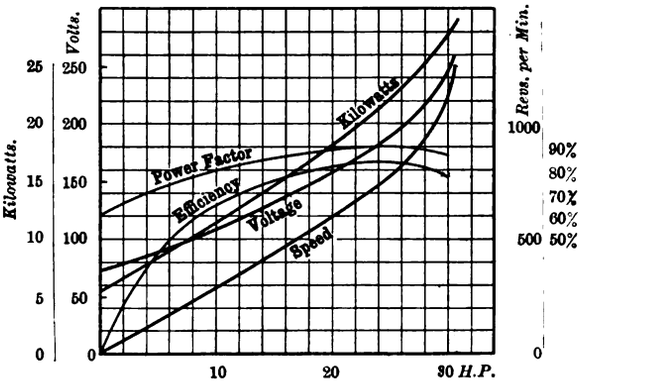


35 H.P. Oerlikon Motor run as Single-phase Series Motor. Frequency 22 ∼ per sec. Current constant at 200 amps.

FIG. 2.

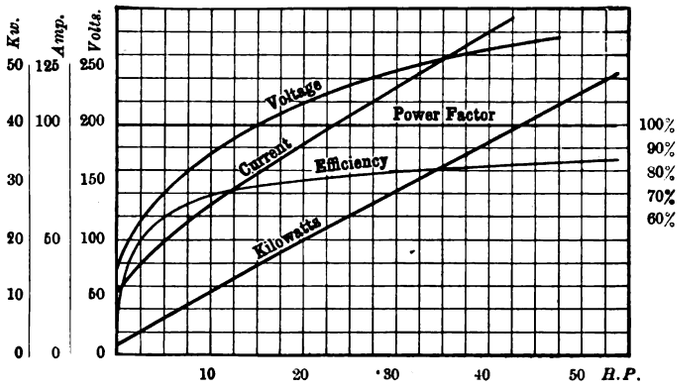


35 H.P. Oerlikon Motor, run as Repulsion Motor with Single-phase Current. Frequency of 44 ∼ per sec. Speed 880 revs. per min.

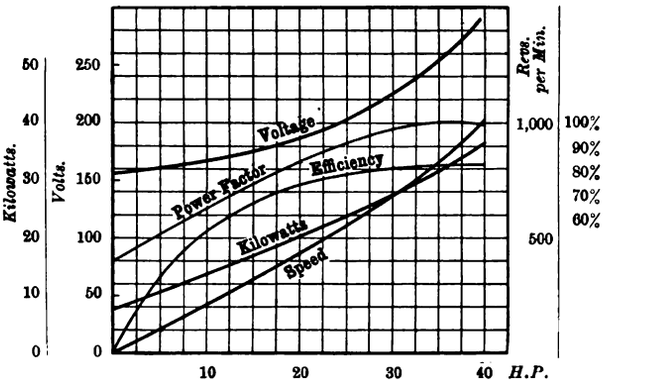


35 H.P. Oerlikon Motor, run as Repulsion Motor with Single-phase Current. Frequency 44∼ per sec. Current Constant at 130 amps.

FIG. 3.



35 H.P. Oerlikon Motor, run as Repulsion Motor of "Latour" type, with Single-phase Current. Frequency 44 ∼ per sec. Speed, 880 revs. per min.



35 H.P. Oerlikon Motor, run as Repulsion Motor of "Latour" type, with Single-phase Current. Frequency 44 ∼ per sec. Current constant at 130 amps.

FIG. 4.

For employment as a repulsion motor or as a motor compensated on the Latour system, the two parts of the stator winding are connected together, so as to form one evenly-distributed winding only. The air-gap is 1mm. wide.

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the ampere-turns of the armature, as well as the number of commutator segments, has to be chosen as high as possible.

It is well known that the current taken by repulsion motors and the loads these are capable of dealing with depend to a large extent on the position of the brushes. In the tests of the above motor when working as a repulsion motor, the brushes were shifted one-tenth of the pole-pitch from the magnetic axis of the stator winding. This position was found experimentally and corresponded to the maximum power-factor, when the following conditions obtained: Output 35 H.P., speed 1,000 revs. per min. and temperature rise within the limit mentioned above.

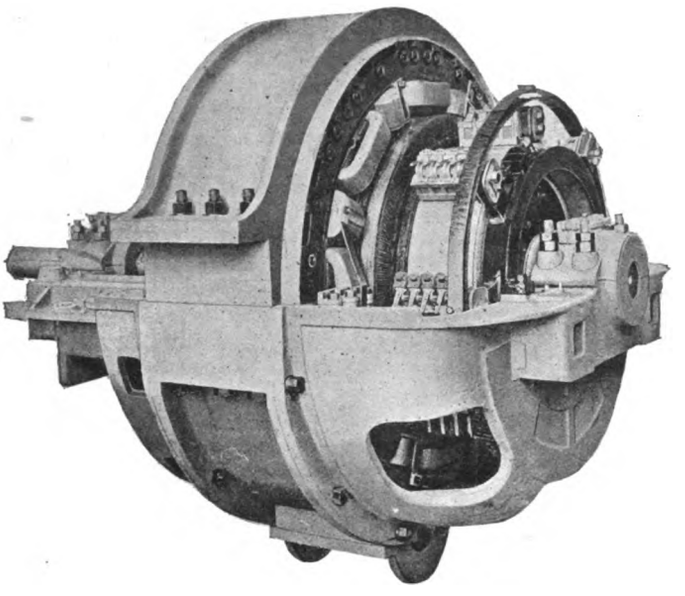

FIG. 5.—OERLIKON 200 H.P. SINGLE-PHASE RAILWAY MOTOR; SEEN FROM THE COMMUTATOR SIDE.

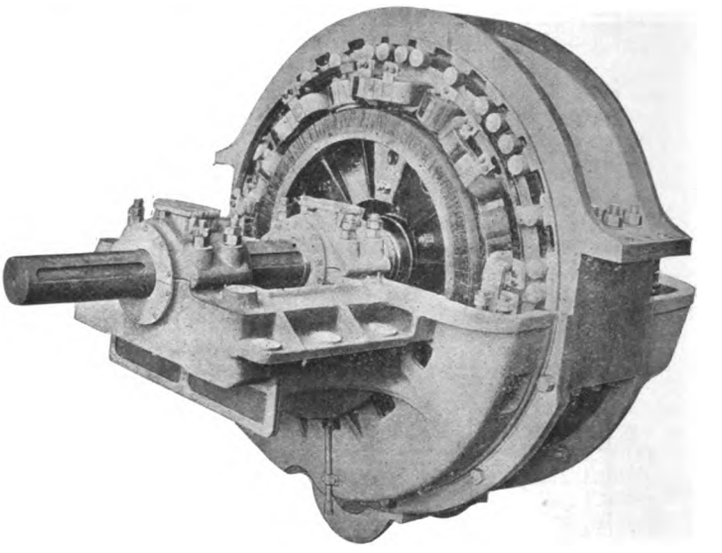

FIG. 6.—OERLIKON 200 H.P. SINGLE-PHASE RAILWAY MOTOR; SEEN FROM THE PINION SIDE.

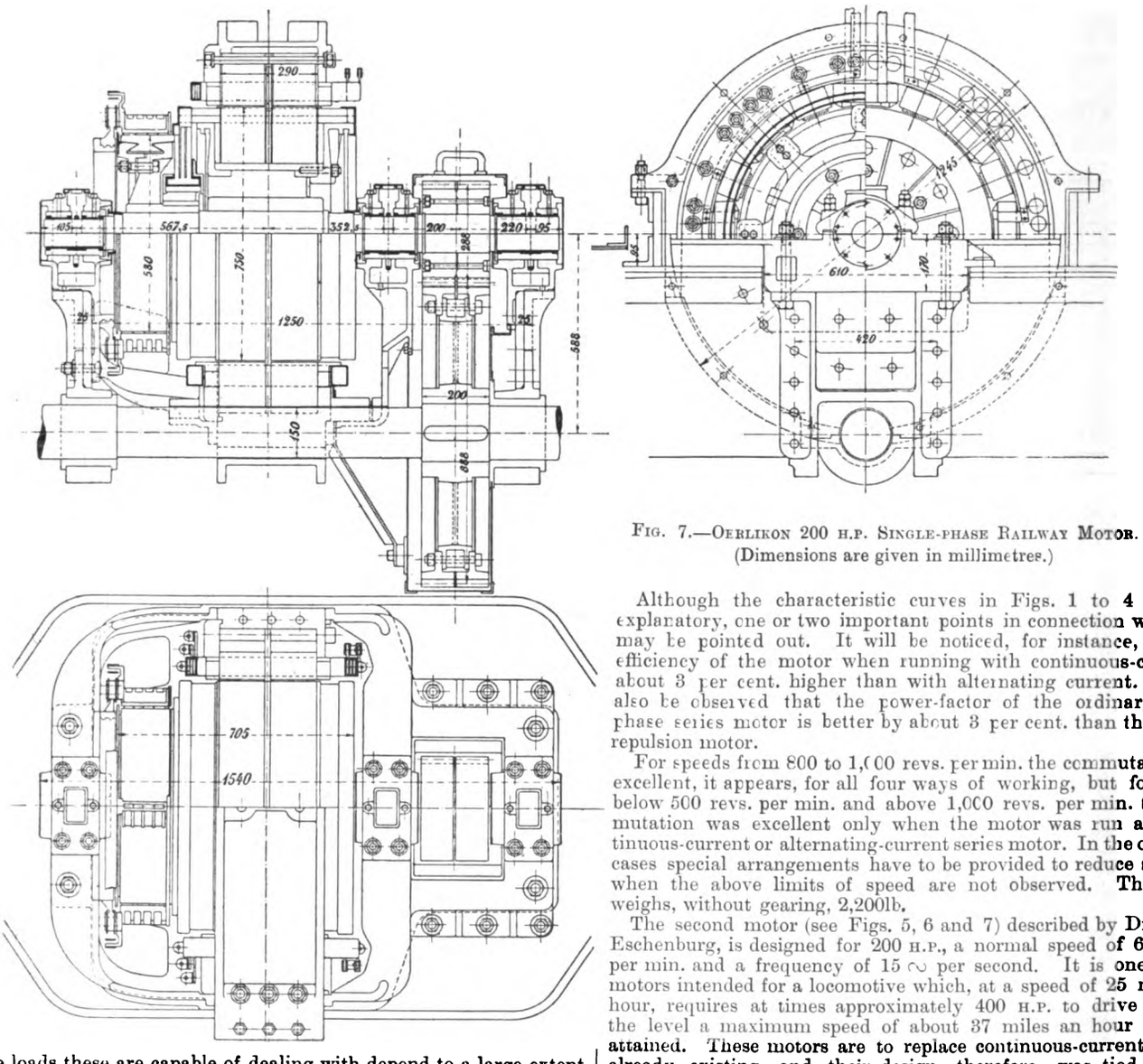

FIG. 7.—OERLIKON 200 H.P. SINGLE-PHASE RAILWAY MOTOR.
(Dimensions are given in millimetres.)

Although the characteristic curves in Figs. 1 to 4 are self-explanatory, one or two important points in connection with them may be pointed out. It will be noticed, for instance, that the efficiency of the motor when running with continuous-current is about 3 per cent. higher than with alternating current. It will also be observed that the power-factor of the ordinary single-phase series motor is better by about 3 per cent. than that of the repulsion motor.

For speeds from 800 to 1,000 revs. per min. the commutation was excellent, it appears, for all four ways of working, but for speeds below 500 revs. per min. and above 1,000 revs. per min. the commutation was excellent only when the motor was run as a continuous-current or alternating-current series motor. In the other two cases special arrangements have to be provided to reduce sparking when the above limits of speed are not observed. The motor weighs, without gearing, 2,200lb.

The second motor (see Figs. 5, 6 and 7) described by Dr. Behn-Eschenburg, is designed for 200 H.P., a normal speed of 650 revs. per min. and a frequency of 15 ∽ per second. It is one of two motors intended for a locomotive which, at a speed of 25 miles an hour, requires at times approximately 400 H.P. to drive it. On the level a maximum speed of about 37 miles an hour is to be attained. These motors are to replace continuous-current motors already existing, and their design, therefore, was tied to certain conditions. The gear ratio was given, for instance, and is 1 : 3·1. Since it was required that the motor carcase was to

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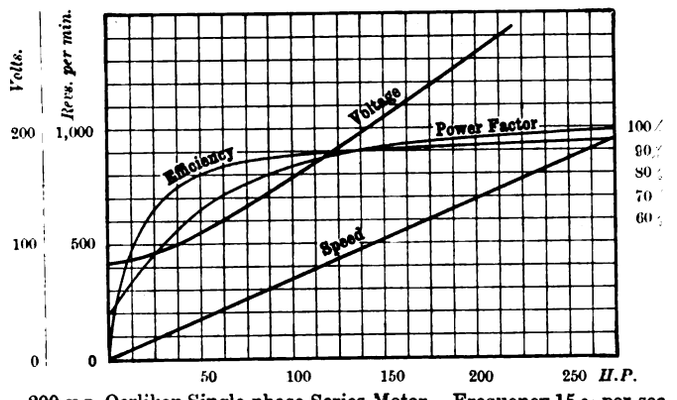
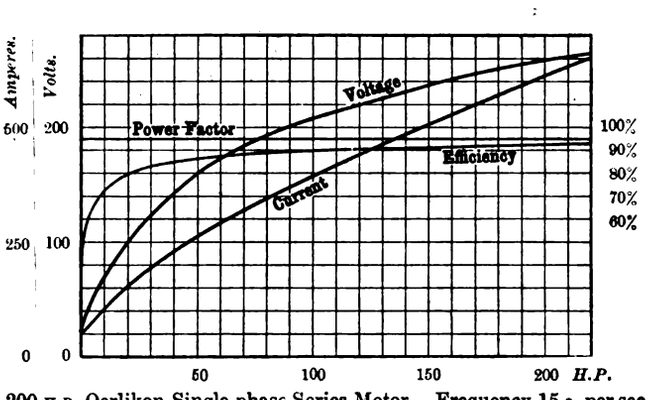
be split, pole-pieces, similar to those of ordinary continuous-current motors, were employed. There are eight poles, and it is seen, therefore, that the normal speed of the motor—*i.e.*, 650 revs. per min., is thrice that corresponding to synchronism. Although this motor might well be run as a repulsion motor, it was decided to run it in this particular case as a single-phase series motor. No special compensating winding is employed, but the armature field is partly balanced by various expedients not described in detail by Dr Behn-Eschenburg. A novel arrangement, likewise only mentioned by the author, has been fitted for further reducing the sparking voltage, and it is stated that the motor commutates well for all speeds between 0 and 1,100 revs. per min., and at frequencies varying between 15 and 22 ∿ per second. The motor weighs 6,600lb. and develops 200 H.P. when consuming 600 amperes at 260 volts. Fig. 8 represents the test curves of the motor. At a speed of 650 revs. per min., and a frequency of 15 ∿ per sec., the author states that the power-factor is 0·94 for all loads; at a speed of 1,000 revs. per min., and at the same frequency, the power-factor is 0·97, and when the frequency is increased to 25 ∿ per second, the corresponding figures for the power-factor are given as 0·87 and 0·93 respectively.



200 H.P. Oerlikon Single-phase Series Motor. Frequency 15 ∿ per sec. Current constant at 600 amps.



200 H.P. Oerlikon Single-phase Series Motor. Frequency 15 ∿ per sec. Speed constant at 650 revs. per min.

FIG. 8.

EXPERIMENTS FOR IMPROVING THE CONSTRUCTION OF PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.*

The committee are glad to report that during the year considerable progress has been made with the construction of the ampere balance. Mr. L. Oertling has constructed the weighing mechanism, which has, however, not yet been taken over by his committee, and the electrical parts of the instrument are nearing completion in the workshops of the National Physical Laboratory. The castings, rods, tubes, screws, &c., intended for the weighing mechanism had their magnetic permeability determined, and no part used in the construction has a permeability differing from unity by more than 0·001 per cent.

During the early part of the year Mr. F. E. Smith completed his researches into the construction of a mercury unit of resistance, of which some account was given in the last report. The results have been communicated to the Royal Society and are being published in the *Philosophical Transactions*. The values of the various tubes (11 in number) are very accordant, and a mercury standard of resistance of a high degree of accuracy now exists. Since the completion of his work, the specification of the Clark cell has engaged Mr. Smith's attention, and a detailed account of his work forms an appendix to the present report. Mr. Smith is continuing his inquiries and hopes shortly to be able to issue a complete specification for Clark and cadmium cells. The completion of the ampere balance will enable an absolute determination of their E.M.F. to be made.

The committee regrets to report that no further progress has been made since its last report with the experiments to determine the permanence and reliability of the platinum resistance thermometers described in that report. It was pointed out last year that a special resistance box was required to enable the work to continue; unfortunately, the funds necessary for its purchase were not forthcoming, and the work has remained stationary for a year. Meanwhile the committee would call attention to the very complete comparison up to a temperature of 1,000°C. between the constant volume nitrogen thermometer, the platinum resistance thermometer and the platinum-platinum-rhodium thermo couple communicated recently from the National Physical Laboratory to the Royal Society by Dr. Harker.

The committee have received a cordial invitation to co-operate in the electrical conference at St. Louis during the forthcoming autumn, and have asked Prof. Perry and the secretary, who are attending as delegates of the Institution of Electrical Engineers, to represent their views on two questions of special interest. The first of these relates to a proposal by Prof. Carhart to substitute the saturated cadmium or Weston cell for the Clark cell as a recognised standard of E.M.F. The committee are aware that the fact that the temperature coefficient of the cadmium cell is one-twentieth of that of the Clark cell offers many valuable advantages, but in view of the fact that experiments designed to lead up to a satisfactory specification of the cell are in progress at the National Physical Laboratory, and that the completion of the ampere balance would enable the absolute E.M.F. of the cell to be determined, the following resolution was passed at the last meeting:—

"The committee is not prepared at present to displace the Clark cell, and prefers to wait for the conclusion of the experiments at the National Physical Laboratory, and with the new balance, before coming to a decision as to the value to be assigned to the E.M.F. of the saturated cadmium cell."

The second question relates to certain proposals as to nomenclature which are to be brought forward by Dr. Kennelly. These are (A) that a systematic nomenclature should be agreed upon for magnetic units, and (B) that the prefix "Abs" should be used to indicate that a unit is given in the absolute C.G.S. electromagnetic system, and "Abstat" to indicate that the unit in question is in the absolute C.G.S. electrostatic system. Thus an "Abs" volt would be the C.G.S. electromagnetic unit of E.M.F. and "Abstat" volt the C.G.S. electrostatic unit of E.M.F. These proposals have been discussed by the committee, which has agreed to the following resolution:—

"With regard to the choice of magnetic units the committee is of opinion that the only two systems which need to be considered are the C.G.S. system and the ampere-volt-ohm system, and that the quantities to be named, if any, are (1) magnetic potential, (2) magnetic flux,* (3) magnetic reluctance. Of the above two alternatives the committee is in favour of the C.G.S. system as that on which to base any nomenclature of magnetic units, but is of opinion that a system of nomenclature is not called for."

The committee disagrees with Dr. Kennelly's prefixes for the absolute electromagnetic and absolute electrostatic systems of units, and expresses the opinion that no system of prefixes should be employed in which each prefix does not bear some definite numerical signification.

In view of the work still necessary with regard to the ampere balance, the cadmium cell, and the platinum standard of temperature, the committee recommend that they be re-appointed, with a grant of £50, that Lord Rayleigh be chairman, and Dr. R. T. Glazebrook secretary.

APPENDIX *on Anomalies of Standard Cells.*† By F. E. SMITH.
(From the National Physical Laboratory.)

During the past two years certain anomalies of Clark and of cadmium cells have been under investigation at the National Physical Laboratory. The work is still far from completion, but the essential results so far obtained are given in this Paper. In March, 1902, some experiments at Bushy House resulted in the isolation of the depolariser employed in both standards as the great disturbing element. Mr. Swinburne arrived

* Abstract of the report of a committee of the British Association, consisting of Lord Rayleigh (chairman), Dr. R. T. Glazebrook (secretary), Lord Kelvin, Profs. W. E. Ayrton, J. Perry, W. G. Adams and G. Carey Foster, Sir Oliver J. Lodge, Dr. A. Muirhead, Sir W. H. Preece, Profs. J. D. Everett, A. Schuster, J. A. Fleming and J. J. Thomson, Dr. W. N. Shaw, Dr. J. T. Bottomley, Rev. T. C. Fitzpatrick, Dr. G. Johnstone Stoney, Prof. S. P. Thompson, Mr. J. Rennie, Principal E. H. Griffiths, Sir A. W. Rücker, Prof. H. L. Callendar and Mr. George Matthey.

* The name "Maxwell" was recommended by the Paris Congress, 1900, as the name of his unit, and this recommendation was adopted by the committee at Bradford.

† Abstract.

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at the same conclusion in 1891*, while recently in America Prof. H. S. Carhart and Mr. G. A. Hulett have traced the variations in E.M.F. of the cadmium cell to the same source. A new specification of the mode of manufacture of the paste was thought to be desirable, and this problem was the first to receive attention.

After numerous experiments, the following mode of preparing the mercurous sulphate for standard cells was arrived at:—Fuming sulphuric acid saturated with SO_3 (32 per cent. of SO_3 is a convenient specification) is added to sufficient pure distilled mercury to ensure the latter being always in excess. The mercury should be contained in a clean glass vessel and violently agitated by a glass stirrer, so that the product may be in a fine state of division. After seven or eight hours the reaction will be sufficiently advanced for the sulphate to be separated from the acid, but if convenient the action may go on for some days. Carefully pour off as much of the strong acid as possible into a large volume of water or into an empty vessel, and afterwards add the pasty product left to 30 or 40 times its bulk of distilled water. Mercury is precipitated and a considerable quantity of heat is evolved owing to the dilution of the acid. A few minutes suffice for the sulphate to settle, when the acid liquid may be decanted and the salt well washed by agitation with acidulated water (one part of conc. H_2SO_4 to 10,000 parts of distilled water). Filtering follows, a filter pump being employed to effect exhaustion. It is advisable next to pound the damp sulphate thoroughly in an agate mortar to ensure the absence of small caked masses, after which acidulated water is again added, filtering effected and the salt washed on the filter paper with two or three lots of neutral saturated cadmium sulphate solution (or zinc sulphate solution for Clark cells). The salt is now removed to a small flask, saturated cadmium sulphate solution added, and the whole well shaken and then allowed to stand for 24 hours. Filtering follows, then three more washings with cadmium sulphate solution, removal to a flask once more with $CdSO_4$ solution, and at the end of 24 hours the solution should still be neutral to Congo red. If so, the sulphate may be filtered and is ready for the manufacture of the paste. The whole of the operations should be conducted in a room screened from sunlight. As thus prepared the mixture of mercurous sulphate and mercury is of a dark grey colour. Cells set up with paste prepared from it require no ageing, and the constancy obtained with pastes made from materials obtained from different sources is an indication of the purity of the salt.

Table A gives the results of comparisons between cadmium cells set up with pastes prepared in this way and cadmium cell W 17. The latter in every case has the greater E.M.F. Differences are expressed in hundredths of a millivolt.

Table A.

Date of observation.	Cell No. 66.			Cell No. 67.			Cell No. 68.		
1904.	*a*	*b*	*c*	*a*	*b*	*c*	*a*	*b*	*c*
May 12	−24	−26	−24		....			....	
,, 12	−21	-20_5	−22		....			....	
,, 12	-20_5	-20_5	−21		....			....	
,, 16		....		−27	−25	−28		....	
,, 16		....		−22	−21	−21		....	
,, 16	−21	−20	−20	−21	−21	−20		....	
June 13		....			....		−29	−29	−27
,, 13		....			....		−23	−22	−23
,, 13	−21	-20_5	−21	−20	-20_5	−19	−21	−20	−19
July 6	−21	−21	−20	-19_5	−20	-19_5	−20	−21	−20
,, 9	-20_5	-20_5	−20	−20	−21	−20	−20	-20_5	-19_5

The first set of observations with each cell was made about five minutes after adding the solution; the second set of observations about 20 minutes afterwards; and the third set three hours afterwards. For the first two sets of observations the temperature of the four-limb cells was unsteady; for the remaining observations they and W 17 were at the same steady temperature. Other cells of the Rayleigh H form have been constructed, and the comparisions are equally satisfactory.

An alternative method of preparing the salt was next sought. This second method is very simple. Any purchased sample of mercurous sulphate is heated together with mercury and concentrated H_2SO_4 on a water bath for half an hour, the mixture being stirred occasionally. At the end of that time the remaining solid is allowed to settle and the hot clear acid carefully poured into a large volume of distilled water. Mercurous sulphate is soluble to a considerable extent in hot concentrated H_2SO_4; the result of the dilution is, in consequence, to precipitate the salt. As thus produced, the mercurous sulphate is in a finely divided state and of a pure white colour. It is well to at once admix with a little mercury and filter. The washing is performed as before. Portions of three purchased samples of Hg_2SO_4 were dealt with in this way, and after treatment gave identical results with the cells dealt with in Table A. The three original samples prepared in the ordinary way produced cells differing in E.M.F. from the standard by 40, 160 and 10 hundredths of a millivolt.

A third method, devised by Prof. Carhart, does not necessitate the use of concentrated acid. In order to hasten the reaction between mercury and dilute sulphuric acid (one to six) an electric current is passed from the mercury to a sheet of platinum foil suspended in the liquid. It is essential that the liquid be kept well stirred so as to keep the mercury surface exposed. Prof. Carhart has employed a beaker or crystallising dish to contain the liquids, and used a current of about 0·3 ampere; the current density, however, is not stated. At Bushy House the salt so produced has been compared with those prepared by the two previous methods. Under ordinary circumstances, about three grammes of the salt—very grey owing to the presence of mercury in a fine state of division—is obtained per hour. The current density at Bushy House has been about 0·01 ampere. It was gratifying to find that the product (washed as before) gave identical results with the other methods. Very violent agitation was maintained during the preparation. When the liquid is not stirred a yellow compound (apparently turpeth mineral $HgSO_4.2HgO$) is also produced, and cells, the pastes of which are prepared with the product, have an E.M.F. when first set up more than a millivolt higher than the normal. Particular stress must, therefore, be laid on the instruction to keep the mercury surface well exposed. I found the same thing happen when attempting to form mercurous sulphate by the electrolysis of a saturated cadmium sulphate solution in an H-form vessel, the electrodes being pure mercury.

It will be observed that the remarks on the depolariser apply equally to Clark and to cadmium cells. Cadmium cells alone were made up in the final tests because of their small temperature coefficients; but Clark cells have also been set up and similar results obtained. Evidence of remarkably stable cells set up with purchased mercurous sulphate is afforded by six cadmium cells made at Bushy House in April, 1902; these have been in constant use, and in the case of two of them have frequently been short-circuited through 100 ohms. One of these cells is taken as a standard in the comparisons. By reference to a seventh cell made up in June, 1904, with a paste made from sulphate identical with that employed for the previous ones, it is thought probable that the whole six cells have fallen 0·07 millivolt since their manufacture. Table B gives the result of the comparisons.

Table B.

Date of observation.	16>17.	16>18.	16>19.	16>20.	16>21.
May 5, 1902	·00000	·00000	·00000	·00000	·00000
September 12, 1902	0	+ 1	0	+ 1	0
February 25, 1903	0	0	0	0	0
December 14, 1903.....	+ 0_5	− 0_5	0	0	+ 0_5
February 6, 1904	0	0	0	0	0
July 9, 1904	+ 0_5	+ 0_5	1_5	− 0_5	0

At the present time the E.M.F. of a cadmium cell set up with a paste made from fuming sulphuric acid and mercury is less than that of these cells by 0·21 millivolt.

With respect to the other elements of standard cells, it is proposed to investigate the cadmium and zinc amalgams, and the solutions of the sulphates of these metals, in a manner very similar to that employed for the pastes. Much valuable information has fortunately accumulated respecting the influence of impurities in these, so that probably the task is a light one. It is interesting to note that neither of the amalgams should have its surface exposed to the atmosphere for any length of time; it is preferably covered with water or a solution of the sulphate of the metal. This prevents oxidation. In addition to these investigations, the effects of acidity and basicity are to be determined, together with observations in connection with lag, polarisation, temperature coefficients, &c.

Remarks on the Rayleigh H Form and the Board of Trade Tube Form of Standard Cells.

In 1892 Dr. Kahle, in a Paper read before the British Association at Edinburgh, described some researches made by him on the Clark cell. Comparisons of H cells set up by him with tube cells set up by Dr. Glazebrook at Cambridge, led to the assignment of an E.M.F. to the H cell four ten-thousandths of a volt less than that of the Board of Trade form. This difference in value has been often quoted, and is at the present time accepted as a fact. In view of the discrepancies produced by the paste, together with theoretical considerations, it was thought desirable to investigate this difference if such should exist. For this purpose the H and tube forms of cell were combined. In addition to the usual terminals to the H cell, a zinc rod was inserted in the limb containing the paste, so that the arrangement of the elements in this limb was in accordance with the specification of the Board of Trade pattern. The sole difference in the elements of the H and tube cells was, therefore, the substitution of the zinc rod for zinc amalgam. In some cases the zinc rod was amalgamated, in others it was merely cleaned, in no case did it touch the paste. With two cadmium cells set up similarly, a rod of cadmium amalgam contained in a glass tube perforated at a few points replaced the plain cadmium rod. Very steady temperatures were maintained before taking observations.

Table C gives the results of comparisons of these Clark and cadmium cells. The standard adopted for the Clarks was cell No. 10, a standard more than two years old and fairly constant; that for the cadmium cells was a third cell, No. 48, made up at the same time.

Table C.—*Differences in Hundredths of a Millivolt.*

Date of observation.	Clark cells.										Cadmium cells.			
	E 10		E 11		C 3		C 7		C 9		49		47	
1904.	H.	T.	H.	T.	H.	T.	H.	T.	H.	T.	H.	T.	H.	T.
July 5 ..	−2	−8	+0	+0	−1	−7	+10	−2	..		+2	+2	+0	+1
,, 6 ..	+0	+2	+3	−5	+4	+0	+10	+7	..		+2	+3	+2	+1
,, 7 ..	..		..		+6	+2	+7	−2	+10	+2	..		..	
,, 8 ..	..		..		+5	+1	+9	+2	+8	+15	..		..	
,, 9 ..	+4	−6	+2	+0	+6	+2	+8	+12	+7	+3	+2	+2	+2	+1
Means ..	+1	−4	+2	−2	+4	-0_4	+9	+3	+8	+7	+2	+2	+1	+1

* See B.A. Report, Cardiff, 1891.

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Cells numbered E 10 and E 11 contained a different paste from that in C 3, C 7, C 9. The differences between H and T are small and irregular, and probably explained by the non-uniformity of the surface of the zinc rods and slight differences in the concentration of the solution. The zinc rods in E 10, E 11, C 3 and C 7 were amalgamated; that in C 9 was cleaned only.

The observations show that no such difference as 0·0004 volt exists between the two forms; the difference found in 1892 is to be attributed to other causes, probably the pastes employed.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Quasi Radio-activity Produced by Point Discharge.—Sella has shown that when a metallic body is connected to one terminal of an electrostatic machine, and made to face a series of points connected with the other terminal of the machine, and the discharge passed without sparking between them for, say, an hour, the body acquires an induced radio-activity if the discharge has taken place in fresh air, and not the air of a room closed for some time, while the presence near the body of thorium during the discharge greatly enhances this radio-activity. S. A. Edmonds has undertaken experiments to discover the origin of this activity. He fixed a series of discs made of aluminium, lead, copper, zinc, iron and brass first to the terminal of a six-plate Wimshurst machine and then to a wire connected with an electrometer to measure the radio-activity. On the face of each disc after a discharge was seen a deposit which was darker at the places immediately opposite the points and very light at intermediate places. Tests made on this deposit showed the presence of slight traces of iron when needles were used as points, the "Prussian blue" precipitate being obtained, while, when other metals—copper, brass—were used, very faint traces of their presence were obtained from the various deposits produced by them. It was noticed that with slight deposits the activity was less than was the case with denser deposits, while, in one case, on accidentally wiping off the deposit, very little activity was found at all, which suggested that the deposit was in some way responsible for this radio-activity. These experiments show that this quasi radio-activity, produced by the action of the point discharge, is due to the presence of dust particles in the air. These dust particles come into contact with the stream of ions present, moving from the points to the plane, carrying the discharge, and, when they become deposited on the plane, trap some of these ions, and hold them, so that they can only enter very slowly indeed into the metal of the disc under the force of attraction they experience by virtue of the charges carried by them. The disc thus has a film of ions held in the dust deposit on its surface, so that, if it be placed in the testing vessel and raised to the potential employed in the experiments, the electric field produced will act upon the ions thus trapped and increase their energy, thus enabling them either to go out from the disc and into the electrode facing it, thereby increasing the charge in the electrometer, or else to go into the metal of the disc, and so show no external effects.

[S. A. EDMONDS, *Proceedings of the Cambridge Philosophical Society*, August 19, 1904.]

Magnetic Deflection of Ionic Current.—McClelland has shown that the space surrounding an incandescent platinum wire conducts electricity. This conduction is a complicated effect, being partly due to the ionisation of the gas and partly to the projection of electrons from the wire. Gwilym Owen has simplified the conditions by heating the wire to a temperature not exceeding 200deg. To determine the ratio e/m for the particles given off he employed Thomson's method of retardation of discharge by a magnetic field which involves the use of electric and magnetic fields at right angles to each other. His results are as follows:—The current of negative electricity from a hot platinum wire at low pressures is mainly carried by corpuscles, the proportion of corpuscles to heavy particles being at least four to one. From 10 to 20 per cent. of the discharge from uncleaned wire newly set up and also from a wire which has been cleaned by boiling in nitric acid is carried by heavy particles. By prolonged heating of the wire and frequently renewing the air in the apparatus the wire can be brought to such a state that the proportion of heavy particles in the discharge is only about 5 per cent. even at very high temperatures. At low temperatures, even for wires that have not been subjected to prolonged heating, the discharge is wholly carried by corpuscles. The value of e/m for these corpuscles was found to be $1{\cdot}41 \times 10^7$. The magnitude of the discharge after varions treatments of the wire suggests that the discharge is due primarily to the ionisation of gases (probably hydrogen) occluded in the wire. This confirms the result obtained by H. A. Wilson. The author believes that the disintegration of the metal is due to the carrying away of particles of the metal by the gas as it escapes, and these particles convey a small portion of the discharge.

[GWILYM OWEN, *Proceedings of the Cambridge Philosophical Society*, 12, Part 6, 1904.]

Effect of Screening on Ionisation.—A. Wood has made an attempt to discover the causes of the so-called spontaneous ionisation of the gas contained in a closed vessel. Wilson and Strutt ascribe it to a primary radiation of the material of the walls, whereas McLennan and Rutherford and Cooke have shown that the ionisation is also to some extent due to a very penetrating radiation from without which passes through the walls of the vessels. The author argues that if the latter is the chief agency at work, it must be possible to intercept it entirely or partly by screen. He therefore surrounded vessels of lead, tin, iron, aluminium and zinc with a lead screen, 1·3cm. thick, and noted the reduction of spontaneous ionisation thus produced. It amounted to 23 per cent. in tin, iron and zinc, and to about half that in lead and aluminium. When an iron screen was substituted for the lead screen, the proportionate reduction remained about the same, except that tin ranged itself among the metals which are less subject to the screening effect. The author concludes that a considerable part of the spontaneous ionisation, being unaffected by the screening, is produced by a radiation from the walls. This "intrinsic" radiation is great in lead and aluminium and small in iron, zinc and tin.

[A. WOOD, *Proceedings of the Cambridge Philosophical Society*, 12, Part 6, 1904.]

Evolution of Metallic Structure.—G. Cartaud reports having found traces of a cellular structure in the soft metals lead, tin and zinc, which he has succeeded in polishing and etching. Lead, which is the most difficult to polish, also presents the most decisive evidence of cellular structure. When attacked by picric acid dissolved in acetone it shows a completely closed microscopic network of cells. There is, however, evidence to show that this network is shown up by a kind of development, and is but the relic of an actual structure in what might be called the embryonic stage. Apart from this small cellular network, there is a much larger crystalline network which indicates the final stage of the solidification. The lines of this network are straight and freely intersect the waving lines of the cellular network. The author compares them to lines drawn along the course of a river, but so as to indicate the general or average course. The crystallisation follows the original or embryonic lines, but rectifies them. When an ingot is deformed and then annealed the relation between the crystalline and the cellular networks disappears.

[G. CARTAUD, *Comptes Rendus*, August 16, 1904.]

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Electric Smelting and Refining: The Extraction and Treatment of Metals by means of the Electric Current." By Dr. W. Borchers. 2nd English edition. Translated from the 3rd German edition by W. G. McMillan. (London: Griffin & Co.) 21s.

"Journal of the Institution of Electrical Engineers." Vol. XXXIII., Part 5. August. (London: E. & F. N. Spon.) 3s. 6d.

"Entwurf und Konstruktion moderner elektrischer Maschinen für Massenfabrikation." By Ernst Schulz. (Hanover: Gebrüder Jänecke.) 7.50m.

"Science Abstracts." August, 1904. Section A, Physics; B, Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

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THE TRADE UNION CONGRESS.

While complaints are made on all sides as to the slackness of trade, while prices are going down and profits are diminishing to the vanishing point in many trades and businesses, British capitalists are naturally shy of investing money in industrial undertakings in their own country. The "tightness" of capital which has been apparent for the last year or more is only slightly giving way, and the low value of Government stocks and "gilt-edged" securities on the Stock Exchange makes it difficult to start new manufacturing businesses or to obtain money for the improvement of existing ones. By taking examples from one or two particular trades and applying them broadly to the whole commercial activity of the country, it is of course easy to exaggerate the extent of the present business depression, but there is no doubt that much hard work and some expenditure of capital is needed to place a number of our manufacturing industries on a firmer basis. Our methods of manufacture must be improved and cheapened, the boundaries of our commerce must be extended, and there must be inducements to attract fresh brains and fresh capital into the ranks of industrialism. To bring this about, it is essential that employer and employed should work together for the common good. "A house divided against itself cannot stand," and when masters and men, capital and labour, are in a constant state of antagonism, the common object for which they should be striving, namely, the advancement of the business in which they are mutually interested, will necessarily suffer. Therefore, the note struck at the Trade Union Congress at Leeds this week is much to be regretted: "The President urged his hearers and the whole of the trade unionists in the country to buckle on their armour and be determined to guard their interests and protect their rights. . . . For over thirty years they had been free from capitalistic confiscations, and had believed they were free. . . . Many of their predecessors had suffered imprisonment and persecution to secure for them the liberty they enjoyed up to the recent decisions, and they must be prepared now to make some sacrifice to regain and maintain that position. They must hold their

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trade unions as first and foremost of all things. . . . They must take full advantage of every opportunity, lest the enemy should pounce upon them without any warning." "The enemy" is not the foreign workman who does more work for lower wages than his British cousin, it is not even the non-unionist labourer or artisan who is unable to appreciate the advantages of the trade union and prefers to be free to offer his services when and where he pleases, nor is it the foreign manufacturer who "dumps" goods on to the English markets at less than cost price and so deprives the British workman of the wages he might have earned if they had been manufactured in this country; "the enemy" is none of these, it is the employer who finds the workmen work to do and who pays them wages, without whom the British workman could not live, be he member of a trade union or not, and without whom the trade union official and agitator would lose his employment. Making every allowance for the distortion of meaning and unconscious exaggeration which are inseparable from unrestrained—and we might almost say untrained—oratory, and for the feeling of pique engendered by the recent trade union reverses in the Law Courts and the House of Lords, we do not hesitate to say that the whole principle which actuates such speakers is a false one. Workmen have, of course, the right to combine in order to obtain better wages from their employers, and may be well advised to create a fund for the purpose and engage officials to administer it. But if, in the pursuance of their object, they act illegally in such a way as to damage the employers, the trade unions must naturally be held responsible for their actions, and the resulting damage must be made good out of the funds they have been accumulating. It is, in fact, not going too far to say that the series of recent decisions, of which the Taff Vale judgment was the first, will ultimately result in an improvement in the conditions under which the workman pursues his avocation. Trade unions will, it may be assumed, no longer rush their members into rash and unconsidered strikes, and disputes will more often be settled amicably or by arbitration; with the result that the industries of the country will be spared the interruptions which have so disorganised and damaged them in recent years, and in this way, it may be, those who have suffered most from such labour troubles may soon retrieve the leading position they formerly occupied in the world's markets.

Although we anticipate that much improvement may result from the legal decision to which we have referred, we are bound to confess that the proceedings at the Trade Union Congress do not appear to have been conducted in such a spirit as fully to justify our optimism. This may perhaps be accounted for by the fact that, in the nature of things, trade union officials must justify their existence, must show fighting spirit, and must continue to imbue their members with the idea of a necessity for open hostility with the capitalist "enemy." But there are not lacking signs that the workman himself, from whom the sinews of war must be extracted, is awakening to the necessity of a spirit of compromise when Labour comes into conflict with Capital. It is this growing conception on the part of the workman that there is unity of interest between him and his employer, which should lead to an amelioration of the conditions which have unfortunately prevailed in the near past. One of the delegates to the Congress received rounds of cheering during an eloquent tirade against international wars, and an earnest appeal for settlement of international quarrels by arbitration. Prolonged strikes may be as cruel as the cruellest warfare, the damage they occasion to the welfare of the country is more permanent, and yet the settlement of such disputes by arbitration is easier.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Text-books of Physical Chemistry: Electrochemistry. Part I.—General Theory. By R. A. LEHFELDT, D.Sc. (London: Longmans, Green & Co.) 1904. 5s.

This book is the second volume of the series of text-books of physical chemistry edited by Sir William Ramsay. As the title would suggest, Dr. Lehfeldt's book deals entirely with the physical and theoretical aspect of electrochemistry; but while the subject is treated in a more or less mathematical manner, the book is fairly free from the higher mathematics.

Although there are 268 pages in the volume, it is divided into only three chapters. The first one, dealing with "Mechanism of Conduction in Electrolytes," is written by Dr. Lehfeldt, the second, "Relation of Chemical Constitution to Conductivity," by Mr. T. S. Moore, and the third, on the "Theory of Chemi-electromotive Force, by Dr. Lehfeldt. In the first chapter, after discussing the various voltameters, Dr. Lehfeldt discusses the mechanism of electrolysis, in which he introduces us to ions and electrons. The subject is so interesting and the potential possibilities of the theory so great that we wish the author had developed it to a rather greater extent. We do not say this in way of disparagement, but because Dr. Lehfeldt has handled the subject in such a way that he has whetted our appetite; perhaps, however, his desire is that we should go to the fountain head and study J. J. Thomson's book. The phenomena which occur at the electrodes, the migration of the ions and conductivity of the electrolyte are successively dealt with. The last-named is, of course, of great importance, and is discussed in considerable detail. It requires careful reading, but it repays the conscientious student.

The chapter upon chemical constitution and conductivity is one of great importance to chemists, and is handled by Mr. Moore in a satisfactory manner. In order to appreciate this chapter thoroughly, those who study it require a good knowledge of chemistry. That a chemist should know physics goes without saying, but do physicists always realise the importance of a sound chemical knowledge? Chemical and physical science are now becoming so welded together that it is more than ever difficult to draw a boundary line between the two subjects The great advantage of books of the nature of the one under review is that they tend to make homogeneous the connection between physics and chemistry. The application of electricity—or, rather, of electrical theories—to chemistry has done so much to advance and elucidate the theoretical side of general chemistry that within the last 20 years many of our ideas and conceptions have been completely revolutionised. In his preface, the author says "Chapter II. is in the nature of an appendix to the first chapter, and may be omitted by those who are not interested in pure chemistry without detriment to the continuity of the book." We think that Dr. Lehfeldt makes a mistake in this statement—electrochemistry should be broad. If it is only to be looked at from the physical side, we shall arrive at intangibilities; if entirely from the chemical side, we shall probably be unable to elucidate our facts.

The final chapter of the book treats of the theory of chemi-electromotive force, and treats in detail of the voltaic cells, E.M.F., standard cells and so on. The book is to be heartily recommended, and we await with interest the second volume, in which the author hopes to discuss the most important applications of the theory to primary and secondary cells, to electrolysis and to the solution of chemical problems.

Testing of Electro-Magnetic Machinery and other Apparatus. Vol. 1.: Direct Currents. By B. V. SWENSON and B. FRANKENFIELD. (New York: The MacMillan Co.) 12s. 6d. net.

The book under review contains instructions for no fewer than 96 tests, and as they are all on the same model it will suffice if we describe one of them. Taking No. 30, which deals with the external characteristic of a compound dynamo, we find first, a large number of references to literature which treats the subject more fully. These references, it may be mentioned in passing, form one of the most excellent features of the book, as the particular parts of the works which should be studied

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are given in volume and page. The next paragraph sets forth in detail the objects of the experiment. Under "Theory and Method," the principles upon which the mechanism depends and the method of performing the experiment are explained. Then follow instructions for obtaining the necessary data, and cautions are administered regarding the way in which the apparatus should be treated. Calculations which must be made and the curves which ought to be plotted are mentioned, and finally the student is given an important question to answer and a feature of the work to explain.

Although, as may be gathered from the above remarks, the book is chiefly for the use of students, yet there are two appendices giving minute directions for commercial shop tests which should prove of considerable value.

Die Verwertung des Koksofengases, insbesondere seine Verwendungen zum Gasmotorenbetriebe. Baum. (Berlin: Julius Springer.) 1904.

Although chiefly a well-deserved advertisement of the large and excellently-designed gas engines which are now made in quantity by several famous German firms, this book has merits of its own. It is right that attention should be called to the successful and growing application of explosion motors for the utilisation of combustible gases obtained as a by-product in various large industries. It is well to realise that our friends across the North Sea, even though they may be in the position of Agamemnon, not unique, are certainly strong men. In the last three years, we are told, German makers have turned out no fewer than 97 gas engines of 1,000 H.P. It is also useful to have good pictures and moderately good diagrams of the mechanism which has been devised to make possible the advance from a 50 H.P. scale to one of 2,000 H.P. The question of purifying coke oven gases has been adequately treated; we suggest that if another edition of the book is required the problem of removing dust from blast-furnace gases should be handled, and that the explosion turbine should be dealt with. The adaptableness of the modern large gas engine is shown by the fact that it will take as fuel, not merely a rich gas like that from coke ovens, giving some 3,000 calories per cubic metre, but will be satisfied with blast-furnace gas worth no more than 900 calories. Even the very poor gas from copper blast furnaces, having only 600 calories per cubic metre, can be employed and is so employed at Mansfeld, the home of the blast-furnace for copper. The elasticity of the machine is sufficiently indicated by the fact that it has been used for driving rolling mills direct. Truly our ironmasters may ponder the matter with more profit than is likely to attend their incursions into international economics.

Loci in Mechanical Drawing. Part. III: Piston Acceleration. By Alex. MacLay, B.Sc. (Manchester: The Technical Publishing Co., Ltd.) 2s. 6d.

For steam engineers and those whose special duty it is to design steam engines, there are many less useful books than the one under review. It is obvious that the author has made a long study of his subject, and the number of worked examples shows that considerable labour has been expended in the production of the book.

THE PREVENTION OF HEAT RADIATION FROM STEAM PIPES.

BY FRANCIS H. DAVIES.

Radiation loss from inefficiently covered or bare steam-heated surfaces, even at the present day, when the importance of the subject may be said to have met with the recognition it deserves, is one of the most fruitful of the many sources of waste that have to be dealt with in the working of steam plant of every description. It a curious fact, and one that needs some explanation, that many power stations and workshops noted otherwise for their efficient management and economy in the smallest details, are often lacking with respect to this important point of heat insulation, and it is no uncommon sight to see bare pipe flanges, uncovered valve bodies and boiler ends innocent of the slightest attempt to prevent the radiation of heat.

The universal practice of covering the ends of a Babcock boiler drum, and the almost equally general custom of leaving that of a Lancashire boiler bare, presents an anomaly that is hard to account for, unless it is that precedent—the bane of so many British methods—is responsible. In like manner, for years it has been customary to bevel down pipe covering at the flanges in order to provide access to the bolts, and to leave boiler manholes and other attachments free to waste valuable heat energy on the plea that it is necessary occasionally to get at them. Such practice is more or less on a par with that of an electrical engineer who would not insulate or protect his street section boxes because he might want to get at them at any time; a rank absurdity, of course, but at the same time no more ridiculous than the practice of wasting large sums per annum in heat loss for the visionary privilege of increased accessibility.

Now that so many efficient removable coverings are made, there is no excuse for repeating the glaring errors that were common practice, say ten years ago, and of late there has certainly been a tendency towards improvement upon the older methods, particularly in this direction of the adoption of removable coverings for flanges, manholes, &c. Much, however, remains to be done in electrical work alone if maximum coal economy is to be secured, and more still in many workshops, mills and factories, generally notorious wasters of power by every conceivable means. If it could be brought home to the steam user that every square foot of uncovered pipe costs him in wasted energy per annum three or four times the amount that would have to be expended in a lagging capable of reducing this radiation to the lowest quantity, we should doubtless see less wilful waste than we do at present.

A direction in which it is important an advance should take place is in the general appreciation of the fact that the nature and quality of the material of which lagging is composed, and the method of its application, have a large bearing upon its efficiency as a heat insulator. There is much rubbish in the way of pipe coverings on the market, and it does not do to take the manufacturer's word that his is the best material; neither does it pay in the long run to follow the too usual practice of accepting the lowest tender upon the erroneous supposition that all lagging possesses much the same economic value. An insight into its manufacture, and, if possible, tests as to its efficiency, are just as important as they are when dealing with machinery, and it is the general slackness that prevails in this direction that is reponsible for much of the so-called cheap and equally inefficient covering that is on the market. Taking the saving effected by good lagging as 80 per cent. of the heat that would be wasted by bare surfaces, it is obvious that instead of being looked upon as a necessary evil, as is frequently the case, it should rather be treated as a matter of high consequence.

Turning to the practical side of the question. Though air in itself is one of the worst of non-conductors, it has been proved that the best coverings are dependent upon its presence in minute particles in their fibres for their efficiency; and for this reason such substances as wool, felt, hair and feathers, stand high in the list of non-conductors of heat.

These and many others are, however, unfortunately, not suitable owing to their inflammability, and in practice it is necessary to fall back upon possibly less efficient, but safer and more durable materials. A list of those in most common use with their approximate comparative values as heat insulators is given below, and serves to show what a wide difference exists between good and bad coverings of equal thickness:—

Material.	Comparative value.
Hair felt, and asbestos, in laminations	100
Cork, granulated and fireproofed	77
Mineral slag wool	75
Fossil meal	71
Carbonate of magnesia	70
Fossil meal and hair, in paste	63
Asbestos millboard	47
Fossil meal and asbestos, in paste	46
Raw asbestos	36
Large air space	18

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The first of these, hair felt, is in itself combustible and unsuitable where high-pressure steam is in use; combined with asbestos in laminations it is, however, comparatively safe, and, owing to the amount of air imprisoned in minute particles in its tissues, ranks as one of the best non-conductors.

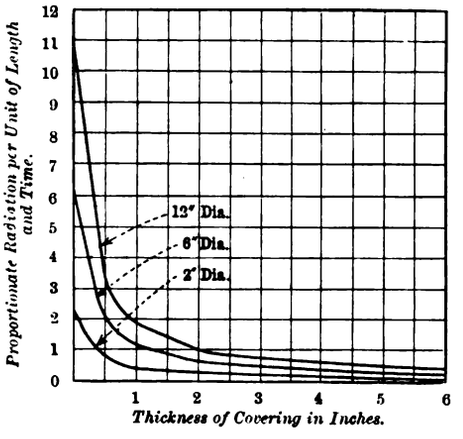
Granulated cork is efficient, but its larger cellular structure allows the enclosed air to circulate to a greater extent than is possible with hair felt, with the consequence that its efficiency is somewhat lower. Cork to be safe must be fireproofed, otherwise it will char, lose its mechanical strength and possibly catch fire. In its carbonised state it is highly efficient, but impossible for the above reasons.

Mineral wool, fossil meal and carbonate of magnesia, are all good coverings, which, if properly applied, will result in a saving of from 85 to 90 per cent. of the condensation that would take place in a bare pipe. These form the base of most good coverings and are combined, according to the fancy of the manufacturer, with other substances suitable to give them tenacity and durability, naturally very important features in all pipe and boiler lagging.

Asbestos is not nearly such a good heat insulator as is popularly supposed, but much depends upon the manner of its application to the pipe. For instance, it has been found that corrugated asbestos sheet is more effective than plain, and, further, that the corrugations should run round the pipe, not lengthways, as the circulation of air is by this means more restricted. In conjunction with other and better materials it appears to pull down the efficiency, but this is compensated for by the increased non-inflammabilty.

The usual thickness adopted for pipe and boiler lagging is 2in., and if the work is well done this should allow for an efficient life of about 10 years. Thinner coverings will not last so long, owing partly to the greater heat of the outside surface and consequent deterioration of the canvas that is generally used to protect it. In cheaper work, where black varnish is put on to form a protective skin, the effect is the same; the greater the heat the more the varnish will crack and split, and when once this begins deterioration is rapid, the cracks on the surface spreading inward until finally the covering falls off in pieces.

The following curves show approximately the proportion of heat that is saved by a good covering at various thicknesses and for different external diameters of pipe.



From these curves it is obvious that the first inch is the all-important one, the second and subsequent inches contributing less and less to the efficiency as a whole. It is not advisable, however, to do away with this second inch, as it costs much less than the first one to apply, and besides saving energy, is useful in prolonging the economical life of the covering by allowing for external and internal wear. The former may be practically nil provided the protection is ample, but the latter is very prevalent in laggings of the pasted type, especially if they are not carefully put on. Continual vibration of the pipes, such as is always present, causes the innermost layer of covering to be ground to powder, the result being that the covering as a whole gets loose on the pipe. The grinding action rapidly increases with the poorness of the grip, until finally the lagging hangs quite loose.

As it is impossible to repair this kind of wear, it must be guarded against by good material and workmanship, special attention being paid to vertical lengths of small pipe, the flexibility of which assists vibration, the position also giving a tendency to the covering to loosen itself and slip down by its own weight. Lagging over 3in. thickness does not really pay for itself, despite the increased life attained, besides which it is clumsy and unsightly; experiments and practical experience both prove that 1in. and 3in. are the two extremes with such materials as are in use at the present time.

THE HOPKINSON TEST AS APPLIED TO INDUCTION MOTORS.*

BY W. E. SUMPNER, D.SC., AND R. W. WEEKES, M.I.E.E.

The late Dr. Hopkinson's method of testing direct-current dynamos was applied to the testing of alternating-current transformers by one of the writers some years ago, and it has since been utilised for the testing of alternators. The application to three-phase machinery involves some special points, and the writers, who have lately tested a number of induction motors by this method, have found it so satisfactory that it seems desirable to draw attention to the experimental details involved in the test.

The two similar machines have their stators connected with the mains, while their rotors are belted together. Switches must be used with the stator connections if the rotors are of the short-circuited type, but are unnecessary if the rotors are supplied with

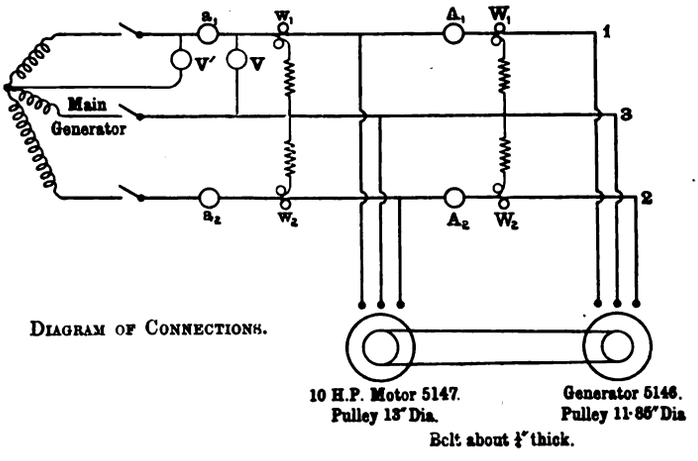


DIAGRAM OF CONNECTIONS.

starting resistances. The connections must be such that the belt is driven in the same direction whichever motor is started. The pulleys on the rotors must be of different diameters, since one rotor must run above and the other below the synchronous speed. The ratio of the diameters must be such as to cause the right amount of slip for the load required, assuming the rotors are to remain short-circuited during the test. If the slip of each motor is 8 per cent. at full load, and if 12 per cent. of the load is lost in each machine, the overload of one machine will be approximately 24 per cent., corresponding with a slip of $8\frac{3}{4}$ per cent.; while the other machine, working as generator, will give out full load and have a negative slip of 8 per cent. The pulley diameters must thus differ by $6\frac{1}{4}$ per cent., assuming no mechanical slip between the belt and the pulley, or if 1 per cent. be allowed for this, the pulleys must differ by about 8 per cent. in size. With such pulleys, the machines, when switched on to the mains, will be subjected to a perfectly steady load admirably suitable for a long run on load. But with given pulleys, the load cannot be adjusted or altered unless resistance is put in the rotor circuits. This can easily be arranged by using low-resistance connections between the rotor slip-rings and the short-circuited starter, or, better still, by using, when available, a rotor starter which can stand the passage of the load currents through the rotor circuits. By adjusting the position of the starting switch the load can be then adjusted to any desired amount, if the rotor pulleys have been chosen sufficiently different in size to fully provide for the slips required. The losses in the rotor resistances are very small, and can in most cases be neglected. They are, however, easily measured, and should be subtracted from the power taken from the mains in order to arrive at the total losses in the two machines and in the belt drive.

Another method of adjusting the load consists in altering the voltage of supply. For given values of the slip, the torque of the machines, and therefore the load, is proportional to the square of the voltage.

* Abstract of a Paper read before Section G of the British Association, Cambridge.

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The arrangement of instruments and circuits is shown in the diagram. The power w taken from the mains must be measured, and also the power W in the circuit between *one* of the machines and the mains. The machine used as motor, of course, takes the greater amount of power, and if W refers to the power given out by the generator, $W+w$ is the power supplied to the motor. Otherwise the difference between these quantities is the power given out by the generator. The load of each machine and the losses in the two are thus determined, and the efficiency can be obtained in the same way as for direct-current machines. In regard to the measurement of power, it will be found sufficiently accurate for all commercial measurements of efficiency to use the single-wattmeter method (which assumes that the load is balanced between the circuits) and treble the reading of a wattmeter with its current coil placed in one circuit, and its volt coil connected between this and the neutral point. It is, of course, more accurate to use the two-wattmeter method as sketched in the diagram. The connections are then less simple, but from the ratio of the two-wattmeter readings the power-factor of the circuit can be determined independently of the ordinary method of comparing the watts with the volt-amperes. Care must be taken in reading the wattmeters in the main circuit if the two wattmeter method is used, since one of these readings will be negative owing to the low power-factor of the current taken from the mains. A curious point about the test is that the machine used as generator produces current of about the same power-factor as that of the current supplied to the motor, while the current supplied by the main circuit consists of the difference of the power components of the machine currents, together with the sum of the inductive components of these currents. The result is that the power-factor of the current from the mains is very low, only about one-third of that of the machine currents. It thus happens that while the power taken from the mains may be less than one-third of that circulating round the machines, the current from the main generator is about equal to and may exceed that passing through the machines, a striking contrast with what happens in the corresponding test of direct-current dynamos.

The slip of each machine can be determined most conveniently and accurately by measuring the frequency of the rotor currents by suitably shunting any ordinary low-reading direct-current voltmeter to the slip-rings of the rotor. The period of the slow oscillations of the pointer can be measured with greater accuracy than the frequency of the main circuit currents. The ratio of the two frequencies is, of course, the slip of the machine.

A most interesting point in connection with the tests is the possibility of determining the belt losses and the value of the mechanical slip between the belt and the pulleys. The losses due to the belt drive are caused by (1) extra bearing friction and in bending and driving the belt; (2) heating of the pulleys due to belt slip. The former loss (1) can be measured by reading the wattmeter in the main circuit, firstly, when only one machine is in circuit and driving the other by belt (with its stator excited, but with its rotor open-circuited), and, secondly, when both machines are running light with the belt off. The difference of the two readings gives the belt-driving losses. The latter loss (2) is determined by the ratio of the circumferential speeds of the two pulleys. This is a quantity difficult to determine with any accuracy in ordinary belt drives. The above test seems specially suitable for determining its amount. The ratio of the rotor speeds is $(F+g)/(F-m)$, where F is the frequency of the current from the main generator, m that of the currents in the motor rotor, and g that of the currents in the generator rotor. Now, m and g are quantities which can be very accurately determined, and are each small compared with F, so that, although F cannot be determined with such great accuracy, the form of the above formula shows that the ratio is not appreciably affected by small errors in F. Thus the ratio of the rotor speeds can be very precisely measured. To obtain the ratio of the circumferential speeds of the pulleys we have merely to multiply the above number by the ratio of the pulley circumferences, a quantity which can be accurately determined. A good experimental means thus exists for finding the actual values for the slip of belts under various conditions.

The accompanying tables give the results obtained by these methods of testing three-phase motors. The trials were made at the Witton works of the General Electric Co. It is also worthy of note that the power-factors calculated from the ratio of the 2-wattmeter readings agrees fairly well with the ratio between the apparent and true watts. The power-factors given are those obtained from the ratio of these wattmeter readings.

Table I.—*Hopkinson Test of Two Three-phase Motors.*
30 H.P. machine as motor, 25 H.P. machine as a generator.

No. of reading.	Time.	a_1.	w_1 neg.	w_2.	A_1.	A_2.	W_1.	W_2.	V.	$V\phi$.	$\sim$	Rotor period sec.		Stator temp. °F.	
												G.	M.	G.	M.
1	12:10	109·5	4·95	19·1	95·0	94·0	10·6	20·7	220	140	41·2	0·65	0·50	—	—
2	12:20	105·0	4·4	18·0	93·5	91·0	9·8	19·6	213	134	41·8	0·65	0·52	—	—
3	12:45	104·5	5 28	18·45	88·0	87·0	9·7	19·45	225	142	40·5	0·76	0·53	118·0	133·0
4	1:45	94·5	5·06	16·32	76·0	74·5	8·25	17·20	224	142	41·75	0·87	0·56	131 0	145·0
5	2:15	91·0	4·82	15·20	73·0	71·0	8·3	15·3	224	142	40·8	0·85	0·59	130·0	143·0
6	2:18	84·0	3·30	12·70	69·0	67 9	7·0	13·45	193	123	40·8	0·78	0·46	—	—
7	2:22	78·0	4·82	12·90	60·0	56·0	5·4	12·95	225	142	40·8	1·16	0 36	—	142·0
8	2:52	95·5	5·50	16·4	74·0	72·5	7·9	16·4	224	142	41·5	0·95	0·60	128·5	147·5
9	3:10	88·0	4·75	15·2	71·0	69·5	7·4	15·8	229	144	41·8	0·93	0·56	129·0	146·6
10	3:20	67·0	4·84	10·6	39·0	37·0	1·5	8·4	225	143	41·8	2·06	0 31	—	—
11	3:30	89·0	3·75	13·8	70·0	73·0	7·7	14·05	197	123	41 0	0 75	0·50	127·0	144·0
12	3:33	59·0	4·84	8·68	26·0	25·0	—	—	220	140	41·0	0·30	4 0	—	—
13	3:35	56·0	5·29	7·61	24·0	25·0	—	—	220	138	41·0	—	—	—	—
14	3:40	56·5	4·72	7·82	24·0	23·0	—	—	220	135	41·0	30·0	5·4	—	—

NOTES.—Reading No. 5 was taken at a low voltage; No. 6 was taken with the first step of the motor rotor resistance in circuit; No. 10 was taken with the two steps of the motor rotor resistance in circuit; No. 11 was taken under varying conditions, and is not reliable; No. 12 was taken with belt on and the motor driving the generator with its rotor circuit open; No. 13 was taken with both rotors open-circuited and the machines standing; No. 14 was taken with the belt off, both motors running light.

Table II.—*Results Deduced from Table I. as to the Efficiency, Power-factor and Slip of* 25 H.P. *and* 30 H.P. *Motors.*

No. of reading	Power supplied. w_1+w_2	Separated losses – 0·60kw. for belts.		Gen. output W_1+W_2.	Motor efficiency.			B.H.P. / 30 H.P.	Generator efficiency.			Slip per cent		Power-factor of motor.				Power-factor of generator.	
		Motor. Kw.	Gen. Kw.		Input. Kw.	Outpt. Kw.	η.		Input. Kw.	Outpt. Kw.	η.	M.	G.	W_1+w_1	W_2+w_2.	Ratio.	Cos ϕ.	W_1/W_2.	Cos ϕ.
1	14·15	7 66	5·9	31·3	45·45	37·79	83·3	1·68	37·20	31·3	84·4	4·85	3·73	15·75	29·7	0 53	0·884	0·518	0·874
2	13·6	7·21	5·79	29·4	43·00	35·79	83·3	1·60	35·19	29·4	83·7	4·60	3·69	15·20	27·8	0·527	0·883	0·504	0·868
3	13·17	7·08	5·49	29·15	42·32	35·24	83·5	1·58	34·64	29·15	84·1	4·19	3·25	14·17	28·15	0·506	0·867	0·498	0·864
4	11·26	6·49	4·18	25·45	36·71	30·22	82·5	1·35	29·63	25·45	86 0	4·28	2·76	12·14	24·57	0·505	0·867	0·480	0·855
5	10·38	5·78	4·00	23·60	33·98	28·20	83·1	1·26	27·60	23·60	85·5	4·16	2·88	10 48	23 23	0·472	0·850	0·543	0·891
6	9·40	5·55	3·25	20·45	29·85	24·30	81·5	1·08	23·70	20·45	86·4	5 33	3·12	10·15	19·70	0·514	0·875	0·520	0·880
7	8·08	5·71	1 77	18·35	..	..	..	0·92	..	..	..	6·80	2·11	8·13	18·30	0·445	0·835	0·416	0·818
8	10 90	6·30	4·00	24·30	35·20	28·90	82·2	1·29	28·30	24·30	86·0	4·02	2·54	10·9	24·30	0·448	0·837	0·482	0·856
9	10·45	6·14	3·73	23·20	33·65	27·51	81·8	1·23	26·93	23·20	86·5	4·26	2·57	11·05	22·60	0·489	0·860	0·467	0·847
10	5·76	4·50	0·66	9·9	..	..	..	0·50	..	..	..	7·51	1·16	3·56	12·10	0·294	0·726	0·179	0·638
11	10·05	5 67	3 78	21·75	31·80	26·13	68·5	1 17	25·53	21·75	85·0	4·87	3·25	10·3	21·50	0·479	0·855	0·549	0·895
12	3·84	..	..	..	3·84	..	..	..	..	..	..	0·61	8·1	..	..	..	..	..	..
13	2·32	..	..	..	2·32	..	..	..	..	..	..	..	..	..	..	..	..	..	..
14	3·10	..	..	..	3·10	..	..	..	..	..	..	..	..	..	..	..	..	..	..

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TESTING OF ALTERNATE-CURRENT MOTORS BY CONTINUOUS CURRENT.*

BY WILLIAM CRAMP.

Since an alternating magnetic field may be resolved into two equal rotating fields, each of 0·7 times the value of the original field, it follows that there is a close connection between the behaviour of an alternate-current motor on its normal supply and that of the same motor having the stator supplied with a continuous current of the proper value, while the rotor is driven round at the proper speed by some independent means.

As an example of this, consider a *repulsion* motor. On account of the fact that such motors will usually be arranged for constant-pressure circuits, it follows that the total flux vibrating within the primary coils is practically constant. This means that the rotating fields, which take the place of this vibrating field, are also practically constant in magnitude for any given brush position. Thus the behaviour of the motor becomes similar to that of a single-phase alternator upon varying load, and consequently obeys the same laws. These laws have already been explained; they form a variant upon the circle diagram so well known as illustrating the behaviour of polyphase motors. The motor, then, may be treated as if it were a short-circuited single-phase alternator, and the more important tests may be carried out as follows:—

I. Arrange the motor so that its stator may be excited with a continuous current, equal to 1·41 A cos 2 d amperes (where A is the normal magnetising current of the motor, d the angle between the brush line and the polar axis), and so that the rotor may be driven by a continuous-current motor.

II.—Calibrate the C.C. motor so that the power required to drive it at any particular speed is known.

III.—Connect it to the A.C. motor shaft (the A.C. motor not being excited), and measure the power required at various speeds. (Friction and windage.)

IV.—Drive as above (in II.), but with the rotor on open circuit, and stator excited with continuous current as explained above. (Rotor hysteresis and eddy losses, hence, also, stator hysteresis and eddy loss.)

V.—Close the rotor circuit by connections which revolve with the rotor, and excite (as in III.), and run at what would be synchronous speed. This gives the rotor current at standstill (if desired, for various values of d). It also gives, if the speed is varied the rotor power-factor at standstill—a most important point.

VI.—With the same continuous current the resistance of rotor and stator may be measured.

Thus all the losses of the motor are completely known, as well as the rotor current and power-factor, and the performance of the motor may be predicted exactly.

The method enables a very satisfactory test to be made, when alternating current of the right voltage and frequency is not available, which is an important point, especially in England, where the frequencies are so varied as to make it necessary to have a great deal of apparatus to test even a moderate run of motors. *No wattmeter is necessary*, which is another advantage; and in technical colleges it will be found that students will grasp the working of alternate current apparatus in general, if such methods are used to bring home the close connection which exists between it and similar direct-current machinery.

THE CALORIMETRY OF THE GASES EXHAUSTED FROM AN INTERNAL-COMBUSTION ENGINE.*

BY PROF. BERTRAM HOPKINSON.

So far as I am aware, in all gas-engine tests hitherto made the indicated work, the heat in the cooling water, and the calorific value of the gas used are the only quantities which have been directly measured. The balance of heat unaccounted for has been put down to exhaust gases, radiation and conduction. In some cases an attempt has been made to separate the last mentioned items by estimation, but those attempts have been very rough in character and have led to very divergent results. The special point of the tests to be described is that the exhaust gases were passed through a calorimeter, and so cooled to near atmospheric temperature, the heat rejected by them being measured. In this way a complete heat account has been obtained, in which the only item not directly determined is the loss by conduction and radiation.

The first set of tests was made on a Crossley engine in the engineering laboratory, Cambridge, giving about 5 H.P. on the brake. This engine is several years old, and must not, therefore, be taken as representative of the more modern engines made by the firm. The following are the particulars of the engine:—Speed, 250 revs. per min.; cylinder diameter, 7½in.; stroke, 9in.; compression space, 143 cubic. in.; ignition, hot-tube with timing valve; cylinder only is water-jacketed, piston and exhaust valve being uncooled. Cambridge coal gas was used, having an average calorific value of 680 B.Th.U. at 0°C. and 760mm., of which about 70 B.Th.U. are the heat evolved in condensing and cooling the steam produced in the explosion.

The calorimeter for the exhaust gases is shown in Fig. 1, from which its construction will sufficiently appear. It consists of a section of flanged cast-iron pipe fitted with baffle-plates, by which the gases are caused to pass several times backwards and forwards through its length, and finally to bubble through the water collected at the bottom. The water, after passing through the jacket surrounding the calorimeter, meets the exhaust gases in a fine jet, and is partly caught by them and carried round with them, and partly trickles down the baffle-plates. It was found that in this way the gases could be cooled, with the engine fully loaded, down to 120°F. or less, the cooling water rising in temperature from about 60deg. to 90deg. This instrument was designed of ample proportions, so that it should be certain to work satisfactorily; there can be no doubt that it is big enough to serve for a much larger engine. In a test on an engine of double the power—to be described later—the calorimeter was very much smaller and the results quite satisfactory.

There is no need to particularise the methods of indicating the engine or of measuring the amount and temperature rise of the jacket water, about which there was nothing peculiar. Some pains, however, were taken to secure accurate measurement of heat put into the engine. The gas was measured with a wet and dry meter in series, and both meters were calibrated with a standard holder at the rate of flow of gas actually used. The calorific value of the gas was determined with a Junker calorimeter at the time of the test on the engine. The amounts of heat stated as having been supplied to the engine are probably correct to within 2 per cent.

The results obtained are shown in Table I.

The fifth column is an estimate of the energy still left in the exhaust gases after passing the calorimeter in those cases in which it is not negligible. It is based on the assumption that the volume of gas discharged per cycle is that of the engine stroke, corrected for the suction pressure (observed) and the suction temperature (assumed), and that these gases are saturated with water vapour. Their temperature is observed, and thence can be calculated the heat which they would evolve (by cooling and condensation of steam) on cooling to 80°F.. which is about the temperature at which the gases leave the Junker calorimeter. This estimate is a very rough one, as the volume may be in error by 10 per cent. in certain cases, and the gases may not be fully saturated; but the item is a very small one. The sixth column shows the balance unaccounted for, and consists of the radiation and conduction losses, and the sum of the errors in the first five columns.

In the first three trials, as appears from the seventh column, there was no load on the engine and practically all the explosions were preceded by one or more scavenging strokes. In the other trials the engine was nearly fully loaded, so that very few of the explosions were preceded by a scavenging stroke. The release pressure in the eighth column is the pressure at a point one-tenth of the stroke short of the out-centre at or about which point the exhaust-valve begins to open. The energy of the gases at release is calculated from the release pressure on the assumption that we have then perfect gas mixed with the steam produced by the explosion, the amount of which is known from the gas analysis. The heat of condensation and cooling of this steam is added to the heat in the gas considered as perfect gas. The actual energy is probably more than this, since the steam and CO^2 are almost certainly somewhat dissociated at the temperature of release. In the tenth column are the temperatures of release. These are calculated from the suction temperature (assumed) and release pressures. In the case of the light-load trials the suction temperature cannot be far different from the temperature of the gas before admission, and I have taken a round figure of 27°C., or 300deg. absolute. In the full load trials the suction temperatures are very uncertain; I have drawn on Prof. Burstall's measurements for these, and have assumed a round figure of 77°C. (350deg. absolute) for Nos. 4, 5, 6 and 7, and 127°C. (400deg. absolute) for the others in which the release temperatures are higher. It will be seen that the temperature measurements are extremely rough, but I have only based conclusions on their relative order of magnitude in the several trials, and that is, no doubt, correctly shown. The "liner temperature" is that of the outer end of the cylinder liner where it projects in front of the cylinder. Since this portion is not water-jacketed, is not exposed to the flame, and is in all trials except No. 5 hotter than the jacket-water, it must receive its heat entirely from the piston, which comes into contact with it on the out-centre. Its temperature is, in the case of the full load trials, a rough indication of the heat being given to the piston. In trials No. 3, 8 and 9 the ignition was retarded, so that it commenced about one-thirtieth of the backward stroke after the in-centre. In the other trials the ignition was normal and commenced slightly before the in-centre.

* Abstract of Paper read before Section G of the British Association at Cambridge, August, 1904.

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Table I.

No. of trial.	Heat value of gas, B.Th.U. per explosion.	Ind. work, B.Th.U. per explosion.	Heat to jacket water.	Heat to exhaust calorimeter.	Heat up chimney.	Balance unaccounted for.	Explosions per min.	Release pres. Lbs. per sq. in. in absolute.	Energy of gases at release, B.Th.U. per explosion.	Release Temp., Cent.	Liner Temp., Fahr.	Temp. of jacket water (exit.), F.	Temp. of exhaust gases after passing calorimeter, F.
		p.c.				p.c.							
1	13·3	2·5 = 19	5·5	4·0	..	1·3 = 10	32	49	6·4	780	102	72	80
2	18·5	3·4 = 19½	8·3	5·2	..	1·6 = 8½	23	53	7·5	870	106	72	80
*3	16·0	2·9 = 18	6·4	5·2	0·4	1·1 = 7	32	56	7·7	930	86	70	100
4	13·0	2·7 = 21	5·1	4·1	0·1	1·0 = 8	110	46	6·0	900	122	80	105
5	12·6	2·5 = 20	4·2	4·6	0·1	1·2 = 9½	117	43½	5·5	800	156	200	105
6	15·1	2·9 = 19	5·9	4·2	0·2	1·9 = 12½	116	45	6·0	880	126	92	118
7	15·0	2·8 = 18½	6·4	4·0	0·1	1·7 = 11½	120	45	6·0	880	126	81	112
*8	16·1	2·7 = 17	6·4	4·3	0·1	2·6 = 16	91	53	7·2	1,250	103	75	107
*9	15·2	2·65 = 17½	5·7	4·2	0·4	2·2 = 14½	111	52	7·0	1,200	100	82	144

* Late ignition.

All the figures are stated in British thermal units per explosion, and the first four columns need no further explanation.

The following points are worthy of note :—

1. The gases lose much heat between release and entering the calorimeter. The following table shows the difference between the estimated energy at release and the energy given to the calorimeter, and sent up the exhaust pipe. The actual difference is greater, since, as already explained, the energy at release is certainly underestimated :—

Table II.

Number of trial	1	2	3	4	5	6	7	8	9
Release temperature ..	780	870	930	900	800	880	880	1,250	1,200
Temperature of passages	cold	cold	cold	hot	hot	hot	hot	hot	hot
Loss in passages	2·4	2·3	2·1	1·8	0·8	1·6	1·9	2·8	2·4

The gases lose heat after release, partly in the exhaust valve and passages, and partly to the cylinder walls in the exhaust stroke of the piston. The latter part of the loss goes to swell the jacket losses ; the former is largely radiated away from the hot exhaust valve. We should expect the amount of loss to depend mainly on the difference of temperature between the gases and the passages or cylinder walls. Thus, high-release temperatures should mean much loss of heat, and in the light load trials, where the passages are fairly cool, the loss should be greater than in the full-load trials, where they are kept hot. These conclusions are confirmed by the last table.

The smallest losses are in trials 4, 5, 6 and 7, where the release temperature is ow, and the passages hot. Then come Nos. 1, 2 and 3, where, though the release temperature averages about the same as in 4, 5, 6 and 7, the passages are cold and the losses undoubtedly higher. Finally, we get the largest losses of all in Nos. 8 and 9.

2. The balance unaccounted for (column 6 of first table) seems to consist mainly of radiation from the exhaust valve. The biggest balances are those in trials Nos. 8 and 9, where, by reason of the late ignition, the release temperature is high. The exhaust valve in these trials was observed to be very hot. It will be noticed that in these cases the temperature of the liner, and, therefore, of the piston, was lower than in the other full-load trials ; and the temperature of the jacket water was by no means excessive. In No. 5, although the jacket water was nearly boiling, the balance is low, because here the exhaust valve was fairly cool.

3. There is no marked improvement in efficiency caused by scavenging.

4. The piston is cooler with the late ignition. Compare the liner temperature of Nos. 8 and 9 with the other full-load trials, Nos. 4, 6 and 7.

One object of these trials was to ascertain whether a practical method of testing gas engines for efficiency could be based on the calorimetry of the exhaust gases. At the present time manufacturers are mainly concerned with making their engines reliable ; the thermal efficiency, being with any design far and away better than in the steam engine, is a secondary consideration. But it cannot be doubted that in the future gas engines will have to be as closely tested for efficiency as steam engines now are. Now, to measure the heat put into a large engine worked with producer gas is a very difficult and costly undertaking. The volume of gas is very great, and its quality may vary largely in the course of a day's trial. It seems to me that it may be easier and more accurate to measure the indicated work and the heat rejected, as is usually done in testing a steam engine. One large part of the rejected heat—that is, the heat in the jacket water—presents no difficulty ; we have, therefore, only to measure the heat carried away in the exhaust gases.

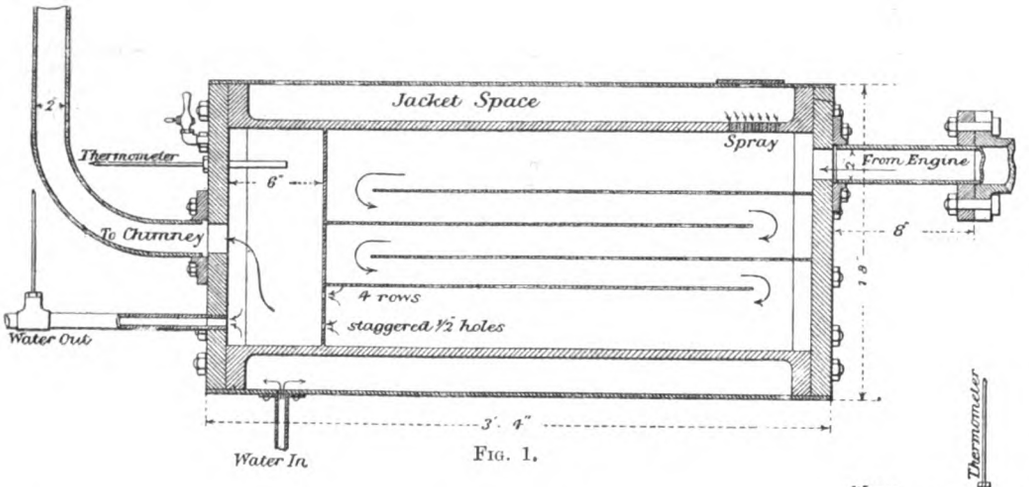

Fig. 1.

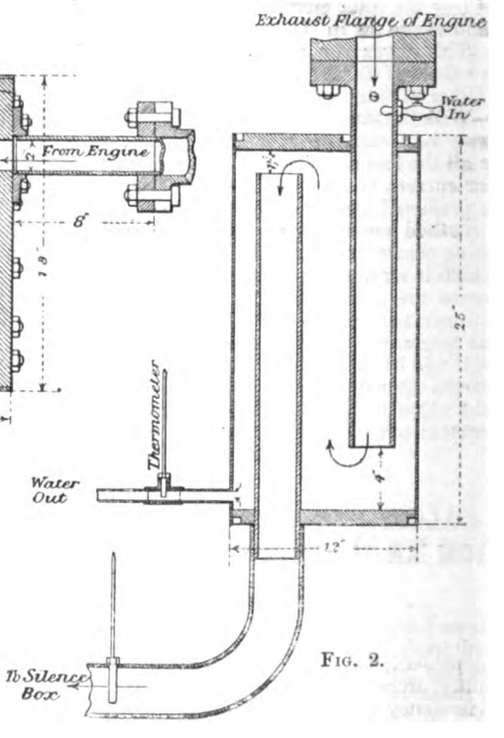

Fig. 2.

The only question is whether the balance of heat unaccounted for, which cannot be measured, is too large a percentage of the total heat. From this point of view, the tests made on the small Crossley engine are not very satisfactory, the heat unaccounted for in the full-load tests ranging from 8 to 16 per cent. of the total. Moreover, in those tests the calorimeter was very much more bulky than was necessary for the purpose. It appeared to me, from consideration of the results, that the lost balance of heat must have gone mainly in radiation from the exhaust valve and other uncooled parts of the engine. I therefore made a similar trial on a second and larger engine in the laboratory, in which, as it had a water-cooled exhaust valve, it appeared probable that the radiation loss would be substantially less.

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This engine is by the Forward Engineering Co., and gives about 10 H.P. on the brake. The following are the principal particulars of it:—Speed, 250 revs. per min; cylinder diameter, 7in.; stroke, 15in.; compression space, 140 cubic in.; ignition, hot tube with timing-valve; cylinder and exhaust valve are water-jacketed, piston being uncooled. This engine compresses to 115lb. absolute, against 70lb. in the Crossley. In the case of this trial the exhaust gas calorimeter was made very much smaller. Fig. 2 sufficiently shows its construction. The water is sprayed through two flat-flame gas burners into the exhaust pipe, so that the exhaust gases, immediately on leaving the engine, encounter a sheet of cold water, and they are further cooled by churning up the water at the bottom of the calorimeter.

The gases, after leaving the calorimeter, were taken into the ordinary exhaust box of the engine, which was provided with a drain and acted as a water separator. It was found, however, that very little water was carried over from the calorimeter by the gases. With this apparatus the gases were cooled down to a temperature of 120°F. or less, the engine being fully loaded, and the apparatus itself occupied but very little more space than the bit of exhaust pipe which it replaced. The following are the results of a trial made on this engine:—

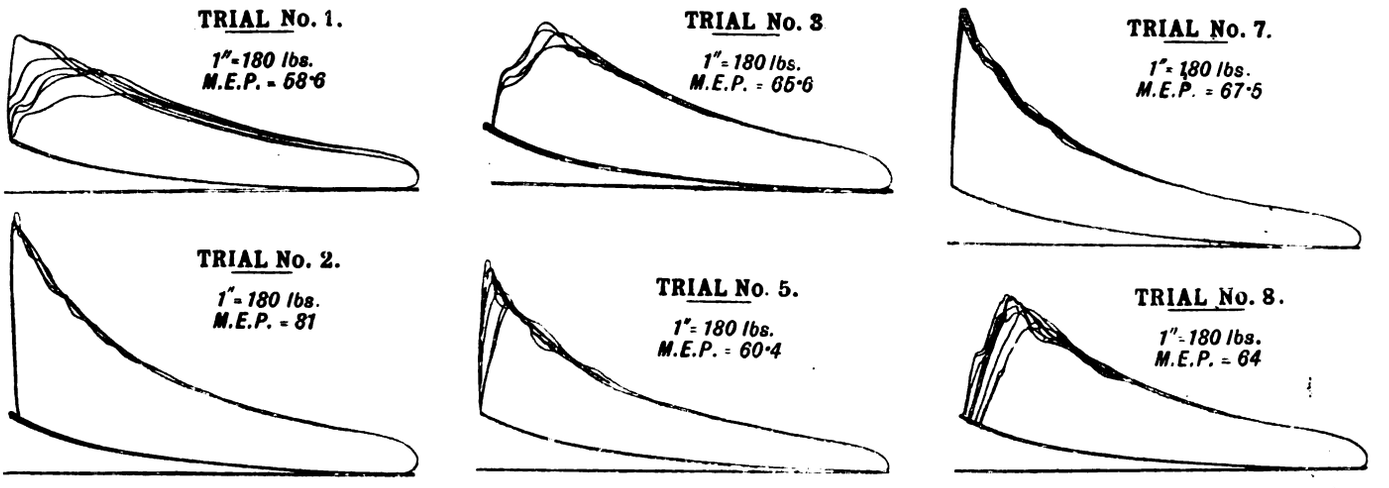

Table III.

	B.Th.U. per explosion.		Per cent.
Jacket-water	7·0	.....	32·0
Exhaust calorimeter	7·5	.....	34·5
Heat up chimney (estimated)	0·3	.....	1·5
Indicated work	5·7	.....	26·0
Balance unaccounted for	1·3	.....	6·0
Heating value of gas used	21·8	.....	100·0

Temperature of exhaust gases after passing calorimeter, 107°F.

Temperature of jacket-water at exit = 105°F. Explosions per minute, 106. Indicated horse-power = 14·2.

The gas measurement in this trial is correct to within 2 per cent. The indicated power is correct to within 5 per cent., and the other measurements to within 2 per cent.

It will be seen that the heat lost by radiation and conduction certainly does not exceed 10 per cent. of the heat put into the engine, and is probably a good deal less. I have made a large number of trials of the same kind on this engine, in all of which the balance unaccounted for is less than 6 per cent. even when the jacket-water was very hot. This seems to me a sufficiently good result to justify trying this method of testing engines on a larger scale, especially having regard to the very compact character of the exhaust-gas calorimeter. In ordinary steam-engine trials it requires extraordinary precautions to get a closer agreement than this between the heat put in and the heat rejected, plus indicated work. Moreover, I think it is reasonable to suppose that in a large engine with a water-cooled piston the loss unaccounted for would be smaller still. Of course, the precise design of the calorimeter for the exhaust gases would have to depend on the arrangement of engine and piping in each case; but there is no doubt, I think, that the secret of success is to spray a sheet of water under high pressure into the exhaust pipe close up to the engine. The gases rushing out break up this sheet into minute drops, and are thus very effectually cooled. The only difficulty then is to separate the suspended water from the gas and to collect and measure its amount and rise in temperature. The separation is by no means so difficult as I had anticipated, and could no doubt be effected in a box somewhat similar to that which I have shown in Fig. 2. It will be found, on calculating out the heat contained in the gas after leaving the calorimeter, that this item does not become seriously high so long as the temperature of the gases is below about 140°F. I find, however, that the radiation and conduction from this particular calorimeter become rather large at temperatures above 115deg. But it is easy to determine the amount of this by a separate experiment.

I append some typical indicator diagrams, sufficient to show the character of the explosion in each case. The whole of the experiments were carried out at the engineering laboratory, Cambridge, by my pupils—Messrs. G. Harrison and A. Blackie, of Peterhouse. They also reduced most of the observations, and I wish to express my indebtedness to them,

SERIES RUNNING OF ENCLOSED ARCS.

BY H. STAFFORD HATFIELD, B.SC.

Successful enclosed lighting demands a special quality of carbon, if the globe is to remain clean, and a heat-resisting glass for the latter. At present, as far as the writer is aware, there are only two glass manufacturers who can produce reliable globes, and the public has still a tendency to buy carbons on price, without regard to their suitability for the enclosed arc. But perfect globes and perfect carbons are to be got at reasonable prices, and the advice of the maker of the lamp should in fairness be followed implicitly in this respect. The cost of upkeep of enclosed lamps is much less than that of the open type. The carbon consumption is hardly one-tenth, and since the best carbons for enclosed lighting are but slightly more expensive than those for open lighting, there is a great saving in material alone. The labour of trimming is reduced about two-thirds in its frequency, and the mechanism requires no attention or cleaning. Simplicity in construction reaches its limit in the enclosed lamp for single parallel running. A series coil and core, dashpot and clutch comprise the whole necessary mechanism. No focussing arrangements are required, as with the open arc, and it is becoming usual to employ only one globe. Here different conditions produce an interesting difference from the American practice of using two globes. The reason is to be sought in the trouble with moths and other insects in the latter country.

In order to run these lamps in series in constant potential circuits, which must be done for the sake of economy with modern supply voltages, it has been necessary to add a shunt coil. This considerably increases the expense of the lamp, for the coil must be designed to stand the very disadvantageous conditions prevailing in the lamp body; and experience has shown that at best it is frequently a source of trouble and breakdown. Hence a further complication has come into use, a substitutional resistance in case of failure. These disadvantages are shared equally by the open arc, but in the case of the latter there is no sure way of evading them.

Three methods have been devised by which enclosed arcs may be run in series without the necessity for a shunt coil. One is the well-known twin carbon lamp, in which two arcs burn in series in one globe, and are controlled by one series coil. Feeding is the difficulty which presents itself in the design of these lamps. If the usual clutch be fitted to each carbon, all will go well after the lamp has been switched on until sufficient carbon has been consumed to bring one of the clutches to the release point. To adjust the clutches so that they should both feed at exactly the same moment and to the same extent would, of course, be impossible; one is bound to feed before the other. The arcs then become more and more unequal in length, one being too long, the other too short, and neither efficient. If the lamp is to continue burning properly, another feeding device must be adopted, or the lamp must be caused to break its arc and start up again before the clutches reach the release point.

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Some time ago Mr. Frank Lewis brought out a twin carbon lamp, in which the two carbons were fed by a single clutch acting on a central rod. He followed this by a lamp, or pair of lamps, in which the two carbons, still controlled by a single solenoid, were separated into two lamp bodies up to 10ft. apart connected by a tube, through which a shaft passed attached to the levers of the two lamps. In one lamp was a solenoid only, in the other a dash-pot. Each carbon was worked by a clutch from the lever in its lamp body, and a device was used to limit the travel of the core in the solenoid, and so cause the lamp to break its arc before the clutches began to feed. This device will be described below.

Mr. Lewis has superseded this lamp by an invention which enables him to run a number of separate lamps in series without the necessity for shunt coils. In an ordinary lamp actuated by a series coil and clutch, feeding takes place for the first two hours or so after starting up the lamp by the travel of the core in the solenoid. The core takes up that position which gives an arc taking such a current that its pull balances the pull of the mechanism on the core, and the weight of the latter. In the usual design, the control is nearly constant throughout the travel of the core, for the weights are hung by links from a lever pivoted through its centre of gravity. If two such lamps be connected in series and started, the arcs will almost certainly begin by being of unequal length; for, although the pull of the current on the core varies slightly with its position, the variation is not sufficient to ensure that the cores in the two lamps will take up similar positions. In the case of the U-core design, the law of the pull would make the position unstable.

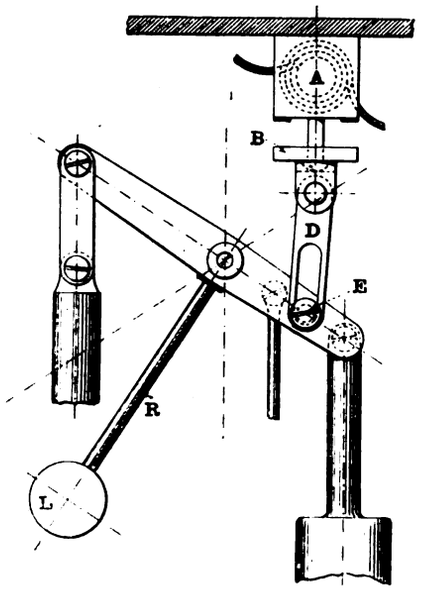

Fig. 1.—Current Off.

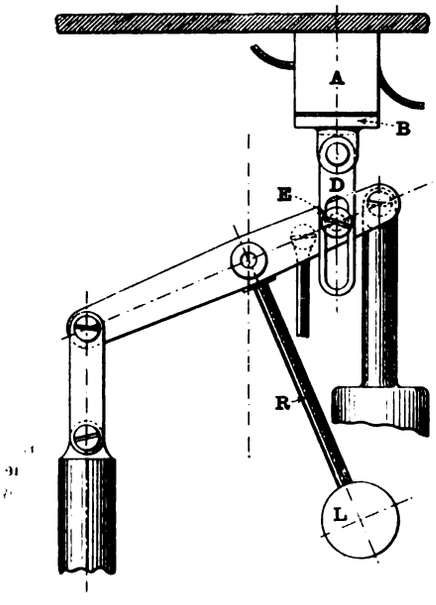

Fig. 2.—Current On.

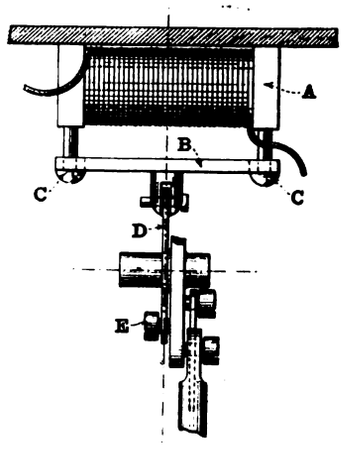

Fig. 3.—End View (Off).

In order to make series running possible, Mr. Lewis makes two important modifications, which are shown diagrammatically in Figs. 1, 2 and 3. He fixes to the lever a vertical rod, R, carrying at its end a heavy bob, L, and he adds a limiting device to prevent the lamp from releasing its clutch. The effect of this construction is as follows:—The control or reaction of the mechanism now varies with the position of the core to a considerable degree. If any number of exactly similar lamps of this sort be connected in series, the arcs will be struck and the mechanism moved as usual until the pull of the current in each balances the reaction of the mechanism. But to the steady current, whatever that may be, there will correspond in each lamp only one position of the mechanism and one length of arc which will balance the pull of that current. Since the lamps are similar the arc in each will be of the same length. As the carbons burn away, feeding will take place by the travel of the core evenly in each lamp, if the carbons burn evenly, but the current taken by the lamps will not remain constant; it will diminish slightly, for the new positions of the core as it feeds down correspond to different currents. Before the clutches come to the release point, the limiting devices come into action, and all the lamps break their arcs and start up again. This process is so quick as to be hardly noticeable, and only occurs at intervals of two hours or so.

The limiting device is constructed as follows:—In series with the lamp is a small electromagnet, A, carrying a keeper, B, which is held by stops, C, from falling more than a short distance when the magnet is not excited. From the keeper hangs a slotted link, D, in the slot of which a pin, E, projecting from the lever of the lamp travels. The action is as follows:—When the current is off (Fig. 1) the keeper falls against its stops, and the lever of the lamp is free to allow the clutch to release and the carbons to come together. When the lamp is switched on, the keeper attaches itself to the magnet, and subsequently, after the lapse of a couple of hours or so, the lever of the lamp is arrested by the pin E coming in contact with the end of the slot (Fig. 2). The arcs break as soon as this happens, and the lever is released. This arrangement is very successful in practice, and as reliable as the singly-run lamp. The necessary variation in current is very small because the pull of the solenoid on the U-core employed follows a square law; it is not sufficient to produce any noticeable effect on the light. With good carbons the consumption is sensibly the same in every lamp, since the arcs are enclosed, and any difference is rectified when the lamps renew their arcs.

This system is very well suited to the construction of the midget arc lamps which are rapidly coming into general use. The midget lamps of foreign manufacture which are being sold somewhat largely in this country, are fitted with shunt coils, and are of concentric design, a form particularly unsuited to this class of lamp, since the lamp body is disproportionately small and the cooling surface insufficient. No provision is made in these lamps for the substitution of a resistance and the cutting in case of failure of one lamp. The Lewis midget lamp is designed on the lever principle, and for this reason, as well as on account of the absence of a shunt coil, keeps very cool in running. These midget lamps should soon be serious competitors of the various forms of incandescent lamps, for the cost of their maintenance is very small, their light of good colour and constant, and they are much more efficient. All these lamps are manufactured by the Reason Mfg. Co., who are the sole licensees of Mr. Lewis' patents.

THE INSTALLATION OF ELECTRIC CABLES.*

BY H. W. BUCK.
(Electrical Engineer of the Nisgara Falls Power Co.)

I should like to bring up for your consideration a few general points bearing upon that part of an electric power system which has to do with the distribution of the electric current after it leaves the terminals of the generators. The design and invention in electric generating apparatus which have been in progress for the past 10 years have resulted in the development of machines which can almost be considered as perfect in their details of construction, and which will give continuous and satisfactory service for many years without repairs. A great deal of thought has also been devoted to the development of those controlling devices commonly known as "switchboards," and appliances and methods of installation have resulted which can be relied upon to meet satisfactorily almost any condition which may arise in the operation of a plant. There is a tendency, however, noticeable in station design to confine electrical engineering to these two elements of the plant alone; to consider that if the generators are well built and installed, and the switchboard constructed along modern lines, that the success of the power system is assured. Of equal importance, however, in my opinion, is the design and

* Lecture delivered before the Electric Club, Pittsburg.

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construction of the cable distribution system, considered as beginning at the terminals of the generators. The details of this part of a plant are too apt to be left until after the station has been completed, upon the assumption that the cables can somehow be run along the wall, through some subway designed for another purpose and through holes which happen to exist here and there in partition walls. Electric cables themselves have undoubtedly reached a high degree of perfection by many manufacturers, but methods of installing them have scarcely kept pace with progress in other departments of electrical work. I believe that if statistics were compiled it would be found that more shutdowns of electric power plants were caused by cable trouble than from any other cause—not troubles which could be blamed upon the cable manufacturer for defects in construction, but ones which are directly attributable to dangerous methods of installation. If you will stop in the street of a large city some time and look into a manhole of some electric power system which has been opened up for repairs and observe the hopeless snarl of cables crossing and twisting around each other, you will ask yourself what would become of the customers dependent upon those cables if a good short-circuit should occur in that manhole. If you will look into the crowded cable runways in some power stations where cables of all voltages and classes are bunched together unprotected, you will agree that the matter has not received the engineering thought in design that it should. In selecting this topic, it was not my intention to try to show you how to instal cables under all conditions (for I do not think that the matter has as yet been satisfactorily standardised), but I shall attempt, rather, to point out certain general principles and to suggest directions in which improvements can be made. Cable installation can essentially be divided into two classes—station wiring and underground wiring—overhead aerial cable work belonging more properly to the subject of power transmission.

Station Wiring.—In laying out the design of a power plant every wire and cable should, if possible, have a definite place provided for it in advance, just as much as for any other piece of machinery. Cables of different classes—that is, cables carrying currents of different voltages and kinds—should, as far as possible, be kept apart from each other. This is a matter of great importance in order to prevent an interlinking of different systems in case of trouble. I have in mind a case where the secondary leads of a series transformer were bunched together with some small 110-volt direct-currrent switch-operating leads led from the exciter system. This combination is very common in modern power plants. Through an abnormal rise of voltage on the system the high-voltage primary of this series transformer broke through to the secondary, which in turn struck through to the adjacent 110-volt direct-current lead mentioned, and the whole exciter system became charged with high potential, doing considerable damage. In laying out a power station cable system the questions are often raised whether to use lead-covered or braided cables, and whether to run in ducts or expose upon racks in cable subways. In my opinion, lead-covered cables should not be used in a power house except in places where protection against water is required. The lead sheath being necessarily grounded makes the cable vulnerable to puncture from ground throughout its entire length, which danger does not exist in a braided cable. On account of the softness of lead, it serves as a very poor guard against mechanical injury. If a lead-covered cable is struck the grounded lead is very likely to be driven through the insulation to copper, and the cable is put out of business. Braid-covered rubber cables are not exposed to this risk. As a protection against fire, a lead covering is useless, for the lead melts at a very low temperature, and exposes the inflammable insulating compound to ignition. When once started, a lead-covered cable will support its own combustion until completely destroyed. In high-voltage work a single-conductor lead-covered cable is especially objectionable. Static discharges seem to take place through the insulation to the lead, which rapidly injures the insulation—especially rubber—and a breakdown soon follows. I have known a number of instances where such single-conductor cables have withstood a test of three times normal voltage, and have broken down at normal voltage a few hours after being put in service. These breakdowns occur usually near the ends of the cable. In multiple-conductor cables this action does not seem to occur, the static activity probably being neutralised.

The present tendency in power station construction is to put all cables in groups of ducts as a protection against fire. The arrangement serves this particular purpose, but it is not, in my opinion, a satisfactory solution of the general problem, and it is open to several objections. In the first place, where cables are drawn into ducts, a lead sheath is usually needed to protect the insulation from abrasion. If the cable is single conductor operating at high voltage, we have the objection stated above against this combination. If the cable is not lead covered and operates at high voltage, a static discharge also takes place to the tile duct, which breaks down the insulation in time. Furthermore, if the cables in the ducts are of low voltage carrying large currents, and if a number of them are grouped together, serious difficulties will be encountered from lack of ventilation and consequent overheating of the cables. In my opinion, as a general proposition, especially in high-voltage work, the best way to wire a power house is to use braided rubber-insulated wire, supported in free air upon porcelain or other insulators which in themselves have sufficient insulation to withstand the operating voltage of the cable. The rubber insulation then serves only as a safeguard to life in case of momentary contact, and to prevent a short-circuit in case of temporarily placing tools or such things upon the cables. Cables should be spread out as far as possible from each other, in order to obtain the best possible ventilation and minimise trouble in case of short-circuit. In connection with the question of ventilation, I should like to call your attention to the fact that the temperature of the outside of a cable does not indicate its maximum temperature. Some experiments made at Niagara by Mr. H. W. Fisher show that there may be a difference as high as 40°C. between the outside of the cable and the inside of the insulation. For this reason cables should have their outside temperature kept lower than is ordinarily the case. In laying out a cable system the matter of ventilation should, therefore, be regarded as of prime importance.

Where cables traverse a floor, the arrangement shown in section in Fig. 1 makes a safe installation for cables of even the highest

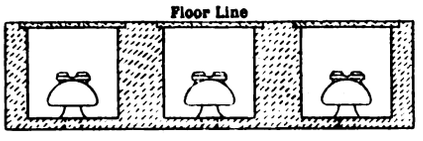

Fig. 1.—Cable Runway for Station Wiring.

potentials. Where cables or wires pass through walls, the ordinary method of cementing a porcelain bushing in the wall has objections against it. The bushing is apt to crack from differences of temperature on the two sides of the wall, or from settling strains in the wall, and a breakdown occurs. It is much safer to cut a square opening in the wall and place an insulator as shown in Fig 2. If exposed to the weather, the construction shown in Fig. 3 is simple and is safe for the highest voltages. Where a large number of cables have to be led through a subway on account of the conformation of the power house structure, they should preferably be racked on insulators in such a way as to give good ventilation and to render each cable accessible. It is well to locate the cables on the walls of the subway and as low down as possible, so as not to be influenced by the hot air which will float at the top of the subway. When cables are installed in this way they should be rendered fireproof by some means. A method which has been adopted by the Niagara Falls Power Co. consists of the following:—Asbestos strip, about 3in. wide and $\frac{3}{16}$in. thick, is soaked in a silicate of soda solution until it is thoroughly impregnated. It is then, while soft, wrapped spirally around each cable which has been put in place

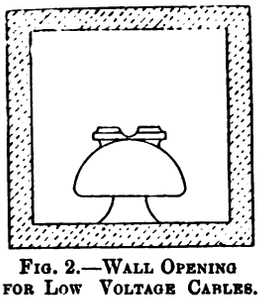

Fig. 2.—Wall Opening for Low Voltage Cables.

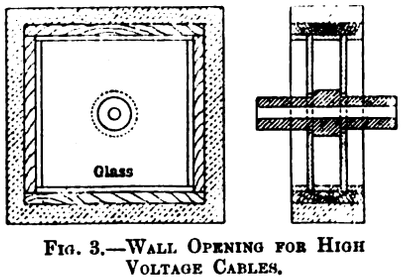

Fig. 3.—Wall Opening for High Voltage Cables.

on its rack in the subway. This covering very quickly hardens and forms a coating like stone over the braid of the cable which is fireproof. Asbestos applied in this way has many advantages. It needs no binding wire or steel bands to hold it in place around the cable, which are apt to uncoil when most needed, for the silicate serves as a firm bond. Furthermore, the asbestos, having its pores entirely filled, becomes a good conductor of heat, and the heat from the copper losses can get out by conduction. Dry asbestos, on the other hand, in a porous, cloth-like condition, is a good insulator of heat, which is likely to subject the insulation of the cable wrapped with it to a high temperature. The method of fireproofing here described has been given severe fire tests, and it has served its purpose in every case. Most of the so-called fireproof braids put on cables are not fireproof for this reason: The coiling and uncoiling of completed cable at the factory and during the process of installation cracks the fireproof braid, which naturally is hard and brittle, and leaves it full of minute cracks and pores. As soon as the cable is heated by the fire the rubber compound of the insulation gives off a combustible gas, which comes out through these cracks and burns in the form of numerous little gas jets, which is practically the

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equivalent of the rubber burning directly. A wrapping of untreated asbestos strip, which is sometimes used, is no better, for as soon as the fire reaches the cables so wrapped the heat melts the rubber compound and the asbestos wrapping draws it out like a wick and burns furiously. The covering of impregnated asbestos strip, as described, while hard and brittle also, is not moved after it is put upon the cable, and remains solid and homogeneous, without cracks or pores. This, when heated, confines the melted rubber and inflammable gas and does not carry fire. Special precautions should be taken in installing the cables in a power house which lie inside of the circuit breakers, for these, in case of trouble, are not protected automatically.

Underground Wiring.—The conditions governing underground cable work are quite different from interior wiring. Here lead covering is absolutely necessary for cable protection on account of water, and also because paper cables must be used for reasons of economy, and all cables must be drawn into ducts underground, for any form of subway with bracket supports for the cable would be prohibitive in cost. My objection to the single-

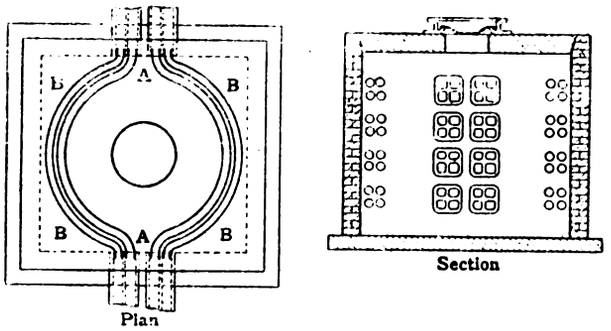

FIG. 4.—ORDINARY TYPE OF MANHOLE.

conductor lead-covered cables still holds for underground use for voltages over 5,000. Such high-voltage conductors should, if possible, be placed in the form of multiple-conductor cables, where breakdown in insulation from static effects is seldom experienced if liberal-sized bells are used at the terminals of the cable. In connection with underground cable work, I should like particularly to call your attention to the grouping of ducts and construction of manholes. Ordinarily ducts are bunched together and brought out at the centre of the manhole, as shown in Fig. 4. Here the cables divide, half passing on one side and half on the other side of the manhole, being racked on the manhole walls. This design is objectionable for a number of reasons. First, it exposes every cable in the conduit to damage from short-circuit at the points AA, where they are in close proximity to each other. Secondly, it necessitates bending every cable sharply at points A and B in every manhole, which tends to crack the insulation and cause trouble. Most breakdowns in underground work do occur at these points. Another objection to this form of

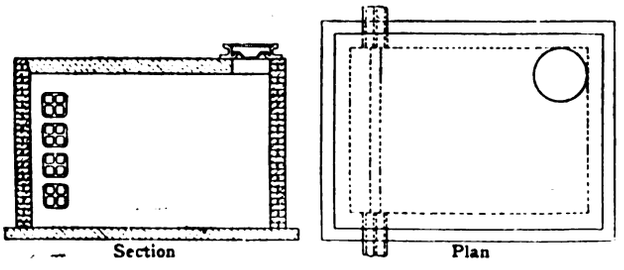

FIG. 5.—IMPROVED FORM OF MANHOLE CONSTRUCTION.

conduit construction is from the standpoint of heating. The cables in the inner ducts, if heavily loaded, will rise to a high temperature, for there is no way for the heat to get away by conduction. The inner ducts are surrounded by chambers containing still air, which constitutes the best possible insulator of heat. Ducts, in my opinion, should never be grouped more than two in width, so that every duct will have an outlet for heat conduction through the surrounding earth. A much better form of construction is shown in Fig. 5. Here the ducts are grouped only two in width, and the conduit enters the manhole at the side so that the cables can pass straight through on the side wall without bending. A further step in design leads to the arrangement shown in Fig. 6. Here the ducts are still laid in one trench, but the ducts are placed in four separate groups, spaced apart by concrete, as shown. The manholes are built with a vertical division wall through the centre, and two entrance holes. Removable soapstone shelves divide the groups of cables horizontally, so that not more than one-quarter of the number of cables in the conduit can be damaged by short-circuit at any time. In this design the cables also run straight through the manhole without bending. This construction has been adopted by the Niagara Falls Power Co. on all its recent conduit work, and the results obtained have been very satisfactory in practice. In places where rock is near the surface of the ground the construction shown in Fig. 7 is adopted, which requires only a very shallow excavation, and affords excellent conditions for the dissipation of heat from the ducts.

The heating of underground conduits is a matter which is overlooked to a great extent, and it is probable that many underground

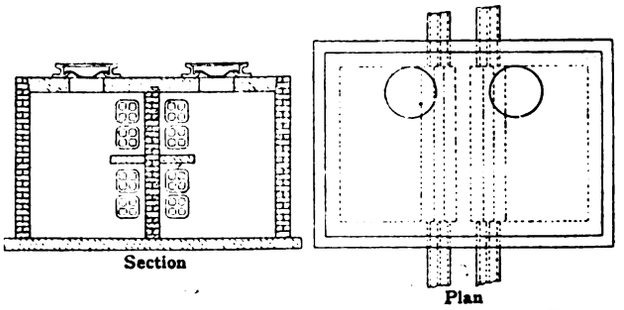

FIG. 6.—MANHOLE CONSTRUCTION ADOPTED BY NIAGARA FALLS POWER CO.

cables for this reason are operating at a much higher temperature than they should. The heating constants vary considerably with the nature of the soil surrounding the conduit, but a fairly safe rule is not to exceed 3 watts per duct-foot as a maximum for copper loss in cable, and not to concentrate too many ducts in one group. The forced ventilation of underground conduits has been tried but without success. Forcing air under pressure through the ducts has the effect only of lowering the temperature at the end where the air enters, but of raising the temperature toward the end where the air escapes. There is a method, however, of cooling cables in ducts which is very effective, but almost prohibitive in cost, except in a

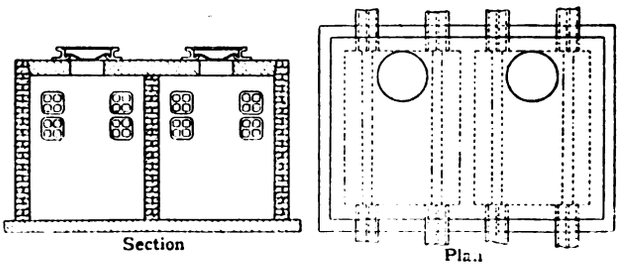

FIG. 7.—MANHOLE CONSTRUCTION OF SHALLOW TRENCHES.

few special cases. It consist of drawing into each duct with the cable a small lead pipe, through which water is kept circulating. This arrangement is used at Niagara in a conduit 250ft. long, between power house No. 2 and the transformer house, and the results have been very good. Where single-conductor lead-covered cables are used in underground installations for carrying large alternating currents at low voltage, trouble from induced current in the lead sheath should be guarded against. I do not refer to local eddies but to the current which flows in the lead sheath of two parallel cables as secondary, induced by the current in the copper of the same cables as primary. This secondary circuit is shown in Fig. 8. When

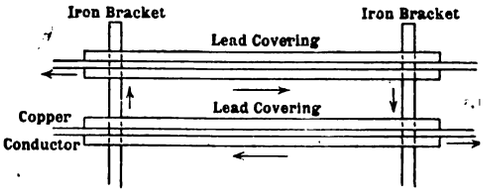

FIG. 8.—SECONDARY CIRCUIT FORMED BY LEAD COVERING.

the lead circuit is closed at two manholes by contact with supporting iron brackets the current which flows in the lead is very considerable, and the resulting loss is nearly equal to the I^2R loss in the copper, even at 25 cycles. At higher frequencies this loss will probably be greater. As a specific example I will cite some readings which were taken on two parallel 300ft. lengths of 1,250,000cm. cable carrying 800 amperes in the copper at 25 cycles. The open-circuit voltage induced in the lead was 15 volts, and with the lead sheaths short-circuited at one end through an ammeter the current was found to be approximately 200 amperes. You can see from these figures that the matter is one of greatest importance,

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and special precautions should be taken in all underground work to meet it. The lead sheaths of all cables should be either bonded together carefully in every manhole or else carefully insulated. If neither one thing nor the other is done, sparking will occur from this lead current at the cable supports at the manholes, which will burn through the lead sheaths and cause a breakdown. In conduits built of insulating material, such as vitrified clay, little trouble need be feared from electrolysis if the conduit is well drained and dry. If the ducts, however, contain water and the cables are partially submerged, the lead covering will rapidly disintegrate, unless the sheath is bonded at frequent intervals to the nearest railway return circuit. In conclusion, I may say that the points brought out in this Paper are not based upon theory, but upon actual experience with a large variety of electric cables operating under various conditions.

AN INSULATOR FOR CONDUCTOR RAILS.

Among the many problems attending the substitution of electric power for steam locomotives in railway working, of no small importance is the attainment of a thoroughly satisfactory means of supporting and insulating the conductor rails. It is essential that the rail supports, while providing permanent insulation under the difficult conditions prevailing on railway tracks, should be substantial enough to withstand rough usage and sufficiently strong mechanically to resist considerable vibration and shock. With a view to meeting these requirements, Messrs. Doulton & Co. (Ltd.), of Lambeth (London), who have had considerable experience in the manufacture of insulators of this class, have patented a new rail support. It consists of a pedestal of porcelain of substantial proportions with a large base resting directly upon the rail tie and secured thereto by external malleable iron fastenings. In this respect it differs considerably from earlier types of rail insulators in which the porcelain is supported on a central stud after the manner of telegraph insulators.

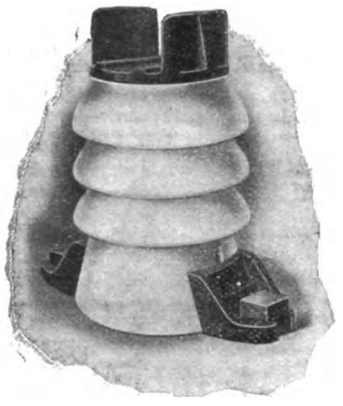

FIG. 1.—GENERAL VIEW OF INSULATOR.

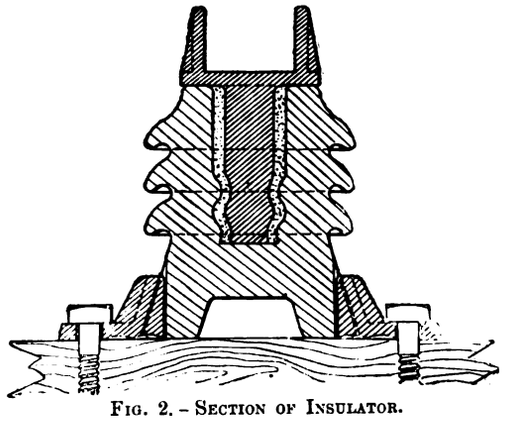

FIG. 2.—SECTION OF INSULATOR.

The conductor rail is held in position by a chair of malleable iron, provided with a depending stud which is cemented into a recess in the insulator. The insulator shown in the illustration is fitted with a chair for a conductor rail of rectangular section. The same type is supplied with chairs adapted for other sections of rail—*e.g.*, flanged or channel sections. The insulator is of high-grade vitreous porcelain of a form well adapted for manufacture, and it will be seen from the illustration that it occupies the whole of the vertical space below the rail, thus presenting a maximum length of path to resist surface leakage of current.

Patents Act, 1902.—Messrs. Mewburn, Ellis & Pryor inform us that it is officially announced that Part I. of the Act of 1902 will come into force on Jan. 1, 1905. The principal points of this act are—(1) Period of provisional protection reduced from nine months to six months; (2) a search will be made for 50 years back in English patent records to ascertain the novelty of the invention (This search will only be made after the complete specification has been lodged, and an extra fee of £1 may be charged.); (3) published provisional specifications and complete patent specifications more than 50 years old will not alone be held to anticipate the novelty of an application for patent under the new act.

LEGAL INTELLIGENCE.

Claremont Municipal Council v. Splatt, Wall & Co.

The Acting Chief Justice in the Supreme Court of Western Australia recently delivered judgment in an action for an injunction to restrain defendants from permitting certain electric cables and wires which they had carried across streets in Claremont to remain so erected, and for a declaration that plaintiffs were entitled to cut down and remove them. It was alleged that defendants, without licence from plaintiffs, had erected and carried across two streets within the municipality of Claremont cables or wires for transmitting electric current for lighting within the municipal area. The municipality denied defendants' right to carry cables across the streets, and alleged that defendants' cables were an obstruction to traffic.

In delivering judgment, his HONOUR said there were only two questions for him to determine: (1) Did defendants' cables or wires obstruct or impede the traffic in the streets? (2) Was the soil in the streets vested in plaintiffs? Having considered the evidence, he had arrived at the conclusion that defendants' cables or wires did not obstruct or impede traffic. The cables or wires were carried over the streets some 17*ft.* above the roadway, which was certainly not lower than the height at which other cables and wires passed over other streets in Claremont, and to which no objection had been taken. It was proved that they had not caused, or were likely to cause, in the common course of events, any appreciable danger to the public. He therefore answered the first question in the negative. On the second question, after referring at length to Crown grants, local land regulations, statutes, &c., he came to the conclusion that one of the streets was reserved by the Crown under statutory authority as a public road, and that the soil of the street vested in the municipality by virtue of sec. 227 of the Municipalities Act, 1900, and plaintiffs were entitled to the injunction asked for. Plaintiffs, however, had not, in his view, established a title to the soil of the other street. There was also no evidence of any reservation or proclamation by the Crown of the second thoroughfare as a street, so as to vest the soil in the municipality under sec. 227 of the 1900 Act. Therefore, plaintiffs had no right to prevent defendants' cables or wires passing across the street at a height above the surface which did not interfere with the ordinary traffic.

Mr. DRAPER, K.C. (for plaintiffs), remarked that the real issue was, had the defendants a right to carry their cables into and across the roads of the municipality so as to be able to compete with plaintiffs in the supply of electrical energy. By the decision now given defendants would be unable practically throughout the greater portion of the municipality to compete with plaintiffs, and he, therefore, moved for judgment for plaintiffs, with costs.

His HONOUR said that judgment would be entered for plaintiffs with the general costs of the action, but that defendants would be granted costs with respect to the issue on which they had succeeded.

Mr. BURT (for defendants) applied for a stay of proceedings, and his HONOUR said he would be pleased if the matter, which was one of considerable importance, were carried to the Court of Appeal. He granted a stay on the usual terms.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Willesden District Council invite applications for the position of resident electrical engineer. Salary £250 per annum. Particulars and forms of application from the consulting engineer (Mr. E. T. Ruthven-Murray), Salusbury-road, Kilburn, London, N.W., to whom applications by Sept. 17.

Messrs. Vickers, Sons & Maxim require a thoroughly qualified travelling representative for the sale of continuous and alternating-current generators, motors, &c. Applications to electrical department, River Don Works, Sheffield. See advertisement.

A wiring inspector is wanted by the Durban (Natal) Municipality chiefly for testing, inspecting and reporting upon house wiring. Salary £300 per annum. Applications to the agents of the Corporation (Messrs. Webster, Steel & Co.), 5, East India-avenue, Leadenhall-street, London, E.C., by Sept. 26. See also advertisement.

Pupils are required at the direct-current station of a London suburb, with and without premium. See advertisement.

Youths with electrical knowledge are required for high-tension sub-stations near London. See advertisement.

A lecturer and demonstrator in physics is required at University College, Nottingham. Commencing salary £130, rising by increments to £180 per annum. Applications (on forms to be supplied by the registrar) by Sept. 20. See advertisement.

A demonstrator and assistant lecturer in electrical engineering is required in October at the Heriot Watt College, Edinburgh. Salary £150 per annum. Applications to the Principal by 24th inst. See advertisement.

The post of junior assistant in the engineering department of the Central Technical College, Exhibition-road, London, S.W., is vacant. Commencing salary £100. Applications to Prof. W. E. Dalby. See advertisement.

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An instructor in electric wiring is required at Redhill Technical Institute. Applications to the secretary (Mr. H. Macan), Surrey County Education Office, Kingston-on-Thames, by 17th inst. See advertisement.

An assistantship in the Meteorological Division of the Physics Department of the National Physical Laboratory is vacant. Salary £200 per annum. Applications to the director (Dr. R. T. Glazebrook, M.A., F.R.S.), Teddington, Middlesex, by Oct. 1. See also advertisement.

The committee of the City and Guilds of London Institute are about to appoint a professor of Mechanical Engineering and Applied Mathematics at Finsbury Technical College. Salary £600 per annum. Applications to the hon. sec., Gresham College, London, E.C., by Sept. 15.

The Council of the Durham College of Science are ready to receive applications for the Principalship. Salary £1,000 per annum. Applications to secretary by Sept. 30.

The chair of mathematics at the University of Aberdeen is vacant. Applications for the post should be sent in by Sept, 26.

A demonstrator in engineering is required for the London County Council Paddington Technical Institute. Salary £150. Applications to the Education Offices, Victoria Embankment, W.C., by 10 a.m. 14th inst.

An engineering master is required at the Carpenters' Company's Technical Institute, Stratford, London, E. Salary £130, and £30 to £40 for evening work if undertaken.

An assistant lecturer and demonstrator in physics is required at University College of North Wales, Bangor. Salary £120. Applications by Sept. 17.

An assistant lecturer and demonstrator is required at the Northern Polytechnic, Holloway, London, for physics and electrical engineering. Salary £150. Applications by Sept. 28.

Bradford Tramways committee recommend the Council to appoint Mr. E. Hobson, formerly of the goods departments of the Great Central and Great Northern Railway Companies, to the post of parcels manager of the Corporation tramways department at £150 per annum. There were 303 applications.

Mr. A. C. Gilbert has been appointed manager of the Ilkeston municipal tramways at a salary of £175 per annum.

EDUCATIONAL NOTICES.

University of Glasgow.—The next session begins on Oct. 3, and continues to the end of March. After that date the students enter engineering works or offices for the six summer months, returning to the University for the next winter session. Particulars of classes and regulations for the degree of B.Sc. in engineering may be obtained from the syllabus, which will be supplied on application. The new James Watt engineering laboratories for students in civil, mechanical, electrical and mining engineering are in full working order, and are thoroughly equipped for experiment and research in most branches of engineering.

Victoria University of Manchester.—The session commences on Oct. 4. Complete theoretical and practical training is given in this university to students preparing for responsible positions in electrical works, and a certificate is granted on the successful completion of the course, which extends over three years. Suitably prepared students are, however, admitted for shorter courses. The John Hopkinson Electrotechnical laboratory is fitted up with powerful modern machinery. Prospectuses from the Registrar.

University College, Bristol.—The session 1904-5 begins on Oct. 4. Lectures on inorganic, organic and advanced chemistry will be delivered during the session. The laboratories are fitted with all improved means for the study of practical chemistry and metallurgy. The laboratory is opened on Monday evening, and lectures on inorganic chemistry, at reduced fees, are delivered. Prospectuses, &c., from the registrar and secretary, Mr. James Rafter.

Glasgow and West of Scotland Technical College.—The next session begins on Sept. 27. The diploma of the college is granted in civil, mechanical and electrical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics, and architecture. The courses of study usually extend over three sessions, and special courses for individual students are arranged as required. The laboratories in the departments of physics, chemistry, metallurgy, mechanical and electrical engineering are equipped with the most approved apparatus. The preliminary examination of candidates for the diploma begins on Sept. 19. Prospectuses from the secretary, 38, Bath-street, Glasgow.

Technical College, Finsbury, London.—The winter lectures at this college begin on Oct. 3. The Wednesday evening lectures will be divided between Mr. P. M. Hampshire ("Electrical Measurement") and Prof. S. P. Thompson ("Magnetism from the Engineering Point of View"). The laboratory work is on Wednesdays or Tuesdays. In the advanced course, from October to Christmas, on Monday evenings, at eight o'clock, Prof. Thompson will lecture on "Single-phase Alternating Currents," including single-phase motors, single-phase transformer design and the analysis of harmonic curves. The advanced laboratory class meets on Mondays at six o'clock.

South-Western Polytechnic (Chelsea).—Complete three years' courses of instruction in electrical engineering are given at this Polytechnic during both the day and evening. Lectures and instruction in practical work are given in electrical engineering (elementary, intermediate and advanced), electrical design, instruments and lamps, alternating and polyphase currents, electrical wiring and fitting, and calculus for engineers. Particulars can be obtained from the secretary.

King's College (London).—The session 1904-5 commences on Wednesday, Oct. 5. Evening classes are also held for civil, mechanical and electrical engineering workshop practice, metallurgy, physics and all science subjects. Prospectuses from the secretary.

Durham College of Science (Newcastle-on-Tyne).—Courses are provided at this college for students proceeding to the degrees in Science or Letters or the diploma in the Theory and Practice of Teaching, and special facilities are offered for the study of agriculture, chemistry, mining, engineering and naval architecture. Matriculation and exhibition examinations begin Sept. 26, and lectures Oct. 4. Prospectuses from the secretary.

Battersea Polytechnic (London, S.W.).—The next term commences on 19th inst. Technical day college courses in mechanical and electrical engineering and day and evening courses in preparation for London University engineering degree are provided at this polytechnic. Prospectus from the secretary.

Birkbeck College, London.—The new session begins on Monday, Oct. 3. There are day and evening classes and systematic courses of instruction (lectures and laboratory) for the degrees of Science and Engineering of the University of London. Further information can be obtained from the Principal.

Sir John Cass Technical Institute (London).—The new session begins on Sept. 26. There are advanced classes in chemistry, metallurgy, physics and mathematics. Facilities are afforded for special and advanced practical work in well-equipped laboratories, both in the afternoon and evening. Courses of instruction will be given in glass blowing during the session by Mr. A. C. Cossor. The Institute is readily accessible, being adjacent to Fenchurch-street, Liverpool-street, Broad-street, and Metropolitan Railway stations. Particulars from the Institute or by letter to the Principal (Mr. Charles A. Kohn, M.Sc., Ph.D., F.I.C.)

College Prospectuses.—We have received a copy of the prospectus of the 1904-5 session of the Paddington Technical Institute, which gives full particulars of the instruction in science, engineering, general technology, &c., together with list of teaching staff, timetable, fees, &c.

The institute was established in 1903 by the London County Council to enable artisans and others engaged in manufacturing and artistic industries to acquire a scientific knowledge of the principles that underlie the processes which they have to carry out in their daily work. Physical, mechanical, and chemical laboratories have been equipped for that purpose. The evening session is to be opened on Sept. 26. The general fee, payable in advance, is 10s. for the session, but apprentices, learners and improvers under 21 years of age are admitted free on production of certificates from their employers, or showing copies of their indentures.

Aberdeen.—The salary of the tramways manager (Mr. David Moonie) has been increased to £305 per annum and that of the cashier (Mr. S. Gordon) to £225.

Accrington.—The Corporation will promote a bill for powers to work and extend the existing tramways.

Afghanistan.—It is reported that the Ameer is desirous of establishing telegraphic communication between all the prominent places near Kabul. Several are already in telephonic communication.

Argentina.—The Barracas al Sud-Quilmes electric tramway will be opened on 15th inst.

The Government of the Argentine Republic have decided to place a lightship at the entrance of the River Plate and to equip it with wireless telegraph apparatus, the object being to enable vessels bound for Buenos Ayres to communicate with the port at a distance of 180km. (about 112 miles).

Mr. M. Henliztka, local representative of the Compania Alemana Transatlantica de Electricidad, has submitted a proposal to Rosario Municipality for the construction of electric tramways in the city.

Aston.—The electric cars on the Aston tramways will probably be running between the city of Birmingham and Witton in a day or two.

Australasia.—The resident electrical engineer at *Sydney* anticipates that the generating plant will be fully loaded by the end of the current year.

Melbourne Council have authorised the borrowing of £25,000 for extensions of their electricity undertaking.

North Fremantle (W. Australia) Council desire to join Fremantle and East Fremantle Councils in their electricity supply and tramways scheme,

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and if the necessary statutory authority can be obtained the request will probably be granted.

Mr. Rew, electrical engineer to the New South Wales Works Department, who was engaged by *Newcastle* (N.S.W.) Council to report upon the proposed extension of the Council's electric lighting plant, has submitted his report, and recommended the acceptance of a tender for the plant from Noyes Bros. Mr. Rew also recommended certain alterations in the generating plant and system of distribution, including the adoption of three-phase plant and the substitution of 90kw. alternators for the 70kw. machines specified, increasing the total capacity to 270kw. The voltage at the station should be increased from 1,000 to 2,200, and the periodicity reduced from 133 to 50. The suggested alterations would necessitate the supply and erection of a third 7/16 cable on the present poles, and the provision of new lamps, fittings, &c. Long-burning enclosed arc lamps should be employed for certain leading thoroughfares. The system of suspending the arc lamps on suspension wires should (Mr. Rew urges) be changed, and posts used instead. A feed-water tank should be obtained for the station, and the plant should be run continuously, a proper system being adopted for recording the work of the station at all times. The Council have, however, we understand, decided not to adopt Mr. Rew's suggestions.

Barnsley.—At an inquiry into the application of the Council to borrow £6,868 for electricity supply, the town clerk (Mr. Horsfield) said that nearly £60,000 had already been sanctioned for the undertaking. Of the amount now required, £6,067. 16s. 9d. was wanted for additional plant, mains, &c., and the balance for an extension of street lighting by the erection of 56 arc lamps. Technical details were given by the borough electrical engineer (Mr. Barker). There was no opposition.

Beaumaris.—The Council have decided to apply for a provisional electric lighting order.

Birkdale.—The Council have declined to sell their tramway undertaking (leased to the Southport Tramways Co.) to Southport Corporation.

Bishop Auckland.—The Cleveland & Durham County Electric Supply Co., who are erecting a generating station at Fylands Bridge, expect to supply electric current in this district next month.

Blackpool.—The chairman of the Tramways committee (Ald. J. Brodie) stated at the Council meeting on Tuesday that the receipts on the tramways during the current year showed an increase of £4,420, the increase during the past two months being £3,554. 9s. 7d. over the receipts for the corresponding period last year. The increase in working expenses during the past two months has been only £12. 17s. 1d.

Bolton.—In discussing at Wednesday's Council meeting a proposal by the General Purposes committee to alter the amount provided annually for depreciation of the permanent way of the tramways from 8 per cent. on the gross capital to £360 per mile,

Mr. WADDINGTON said they had spent £270,000 (or £6,760 per mile) on the track, and after a four years' payment on the 8 per cent. basis they now owed £4,780 per mile. It was fallacious to take mileage as the basis of depreciation. Unfortunately, the undertaking was too heavily capitalised. There was some £100,000 worth of property which they could not realise.

In reply, the chairman of the Electricity committee (Dr. PANTON) said they preferred to keep the charge for depreciation per mile of track constant rather than variable, as it would be by working to percentages. What would the Tramways committee be able to do if they increased the depreciation? Were they to make the fares higher or levy a rate for the relief of the department?

It was agreed that no action could be taken at present, and the motion was withdrawn.

The Electricity committee have adopted the following scale of charges for current supplied to cotton mills, &c.:—Consumers using 500,000 units per annum, 10 per cent. off ordinary charges; 750,000 units, 12½ per cent. off; 1,000,000 units, 15 per cent.; 1,250,000 units, 17½ per cent.; and 1,500,000 units 20 per cent.

Bristol.—An inquiry will be held here next week into the application of the Corporation for permission to borrow £125,000 for extensions of the Avonbank electricity works, for additional plant for the Temple Back station, &c.

Bury (Lancs.)—Electrical energy is to be supplied to the workhouse hospital at 3½d. per unit on a yearly minimum guarantee of £200 for 10 years.

Cardiff.—An important application for electrical energy for power and lighting was before the Electric Lighting committee on Tuesday. The Ely paper works asked for terms for supply of current, and the borough electrical engineer and tramways manager (Mr. Arthur Ellis) said the works were likely to consume about 2,000,000 units per annum, and with the South Wales Electrical Power Distribution Co. nibbling on the boundaries of the borough, it would be as well to offer as good terms as possible. To consider the question a special meeting of the committee has been arranged for.

Clydebank.—The Clyde Trustees are about to equip Clydebank Dock with four or five electric hoists for loading coal and electric cranes for discharging ore and other minerals. A contract has been entered into with Messrs. Stothert & Pitt for the supply of the first six electric cranes.

Coal Haulage on Tramways.—Huddersfield Corporation are making experiments in the haulage of coal on their tramway system.

An agreement has been made with the London & North-Western and Lancashire & Yorkshire Railway Companies and Parliamentary powers have been obtained for constructing a branch line from the tramway lines on Bradford-road along Whitestone-lane to the coal shoots at Hillhouse, a distance of about a quarter of a mile. A local company has now entered into a contract for 45 tons of coal per week being hauled to their premises over the tramways, and rails have been laid from the Corporation line into the company's mill yard at Lindley, and the Corporation have put up overhead equipment. The total distance from the railway coal shoots to Lindley is between 3 and 3¼ miles. The Corporation have provided a special motor coal waggon, which can be worked from both ends. The waggon is constructed to carry 10 tons, but, on account of the electrical equipment, there are no openings in the bottom for unloading the coal, which is discharged by letting down both sides. The trial of the waggon, which took place on Friday last, is reported to have been a great success. The difficulty hitherto in Huddersfield has been the design of a suitable truck to carry large quantities of coal, and at the same time to negotiate the curves on the city tramway line; but this has now been overcome, thanks to Mr. H. N. Thomas, the tramway manager, who, by the way, has just been appointed to a similar position at Durban (Natal). Many other provincial municipalities have powers to carry goods and minerals upon their tramways, but this appears to be the first instance in which they have been put into operation.

Colliery Lighting, &c.—Messrs. Bolckow, Vaughan & Co. are adopting electricity for lighting and power at their Shildon Lodge pit, energy being supplied from their generating station at Auckland Park colliery. The company will also supply other consumers at Shildon with current for lighting.

Customs Decisions.—A recent decision of the Italian Ministry of Finance imposes a duty of 25 lire (£1) per 100kg. upon small electromagnetic appliances imported for lighting gas in gas engines, the classification of these appliances coming under dynamo-electric machinery.

Darlington.—To consumers of 20,000 units of electric current for lighting the charge in future will be 3¾d. per unit.

The General Purposes committee reiterate their recommendation to increase the salary of the borough electrical engineer (Mr. J. R. Lunn) by £110 per annum.

Derby.—Official inspection of the second section of the Corporation electric tramway system took place on Wednesday.

Dundee.—The report of the city electrical engineer (Mr. H. Richardson) upon the scheme of Mr. G. Balfour for obtaining powers to erect a generating station for the supply of electricity for power only has been circulated.

Mr. Richardson states that the Corporation have never refused to supply energy in bulk at special rates owing to want of machinery, plant, &c., nor for any other reason, and that they have never been approached by any of the mills in Dundee with a request for power in bulk. One important fact that had to be faced was that in any case, whether the proposed company supplied power in Dundee or not, a new generating station would have to be built by the Corporation in a comparatively short time owing to increasing demand for electricity. He considered it was no use spending more capital on the present station when they had to prepare to build a new one. As regarded the cables in the town, these had been carefully considered, and were ready to work in conjunction with the new power station which they would have to build. They were beginning to feel the advantage of the alterations and improvements of the present system, and the existing station was quite capable of paying for itself. On reading the proposed agreement with Mr. Balfour it would be seen that the Corporation would be deprived of all profitable forms of work, and, moreover, would be handicapped by being forced to supply unprofitable loads which the company could refuse. Pointing out the probable electrolytic troubles due to leakage from the two systems, Mr. Richardson states that the Corporation would not be allowed any special clauses dealing with this, but whether they were protected or not, such troubles were a serious inconvenience and danger and a source of complication. As for the company's proposed charges for current, which had been put at ¾d. per unit, he might say that that charge would only be in exceptional cases, and the real prices which the company said they were going to charge varied from 1½d. down to ¾d. There was one scheme from an outside company which he might be prepared to advise the Council that they need not trouble to oppose if they decided that they did not want the work. That was that the company should start at five o'clock in the morning and shut down at six o'clock at night to the minute. This would confine them to their first proposal—viz., a day load station for mills only.

Electric Driving.—At the meeting of the Steel Co. of Scotland on Wednesday, the chairman (Mr. W. Lorimer) referred to various additions to and improvements in the plant and machinery at the company's great works, and referred to the extension of the electric power plant at the works.

Electricity in Victorian Mines.—The report of the Victorian Mines Department for 1903 says that during the past year a number of mining companies discarded old methods of working and adopted the use of electric power:—

The Berry Consols Extended Co. substituted electric haulage for horse traction underground, and results have fully justified this action.

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The Duke United Co. completed the installation of their electrical plant, and the managers have no doubt they will be enabled to work the property more efficiently and much more economically than heretofore.

The pumping, winding, and rock-breaking operations of the Victoria A1, Gaffney's Creek, are now carried on by electric power, and a saving of about 60 per cent. is effected by this means.

The Long Tunnel Extended Co., at Walhalla, light the surface and the various levels of the mine by electricity, and are using electric motors for trucking stone and wood.

The Electric Transmission Co., Charlotte Plains, have had an up-to-date electric plant in operation for two years, and this has proved an excellent object lesson to mining men.

The following companies have put down electric lighting installations: The Long Tunnel (Walhalla), Star of the East (Ballarat), Glenfine South (Pitfield), Birthday (Berringa), Jubilee (Scarsdale), Forest Creek, Golden Point, Campbell's Creek, and Loddon Dredging Companies (Castlemaine), and Enterprise and Creswick Dredging Companies (Creswick).

The Mining Conference in May, 1903, resolved "That the adoption of electric signalling in mines in connction with telephonic communication is highly desirable, and should be adopted where advisable in the opinion of the mining inspector." The difficulty of devising a suitable system of signalling in mines has been surmounted at Bendigo and Maldon, at least as far as quartz mines are concerned. For nearly three years the New Moon Co., at Bendigo, have had a telephone installation, and telephones are also employed by the South German Co. (Maldon), the South New Moon and the Johnson's Reef Companies (Bendigo). The report throughout strongly advocates the adoption of electric working in mines.

Felixstowe.—The Council have decided to ask the Suffolk Electric Supply Co. to fix a cash price for disposing of the Felixstowe portion of their undertaking to the Council.

Fire.—A fire broke out on Friday morning upon the premises of H. Ingram (Ltd.), electrical engineers, Leigh-street, Warrington, resulting in considerable damage to the stock.

"Gas or Oil"!—Messrs. Foster & Co., makers of the Foster arc lamp, have received the following instructive post card, dated "Beauly, August 23":—

DEAR SIRS: Please forward your price list and particulars of arc lamps. Please say if for gas or oil.

Our readers will agree with Messrs. Foster & Co. that this request "shows the want of electrical knowledge even at the present day in the outlying districts of our country."

Grimsby.—Sanction has been obtained to a loan of £3,200 for extensions of the electric lighting mains, &c.

Halifax.—On Wednesday the Council authorised the extension of the tramway system from the present terminus at Sowerby Bridge to Style Bank, Triangle, at an estimated cost of £4,200, "provided Sowerby Council agree to forego rating the tramway lines in their district for five years."

Inquest.—An inquiry was held at Bury (Lancs.) on Friday last into the circumstances attending the death of Joseph Fisher Dands, a foreman electrician, in the employ of Salford Tramway committee, which took place on 31st ult.

Deceased, with a man named Martin, was working on the overhead wires at Whitefield, where the Salford Corporation tramway service joins that of Bury. The two men had taken the slack out of the trolley wire, and Dands was standing on the platform of a trolley waggon when Martin heard him cry out "Oh," and turning round saw him hanging over with his hands on the wire. Before Martin could release Dands the latter had fallen over the side of the waggon to the ground, a distance of about 20ft. Deceased was not wearing gloves, though the men were instructed to carry gloves, and notices were put up to that effect. There was a spare pair of gloves in the trolley.

Medical evidence proved that deceased died from fracture of the skull, which caused laceration of the brain, and not from electric shock. There was a slight burn on the left forefinger and one on the calf of the left leg.

A juryman suggested that if the sides of the cage had been higher deceased would not have fallen over.

Mr. Jackson (for the Corporation) pointed out that the cage was specially constructed for the class of work upon which deceased was employed. The rails were insulated, and if deceased had taken the precautions he was instructed to do he would not have met with his death.

A verdict was returned in accordance with the medical evidence.

Kirkcaldy.—The Corporation electric tramways will shortly be extended to Dysart, and a further extension will probably be made subsequently through the Wemyss estate to Leven.

Leeds.—The Corporation will apply for sanction to a further loan of £60,000 for tramway extensions.

Light Railway.—The British Electric Traction Co. have asked the Board of Trade to extend until Oct. 4, 1905, the time for the completion of the railways authorised by the Durham and District Light Railways Order, 1901. Objections by 24th inst.

Linlithgow.—The County Council will apply for a provisional electric lighting order for Broxburn and Uphall. A site for a generating station has been acquired.

London County Council Tramways.—The electric tramway route from the Elephant and Castle to Southwark Bridge is now open, and a partial service of cars between Southwark Bridge and Water-lane, Brixton, has been running since Monday. Yesterday the journey of the cars which have hitherto run from Southwark Bridge to Asylum-road, Peckham, was extended to New Cross-gate and a service between Southwark Bridge and Clapham Common was commenced.

Liverpool.—At Wednesday's Council meeting the Tramways committee's report on various matters was presented.

In the course of the discussion of the report, Sir CHARLES PETRIE (chairman of the committee) said of the £600,000 paid by the Corporation for the tramway undertaking only about £100,000 had been derived from sale of horses and property, and, in addition, the committee had to take over £260,000 debts of the old company. Therefore, any charges placed on the tramways account would be a heavy burden. The committee contributed one-third of their profits to the rates (amounting last year to £32,000). Could not this sum be used for street-widening projects? If any further burden were placed on the undertaking the Council's object—to carry the citizens cheaply and expeditiously—would be defeated.

Notwithstanding, a motion by Ald. BOWRING, that a conference on the subject of the Tramways committee's contribution to street widening works, was carried by 52 votes to 30.

Longton (Staffs.)—The gross profit of the electricity works for the past year was £714. 12s. 9d. Interest required £931. 15s. and sinking fund £548. 11s., leaving the deficiency £765. 14s. 1d.

With the balance from the previous year the total deficit was £1,911. 9s. 8d. During the year the additional connections in incandescent and arc lamps, motors, &c, were equivalent to 856 8 c.p. lamps, making a total of 5,178 8 c.p. lamps connected to March 31, 1904.

Lytham-Southport Tramway.—It is reported that the financial difficulties in connection with the scheme for constructing a tramway across the Ribble estuary near Lytham to connect Southport, Lytham, St. Anne's, Blackpool and Fleetwood by tram have been overcome. Sir Hiram Maxim is the chief supporter of the scheme, and Messrs. Vickers, Sons & Maxim will construct the transporter bridge over the Ribble. Tenders have already been invited for the work.

Manchester Suburban Tramways.—Manchester Corporation is to be invited to deal with the question of the construction of electric tramways in Bucklow, Cheadle and Gatley districts, by passing resolutions notifying the Manchester Southern Tramways Co., that Manchester Corporation intend to exercise the powers and assume the obligations conferred or imposed by the Southern Tramways Act, 1903, in relation to the construction, maintenance and working of so much of the tramways authorised by that act as are situate in those districts.

On Tuesday evening the first electric car was run from Bury to Whitefield, making electric tramway communication between Bury and Manchester and Salford. Radcliffe will shortly be linked up.

Metropolitan Asylums.—On Saturday the Metropolitan Asylums Board adopted a recommendation contained in a report of the engineer-in-chief as to the reorganisation of the fire-alarm system at Gore Farm (Upper) Hospital at an estimated cost of £350.

Municipal Contracts and Workmen's Wages.—At the meeting of Newcastle-upon-Tyne Corporation on Wednesday, the following resolution was adopted:—

That a clause be inserted in all Corporation contracts binding the contractor to pay the whole of his employés wages not less, and to observe the hours of labour not greater, than are recognised by the workmen's trade unions of the district where the work is to be executed, and that he shall not assign nor underlet or make a sub-contract with any person for the execution of any part of such work who does not also observe in his district similar rates of wages and hours of labour; and where no trade union exists, such rates of wages and hours of labour as are generally accepted as fair in the trade shall be observed.

Obituary.—The death is announced of Sir T. Raikes Thompson, Bart., director of the British Thomson-Houston Co., the Cork Electric Tramways & Lighting Co. and the Lanarkshire Tramways Co.

Oldbury.—The District Council have decided to transfer their provisional electric lighting order to the British Electric Traction Co., the company to pay 5 per cent. of the gross receipts and to construct an electric tramway between Oldbury and Blackheath.

Patent Amendment.—Notice is given that Carlo Turchi and Edmondo Brunè, both of 89, Via Giovecca, Ferrara, Italy, seek leave to amend the specification of letters patent No. 7,585 of 1903, granted to them for improvements in apparatus for enabling telephonic and telegraphic messages to be transmitted over the same line. Particulars of the proposed amendment were set forth in the "Illustrated Official Journal" (Patents), Aug. 31, and notice of opposition must be given within one calendar month from that date.

Personal.—Our congratulations to Mr. F. C. C. Nielsen, representative in England of the Great Northern Telegraph Co., on the occasion of his silver wedding. On Sept. 2, 1879, Mr. Nielsen was married in Copenhagen to Antoinette Caroline Manicus, daughter of the late Emil Manicus, Ph.D., of Copenhagen.

Mr. Marshall Osborne, for a number of years on the staff of the British Thomson-Houston Co., Rugby, has resigned, to accept the position of assistant manager of the Stirling Boiler Co. Mr. Osborne takes with him the well wishes of a host of friends.

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Pitlochry (N.B.)—The local gas company are endeavouring to defeat the scheme for the utilisation of the water power of the Falls of Tummel for the generation of electric energy. The company, however, offer to supply gas for a gas-driven station.

Poplar (London).—The Electricity committee have been authorised to lay a feeder and distributing main to Hackney Wick at an estimated cost of £1,400 to meet the demand for current in that district. Already the committee have orders in hand for 34·56kw.

Presentation.—Mr. J. C. Whiteley, chief assistant engineer (on behalf of the employés of Huddersfield Corporation tramways department) last week presented the retiring manager (Mr. H. N. Thomas) with a breakfast tureen and silver cigar case.

In making the presentation Mr. Whiteley said that three years ago the receipts on the tramways were £30,000 per annum, and were now £65,000 with practically the same mileage and the same population.

Pronounceable Code Words.—The decision of the International Telegraph Conference in London last year as to the use of pronounceable words in telegraphic coding has furnished opportunities for some ingenious code-word compilation by experts in this class of literary work We have already referred to Mr. Nicolson's code vocabulary, and we have now to acknowledge receipt of particulars of Hawke's "Maximum Telegraphic Code," which has been prepared to provide "six hundred and forty thousand million pronounceable code words arranged on various systems suitable to every class of business." Mr. Hawke's acquaintance with the art and craft of telegraphic code compilation will be a sufficient guarantee that the standard of usefulness of his telegraphic ciphers is to be depended upon. The book is published price £1. 1s. by Messrs. Whitehead, Morris & Co., Fenchurch-street, London.

Redcar.—The Board of Trade have inquired as to the steps taken by the Council to carry out their obligations under the Redcar Electric Light Order, 1900. The Council's reply is that the probable demand for current for private lighting is being ascertained.

St. Helens.—The annual report of the borough treasurer (Mr. J. Brown) states that the total capital expenditure on the electricity undertaking is £138,080. 13s. 6d., which, added to £123,153 on tramways, made a total of £261,233. 13s. 6d. The net loss on the tramways last year was £1,184. 3s. 2d., against a profit of £118. 17s. 11d. in the previous year. The deficit is due to the large increase in the cost of repairs.

St. Petersburg.—It is stated that a commission appointed to consider the question of urban railways in St. Petersburg has for some time past had under consideration the best means of utilising the water power of districts within reach of St. Petersburg for the purpose of generating current for an electric service of tramways. The waterfalls of the River Vonoksa, in Finland, distant about 150km., are considered the best suited for the purpose, and in a report recently issued, the necessary outlay required for carrying out the work is put at from 14,000,000 to 16,000,000 roubles, or about 100,000 roubles per kilometre of line.

Salford.—An inquiry has been held into the application of the Corporation to borrow £5,000 under the Prestwich Electric Lighting Order, 1900. Originally Manchester Corporation had power to supply Prestwich, but in May, 1903, the order was transferred to Salford, on the understanding that it would be put into operation within two years. The loan is required to erect a generating station and to lay mains. There was no opposition.

South Africa.—Kalk Bay Town Council have obtained powers to generate and supply electricity.

South Shields.—On Wednesday Councillor Wylie moved that the resolution passed by the Council a year ago (deferring the tramway question until the committee had obtained information as to the best terms possible for leasing the system) be rescinded, and that the Corporation themselves construct and work the tramways. The resolution was defeated by 21 votes to 15. The committee will probably present their report on the subject at the November meeting.

Sowerby.—The Parish Council have accepted the tender of the Northern Counties Electricity Supply Co. for public lighting.

Spalding.—Two companies having given notice of intention to apply for provisional electric lighting orders, the Council have resolved to themselves apply for an order.

Stourbridge.—The Electric Powers committee have reported that they do not propose to proceed further with the application for a provisional order for Pedmore, Hagley, Clent and Belbroughton.

Stockport.—The annual financial statement of the tramways department was submitted to the Council on Wednesday.

In reply to criticism, the mayor (as chairman of the Tramways committee) stated that during the past year they had carried 3,170,854 passengers, compared with 2,737,261 in the previous year, and income had exceeded expenditure by £6,973. The capital expenditure had been £140,276, including £3,504 spent in obtaining the Tramways Act and provisional orders. £3,834 had been paid as interest, £1,334 in sinking fund charges, £1,175 as rent of leased lines, leaving a sum sufficient to extinguish an adverse balance of £563 from the previous year and to carry forward £67.

Sunderland.—The borough electrical and tramways engineer (Mr. J. F. C. Snell) has submitted a report to the Electricity and Lighting committee recommending the provision of additional three-phase plant at Pallion sub-station at an estimated cost of £3,000. The report and recommendation have been endorsed by the committee.

Technical Instruction for Tramway Employes.—Leeds Tramways committee have approved the establishment of an electricity class for Corporation tramway employés at Leeds Institute, and have offered to pay the fees for men who make a reasonable number of attendances.

Trades Union Congress.—The thirty-seventh annual Trade Union Congress opened at Leeds on Monday. The unions represented at the Congress now embrace 447 societies and about 1,500,000 members. The following resolutions were submitted :—

Cheap Transit.—A resolution was passed unanimously urging (*a*) that wherever the supply of workmen's trains was not adequate to the needs of the population representations should be made to the Board of Trade with a view to securing the more thorough use of the powers already possessed by the Board (under the Cheap Trains Act, 1883) ; (*b*) the rapid development of electric tramways and light railways (owned and worked by the municipalities) ; (*c*) the passing of legislation to secure a uniform system of cheap fares over areas surrounding large centres of population.

Workmen's Compensation.—A resolution was passed by a large majority calling for an amendment of the Workmen's Compensation Act so that it should apply to all workers, organised and unorganised; that the basis of payment for injury should be not less than one-half the amount of wages received while working full time, that payments should date from the day of accident, that compensation should be payable to dependants, and that injured workmen should have power to apply for commutation by lump sum, and that in case of permanent injury the commutation should not be less than 75 per cent.

Minister of Labour.—The Congress agreed that the time had come when a Minister of Labour should be appointed, to whom would be entrusted the administration of labour enactments. A resolution, proposed by Mr. B. Tillett, in favour of the appointment of a Minister of Industry to preside over the Department of Industry, and of an advisory board to undertake investigation, conciliation and arbitration in industrial disputes, with option to unions and employers to register under the compulsory or voluntary arbitration sections of the act, was defeated. Several members spoke strongly against compulsory arbitration,

Metric System.—The Parliamentary committee was instructed to support the bill for the adoption of the metric system of weights and measures.

Old Age Pensions.—The Congress urged on the Government the necessity of establishing a national system of old age pensions.

Factory Acts.—The Parliamentary committee were urged to secure building inspectors for the examination of machinery and plant during construction and demolition of buildings, more inspectors for other trades, with authority to enforce that a record be preserved of all accidents, to be tabulated and published yearly by the Labour Department of the Board of Trade.

Eight-hour Day.—A resolution in favour of an eight-hour day in all trades and occupations was passed.

Parliamentary Committee's Report.—The Parliamentary committee's report stated that, as the results of their work as a whole, the position of trade unionists was in advance of that which they held when they last met. On the subject of the Trade Unions and Trades Disputes Bill the best advice possible had been obtained, a measure being drafted to remedy the existing evils, but the result of the ballot at the beginning of the session proved unfavourable to their cause. Renewed and determined exertions would be required to secure the passing of the measure next session.

Presidential Address.—In his presidential address, Mr. R. Bell, M.P., complained that the Government had not amended the Workmen's Compensation Acts. The Taff Vale decision had played a very active part since the last Congress, while the Royal Commission on Trade Disputes dragged leisurely on. For over 30 years they had been free from capitalistic confiscations, and had believed they were free ; but their trade unions must be protected. Their movement had been built up at too much cost, sacrifice and suffering, and they must be prepared now to make some sacrifice to regain and maintain their position. The unions were the fortresses of their labour. It was to them that their condition to-day was due. Their movement would not permit them to wait for an indefinite period to regain their position. They must take full advantage of every opportunity, lest the enemy pounce upon them without warning. It was, therefore, imperative that all trade unionists should support only those seeking their suffrages who would pledge themselves to support the Trades Disputes Bill. They must be prepared to co-operate with all sections having that and other objects in common who were in sympathy with their aspirations, and who were desirous and willing to assist them.

Tramway Bye-Laws.—The Board of Trade have approved bye-laws for the regulation of tramway traffic in Devonport. Hitherto there has been no regulation in regard to overcrowding of cars and one of the new bye-laws limits the number of passengers carried on each car to the seating accommodation.

Wages in the Engineering Trade.—The Employers' Federation have given the north-east coast organising delegate of the Amalgamated Society of Engineers two months' notice of a reduction of

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2s. per week on time and 5 per cent. on piece rates, to take effect on the first full pay day after Oct. 22. The standard wage is at present 35s. per week.

Worcester.—Discussion took place at the Council meeting on Wednesday as to the working of the electric tramways, and the company were urged to provide a 10-minute service throughout the whole of the city.

Workhouse Lighting.—Sanction has been given to a loan of £15,700 for electric lighting of Burslem workhouse. The loan is repayable in 20 years.

Workmen's Compensation.—The return issued by the Home Office giving statistics of the proceedings under the Workmen's Compensation Acts, 1897 and 1900, and the Employers' Liability Act, 1880, during 1903 states that a comparison of the returns for 1903 with those for 1899 to 1902 does not show any great change in the operation of the Workmen's Compensation Act.

Compared with 1902, the year shows an increase in the number of cases taken into the Courts, but a decrease in the number of appeals. As in previous years, the majority of claims were settled by agreement, only a small percentage being made the subject of formal arbitration. Even in case of death, in less than 22 per cent. of the cases were proceedings taken, including a number of cases finally settled out of court.

Worthing.—There has been trouble at Worthing electricity works with the boiler water, and Mr. G. Porter, borough electrical engineer, recently reported to the Electricity committee that he had investigated the matter, and found that the corrosion and pitting of the boilers was due to the oxidising action of the local water on the boiler plates. On analysis the water was found to contain small quantities of free carbonic acid. It has been decided to treat the water in future with quicklime.

Tramwaymen's Sports.—The annual sports of the employés of the London United Tramways took place last week at Isleworth, and a long and varied programme was successfully carried out. The proceeds go towards the endowment of a "Mrs. Clifton Robinson Cot" for children at the West London Hospital. The distribution of the prizes was made by Mrs. J. Clifton Robinson.

Outing.—The annual outing of the employés of the electrical departments of the Sir Hiram Maxim Electrical & Engineering Co. (Ltd.) took place on Saturday, when a large party journeyed to Clacton-on-Sea, and were entertained to dinner by Sir Hiram Maxim and to tea by the directors. Mr. A. W. Hill, works manager, who presided, said the fact that they were gathered in greater number than ever before spoke for the appreciation shown by the electrical industry for the company's various manufactures. He trusted the coming year would show the same substantial progress as had the past. In spite of the unpromising weather at the outset, a very enjoyable day was spent.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Edmonton District Council are desirous of entering into an arrangement with a company for the exercise of their powers under their provisional order. Particulars and forms of tender of the clerk (Mr. W. F. Payne), Town Hall, Edmonton, to whom tenders by noon Sept. 27. See also advertisement.

Tynemouth Corporation invite tenders for supply and erection of a 600kw. steam dynamo. Specifications from the borough electrical engineer (Mr. C. Turnbull), electricity works, North Shields. Tenders to the town clerk (Mr. Horatio A. Adamson) by first post Sept. 3. See also advertisement.

Tenders are invited by the *Postmaster-General* until noon of Sept. 26 for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles. Forms of tender from the controller of stores (Mr. S. C. Hooley), Stores Department, G.P.O., 17-19, Bedford-street, London, W.C.

Leyton District Council invite tenders for the electric wiring and fittings required at Newport-road School, Leyton. Specifications, &c. (after 12th inst.), from the architect (Mr. Wm. Jacques, A.R.I.B.A.), 2, Fen-court, Fenchurch-street, London, E.C. Tenders to be delivered at meeting of Education committee at 7 p.m. Sept. 23.

Aberdeen Tramways committee invite tenders for supply and delivery of 20 top-deck car covers. Tenders to city electrical engineer (Mr. J. Alex. Bell), electricity works, Millburn-street, Aberdeen, by Sept. 27.

Tenders are required by 17th inst. for the supply at the District Asylum, *Ballinasloe* (Ireland) of a storage battery of 110 cells of not less than 342 ampere-hours' capacity, and having a maximum discharge rate of not less than 60 amperes.

Andover Council wish to enter into arrangements for taking a transfer of their proposed electric lighting order. Proposals by Oct. 1.

Wallasey District Council require tenders by 14th inst. for supply and erection of high-tension switchgear of British manufacture.

West Ham Guardians require tenders by 10 a.m. 14th inst. for 12 months' supply of electrical fittings.

Johannesburg Town Council invite tenders for the supply of (*a*) 800 10-ampere a.-c. meters; (*b*) 250 10-ampere, 40 25-ampere and 10 50-ampere d.-c. meters; and (*c*) 500 concentric and 100 triple concentric service fuse boxes. Tenders to the consulting engineers (Messrs. Mordey & Dawbarn), 82, Victoria-street, Westminster, S.W., by noon Sept. 12.

The Secretary of State for *India* invites tenders by 2 p.m. Sept. 20 for electrical plant.

The Municipal Council of *Philippopoli* (Bulgaria) invite tenders for the establishment of electricity supply and electric tramway undertakings in the town. The concession will be for 50 years. Particulars from M. Penkoff, Chef de la Section Technique, Municipal Offices. Tenders will be considered on Oct. 2, at 10.30 a.m., but will be reconsidered if by 10:30 a.m. on the following day a reduction of not less than 5 per cent. in the charge per kilowatt-hour for current is offered by any competitor.

The Société Orotschar et Kablar, *Tchatschak* (Servia), invite tenders until Oct. 2 for two turbines and two dynamos.

TENDERS RECEIVED AND ACCEPTED.

Poplar Borough Council has received the following tenders for condensing plant and motor:—

R. Woods & Co. (*recommended*)	£240 10	Bruce Peebles & Co.	£275 0
Cutting Bros.	290 0	Ditto	260 0
		Electromotors Limited	267 17

For the supply of coal to the end of March, 1905, nine tenders were received, and that of Facer & Co. (offering Hardwich, Pilsley and Staveley at 11s. 2d. per ton delivered by rail) is recommended for acceptance.

The contract for the hydraulic lift installation for the Finsbury Park station of the Great Northern, Piccadilly & Brompton Railway has been placed with C. & A. Musker, Liverpool. This is a similar installation to that which the same firm are just completing for the Highbury station of the Great Northern & City Railway, but of larger size.

The Army Council have placed a contract with Geipel & Lange, Vulcan Works, St. Thomas-street, Southwark, London, S.E., for 88 Geipel patent steam traps, to be fitted at the Royal Gunpowder Factory, Waltham Abbey. This is the seventh repeat order received for this factory, making in all 210 Geipel traps fitted there.

The South Lancashire Tramway Co. has accepted the tender of Krauss & Son for the construction of permanent way of the Tyldesley-Boothstown tramways.

Leeds Corporation have accepted the tender of the British Thomson-Houston Co. for 130 d.c. arc lamps at £3. 11s. 6d. each and 300 a.c. lamps at £4. 12s. 6d. each.

The tender of the Private Wire & Telephone Installation Co. has been accepted for installing electric light, telephones and electric bells at Baltic House, London, E.C.

Warrington Electricity and Tramways committee have accepted the tender of the St. Helens Cable Co. for supply of cables at £376. 13s. 2d.

The Metropolitan Asylums Board have placed an order with Messrs. Vickers, Sons & Maxim for engines, dynamos, extra boilers and electric motors for the training ship "Exmouth" at £2,270.

Metropolitan Asylums Board have accepted the tender of Baxter & Impey at £437 for installing internal telephones at the Eastern and Western Hospitals.

Dartford Council have accepted the tender of the Western Electric Co. for cable at £850. 6s. 10½d., and that of Nalder Bros. & Thompson for alterations to switchboard at £17. 11s.

The tender of G. H. Woods, Slacke & Co. has been accepted for the supply of generating plant and for the wiring of the York new asylum at £6,072.

Plymouth Electricity committee have accepted the tender of the British Westinghouse Co. for steam alternators at £4,141, and that of Hewitt & Kellet for boilers and piping at £3,228.

The tender of D. W. Davies & Co. has been accepted by Cardiff Electric Lighting committee for the erection of a sub-station at the docks.

Dublin Corporation have accepted the tender of Alex. Duckham & Co. for supply of engine oil for the Pigeon House electricity works at 1s. 5d. per gallon.

Worthing Town Council have accepted the tender of Danks & Co. for the removal of defective boiler-flues and the supply and fitting of new flues at £110.

Belfast Harbour Commissioners have accepted the tender of J. H. Wilson & Co. for two additional electric cranes at £3,200. This firm have already supplied 16 cranes to the Commissioners.

The Clyde Trustees have placed an order with Stothert & Pitt for the supply and erection of six electric cranes at the Clydebank dock.

Lincoln City Council have accepted the tender of E. Nuttall & Co. for the construction of the permanent-way of the High-street tramway.

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L. M. Ericsson & Co., Stockholm, have secured the contract for the equipment of the Johannesburg telephone system at £12,000.

Plymouth Education committee have accepted the tender of Heath & Co. for wiring the Technical School at £550.

BUSINESS NOTICES.

The Electrical Power Storage Co. (Ltd.), 4, Great Winchester-street, London, E.C., have appointed Messrs. Saunders, Todd & Co., Maritime-buildings, King-street, Newcastle-on-Tyne, their sole agents for Northumberland, Durham and the Tees district. The company has also made arrangements with Mr. J. W. Barnard whereby the "Q," "V" and small type E.P.S. cells (which come under his sole agency) will also be sold through Messrs. Saunders, Todd & Co., who will, therefore, be in a position to deal in all types of cells listed by the E.P.S. Co.

The offices of the Tudor Accumulator Co. (Ltd) have been removed from 16 to 119, Victoria-street, Westminster, London, S.W., where all correspondence should be addressed, and not to the company's works. Telegraphic address: "Subconical London," telephone 24 Victoria.

Mr. David Alexander, 43, Mains-street, Waterloo-street, Glasgow, has been appointed sole agent for Scotland for Messrs. Bray, Markham & Reiss (Ltd.), electrical engineers and manufacturers, Walthamstow, London, N.E.

Templer & Ranoe (Ltd.) have removed to Sterling Works, Spon-street, Coventry. Telephone number altered to 197.

Messrs. Cutting Bros., electrical engineers, Derby, have secured a site at Stamford for the erection of new works.

Messrs. John Wood & Wm. Wardle, electrical contractors, Durban (South Africa), have dissolved partnership. Mr. Wardle continues in his own name.

Messrs. J. Hubert Davies & Spain, electrical engineers, Pretoria, Johannesburg and Durban, have appointed a London representative at Salisbury House, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

J. W. Hunter and Albert Clapham (trading as the Yorkshire Motor Car & Electrical Engineering Co.), 101, Kirkstall-road, Leeds, have been adjudicated bankrupt.

Claims against the Electric Extension Co. (Ltd.) must be sent in by Oct. 1 to the liquidator (Mr. C. E. Ruckley), 12, St. John's-lane, Liverpool.

The Pioneer Electric Co. (Ltd.), is to be wound up voluntarily, with J. F. Albright and Robert Dand, 66, Victoria-street, London, as liquidators.

Sale by Auction.—Catalogues are now ready relating to the sale by Messrs. Brackett & Sons, on Tuesday next, at "Broomhill," Woodside-lane, North Finchley, London, N., of a complete private electric lighting plant installed on the premises. Some further particulars are given in an advertisement. There will be a private view on Monday, for which cards can be obtained of the auctioneers, 34, Craven-street, Charing-cross, London, W.C., and Tunbridge Wells.

Plant Wanted.—Vertical steam, feed and general service pumps are required. Particulars from borough electrical engineer (Mr. H. Faraday Proctor), Temple Back, Bristol. See also advertisement.

Plant for Sale.—Sunderland Corporation invite tenders for the purchase of two Willans-Holmes steam dynamos, two Crompton single-phase motor-alternators and 10 6kw. and two 10kw. E.C.C. single-phase transformers. Information from the borough electrical engineer (Mr. John F. C. Snell), Town Hall, Sunderland, and tenders (addressed chairman of Electricity and Lighting committee) to the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon Sept. 30. See also advertisement.

A small electric lighting plant suitable for a hotel or small works (including a 6 H.P. Otto gas engine, Taunton dynamo, &c.) is advertised for sale by Messrs. Blane and Riding, C.A., 80, Birley-street, Blackpool.

Messrs. Neil McLean & Co., 227, Main-street, Gorbals, Glasgow, have for sale some electric lighting plant, including five Edison-Hopkinson, three Siemens, one Kapp and some Brush dynamos, and steam engines by Galloways, Marshall and other makers. See also advertisement.

Mr. W. J. Crampton, 73, Queen Victoria-street, London, E.C., has for sale three electric motors. See advertisement.

Mr. M. M. Henderson, 4, Stirling-street, Airdrie, N.B., has electric lighting plant for sale. See advertisement.

Premises to Let.—Messrs. Marshall & Co., Campbell Works, Stoke Newington, London, N., have some premises (with electric power) to let. See advertisement.

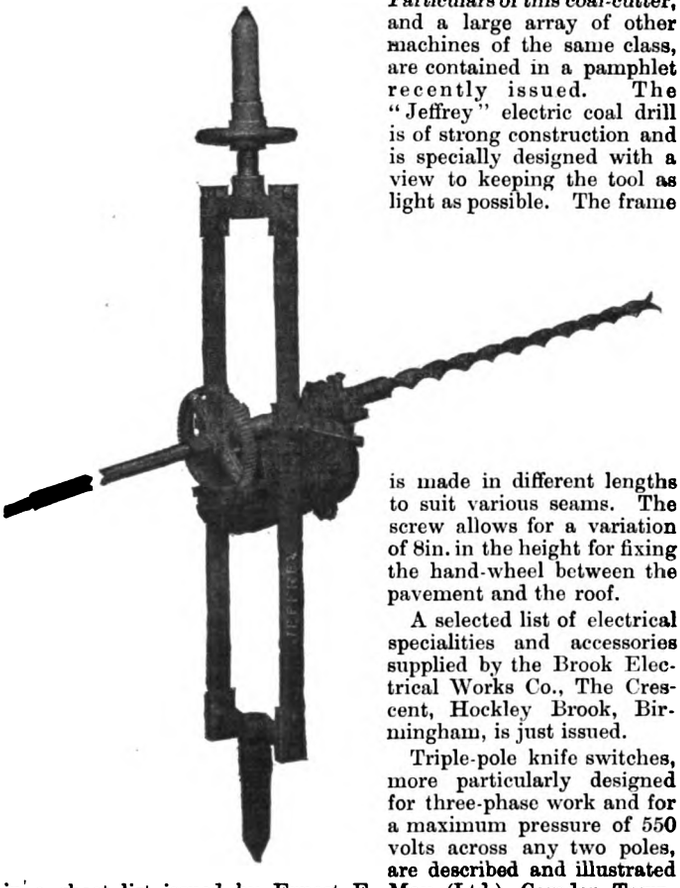
"**The Journal.**"—Part 168 of the "Journal" of the Institution of Electrical Engineers is now ready, price 8s. 6d. Particulars of contents are set out in an advertisement.

"**Engineering Telegraph Code.**"—A new edition of the "Engineering Telegraph Code" has been prepared by Mr. James Stevens, and will be welcomed by the engineering industry, for the work has come to be regarded as essential to the profession and industry of engineering. Mr. Stevens has brought to bear upon the "Engineering Code" an experience extending over 20 years, and the fact that the book has still no competitor may be accepted as proof that he has accomplished his task in a satisfactory manner. There are special features of the "Engineering Code" which enables its use in conjunction with other well-known telegraph codes without liability to confusion or error. The book consists of over 900 quarto pages, and is published at 9, Fenchurch-avenue, London, E.C.; price 40s. net.

"**Four Powers.**"—Under the title of "The Book of the Four Powers" (Steam, Gas, Water, Electricity) the Allis-Chalmers Co., of Chicago, have prepared a pamphlet describing and illustrating examples of plant built and erected by the company for various classes of work. Much of this plant has been erected in the United Kingdom, including the power stations of the Dublin United Tramway Co., the London United Tramways Co. and the Central London Railway.

Catalogues, &c.—The Electric Construction Co., Dashwood House, New Broad-street, London, E.C., and Bushbury Engineering Works, Wolverhampton, have prepared for issue to the trade an effective illustrated hanging sheet, showing numerous fine examples of the company's standard makes of electric generating machinery, motors, converters, mining locomotives and machinery, pumping plant, haulage gear, and switchboards and apparatus for use in polyphase or continuous-current work. The illustrations are excellent examples of the printing art, and the sheet is altogether admirably arranged and well adapted for giving prominent publicity to the company's manufactures.

The accompanying illustration shows one type of electric coal drill supplied by Messrs John Davis & Son, All Saints Works, Derby. Particulars of this coal-cutter, and a large array of other machines of the same class, are contained in a pamphlet recently issued. The "Jeffrey" electric coal drill is of strong construction and is specially designed with a view to keeping the tool as light as possible. The frame



is made in different lengths to suit various seams. The screw allows for a variation of 8in. in the height for fixing the hand-wheel between the pavement and the roof.

A selected list of electrical specialities and accessories supplied by the Brook Electrical Works Co., The Crescent, Hockley Brook, Birmingham, is just issued.

Triple-pole knife switches, more particularly designed for three-phase work and for a maximum pressure of 550 volts across any two poles, are described and illustrated in a sheet list issued by Ernest F. Moy (Ltd.), Camden Town, London, N.W.

The British Thomson-Houston Co., in their pamphlet No. 172, just issued, describe and illustrate the Hospitalier "Ondograph," which is intended for use in connection with alternating-current phenomena. It is claimed by the manufacturers that the "Ondograph" will register waves directly upon a sheet of paper within a period of half a minute without the necessity of bringing complicated scientific apparatus into use, the action of the instrument being based, to a large extent, upon the Joubert method of plotting alternating-current waves by momentary contact. A full description of the "Ondograph" appeared in *The Electrician* of Dec. 11, 1903.

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The St. Helens Cable Co. have prepared a neat booklet describing the construction, manufacture and use of "Dialite" cables. Accompanying these descriptions are particulars of various tests and a long list of testimonials from users of "Dialite." The company claim that the past year's practical experience of these cables has exceeded the most sanguine anticipations.

New lists of Ediswan lamps, of measuring instruments, recorders, meters and testing sets, and of wires and cables are issued by the Edison & Swan Co.

In a pamphlet issued by the Edison Electric Illuminating Co., Boston, America, some excellent illustrations of illumination on the Edison system are illustrated and described. In one building of which an illustration is given 5,388 Edison incandescent lamps are installed.

Price lists of new Lahmeyer motors, one for continuous-current machines up to 10 H.P. and the second for the company's Schuler patent single-phase alternating current motors, are issued by the Lahmeyer Electrical Co., 109-111, New Oxford-street, London, W.C. The company notify further that literature describing the advantages of the Schuler motors is in preparation and will be issued shortly.

Imports.—The following are official values of imports of electrical machinery, material and apparatus into this country during August:

Electrical machinery, £56,745 (an increase of £22,954 compared with August, 1903); telegraph cables and apparatus, £3,235 (decrease £5,164); other electrical goods £67,766 (decrease £10,641). The total imports of the three classes during the eight months ended 31st ult. were respectively £372,921 (decrease £18,616), £23,666 (decrease £18,446) and £502,265 (increase £2,458).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Aug. 31 to Sept. 6, with the ports of destination:—

Africa—Alexandria, £76; Cape Town, £979 (including £245 telegraph material); Delagoa Bay, £200; Durban, £3,357 (including £1,109 telegraph wire); East London, £361; Larache, £70; Mombasa, £16; Port Elizabeth, £45; Sierra Leone, £9. *Argentina*—Buenos Ayres, £979. *Australasia*—Adelaide, £125; Brisbane, £268; Fremantle, £111; Hobart, £38; Melbourne, £153 (including £43 telegraph material); Otago, £352; Perth, £116; Sydney, £700; Wanganui, £75; Wellington, £181. *Brazil*—Pernambuco, £162; Rio Janeiro, £260. *Burma*—Rangoon, £14. *Canary Islands*, £14. *Ceylon*—Colombo, £105. *Channel Islands*, £146. *Chili*—Santiago, £37; Valparaiso, £149 (telegraph material). *China*—Shanghai, £527. *Colombia*—Santos, £9. *France*—Paris, £124. *Germany*—Hamburg, £10. *Gibraltar*, £18. *Holland*—Amsterdam, £40; Rotterdam, £17. *Hong Kong*, £22. *India*—Bombay, £144; Calcutta, £1,102 (including £140 telegraph material); Madras, £260. *Portugal*—Lisbon, £461 (telegraph material). *Russia*—St. Petersburg, £881 (including £810 telegraph material). *Siam*—Bangkok, £263. *Straits Settlements*—Penang, £647 (including £435 telegraph material); Singapore, £2,061 (including £79 telegraph material). *Sweden*—Stockholm, £77 (telegraph cable). *U.S.A.*—Newport News, £35. *West Indies*—Barbados, £34. Total £15,830, against £8,019 in the corresponding week last year (Sept. 2 to 8).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

July 8, 1904.

15,300 B.T.-H. Co. (G.E. Co., U.S.). Transformers.
15,301 B.T.-H. Co. (G.E. Co., U.S.). Electric railways.
15,302 B.T.-H. Co. (G.E. Co., U.S.). Systems of electrical distribution.
15,303 B.T.-H. Co. (G.E. Co., U.S.). Enclosed fuses.
15,304 B.T.-H. Co. (G.E. Co., U.S.). Electric controllers.
15,312 W. H. TOMSON and W. G. HANNA. Brasses or bushes for bearings of motors.

July 9, 1904.

15,332 J. W. LEA and J. H. PERRINS. Birmingham. Sliding apparatus for raising or lowering electroliers, &c.
15,343 A. ANDERSON and J. F. DUNNE. Liverpool. Overhead electric railways.
15,344 H. H. BERRY and F. RISCH. Automatic safety device for overhead wires.
15,360 A. KÖLLING. Germany. Electrolytic circuit-breaker.*
15,357 J. G. THOMAS and D. E. LEWIS. Couplings for electrical wires.*
15,383 I. B. BIRNBAUM and H. G. WHITE. Sub-station connecting arrangement for telephone systems.
15,384 J. A. GAMBLE. Liverpool. Memorandum and like appliances for use in connection with telephones and for other purposes.
15,386 J. B. RUBANDO, A. ESTIER, H. ESTIER, J. MALLET and A. MOUREN. Electrical elevator.
15,391 W. M. BROWN. Surface-contact electric railway systems.*

July 11, 1904.

15,396 J. YOUNG. Protecting insulation of electric light flexible cords.
15,419 J. H. BAINBRIDGE. Laminated iron sections for alternating-current transformers.
15,441 H. VON PÉCHY and V. REA. Automatic firing apparatus for guns and firearms having electrical or electro-mechanical ignition.*
15,452 J. S. PECK. Systems of electrical distribution. (Date applied for, Aug. 8, 1903, date of application in U.S.)*
15,453 C. OLIVER. Arc lamps.
15,455 M. B. FIELD, C. C. GARRARD and FERRANTI LIMITED. Relays for automatic circuit-breakers.
15,465 B.T.-H. Co. (G.E. Co., U.S.). Hoisting and similar apparatus.
15,467 O. O. KRUH. Vapour electric conductors. (Date applied for, July 11, 1903, date of application in U.S.)*
15,468 E. WEINTRAUB. Vapour electric lamps or rectifiers. (Date applied for, July 11, 1903, date of application in U.S.)*
15,469 O. O. KRUH. Vapour electric conductors. (Date applied for, July 13, 1903, date of application in U.S.)*
15,472 A. FREY. Incandescent lamps.*

July 12, 1904.

15,495 LANCASHIRE DYNAMO & MOTOR CO. and R. S. MCLEOD. Liverpool. Dynamo-electric machines for regulating the charge and discharge of storage batteries used with main generators.
15,512 E. J. CLARK and HART ACCUMULATOR CO. Lid for acid containers.*
15,517 J. LOMMATZSCH, B. MENSCH and O. SIEGERT. Dynamo-electric engine.*
15,525 F. DREXLER. Electro-pneumatic actions of keyboards.
15,529 E. G. S. MCCLELLAN. Electrically-operated wire entanglements for protection of harbours in war-time.
15,551 O. WILHELMI. Prevention of fires from short circuits.
15,561 W. P. THOMPSON. Liverpool. Indicators for electric oscillations. (Gesellschaft für Drahtlose Telegraphie m.b.H., Germany.)*
15,563 J. WILLIS. Liverpool. Electromagnetic signalling devices.
15,567 H. CABBONNELLE. Electric or telephonic transmission.*

July 13, 1904.

15,581 A. C. BROWN. Telephone, telegraph and other call systems.
15,599 A. B. THOMPSON. Oldham. Metallic thermo-metrical electrical indicator.
15,612 E. G. P. BOUSFIELD and OZONISED OXYGEN CO. Changing or reversing direction of electric currents.
15,614 W. LANGDON-DAVIES and A. SOAMES. Dynamos used with other dynamos or cells.
15,616 CROMPTON & CO. and R. GOLDSCHMIDT. Chelmsford. Single-phase alternate-current motors.
15,617 CROMPTON & CO. and E. W. ABBOTT. Chelmsford. Electric contact or supporting gears.
15,618 CROMPTON & CO. and R. C. HARRIS. Electric circuit-breakers.
15,626 W. B. SAYERS and MAVOR & COULSON. Dynamo-electric machines.
15,627 G. B. BOWELL. Electric clocks.
15,632 B.T.-H. Co. (G.E. Co., U.S.). Protection for parallel electric feeders.
15,633 B.T.-H. Co. (G.E. Co., U.S.). Hoisting apparatus.
15,634 S. FERGUSON. Systems of electrical distribution. (Date applied for, July 13, 1903, date of application in U.S.)*
15,637 W. T. UPTON, J. E. ELLIOTT and H. B. PRATT. Regulating mechanism for arc lamps.*

July 14, 1904.

15,646 VERITYS LIMITED and A. E. GOTT. Birmingham. Fuse, distribution and like boxes.
15,648 VERITYS LIMITED and A. E. GOTT. Birmingham. Electric motor starters and electrical resistances.
15,651 E. A. GREAVES. Liverpool. Life-guards for electric vehicles.
15,677 W. H. DANSON. "Shoulder-grip" telephone receiver rest.
15,691 A. E. MEAD. Electric lighting and advertising.
15,692 F. E. ELMORE. Collecting current from armatures of unipolar dynamo-electric machines.
15,699 W. BOEHM. Resistances.*
15,701 A.E.G. Instruments for determining drop of potential in electric transmission systems. (Date applied for, July 14, 1903, date of application in Germany.)*
15,704 W. M. MORDEY and G. C. FRICKER. Electricity meters.
15,708 LA SOCIÉTÉ L. GAUMONT & CIE. Electrically controlling phonographs and cinematographs in combination. (Date applied for, July 17, 1903, date of application in France.)*
15,712 L. H. WALTER. Wireless signalling.

July 15, 1904.

15,730 L. SMITH. Manchester. Electroliers, &c.
15,732 VERITYS LIMITED and J. SOTHCOTT. Birmingham. Electric light fitting.*
15,762 S. COWPER-COLES and SHERARD COWPER-COLES & CO. Electrotypes.
15,770 T. H. MARSH and A. B. MUDIE. Cases for switches, fuses, &c.
15,771 SIEMENS BROTHERS & CO. and H. BERRY. Connector for the armature and commutator of dynamo-electric machines.
15,772 SIEMENS BROTHERS & CO. and W. DIESELHORST. Manufacture of insulated conductors and apparatus therefor.*
15,778 W. GRIFFITHS and B. H. BEDELL. Contact stud and switch for surface contact systems.
15,796 C. H. MERZ and B. PRICE. Alternate-current distributing systems.
15,802 M. J. STONE and E. T. FENWICK. Liverpool. Conduits.

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SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1903.

15,970 LYCETT and CONATY. Electric tramcars.
16,868 RAMSBOTTOM and RICHARDSON. Portable accumulators.
17,179 LAKE (Morgan Electric Machine Co.). Electric railway systems and apparatus.
17,207 DUTTON and SANDYCROFT FOUNDRY CO. (LTD.). Dynamo-electric machines.
17,603 MANLEY. Reversing mechanism for dynamos.
18,121 MENSING. Enclosed or open arc lamps.
19,948 HUNT and SANDYCROFT FOUNDRY CO. (LTD.). Alternating-current induction motors.

1904.

4,663 and 4,663A THOMAS. Rupturing electric circuits. (Date applied for, June 27, 1903.)
5,105 THOMPSON (Gesellschaft für drahtlose Telegraphie, m.b.H.). Method of receiving electrical vibrations utilising electrolytic cells.
7,586 KITSEE. Telegraphy.

STATUTORY RETURNS, LIENS REGISTERED, &c.

STATUTORY RETURNS.

EASTERN & SOUTH AFRICAN TELEGRAPH CO. (LTD.)—The return to Aug. 5 gives capital as £600,000 in 60,000 shares of £10 each, all of which have been taken up and paid for in full. Mortgages and charges, £500,000.

ELECTRIC CONSTRUCTION CO. (LTD.)—The return to July 28 gives capital as £400,000 in 50,000 preference and 150,000 ordinary shares of £2 each, of which 31,390 preference and 112,100 ordinary shares have been taken up. £2 per share has been called on 18,245 preference and 2,100 ordinary. £246,290 is considered as paid on 13,145 preference and 10,000 ordinary shares. Mortgages and charges, £250,000.

CHILI TELEPHONE CO. (LTD.)—According to return to Aug. 3, 1901, the capital is £250,000 in 50,000 shares of £5 each, of which 44,000 have been taken up. £220,000 has been received. Mortgages and charges, £35,000.

CROMPTON & CO. (LTD.)—In the return to Aug. 22 (filed Aug. 27) the capital is £300,000 in 100,000 shares of £3 each, of which 85,000 have been taken up. £255,000 has been received. Mortgages and charges, £100,000.

MORTGAGES AND CHARGES.

BRITISH ELECTRIC CALIBRATED FUSE CO. (LTD.)—Issue on Aug. 29 of £550 5 per cent. debentures, part of series created Dec. 4, 1903, to secure £3,000, charged on company's undertaking and property, present and future, including uncalled capital. Holder, J. Lang. No trustees. Previously issued of same series, £2,150.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—A mortgage by sub-demise dated Aug. 5, 1904 (supplemental to trust deed dated July 20, 1894, securing £250,000 first debenture stock), and a further mortgage by sub-demise of even date (supplemental to trust deed dated July 4, 1899, securing £250,000 second debenture stock), have been registered. Property charged in both cases, certain freehold and leasehold hereditaments. Trustees for first debenture stockholders, Sir R. G. W. Herbert, G.C.B., and Sir James Pender, Bart. Trustees for second debenture stockholders, D. Meinertzhagen and Admiral Lord John Hay, G.C.B.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26 5/16d. per oz. (Sept. 8). Consols 88 5/16—88 7/16, for money, 88 9/16—88 11/16, for account; 2½ per cent. annuities 87½—88. Consols Pay Day, Oct. 5; Stocks and Shares Continuation Days, Sept. 13 and 27; Ticket Days, Sept. 14 and 28; Pay Days, Sept. 15 and 29; Mining Share Carry-over Day, Sept. 12.

ELECTRIC RAILWAY & TRAMWAY CARRIAGE WORKS (LTD.)—The report for the year ended June 30 states that the works have been efficiently maintained out of revenue. After paying interest (£2,500) and charging £4,299. 7s. for depreciation, the profit is £5,546. 3s. 4d., added to £4,826. 18s. 7d. from last year. The directors recommend payment of a dividend of 5 per cent. (less tax) for the year, absorbing £7,500. Severe competition and general slackness of trade account (it is stated) for the falling off in profits for the past year, but the directors consider the prospects for the coming year have improved.

GENERAL ELECTRIC CO. (LTD.)—The transfer books of the 4 per cent. debenture stock will be closed from 17th to 30th inst. inclusive.

RAND CENTRAL ELECTRIC WORKS (LTD.)—The result of working for August is 879,475 kw.-hours generated, yielding a gross revenue of £8,150, compared with 727,545 kw.-hours and £6,394 for the corresponding period of last year.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.)—The 4½ per cent. first mortgage debenture stock transfer register will be closed from 17th to 30th inst. inclusive for the preparation of interest warrants payable Oct. 1.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee have been asked to appoint a special settling-day in and to grant a quotation to a further issue of 10,000 £5 fully-paid 6 per cent. preference shares of the *London Electric Supply Corpn. (Ltd.)*.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept. 3	1,667	+ 355	13	23,218	+ 4,457
Airdrie	Aug. 26	209	...	29	5,748	...
Ayr Corporation	Sept. 3	349	+ 74	16	6,704	+ 225
Barnsley	Aug. 16	231	- 26	34	5,805	- 420
Barrow	,, 26	261	...	29	5,550	...
Bath Electric Trams, Ltd.	,, 31	804	...	35	22,226	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	Sept. 4	1,100	- 88	...	...	...
Birmingham Corporation	...	...	...	...	...	...
Birmingham Tramways Co.	,, 3	5,179	- 22	9	49,040	+ 2,594
Blackburn Corporation	,, 2	1,026	+ 238	23	22,587	+ 2,336
Blackpool Corporation	,, 1	2,231	+ 618	21	30,892	+ 4,108
Blackpool and Fleetwood	,, 5	1,464	+ 95	9	14,046	- 40
Blackp'l, St. Anne's & Lytham	,, 1	902	+ 207	44	16,747	+ 6,854
Bolton Corporation	,, 4	1,842	- 71	23	43,645	+ 271
Bournemouth Corporation	Aug. 31	1,455	+ 26	‡22	26,567	+ 1,474
Bradford Corporation	Sept. 3	5,117	+ 1,342	22	106,499	+ 18,970
Brighton Corporation	,, 4	1,280	+ 178	22	25,182	+ 2,479
Brisbane Tramways	July 20	2,147	- 66	3	6,463	- 806
Bristol Trams & Carriage	Sept. 2	4,494	+ 295	15	81,765	+ 683
Buenos Ayres & Belgrano	Aug. 7	3,410	+ 500	16	52,233	+ 2,801
Burnley Corporation	Sept. 3	1,117	+ 278	23	24,616	+ 5,686
Burton Corporation	,, 4	383	- 11	¶22	8,353	+ 2,098
Calcutta Tramways Co.	,, 3	a36,474	+ a2,714	10	a321,195	+ a37,338
Camborne-Redruth	Aug. 22	124	- 9	17	2,012	- 116
	,, 29	116	- 15			
Cardiff Corporation	Sept. 3	2,159	+ 121	22	47,800	+ 1,638
Carlisle Tramways Co.	,, 3	228	+ 6	35	7,065	+ 278
Central London Railway	,, 3	5,602	+ 109	9	52,182	- 1,957
Chatham & Dist. Lt. Rys.	,, 1	671	- 63	35	20,799	+ 2,157
City & South London Rly.	,, 4	2,439	+ 24	10	23,206	- 1,067
Colchester Corporation	,, 1	356	...	5	1,979	...
Cork Electric Trams Co.	,, 1	568	- 66	35	16,453	- 2,123
Darwen Corporation	,, 2	251	+ 21	22	5,247	- 78
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	Aug. 26	629	+ 147	34	18,310	+ 3,038
Dover Corporation	Sept. 3	285	- 25	23	5,662	- 158
Dublin & Lucan Railway	,, 2	158	- 8	9	1,358	+ 24
Dublin Southern District	,, 2	1,193	+ 138	9	52,047	- 3,117
Dublin United	,, 2	4,498	+ 153			
Dudley—Stourbridge	Aug. 26	945	+ 7	34	29,756	+ 1,155
Dundee Corporation	,, 31	867	- 89	...	...	...
East Ham Council	Sept. 3	746	- 12	22	17,485	+ 1,871
Gateshead & Dist. Trams	Aug. 26	930	- 24	34	30,363	+ 1,349
Glasgow Corporation	Sept. 3	15,026	+ 1,401	†14	195,769	+ 12,509
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	Aug 26	295	- 29	34	8,892	+ 774
Gt. Northern & City Rly.	Sept. 3	1,054	...	29	27,368	...
Greenock & Port Glasgow	Aug. 26	638	- 15	34	19,557	+ 937
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 26	331	+ 5	34	10,195	+ 948
Huddersfield	...	...	...	...	...	...
Hull Corporation	Sept. 3	2,300	+ 458	23	48,727	+ 6,658
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	Aug. 31	170	- 22	...	...	...
Ipswich Corporation	Sept. 3	617	...	22	12,250	...
Isle of Thanet Co.	,, 3	1,618	+ 110	¶49	28,597	+ 929
Kidderminster & District	Aug. 26	154	+ 5	34	4,514	- 12
Kirkcaldy Corporation	,, 31	257	+ 28	35	8,108	...
Lanarkshire Trams Co.	Sept. 1	762	+ 171	35	22,253	...
Leeds Corporation	,, 3	6,290	+ 961	24	157,687	+ 8,788
Leicester Corporation	,, 3	1,506	...	16	21,645	...
Liverpool Corporation	Aug. 27	10,411	+ 11	35	361,869	+ 11,785
Liverpool Overhead Rly.	Sept. 4	1,594	- 120	†10	16,968	- 271
*London County Council	Aug. 27	13,399	+ 3,236	§22	270,478	+ 55,049
Lowestoft	Sept. 3	391	+ 9	...	...	...
Maidstone Corporation	...	...	...	...	...	...
Manchester Corporation	,, 3	12,987	+ 1,097	22	276,784	+ 11,474
Mersey Railway	,, 3	1,406	+ 148	9	12,942	+ 846
Merthyr	Aug. 26	206	+ 2	34	6,899	+ 132
Metropolitan Elec. Trams	Sept. 2	2,224	+ 784	9	17,573	+ 3,642
Middleton	Aug. 26	488	+ 68	34	11,317	+ 128
Nelson Corporation	Sept. 3	145	+ 34	23	2,794	+ 991
Newcastle-on-Tyne Corp.	,, 3	3,655	+ 260	9	33,461	+ 2,388
Newport (Mon.)	,, 3	589	+ 49	22	11,940	+ 2,158
Oldham, Ashton & Hyde	Aug. 26	646	+ 86	34	18,766	- 890
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams.	Sept. 2	1,244	+ 66	35	45,954	+ 5,731
Peterborough	Aug. 26	171	- 7	34	5,245	- 115
Poole and District	,, 26	430	- 11	34	10,416	- 20
Portsmouth Corporation	...	...	...	...	...	...
Potteries	,, 26	1,595	+ 16	34	57,869	+ 4,938
Reading Corporation	Sept. 1	716	+ 29	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	Aug. 26	330	+ 5	34	5,462	- 115
Salford Corporation	Sept. 5	4,158	+ 1.0	22	94,281	+ 6,879
Sheerness	Aug. 24	93	- 4	34	2,172	- 456
Sheffield Corporation	Sept. 4	4,810	+ 107	§23	110,005	+ 2,675
Southampton Corp'ation	Aug. 18	1,064	- 125	...	...	...
	,, 25	1,10:	- 70			
Southend Corporation	,, 31	540	+ 59	22	9,497	+ 1,138
Southport Tramways	,, 26	497	+ 112	34	11,420	+ 620
S. Staffordshire Trams.	,, 26	725	- 371	34	26,309	- 8,928
Stockport Corporation	Sept. 2	640	+ 266	22	13,854	+ 5,888
Sunderland Corporation	,, 4	1,388	+ 13	22	30,282	+ 726
Swansea Trams	Aug. 16	610	+ 8	34	18,838	+ 1,011
Taunton Trams	,, 26	68	- 1	34	1,936	- 180
Tynemouth and District	,, 26	371	- 105	34	10,354	- 803
Tyneside Trams Co.	,, 31	448	+ 89	35	13,565	+ 2,188
Wallasey District Council	Sept. 3	860	+ 87	§22	18,098	+ 1,138
Walsall	,, 3	495	...	35	17,070	...
Warrington Corporation	,, 1	232	+ 15	22	7,287	+ 249
West Ham Corporation	,, 1	1,212	...	27	23,870	...
Weston-super-Mare	Aug. 24	343	+ 28	34	4,573	+ 272
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 26	424	- 4	34	13,391	- 91
Worcester	,, 26	343	+ 185	29	9,349	+ 4,372
Wrexham	,, 26	111	- 32	34	3,820	- 559
Yorkshire Woollen District	,, 26	592	+ 95	34	20,432	+ 8,161

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Sept. 7.	Rate per Cent. Yielded.	Dividend Due.	Business Week to Sept. 7.	Share.	Last Dividend.	Name.	Price Wed., Sept. 7.	Rate per Cent. Yielded.	Dividend Due.	Business Week to Sept. 7.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.		Highest. Lowest.			**ELECTRICITY SUPPLY.**		£ s. d.		Highest. Lowest.
5	..	Anglo-Argentine Ordinary Shares	6⅛–6⅝		April, Oct	6⅝ 6⅛	1	..	Blackheath & Gr'nwich Dist. Ord. (f.p.)	¾–1			
5	2 6	Do. 5% Cum. Pref.	5⅝–5⅞	4 8 10	..	5⅞ 5⅝	1	0/8½	† Do. 7% Cum. Pref.	1⅛–1⅜	5 1 9	..	.. ..
8s.	6%	Do. Permanent 6% Deb. Stock	137 –141	4 5 0	..	140 ..	8s.	..	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & com.)	105 –109	4 3 0	..	107 ..
8s.	5%	Auckland Elec. Trams 5% Deb. (red.)	99 –101	4 19 9	..	100 ..	10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½–12½	6 8 0	..	12 ..
10	6%	Barcelona Tramways Ord.	9 –10	3 0 0	..	⅝ ..	10	4/6	Do. 4½ per Cent. Cum. Pref	9½–10½	4 5 9	..	.. ..
10	5/0	Do. 5% Cum. Pref.	9 –10	5 0 0	..	.. ..	10	6/0	Do. 6% Cum. Second Pref.	10½–11½	5 4 4	..	.. ..
8s.	4½%	Do. 4½% Deb. Stock (red.)	91 –96	4 14 0	..	100 ..	8t.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 –105	4 6 3	..	.. ..
100	5%	Do. 5 per Cent. Debs.	98 –101	4 19 6	..	.. ..	5		Bromley (Kent) El. Lt. & Power Shares	5½–6			
1	..	Bath Elec. Trams Pref. Ord.	1⅛–1⅜		..	1⅛ ..	8t.	4½%	Do. Do. 1st Debs	100 –103	4 7 5	..	.. ..
1	..	Do. 5% Cum. Pref.	⅞–1	..	..	⅞ ..	5	4/6	Brompton & Kensington Elec. Sup. Ord.	10¾–11¼	4 8 11	..	11⅛ 11
5	..	Brisbane Electric Trams. Invest. Ord.	1¾–2⅛		..	.. ..	5	3/6	Do. 7 per Cent. Pref.	10¾–10⅞	3 5 1	Mar, Sept	.. ..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅞–4⅛	5 17 8	..	.. ..	5	4/0	Calcutta Electric Supply Ord.	7⅛–7¼	4 10 5	..	7⅛ 7
8t.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96 –101	4 9 3	..	98½ 98	8t.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 –109	3 13 11	..	.. ..
10	8%	Bristol Tramways and Carriage Ord.	19 –20	4 0 0	Feb, Aug	.. ..	5	4/0	Charing Cross & Strand Electric Sup.	7⅜–8⅛	4 17 0	Feb, Aug	8⅛ ..
10	4%	Do. Cum. Pref. (fully paid)	10 –10½	3 16 2	..	.. ..	5	2/3	Do. 4½ per Cent. Pref.	5⅛–5⅜	4 3 7	Feb, Aug	.. ..
8t.	4%	Do. 4 per Cent. Debs.	107 –109	3 13 4	Feb, Aug	.. ..	5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅜–5	4 10 0	..	4⅜ ..
8t.	6%	British Columbia Elec. Rlwy. Def. Ord.	97 –100	6 2 6	..	.. ..	5	2/3	Do. Do. (1903)	4⅜–5	..	..	4⅜ ..
8t.	5%	Do. Pref. Ord. Stock	100 –103	4 18 0	..	.. ..	8t.	4%	Do. 4% Deb. Stock (red.)	102 –104	3 17 0	..	.. ..
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10½	4 15 3	..	10⅛ 10⅛	5	3/6	Chelsea Electric Supply Ord.	6½–7	4 2 2	March ..	6⅞ 6⅞
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅞–105⅞	4 6 2	..	.. ..	8t.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –109	4 2 6	Jn, Dec ..	.. ..
100	4½%	Do. Vancouver Power Debs.	97 –100	4 10 0	..	.. ..	10	5/0	City of London Electric Lighting Ord.	10½–10⅝	4 13 0	Feb, Aug	10⅝ 10⅛
10	6/0	British Electric Traction Ord.	8⅞–9⅛	6 9 9	..	9⅛ 9	10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	.. ..
10	6/0	Do. 6 per Cent. Cum. Pref.	10½–11	5 9 1	Feb, Aug	10⅜ 10⅛	8t.	5%	* Do. 5 per Cent. Deb. Stock (red.)	120 –125	4 0 0	Jn, Dec ..	.. ..
8t.	5/0	Do. 5 per Cent. Perpetual Debs	117 –120	4 4 9	..	118⅛ ..	8t.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 –105	4 5 9	..	.. ..
1 t.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	94 –97	..	..	96 96⅛	10	4/0	County of London Elec. Supply Ord.	7⅛–8⅛	4 14 3	..	8⅛ 8
5	3/0	Buenos Ayres and Belgrano Ord.	3 –3⅛	4 12 3	..	3⅛ 3	10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12	5 0 0	Mar, Sept	.. ..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5⅛–5⅜	5 4 4	..	5⅜ ..	8t.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	105 –108	4 3 6	..	.. ..
5	3/0	Do. "B"	5 –5⅛	5 9 1	..	.. ..	8t.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 7 10	..	.. ..
8t.	5%	Do. 5 per Cent. Debs.	105 –108	4 12 8	..	.. ..	8t.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 –93	5 7 6	..	.. ..
8t.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	101 –104	4 16 6	..	.. ..	5	3/6	Folkestone Electricity Supply Co. Ord.	5⅜–6⅛	4 8 0	..	.. ..
5	3/6	Calcutta Tramways	7⅛–7⅜	3 17 6	..	7⅛ 7⅛	8t.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 9	..	.. ..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	104 –107	4 4 6	..	106 ..	10	..	Havana Electricity Co. Shares	9½–10½	..	..	.. ..
1	1/0	Cape Electric Tram Shares	1⅜–2	5 0 0	..	.. ..	5	5/0	Hove Electric Lighting Ord.	7⅛–8½	5 0 0	..	.. ..
8s.	4%	Central London Ordinary Stock	86 –88	4 10 11	June, Dec	87½ 86½	8t.	4½%	I. of W. Elec Lt. & Power 4½% Db. St (red.)	101 –103	4 7 6	..	.. ..
8t.	4%	Do. 4 per Cent. Pref. Stock	100 –102	3 18 3	..	.. ..	1		Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅛–⅜	..	..	.. ..
8t.	4%	Do. Deferred Stock	80 –82	4 17 7	..	.. ..	5	5/0	Kensingtn & Knghtsbdge Ord.	12 –13	4 12 4	..	.. ..
100	4%	Do. 4 per Cent. Debs.	106 –109	3 13 5	..	107½ ..	5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	.. ..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½–5	5 0 0	..	.. ..	8t	4%	Kensingtn. & Knghtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 –105	3 16 6	..	.. ..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 –101	3 19 2	..	.. ..	3	..	London Electric Supply Ord.	1½–2	..	..	.. ..
8t.	2½%	City and South London Rly. Con. Ord.	42 –44	5 2 6	Feb, Aug	42½ 41⅞	5	3/0	† Do. 6 per Cent. Pref.	5 –5⅛	5 9 1	..	5⅛ ..
8t.	5%	Do. 5 per Cent. Perp. Pref. (1891)	121 –124	4 0 8	Feb, Aug	.. ..	8t.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 –99	4 1 6	Mr, Jn, S, D	97⅛ ..
8t.	5%	Do. (1896)	117 –120	4 3 6	..	.. ..	10	9/0	Metropolitan Electric Sup. Ord.	15½–16½	5 9 0	April, Oct	16½ 16
8t.	5%	Do. (1901)	115 –118	4 5 0	..	.. ..	5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅝–5⅞	4 0 0	Jan. July	5⅞ 5⅝
8t.	4%	Do. 4 per Cent. Perpetual Debs	105 –108	3 14 9	May, Nov	.. ..	8t.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 –115	3 18 11	Jn, Dec ..	.. ..
8t.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	100 –103	4 17 10	..	.. ..	8t.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 –99	3 10 6	..	.. ..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½–13½	4 8 11	..	.. ..	100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93 –96	4 13 9	..	.. ..
10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	.. ..	10	6/0	Notting Hill Electric Ord.	14 –15	4 0 0	March ..	.. ..
10	3/0½	†Gt. Northern & City Rly. Prf. Ord. (4%)	4⅛–5	..	..	.. ..	100	4%	Do. 4 per Cent. 1st Mt. Debs.	100 –103	3 18 3	..	.. ..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 –10	..	..	.. ..	5	4/0	Oxford Electric Ord.	5⅜–6⅛	5 4 0	March ..	.. ..
10	10%	‡ Imperial Tramways Ord	19 –20	4 10 0	Mar, Sept	.. ..	8t.	4%	Do. 4% Deb. Stock	97 –100	4 0 0	..	.. ..
10	6%	‡ Do. 6 per Cent. Pref.	14 –14½	4 2 9	Mar, Sept	.. ..	1	..	Rand Electric	1 –1⅛	..	..	.. ..
8t.	4½%	‡ Do. 4½ per Cent. Debs.	108 –110	4 1 10	Jan, July	.. ..	100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 –103	4 7 9	April, Oct	.. ..
5	2/6	†Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–4	6 5 0	..	.. ..	5	5/0	St. James' & Pall Mall Elec. Ord.	14½–15½	4 13 7	Feb, Aug	.. ..
8t.	4%	Do. 4 per Cent. Deb. Stock	88 –91	4 7 11	..	.. ..	5	3/6	Do. 7 per Cent. Pref.	8 –9	3 17 9	Feb, Aug	.. ..
10	13%	†Liverpool Overhead Railway Ord	3⅛–3⅜	3 9 9	Feb, Aug	.. ..	8t.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 –100	3 10 2	..	.. ..
10	5%	† Do. 5 per Cent. Pref.	10 –10½	4 15 3	Feb, Aug	.. ..	5	4/0	Smithfield Markets Electric Sup. Ord.	2⅞–3⅛	6 3 1	..	.. ..
8t.	4%	Do. 4 per Cent. Deb.	99 –101	3 19 3	Jan, July	.. ..	8t.	4%	Do. 4 per Cent. Deb. Stock	83 –88	4 10 11	..	.. ..
10	5/0	London United Trams. 5% Cum. Pref.	10⅛–11	4 10 11	..	10⅛ ..	5	3/0	South London Electric Supply Ord.	3¾–4⅛	8 10 7	..	4⅛ 4⅛
8t.	4%	Do. 4% 1st Mort. Deb. Stock	103 –105	3 16 4	..	.. ..	5	2/6	Urban Electric Supply Ord.	4⅛–5⅛	4 15 3	..	.. ..
8t.	..	Madras Elec. Trams 5% Deb. Stk.	100 –103	..	Jan, July	.. ..	5	2/6	Do. 5% Cum. Pref.	4⅛–5⅛	4 15 3	..	.. ..
8t.	..	Mersey Con. Ord. Stock	6 –9	..	..	.. ..	5	6/6	Westminster Electric Supply Ord.	12½–13½	5 0 0	Mar, Sept	12⅝ 12⅜
8t.	..	Do. 3 per Cent. Perp. Pref.	12 –15	..	..	.. ..	5	2/6	Do. 5 per Cent. Cum. Pref.	6 –6½	3 16 11	..	6⅜ ..
1	..	Metropolitan Electric Trams Def	⅛–⅜	..	..	.. ..							
1	0/6	Do. 5% Cum. Pref.	⅜–1	5 0 0	..	.. ..			**TELEGRAPHS.**				
8t.	13/7	Do. 4½% Deb. Stock	98 –100	..	..	99⅝ 99⅜	100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	97 –101	3 19 2	Jan, July	.. ..
100	5%	†Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	100 –103	4 17 3	..	.. ..	10	..	Amazon Telegraph	2⅜–3⅛	..	Jn, Dec ..	.. ..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 –105	4 5 9	..	.. ..	8t.	12/6	Anglo-American	51 –54	5 3 9	F, My, Ag, N	53½ 51½
5	..	New Gen. Tract. & per Cent. Cum. Pref.	1 –2	..	May	.. ..	8t.	25/0	Do. Preferred	56 –98	5 11 6	F, My, Ag, N	98½ 98
8t.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	100 –103	4 17 9	..	.. ..	8t.	2/0	Do. Deferred	8½–8¾	1 2 9	F, My Ag, N	8⅝ 8
10	10/0	Potteries Electric Traction Ord.	8 –9	5 11 2	..	.. ..	100	$2	Commercial Cable Capital Stock	170 –190	4 4 2	Jn, Ap, Jy, O	.. ..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½–9½	5 5 3	Feb, Aug	.. ..	8t.	4%	Do. 4 per Cent. Deb. Stock	94 –96	4 3 6	Jn Ap, Jy, O	96 94
8t.	4½%	Do. 4½ per Cent. Deb. Stock	101 –104	4 6 7	..	.. ..	10	5/0	Cuba Submarine Ord.	7 –8	7 10 0	Feb, Aug	.. ..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	.. ..	10	10/0	Do. Preference 10 per Cent.	15 –16	6 5 0	Feb Aug	.. ..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	.. ..	5	2/0	Direct Spanish Ord.	2¾–3⅛	5 14 4	April, Oct	.. ..
8t.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	.. ..	5	5/0	Do. 10 per Cent. Cum. Pref.	7 –8	6 5 0	April Oct	.. ..
8t.	3%	Waterloo and City Ord.	86 –89	3 7 5	June, Dec	.. ..	50	4½%	Do. 4½ per Cent. Deb.	98⅝–101⅝	4 9 2	Jan, July	.. ..
		ELECTRIC MANUFACTURING, &c.					20	3/0	Direct United States Cable	10 –10½	5 14 3	Ja, Ap, Jy, O	10⅛ 10
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	⅞–1	8 0 0	..	.. ..	100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 –101	4 9 2	Jn, Dec ..	.. ..
1	..	Aron Elec. Meter 6% Cum. Pref.	½–⅝	..	..	.. ..	8t.	65/0	Eastern Ordinary	126 –131	5 6 9	Ja, Ap, Jy, O	129 128
5	4/0	British Insulated & Helsby Cables Ord.	5¾–6⅛	6 8 0	July, Feb	.. ..	8t.	17/6	Do. 3½ per Cent. Pref. Stock	87 –60	3 18 6	Ja Ap, Jy, O	89 88
5	3/0	Do. 6 per Cent. Pref.	5⅝–6	5 0 0	Jan, July	.. ..	8t.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 –108	3 14 6	May, Nov	12⅞ 12⅝
8t.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 –104	4 6 7	..	.. ..	10	2/6	Eastern Extension	12 –12⅛	5 12 0	Ja, Ap, Jy, O	.. ..
8t.	4½%	†British Thoms'n-Houst'n 4½% 1st Mt. Db.	99 –101	4 9 1	..	.. ..	8t.	4%	Do. 4 per Cent. Deb. Stock	103 –106	3 15 6	Feb, Aug	106 ..
5	3/0	British Westinghouse 6% Pref.	2⅜–3⅛	9 4 6	..	3 2⅛	100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	99 –102	3 18 9	Feb, Aug	.. ..
8t.	4%	Do. 4 per Cent. Mort. Deb. Stock	85 –88	4 10 11	..	.. ..	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100⅞–103⅞	3 18 6	May, Nov	.. ..
2	..	Brush Electrical Engineering	⅛–⅜	..	March ..	.. ..	10	5/0	Gt. Nrthn. (of Copenhagen)	25⅛–26⅛	5 18 2	Jan, July	.. ..
2	2/4⅛	Do. 6 per Cent. Pref. Non-Cum.	1 –1⅛	8 0 0	Mar, Sept	1⅛ 1⅛	100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 –101	4 9 2	June, Dec	.. ..
8t.	4½%	† Do. 4½ per Cent. Perp. 1st Deb. Stock	94 –97	4 12 10	Mar, Sept	.. ..	25	37/6	Indo-European	43 –46	5 8 9	May, Nov	.. ..
8t.	4½%	Do. Perpetual 2nd Deb. Stock	70 –75	6 0 9	Jan, July	.. ..	100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 –100	4 0 0	June, Dec	.. ..
5	7/6	Callender's Cable Con. Ord.	9½–10½	5 14 3	Jan, July	10⅜ ..	10	6/0	West African Telegraph Shares	6 –7	5 14 3	..	.. ..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 10 11	Jan, July	.. ..	2½	..	West Coast of America	⅛–¼	..	..	.. ..
8t.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	101 –105	4 5 8	Nov, May	.. ..	100	4%	Do. 4 per Cent. Debs.	97 –100	4 0 6	Jan, July	.. ..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	⅜–½	6 17 2	..	.. ..	10	..	West India and Panama	⅜–½	..	May, Nov	.. ..
8t.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 –93	4 16 10	..	.. ..	10	6/0	Do. 6 per Cent 1st Pref.	6½–6¾	8 17 9	May, Nov	.. ..
1	1/2	Chadburn's (Ship) Telegraph Ord.	¾–1⅛	8 0 0	..	.. ..	10	..	Do. 6 per Cent. 2nd Pref.	5 –6	..	May, Nov	.. ..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½–2	3 15 0	Jan, July	.. ..	100	5%	* Do. 5 per Cent. Debs.	100 –103	4 17 10	Jan, July	.. ..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	90 –95	5 6 5	Jan, July	.. ..	10	3/0	Western Telegraph	12 –12½	5 12 0	Mr, Jn, Q, D	12⅝ 12⅜
5	..	Dick, Kerr & Co. Ord.	7½–8	..	..	.. ..	100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 –104	4 16 3	June, Dec	101 101
5	8/0	Do. 6% Cum. Pref.	5¼–5⅝	5 4 4	..	5⅜ ..	8t.	4%	Do. 4% Deb. Stock (red.)	100 –103	3 18 0	..	.. ..
8t.	4½%	Do. 4½% Deb. Stock	102–105	4 6 0	..	.. ..							
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½–¾	..	Feb, Aug	.. ..			**TELEPHONES.**				
5	..	Do. (£5 paid)	1 –2	..	Feb, Aug	.. ..	5	4/0	Chili Telephone (fully paid,	5 –5½	6 7 3	August ..	5⅛ 5⅛
8t.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 –82	4 18 1	June, Dec	.. ..	1	7½	Monte Video Teleph ne Ord.	⅛–⅜	..	..	10⅝ 10⅜
8t.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 –83	6 8 8	..	.. ..	8t.	6%	National Co. Pref. Stock	104 –106	5 18 9	..	93 ..
5	4/6	Edmundson's Elec. Corp. Ord.	6 –6½	5 12 0	H'lf-yearly	6⅜ 6⅛	8t.	5%	Do. Def. Stock	91 –94	5 6 9	..	.. ..
5	3/0	Do. 6 per Cent. Cum. Pref.	6 –6½	4 16 0	..	6⅜ 6⅛	10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 –14	4 5 8	Feb, Aug	13⅜ ..
8t.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 –107	4 4 0	..	106 ..	10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 –13	4 12 4	Feb, Aug	5⅞ ..
2	1/7½	Electric Construction Co.	1 –1½	6 8 0	July	.. ..	5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½–5⅝	4 13 0	Feb, Aug	9⅝ 9⅜
2	2/9⅜	Do. 7 per Cent. Cum. Pref.	2 –2⅛	5 12 0	July	2⅛ ..	8t.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 –99	3 10 8	June, Dec	105 ..
8t.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	96 –99	4 0 9	Jan, July	.. ..	8t.	4%	Do. 4 per Cent. Deb. Stock (red.)	104 –106	3 15 9	..	6⅛ ..
8t.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	.. ..	..	5/9	Do. Do. Prov. Certs. 35% to be pd.	66 –63	..	..	1 ..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 –9½	5 5 3	..	9⅜ 9⅛	1	0/6⅝	Oriental	⅛–1⅛	6 6 3	April, Oct	.. ..
8t.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 –98	4 1 8	..	.. ..	1	0/7½	Do. 6 per Cent. Cum. Pref.	1 –1⅛	6 4 6	..	6⅞ ..
5	9/0	Henley's Telegraph Works Ord.	11 –12	6 5 0	Feb, Aug	11⅜ ..	5	5/0	United River Plate	6 –6⅛	6 3 3	July	.. ..
5	2/3	† Do. 4½ per Cent. Pref.	5 –5½	4 1 10	Feb, Aug	5⅛ ..	5	2/6	Do. 5 per Cent. Cum. Pref.	4½–5⅛	4 15 3	June, Dec	.. ..
8t.	4½%	† Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 –111	4 1 5	Feb, Aug	.. ..	St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 –106	4 14 4	June, Dec	.. ..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½–19½	5 2 6	Feb, Aug	.. ..							
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.	100 –103	3 18 5	Mar, Sept	.. ..			**FINANCIAL, INVESTMENT, &c.**				
10	5/0	†Mather & Platt 5 per Cent. Cum. Pref.	10¼–11	4 10 11	Mar, Sept	.. ..	5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4⅜–5⅛	5 14 4	..	5⅛ 5
1⅝	12/0	Telegraph Construction & Mainten'ce.	34 –37	6 9 11	Mar, Sept	35 ..	10	2/0	Globe Telegraph and Trust	8⅞–9⅛	5 19 0	Ja Ap, Jy O	9⅛ 9
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 –104	3 17 6	Jan, July	.. ..	10	3/0	Do. 6 per Cent. Pref.	13⅜–14⅜	4 4 0	Ja Ap, Jy O	14⅛ 14
5	..	Willans and Robinson Ord.	2 –3	..	Apr, Oct	.. ..	100	6%	Submarine Cables Trust (Ltd.)	118 –123	4 18 9	April, Oct	.. ..
5	..	Do. 6 per Cent. Cum. Pref.	2 –3	..	..	.. ..							

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THE ELECTRICIAN:

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NOTES.

There have been hard fights in Dublin over the electricity supply question, and the expiry of a contract with Mr. Robert Hammond on July 31st has given rise to an outburst of feeling on all sides. Mr. Hammond had been engaged as consulting engineer for the design and erection of the new electricity works at Pigeon House fort, and on his advice a three-phase 50 ~ system was adopted to displace the old single-phase 83 ~ system. When the time came for changing-over the supply from one system to the other last year, Mr. Hammond pointed out that his engagement as consulting engineer was merely for the design and erection of the new works, and that he could only take charge of the change-over on the basis of a new contract. At his suggestion, therefore, he was appointed to manage the undertaking for a year from July 31, 1903, at a fee of 1,000 guineas and travelling expenses, the resident staff to be selected by him, but to be in the pay of the Corporation. Now that the term of Mr. Hammond's stewardship has expired, the resident staff has shown its disapproval of this arrangement by finding fault with a number of the present arrangements at the works and suggesting that the plant is not yet in proper running order. The reports and counter-reports, which are not without their amusing side, are summarised elsewhere in this issue.

Finally, Mr. Hammond has endeavoured to clinch the matter by offering to take over the entire management of the works himself as a speculation,—rather an unusual course, it must be admitted, for a consulting engineer, although there is a precedent in a somewhat similar proposal made by Mr. Arthur Wright to the Marylebone Borough Council. Mr. Hammond makes two alternative offers: One is to manage the works on a remuneration which is only to be paid if the works costs are less than 1½d. per unit, in which case he is to have the difference. The second proposal is that he should take over the entire business for 14 years on his own account, repaying the Council the annual capital charges they will be obliged to pay in the meantime, and making as good a profit as he can of the concern; the consumers' interests to be safeguarded, however, by a tariff of charges per unit, to be fixed in advance by mutual agreement between Mr. Hammond and the Dublin Corporation. The Electricity Committee have naturally recommended the Council to refuse both of Mr. Hammond's offers. The whole series of incidents is regrettable, and it is to be hoped that Mr. Hammond and the present resident staff will now sink their differences for a few weeks, and co-operate amicably until the works are in thorough going order, after which Mr. Hammond can hand the undertaking over to the Corporation. In spite of the excessive amount of capital that has been spent on the scheme, it should certainly be possible to make it pay its way, if properly managed by a capable resident engineer loyally assisted by an efficient staff.

An arc lamp controlled by a hot-wire arrangement instead of by the ordinary solenoid device has considerable fascination; but, although the problem seems simple at first sight, there has been considerable difficulty in evolving a lamp which will work satisfactorily under all conditions. One of the chief difficulties hitherto, we believe, has been due to the fact that there is a considerable time-lag between a decrease of the current and the cooling of the hot-wire, with the result that the arc constantly gets too long and the lamp does not feed with sufficient rapidity until the arc is extinguished. We understand that this action is avoided in the latest type of Foster arc lamp, described in another column, by employing a higher temperature for the hot-wire than hitherto, the cooling, of

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course, being more rapid at the upper part of the temperature curve. The strut device, which controls the motion of the bottom end of the hot strip, is also a feature peculiar to the design of the Foster lamp. If the lamp fulfils the anticipations of the inventors after prolonged trial, it will certainly find considerable application on electricity networks, for the fact that the control is independent of the frequency and that it will work equally with continuous or alternating current is one not to be despised.

ALTHOUGH the method on p. 869 employed by Mr. E. ALEXANDERSON for measuring the output of induction motors is ingenious, its application, we fear, will be limited to those cases only where a motor is to be tested for output roughly and quickly. The reason is that the method is based on a number of assumptions which are not strictly correct. Thus, the slip is not exactly proportional to the torque of the motor armature, and the bearing losses and the belt losses are not the same whether the continuous-current generator be loaded or not. It might, therefore, be expected, and is, in fact, borne out by the figures quoted by the author, that the outputs obtained by this method do not always agree closely with the values found by more exact methods Moreover, the testing equipment required for this mode of output determination is not so much simpler than that necessitated by other methods as to constitute any real advantage in this respect. Still, the method deserves to be recorded if only for the fact that it is employed by the American General Electric Co. in the commercial test of induction motors. A useful hint is given by the author that when once the full-load slip of a motor is known (no matter by what method this has previously been determined) the output of the motor may always be estimated subsequently by means of a slip reading without the motor being removed from its position. The only apparatus necessary are an arc lamp fed from the same source of supply as the motor, and a piece of chalk.

WE were none too soon in publishing a warning a fortnight ago that supply station engineers would do well to examine and test their networks in view of the break-up of the hot and dry weather. During the past week, a number of cases of mains breakdowns—happily most of them only attended with slight interruptions to supply—have been reported from various parts of the country. The one which occasioned the most trouble was in Dundee, where, it appears, from a semi-official report in the *Dundee Advertiser*, a service cable gave way, and the excessive current through the copper strip feeders caused these to collapse also. This threw an excessive load on other feeders and an important distributor, and, the latter being also faulty, an interruption of supply occurred over a considerable portion of the town. The moral to be drawn from this is: Test your network constantly and keep it in repair, and, above all, divide it up into districts connected through fuses.

THE announcement that the London County Council has granted a loan to the St. Marylebone Borough Council for the establishment of municipal electricity works, leads us to express the hope that less troublous times than those encountered during the past two years are in store for the Electricity Committee. The London County Council, it may be remembered, at its meeting on July 26th, agreed to a recommendation to invite and accept tenders for £1,500,000 to provide the funds for the purpose of enabling the Marylebone Borough Council to discharge its indebtedness to the Metropolitan Electric Supply Co. under the arbitration award of 1902. The additional loans now sanctioned are as follows:—£340,405 for 42 years for electricity works, the Borough Council providing, either by means of a sinking fund or from maintenance account, for all renewals and the replacements of plant, machinery and works during the period of the loan; £48,545 for 38 years for putting the plant acquired under the award into proper working order; and £44,850 for 10 years for new meters and alterations to existing meters consequent on the change of pressure under the municipal scheme. We dealt with Mr. ARTHUR WRIGHT'S specification for generating plant in our issue for July 1st, but so far the result of the invitations for tenders has not been announced. An application, however, is being made to the London County Council for approval to the alteration of the standa rd pressure of supply to consumers to 240 volts continuous current.

AN instructive discussion took place at Southwark on Wednesday on the proposal to advertise for a Chief Engineer and Manager of the electric supply undertaking in place of Mr. BLAIKIE, who has resigned. In the discussion of the proposal, reported elsewhere in this issue, the opposition expressed the opinion that an electrical engineer "with a lot of letters after his name" was not wanted; in fact, "properly speaking, there was no such thing as an electrical engineer." They wanted a "good business man," whose duties would consist of canvassing for consumers, and a "good mechanic" to supervise the station; the latter, being a person of ordinary intelligence, "could read up in a month all that an electrical engineer knew." These views, it may be added, were expressed by an alderman and supported by other members of the Council, although ultimately the original proposal was carried by a large majo ity. Nevertheless, we pity Mr. BLAIKIE'S successor.

Obituary.—The death is announced of Mr. J. T. Pearson, of the Hall, Melmerby, Yorkshire, who was one of the founders of the Yorkshire House-to-House Electricity Supply Co.

Society of Engineers.—On Wednesday next, September 21st, the members of this Society will visit the pianoforte works of Messrs. John Broadwood & Sons at Old Ford. The works, which are electrically driven, were described in *The Electrician*, Vol. LII., p. 619.

Power Supply to Tramways in North London.—In our recent series of articles on the above subject, we should have mentioned that the electrical equipment of the sub-stations of the traction system, as well as the inverted rotaries and oil-cooled transformers at the Willesden station, were supplied by the British Thomson-Houston Co.

Dielectric Hysteresis.—According to *Nature*, the mathematical and scientific section of the Imperial Academy of Sciences, Vienna, announces a prize of 2,000 kronen to be awarded for the best thesis embodying "An Improvement in our Knowledge of the Hysteresis of Dielectrics." The competition will close on December 31, 1906.

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A Prize for a new Current Gauge.—The French Society of Manufacturers are offering a prize of 6,000f. for the invention of an apparatus for gauging the current of an electrical conductor. Particulars of the competition, which closes on December 31, 1904, can be obtained from M. Le Président, Association des Industriels de France, 3, Rue de Lutèce, Paris.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 18, 1902
Relssi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Cayenne—Paramaribo	July 13, 1904
Cap Haitien—Mole St. Nicholas	Aug. 20, 1904
Bundaberg—Gomen (New Caledonia)	Aug. 30, 1904

Opening of the Single-phase-Current Stubaitalbahn.—According to the *Schweizerische Elektrotechnische Zeitschrift* this single-phase-current railway was inaugurated on August 1st. Our contemporary gives the following data concerning it:—Length 11·5 miles, gauge 1 metre, maximum gradient 4·6 per cent., smallest curve 130ft. radius, highest speed 15½ miles per hour, altitudes of lowest and highest points 1,870ft. and 3,500ft. respectively, feeder voltage 10,000 volts, frequency 42 ~ per sec. There is one transformer sub-station, where the voltage is reduced to 2,700 volts, at which pressure the current is fed into the trolley line. The cost of the railway amounted to £111,000.

Electric Shock Fatality.—An unfortunate fatal accident occurred at the works of Messrs. C. A. Parsons & Co., Newcastle-on-Tyne, last week. Two men were engaged in testing a turbine set, when one of them was killed whilst the other was not looking his way. The supposition is that he touched one of the brushes in attempting to put on a new driving cord to connect up the speed counter. There were no marks on the body except a cut on the fingers, evidently caused by the driving cord. The E.M.F. of the machine was only 300 volts. At the inquest Mr. Gerald Stoney, Messrs. Parsons' manager, informed the coroner that although he himself had received shocks from as high pressures as 4,000 volts he was still alive. A verdict of accidental death was returned, and the jury added that no blame could be attached to anyone.

Junior Institution of Engineers' Summer Meeting.—The summer meeting of the Junior Institution of Engineers was held this year in Germany, from August 13th to 28th, and amongst the towns visited during an extensive tour were Düsseldorf, Oberhausen, Benrath, Elberfeld, Hanover, Berlin, Mariendorf, Charlottenburg, Leipzig, Frankfort-on-Main, Hanau and Hamburg. Among the places of interest inspected during the first few days were the Düsseldorf Exhibition, Barmen–Elberfeld suspended railway and Messrs. Körting Bros'. gas engine works in Hanover. In Berlin, a most interesting visit was paid to the Berlin electric overhead and underground railway and the works of Messrs. Siemens and Halske. This concluded the first week of the meeting. On August 22nd the party left Berlin for Leipzig, where they remained for three days. Thence they proceeded to Frankfort-on-Main, where they were conducted over the waterworks and the electricity works. The arrangements for entertaining the Institution throughout the visit were of a most excellent character, every effort being made in each town visited to make the time pass as pleasantly as possible. All the works of electrical interest were described in our columns when the Institution of Electrical Engineers visited Germany in 1901.

A New Variable-speed Shunt Motor.—According to the *Electrical World and Engineer*, the principal feature of novelty in an invention relating to this subject, for which a patent was granted to C. P. Steinmetz, August 9, 1904, is to be found in the fact that the armature winding is composed of open-circuited sections, preferably three for each pair of poles. The adjacent ends of adjoining sections are connected to two corresponding segments of two segmental rings. For each pair of poles there is provided a group of brushes insulated from each other and from the frame of the machine, and each arranged to connect the corresponding segments in two rings as they pass under the brush. The brushes are so spaced that the sections of the armature winding between the poles in any given pair of poles are connected, while the section or sections between every two pairs of poles are left open. At each pole is a brush bearing on the commutator, to whose segments the armature coils in each section are connected, as usual. The result is that there are as many separate armature circuits as there are pairs of poles. For instance, a 12-pole machine will have six distinct armature circuits. By means of a suitable controller, these circuits can be grouped in various ways, either in series for low speed, series-multiple for intermediate speed, or multiple for full speed.

Another Projected Single-phase Railway.—The *Western Electrician* of Chicago gives particulars of a projected 30-mile electric railway between Kewanee and Geneseo, by way of Cambridge, in Henry County, Illinois, in which single-phase alternating-current will be employed. The power house will be located near Cambridge, and will be of 1,000kw. capacity at the start. Current will be generated at 2,200 volts and transmitted at 11,000 volts to the two end divisions of the line, where step-down transformers will be placed to reduce the pressure to 2,200 volts, which will be the line voltage. The central division will be supplied at 2,200 volts directly from the power house. On the locomotives and motor cars the voltage will be again reduced to 500, at which the single-phase motors will operate. The rolling stock will include two 40-ton electric locomotives, each equipped with four 250-volt motors (two in series) of an aggregate capacity of 600 H.P. There will also be 10 passenger cars, each fitted with four 75 H.P. motors, and 20 coal and box cars. The company expects to haul coal and heavy freight under steam railroad conditions, and it is expected that 40 per cent. of the receipts will be from passengers and 60 per cent. from freight. The road will be laid with 60lb. rails, the maximum grade being 1 per cent. and the maximum curve 5deg. The line will be built across country on the company's own private right of way, and in the towns 50-year franchises have been secured. It is of interest to note, further, that the company expects to mine its own coal.

Closing of Ben Nevis Observatories.—A correspondence between the directors of the Ben Nevis observatories and the Prime Minister relative to obtaining the necessary funds for the continuance of the Ben Nevis and Fort William observatories has just been published. In June, 1902, it was announced that the public funds for carrying on the work were exhausted, and that the observatories would be closed at the end of the year. In view, however, of the appointment by the First Lord of the Treasury of a Committee to inquire into the matter, an effort was made to maintain the observatories until the inquiry by this Committee had been held, and private subscriptions, in addition to the sum of £350 given annually by the Meteorological Council, were obtained, and by this means the work of the observatories was enabled to be carried on until October next. When the report of the above Committee was presented, however, although the opinion was expressed that the observatories should be kept working, no recommendation was made as to how this could be accomplished. Consequently, the directors appealed to the First Lord of the Treasury for assistance, the sum necessary being put at £650, in addition to the £350 granted annually by the Meteorological Council, but which was to be withdrawn. In reply to this letter, Mr. Victor Cavendish, on behalf of the Treasury, could only promise a continuance of the £350 annually granted hitherto by the Meteorological Council, and as no public body can be found to provide the remaining £650 per annum, it has been decided to close the observatories next month.

Wireless Telegraph Notes.—Prof. Slaby, in a second communication to the *Elektrotechnische Zeitschrift*, describes in detail the effect of placing a condenser between the air-wire and the spark-gap of a sender, the air-wire being connected to one plate of the condenser and one side of the spark-gap to the other plate. He shows that when the length of wire between the condenser and the spark-gap is negligible, the effect is to produce a potential node at a distance up the air-wire depending on the capacity of the condenser employed. In fact, the wire is so divided at the node that the shorter

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piece near the condenser, in conjunction with the condenser, vibrates with the same frequency as the upper free portion of the wire. Thus, the addition of a condenser in the manner described produces a shortening of the wave-length emitted. Prof. Slaby then shows that the determination of the capacity required in any given case to shorten the wave by any assigned percentage is merely a matter of arithmetic, and confirms his calculations by a number of experimental results. The utility of these investigations lies, of course, in the consideration that the tuning of a sending station can thus be accomplished automatically.

The National Electric Signalling Co. (Washington, U.S.A.) announce that on August 23rd the U.S. Navy Wireless Board made a severe test of a method of preventing interference with wireless messages. Three 2 H.P. stations, with 40 metre masts at distances of 5 miles, 1,000yds. and 300yds. respectively from the receiving station, and one 10 H.P. station, 200ft. high, 174yds. away, were operated at full power for the purpose of interference, and only the last-mentioned station was able to prevent the perfect receiving of messages. The company advertise that they are prepared to supply apparatus guaranteed to give these results.

Extension of the Londonderry Electric Supply System.—Although in 1891 the Londonderry Corporation obtained a provisional order authorising the supply of electricity for all purposes, it was decided only to undertake street lighting at first, and Dr. John Hopkinson, in conjunction with Mr. W. Blake, prepared a scheme which was put into operation in May, 1894. Early in 1901, however, a scheme for private lighting and power supply was prepared by Messrs. Preece & Cardew and accepted by the Corporation. Contracts were entered into to the extent of £25,000 for new buildings and plant, and the total capital expenditure is expected to reach £35,000. The new scheme was put into operation at the end of last week. Three Lancashire boilers have been added to the old equipment. These supply steam to four B.T.-H.-Allen sets, two having a capacity of 250kw. and two an output of 100kw. The latter are six-pole compound-wound machines, the idea being to utilise them for tramway purposes later on. A B.T.-H. balancer-booster set is also installed. The battery supplied by the E.P.S. Co. has 268 cells, each containing nine "P" type plates, the capacity of the battery being 50 amperes for 10 hours or 95 amperes for 3½ hours, and 200 amperes for short periods without injury. The cables were supplied by the Western Electric Co. The feeders are triple concentric and lead covered, drawn in, the distributors being three-core lead covered, laid solid in earthenware troughs. Experimental street lighting is being carried out with Nernst lamps. At present there are 202 arc lamps in the city, which was all the old machinery could maintain. Mr. R. V. Macrory, the resident engineer, assisted in the preparation of the scheme.

Tramway Dispute in Handsworth.—A dispute between the Handsworth District Council and the South Staffordshire Tramways (Lessee) Co. which is now in progress, has been causing much amusement in the Midlands. The Handsworth District Council have leased certain tramway lines within their district to the South Staffordshire Tramway (Lessee) Co., the Council constructing the track and the company paying the interest, &c., on the capital expenditure. When the lease came before the parties for completion, the company objected to the inclusion in the amount of the capital expenditure of a sum for levelling and widening the road, which, it contended, was a street improvement and should be charged to the rates. The lease, therefore, not being concluded, the District Council argued that, pending the settlement of the dispute, the company had no right to commence the service of cars, whilst the company, despairing evidently of a speedy settlement being come to, determined to run the service at all hazards. Current for the line in question was to be supplied by the West Bromwich Corporation and a through service maintained, and a difficulty with the latter body on a similar point having been amicably settled, a supply of energy was available for running the Handsworth lines. Knowing the determination of the Handsworth Council that the service should not be commenced until a settlement was arrived at, the company took precautions to have the necessary connection to the electrical supply made during the night, but the officials of the Council having got wind of the proposal, took prompt measures to short-circuit the line. The short-circuit, however, was speedily removed, and the company ran a trial car. The Council, however, wished to make sure that the service should not be continued, and a steam roller was, therefore, sent out, and placed across the lines at a suitable spot. Letters are now passing between the two parties, and it is to be hoped that the convenience of the public will be placed before everything, and the service of tramways soon properly inaugurated.

A 500,000-volt Transformer at St. Louis.—At the St. Louis Exhibition there is a 500,000-volt transformer of 20kw. capacity, of the closed magnetic circuit type, and operated from 110-volt 60-cycle mains. The primary and secondary coils are wound on a laminated core, the whole being immersed in oil. The weight of the iron in the magnetic circuit is 700lbs., and the weight of copper is 45lbs. in the primary and 60lbs. in the secondary coils. A wooden tank lined with metal contains the oil. The two terminals of the secondary coil rise out of the oil to a height of 2ft. above the top of the tank. These terminals, placed 32in. apart, are surrounded by standards heavily insulated with paper boiled in paraffin. The wires emerge from glass insulators which cap the paper insulation. After leaving the insulated standards the current passes through heavy choking coils and then to the terminals proper. As usually operated, a heavy glass plate is placed between the two points. The discharge leaps a maximum distance of 32in. around this plate, and is attended with a sharp crack. Smaller and frequent reports continue as long as the arc is sustained. These are due to the opening of shorter paths across the atmosphere when the main arc assumes such a shape that the resistance of a short cut across the air is less than that of the long arc between the two points. More vehement displays are produced by leading the terminals to sheets of tinfoil on opposite sides of the large glass plate, the discharges emerging from the edges of the tinfoil in great numbers, and passing over the edges of the plate. The noises accompanying such discharges can be heard in all the neighbouring sections of the building, even above the constant hum of the machinery. For varying the voltage of the transformer a regulator is provided. This consists of a transformer with a ratio of 1 to 1, whose primary is connected to the Exhibition mains. The secondary coil is movable, and by operating a regulating wheel can be moved out of the main path of the magnetic flux of the transformer and the voltage so reduced.

Electric Car with Six-wheel Trucks and Motors of 800 H.P.—The following interesting particulars with regard to a new high-speed electric car for inter-urban railway service are gleaned from a recent issue of *Engineering News*:—In nearly all cars fitted with two four-wheel trucks and running at high speeds there is, says our contemporary, an unpleasant vibration and jerking, which has been modified in some cases by the substitution of elliptical springs for spiral springs, but in many designs of four-wheel trucks, with a motor to each axle, there is difficulty in finding room for the elliptical springs. Among the numerous electric cars at the St. Louis Exhibition is one which is notable in having six-wheel trucks in order to ensure easy riding at exceptionally high speeds, and this car is designed to be equipped with four motors of 200 H.P. each. The car is 46ft. long over the body and 57ft. over the bumpers, it is 8ft. 9in. wide over the sheathing and 9ft. 8in. high from bottom of sill to top of roof. The total weight is 39 tons. The underframe consists of six longitudinal sills; the side sills are each composed of two pine timbers, with a steel plate sandwiched between them; the other sills are 6in. I-beams with wood fillers. The cross bars are of malleable iron, each with two truss rods, and they are so arranged that electric or air-brake apparatus can be suspended from them. On top of these bars is laid "Transite" board ¼in. thick, and on this again is the floor, securely fastened to the side sills and centre sill fillers. These fillers are covered with "Transite" board, and the construction is such as to be practically fireproof and sound-proof. The frame is equipped with built-in bolsters,

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having heavy steel centre plates and 3in. king pins; all parts are machine fitted. The total weight of the underframe is 20,000lb. There are three compartments—passenger, smoking and private—with a total seating capacity of 52 passengers. The ends are vestibuled, and are tapered to reduce the air resistance. On account of the exceptionally heavy motors, the trucks are built more solidly than ordinary trucks for steam railways. The side frames are made of I-beams, with solid steel fillers, all of these fillers being milled and machine fitted. The wheels are 36in. diameter, steel-tyred. On the centre wheel the flange has been omitted in order to enable the trucks to take 60ft. curves. The axles are 6½in. diameter, with journals 5½in. by 9in. The oil boxes are of malleable iron, and all other castings on these trucks are either of malleable iron or steel, the only gray iron castings being the brake shoes. The wheel base of driving axles is 10ft. 4in. The truck bolster is of special construction and built exceptionally rigid to withstand the heavy work required of it. The weight of these trucks is 19,000lb.

Rail Resistance and Brake Tests.—The Electric Railway Test Commission, working in conjunction with the Department of Electricity at the St. Louis Exhibition, after several weeks spent in the organisation of the tests, the construction of special instruments required in the work, and in preparation in general, has begun the actual work of testing the several pieces of apparatus submitted. The first of the series of tests, says the *Street Railway Journal*, was the determination of the resistance to alternating current of rails of standard section. Tests were made through wide ranges of both currents and frequencies. The frequencies varied far beyond the limits of present railway alternating-current practice, the variation being from 10 to 60 cycles. The current employed was from 600 amperes downwards. These tests were made in the exhibit space of the Bullock Electric and Mfg. Co. in the Palace of Electricity. A non-inductive carbon resistance was placed in series with the rail; heavy bar connections were necessitated by the large currents used. For measuring the power consumption, the three-voltmeter method was employed. The voltages were measured across the terminals of the non-inductive resistance, across the portions of the rail to be tested, and the total across both the non-inductive resistance and the rail. From the three readings so obtained the phase position of the current with respect to the E.M.Fs. were readily deduced, and, together with the ammeter readings, the power consumed in the rail was easily computed. In connection with general tests on air-brake apparatus, very complete data were obtained from the compressor station of the St. Louis Transit Co., located at the extremity of the Park Avenue line. The cars of the St. Louis Transit Co. are equipped with the Westinghouse storage air-brake system, the storage tanks on the cars being charged from compressor stations located at convenient points on the line. The station tested was equipped with two Ingersoll-Sergeant compressors driven by Westinghouse motors. The test continued over a period of 36 hours. Readings were made to determine the total input in watts, as well as the output measured in cubic feet of free air compressed to 300lb. per square inch. Another test on air-brake apparatus was made on car No. 2,600 of the St. Louis Transit Co. This is one of the 450 new cars purchased for World's Fair traffic, having a seating capacity for 48 persons, the car body measuring 33ft. 4¾in. over corner posts. For the test, the car was specially equipped with National Electric Co. air-brake apparatus complete. The compressor used was controlled by an automatic governor. In general, the readings obtained were those required to compute the total watt consumption in the compressor motor and the output of the compressor. Record was also kept of the number of applications of the brakes, the pressure used at each application, the number of revolutions of the crankshaft of the compressor and the length of time the compressor was operating. Personal error was largely eliminated by the use of automatic recording instruments. A recording gauge connected to the train line registered the maximum pressure at each application. An electrically-connected counter recorded the number of revolutions of the crankshaft of the compressor. Reading signals were given by means of a clock, which at intervals of five seconds operated electric bells. To eliminate errors in the measurement of the air compressed, through the possibility of the pump operating, while an application of the brakes was being made, the governor connections were somewhat modified. With this modification the pump could not be started as long as there was any pressure in the train line, and if the pump were in operation when the application was made it was immediately cut out. During the tests on the brake apparatus very complete data were obtained on the motor consumption. For this purpose an Armstrong recording ammeter, with time marker registering every five seconds, was used. Temperature readings of the motors were also obtained at the end of each run.

A Powerful Electric Crane.—Herr R. Kann, in a summary of modern crane work which appeared recently in the *Zeitschrift für Elektrotechnik*, gives the following interesting data of a powerful crane erected in the autumn of last year at Lloyd's arsenal at Trieste. It is situated alongside the dock, and is chiefly intended for transporting completely assembled boilers and machinery to and from large warships and mercantile vessels. Arrangements have also been made for conveying lighter loads at higher speeds. A tower of girder work forms the bearing for the movable portion of the crane, which takes the form of a T. The principal dimensions of the crane are:—Height of the crane above the ground 112ft., length of track 185ft., maximum radius of action for a load of 120 tons, 65½ft., and for loads not exceeding 35 tons, 100ft. There are two crabs, one for a normal load of 120 tons, the other for 35 tons. After erection these were tested with 170 and 50 tons respectively. Arrangements have been made in connection with the smaller crab, so that the gearing of the latter may be changed by pulling a rope from the motorman's cab. This allows of loads under 10 tons being hoisted exceptionally quickly. The various hoisting and travelling speeds are: Hoisting speed of large crab, 1·8ft. per minute; travelling speed of large crab, 27·8ft. per minute; hoisting speed of small crab for loads less than 10 tons, 26·2ft. per minute, and for loads between 10 and 35 tons, 9·8ft. per minute; travelling speed of small crab, 65ft. per minute. The crane may be slewed completely round in six minutes. All motions are performed by 110-volt series motors, of which the following have been provided:—On the large crab there are two 25 H.P. to 30 H.P. hoisting motors, and one motor of the same capacity for travelling purposes. On the small crab the motor equipment consists of one 35 H.P. motor for hoisting and one 10 H.P. motor for travelling. The slewing is done by one 35 H.P. motor. In addition to the two crabs mentioned, there is also a small waggon, carrying the balance weight and running on the same rails. By suitably disposing the crabs and the balance weight on the track, the crane may always be well balanced. In order to avoid excessive stresses due to strong winds, the movable part of the crane is allowed—when not in use—to turn with the wind like a weather cock. The weight of iron used in the construction of this crane approximates 250 tons, the total maximum weight which the foundation of the crane will normally have to carry being not far short of 400 tons. Slewing is performed by the 35 H.P. motor mentioned, driving through a multiple gearing on to a large spur wheel cast in one piece, and having a diameter of 13ft. and a weight of more than 12 tons. Current is conveyed from the iron-armoured cables to the crane itself by means of two slip-rings. From the slip-rings the current is transmitted to the motorman's cab situated underneath the centre of the track. All controlling apparatus are concentrated here, and cables emanate from this cab to the various motors. In order to obviate confusion, the levers of the hoisting motors are made to work in a vertical plane and those of the travelling motors in a horizontal plane. Arrangements are made so that the current is automatically interrupted should the crab travel too near to the end of its run, but it is still possible to operate the crab backwards, and when this has been done the interrupted circuit is closed again, so that both forward and backward movements are possible. The crane was built by Messrs. J. v. Petravič of Vienna, the electrical equipment being supplied by the Austrian Union Elektricitäts-Gesellschaft.

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THE TWICKENHAM AND TEDDINGTON ELECTRICITY UNDERTAKING.

BY MAX. J. E. TILNEY.

The use of high-tension continuous-current plant has so far been comparatively rare on account of the difficulties met with in commutation and in the design of the armatures generally. Probably the first high-tension continuous-current station in England was that at Oxford; but the pressure adopted there was considerably below that now in vogue at other places. Hull is supplying current at 2,000 volts to sub-stations over a very large area, and Walsall is also using the same pressure. The system at Hull has the peculiarity that some of the big rotary transformers only supply at 230 volts on the secondary side, being in the nature of balancers, and two of these machines are put down in a sub-station, each being started up independently from the generating station and switched in on its own particular side of the 2 × 230-volt low-tension mains by means of a long-range switch.

Edmundson's Electricity Corporation have, however, made the most extended use of the high-tension continuous-current system, having put down plant at Guernsey, where a pressure of about 2,600 volts is used for transmitting power to outlying parts of the island; at Folkestone, for supplying Hythe and Sandgate; at Bromley (Kent), for supply to Chislehurst; and at Newport (I. of W.), for supply to Cowes. This last-named scheme possesses several novel points, as it has in view the ultimate use of 5,000 volts on a three-wire system, and is, therefore, very similar to the schemes now in progress at Twickenham, for supply to Teddington and Hampton, and at Weybridge, for supply to Walton and Hersham. It is proposed to give herewith a short outline of the Twickenham scheme. High-tension generating plant has been laid down in the present station at Twickenham and steam is supplied from the same boilers as supply the ordinary low-tension sets. The two generators are of the four-pole type, each of 200kw. capacity. Fields excitation is obtained from the low-tension 'bus bars at 480 volts. The armature cores are smooth, the conductors being former wound and very carefully insulated. Hard-drawn copper bars are employed for the commutators which are built up in the usual way with mica insulation, but the inside is left rough with all the mica sheets projecting considerably beyond the bars, as it has been found that machining the inside of the commutators, even roughly, increases the risk of short circuits by tending to carry a skin of copper over the mica insulation. A shield of mica about 1in. high projects above the commutator, between the bar and the sleeve that carries them, and in each of the machines for Twickenham there are 549 bars on the commutator giving between 19 and 20 volts per bar. The brushes are of the galvanic type, and on test the machines ran sparklessly from no load to full load with fixed brush lead. The machines are directly coupled to Belliss T 3 engines and run at 475 revs. per min.

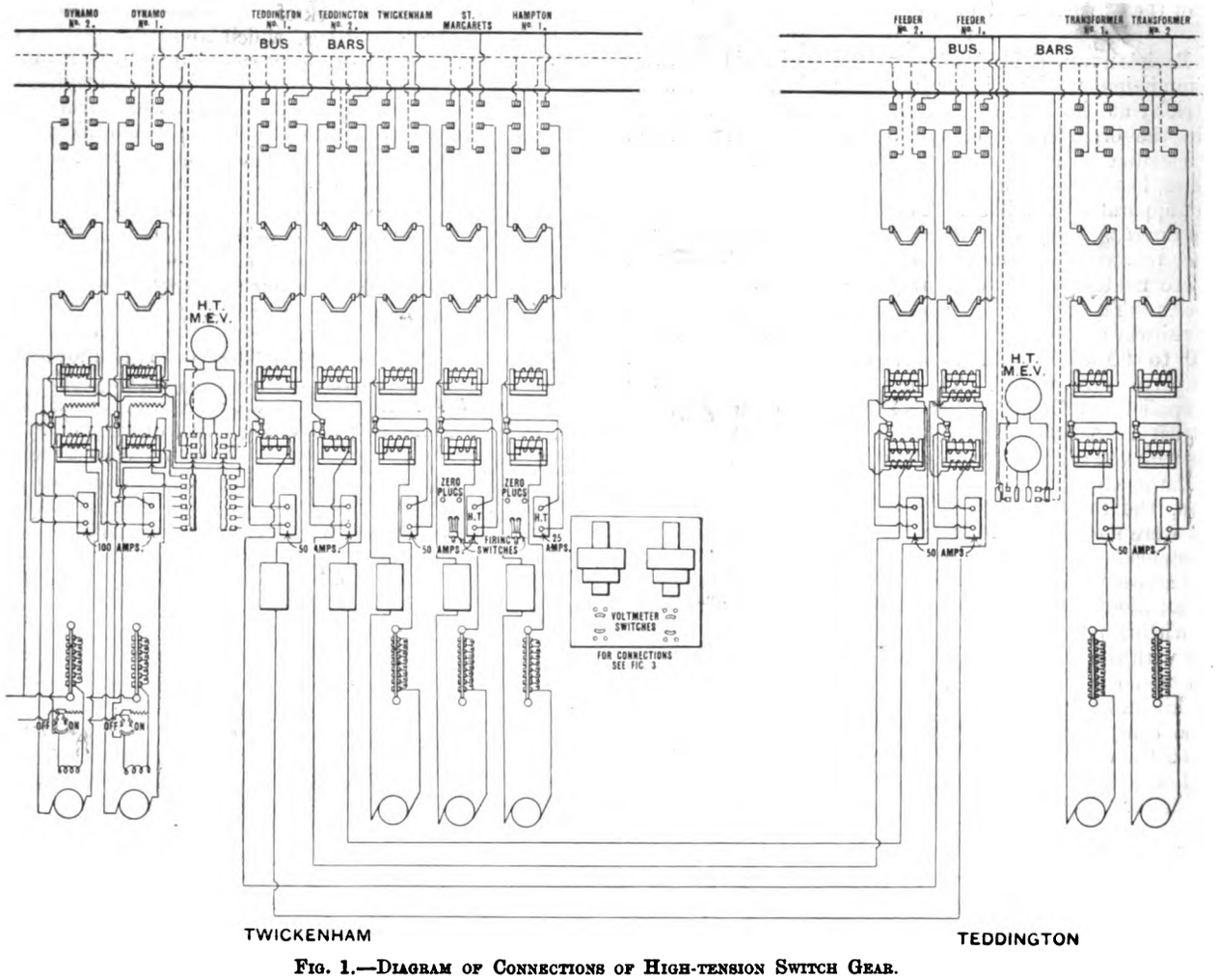

FIG. 1.—DIAGRAM OF CONNECTIONS OF HIGH-TENSION SWITCH GEAR.

Figs. 1 and 2 show the high-tension switch gear. Each generator, feeder and transformer has its own separate panel with all the necessary gear for regulating it. The two generator panels are shown on the left in Fig. 2, and have mounted below them the shunt-regulating resistances, on the front of which are fixed the necessary exciting switches with carbon breaks, and these switches also serve for exciting the reverse current coils on the main automatics. The actual switch gear for the high-tension circuits is mounted on very substantial iron castings supported on a steel framework, the parts being insulated from the iron by means of thick mica bushings and washers. Each panel is an independent section, and it is, therefore, quite a simple matter to alter the position of any

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panel as required. On each panel there are two main switches coupled in tandem, and very carefully insulated from one another; these are closed by means of a handle coming well below the parts carrying high-tension current. This handle can also be used for switching off, but the switches can also be brought out by a small tripping lever, or by the action of the maximum and reverse-current coils, which draw up armatures

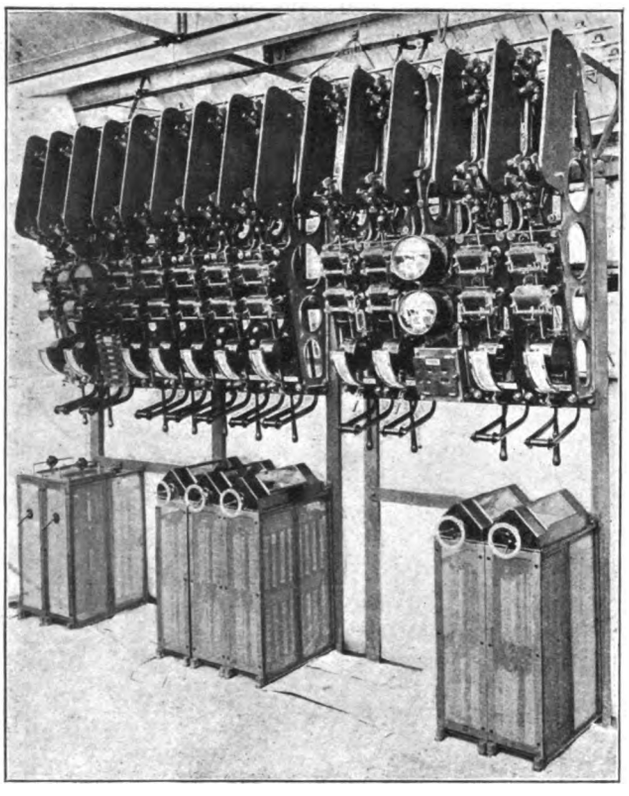

FIG. 2.—HIGH TENSION SWITCH-GEAR.

that release the same catch as is used for the tripping lever. A slate shield is fixed between each pair of panels, so as to completely isolate them.

Behind the main automatic on each panel is fixed a double-pole throw-over switch, which is interlocked with the main switch in such a way that the throw-over switch cannot be moved at all until the main switch is in the "off" position. The object of this throw-over switch is to enable the generator, feeder or transformer controlled by that panel to be connected on to either side of the three-wire 'bus bars at the top of the board. The main switches for the feeders and transformer at the generating station are the same as those for the generators, except that the automatics are only wound for maximum current. The high-tension ammeters are of Kelvin and White's edgewise type, and are tested up to 4,000 volts between the coils and case. Each feeder and transformer panel has also a special Hookham meter calibrated to read in units at 1,000 volts. These meters are mounted in teak cases with glass fronts.

Below the three right-hand panels are the starting and regulating resistances for the transformers, all regulation being done from the high-tension side. The first of these three panels counting from the left is for the transformer fixed in the generating station, the next one is for a transformer in the St. Margaret's district of Twickenham, and the last is for the transformer at the Hampton sub-station. It will be noticed that the last two have a small switch and a pair of zero indicator plugs on the left of the ammeter, the use of which will be described later on. The panel between the generator and feeder panels carries the multicellular electrostatic voltmeters reading up to 3,000 volts, and a special plug board, by means of which it is possible to plug either voltmeter on to either pair of 'bus bars or on to the dynamo potential board. This latter board is so arranged that by means of a shutter only one machine can be plugged on to it at a time. In the same way, the upper part of the plugging board is designed so that a voltmeter can only be plugged on to one of the three alternative circuits. These plugging boards are further protected by being connected to the various circuits with very fine aluminium wire run in glass tubes, the tubes being firmly clamped to the framework of the board. In addition to the shutters mentioned above, which are made of ebonite, the fronts of the plug boards are further protected by slate shields.

On the extreme right of the board is a small panel containing two low-tension electrostatic voltmeters, and two three-way double-pole switches. This panel is for watching the low-tension pressure at the various sub-stations. To each of the sub-stations a 5-core pilot cable is run, three cores being 0·008 sq. in. section and two 0·0018 sq. in. The three larger cores are for use with the zero plugs and firing switches, mentioned above, one of the small cores is used as the neutral potential wire for the electrostatics, and the other core is used as a telephone line. Fig. 3 explains the connections of the pilot cables.

The sub-stations at St. Margaret's and Hampton will, at present, not have attendants, the transformers being started up on the high-tension side from the generating station, and switched in on the low-tension side also from the generating station by means of long range switches fixed in the sub-stations. These long range switches are worked by the "firing" switches fixed on the left of the ammeters on the high-tension board. They are fitted with maximum and reverse-current cut-outs, and are closed or opened by the movement of a heavy plunger working on a star wheel with a cam mounted on the same spindle. The main rod of the plunger is inside a powerful solenoid to which current is applied from the 480-volt 'bus bars by means of the firing switch; this lifts the plunger sharply, and the star wheel moves forward one tooth, the cam forcing the switch into place When the firing switch is opened the plunger drops, moving the star wheel forward another tooth and setting the cam ready

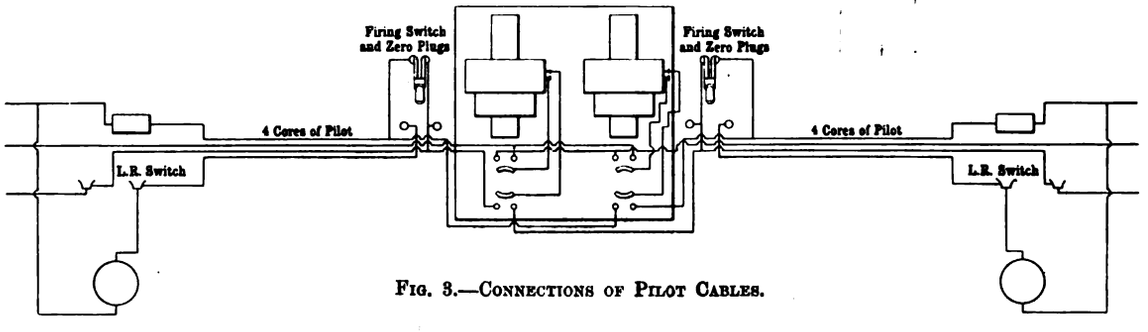

FIG. 3.—CONNECTIONS OF PILOT CABLES.

to draw the switch out when next the firing switch is closed. Should the switch come out by the automatic release, the switch will not close again on the first use of the firing switch, as that only sets the star wheel and cam for switching in, and it is therefore necessary to close the firing switch a second time to switch in again. The zero plugs are for use with Messrs. Kelvin and White's standard type of zero indicator, and their use is believed to be new in this connection, as the more usual way is to take the volts across the low-tension side of the transformer, and when the pressure is approximately that of the network the firing switch is closed. This sometimes causes a considerable flicker if for any reason the network pressure varies to any extent from the normal.

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The high-tension switchboard at Teddington sub-station is similar to that in the generating station, except that the feeder automatics are fitted with reverse-current cut-outs only, so that, should one feeder break down, it would be cut out by its maximum automatic at the generating station and by its reverse-current automatic at the sub-station. The latter being set for about 8 amperes reverse current, would come out before the other feeder could be overloaded through supplying the fault in a reverse direction. All the transformers so far, with the exception of one 105kw. variable ratio set just ordered, are of the two-pole type, though when sets of 200kw. are required they will be four-pole machines. The armatures are carried on pedestals above the magnet windings, and the pole-pieces being fitted with hinged poles, it is an easy matter to take the armatures out by a direct vertical lift. The windings, both high and low-tension, are put on to the same core, in both cases being wound on "formers." The low-tension windings are put on first, and the high-tension are put on over them, very great care being taken to see that the two sets are absolutely insulated from one another. In the larger sizes of four-pole machines steel clamps are forced on over the ends of the low-tension windings and the high-tension windings are put on over these clamps, and another clamp is put on over each end of the high-tension windings. In the case of the two-pole machines, the armatures have smooth cores, but in the four-pole machines the cores are slotted. This necessitates the ratio of transformation being such as 4 to 1 or 5 to 1, while in the two-pole machines it can be anything required, such as 4¼ to 1. When the machine is supplying low-tension side current its fields are excited from the low-tension armature, but there is a small winding in series with the high tension armature windings which provides the necessary excitation for starting up, and this winding is automatically short-circuited when the voltage on the low-tension side reaches a predetermined figure, such as 300 volts, by means of a small switch with carbon breaking points, which is worked by a solenoid in series with the low tension shunt windings.

In some cases, as at Chislehurst and at Newport (I. of W.), it is necessary to be able to work either way with the transformers—that is, to use them either as "step-up" or "step-down" transformers. The transformer is then built with an auxiliary pole-piece embracing extended windings on the low-tension end of the armature, and the flux of this pole-piece opposes the flux of the main field; thus, by altering this opposing flux, one is able to vary the ratio of transformation to suit the conditions met with both in stepping up or down. At Chislehurst the entire regulation of the output of the machines on the low-tension side is effected by this auxiliary magnet, the opposing flux being reduced as the machine is required to pick up load. At Newport the 105kw. set is required to supply either low-tension current in Newport or to act as a spare to the high-tension generator and supply high-tension current to Cowes, and the limits of transformation are: Stepping up, with 490 volts on the low-tension windings, anything from 2,330 to 2,760 volts on the high-tension side; or with 530 volts on the low-tension side, anything from 2,620 to 2,980 on the high tension side. Similarly, stepping down, with 2,650 volts on the high-tension side (the most usual pressure), any volts from 410 to 505; or, if a higher pressure is used on the high-tension windings, such as 2,750 volts, a range of from 495 to 525 is available. The brushes used are of the galvanic type; the 105kw. sets run at 480 revs. per min. and the 52kw. sets at 580 revolutions.

The high-tension feeders from the generating station at Twickenham to the various sub stations are concentric, and two sizes are used; the feeder to the St. Margaret's sub station has both inner and outer conductor 0·075 sq. in. section, and the others are all of 0·05 sq. in. section. The conductors are insulated with paper impregnated with bitumen, the thickness of the insulation over the first conductor being 0·135in., the insulation over the outer conductor 0·085in., and over this paper insulation is formed a sheath of bitumen 0·18in. thick, which is put on under heavy pressure. Over the sheath is wound a protecting layer of tape and then a serving of yarn, the cable being finally armoured with a single layer of galvanised wire 0·1in. in diameter well covered with compound. Two systems have been adopted for laying the cables, according to the conditions met with.

Two cables are laid from Twickenham to Teddington sub-station, both cables being in the same wood trough and run in solid with bitumen, a tile cover being put over it and cast-iron straight-joint boxes being used. A three-way Sykes duct has been laid at the same time, so that future extensions can be drawn in without having to open up the road again. The cable to Hampton has also been laid solid, and a 4in. single duct has been laid with it for extensions. That to St. Margaret's has, as mentioned above, been made of a larger section, and has been laid solid in a wood trough, no duct being provided, as there is no possibility of more than 200kw. being required in this district. The cables are made for a working pressure of about 2,600 volts between conductors, the outer conductor being earthed. The specified resistance was 100 megohms per mile when tested at the factory

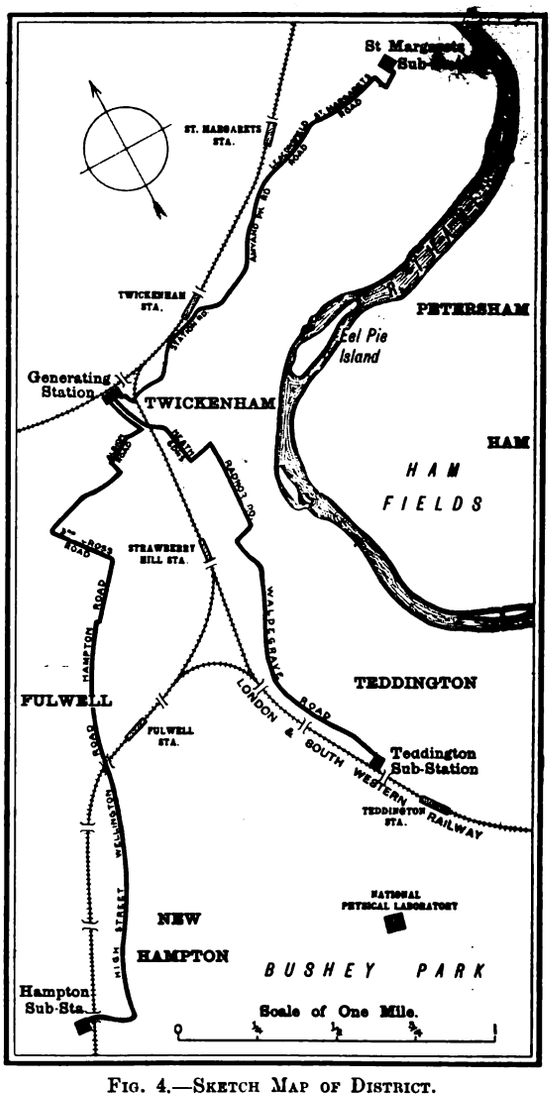

FIG. 4.—SKETCH MAP OF DISTRICT.
Route of Feeder Mains shown thus ——

after 24 hours' immersion in water, and the pressure tests were 7,500 volts alternating, kept on for 15 minutes between conductors, and 2,500 volts alternating between the outer and earth. It will be noticed that the cables have twice as much copper in what will be the "neutral" as they have in each of the outers. The object of this is, of course, to make it possible to use the system economically as a two-wire one at any time, and the extra expense in copper is so small that it is more than compensated for by the flexibility thus given to the system. In the Newport–Cowes cables the "neutral" is only half the cross-section of each outer, and in order to be able to use it economically as a two-wire system, the neutral has to be connected to one of the outers, thereby introducing complications into the switch gear, which have been avoided in this newer arrangement.

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A NEW APPLICATION OF ELECTRICITY IN THE FIRE BRIGADE.

Chief Officer Bayliss has just put into service a novel improvement in fire apparatus, specially constructed by Messrs. Merryweather & Sons, of London, for the Manchester Fire Brigade. This appliance, which is illustrated in Figs. 1 and 2, consists of a steam fire engine with certain interesting additions intended to facilitate the work of the firemen and to maintain communication between them and the officer in charge. The novelty consists in the provision of helmets for the firemen, fitted with telephones and an air draught arrangement, and also in an electric lighting circuit supplying current to protected incandescent lamps which the men carry.

By the side of the steam cylinder is a single-barrel air pump, driven by a coupling and gear from the crankshaft, and also arranged so that it can be thrown out of action when desired. The air pump supplies four valves fixed on the side frame, quick hitching couplings being fitted to these valves for hose connections to the smoke helmets.

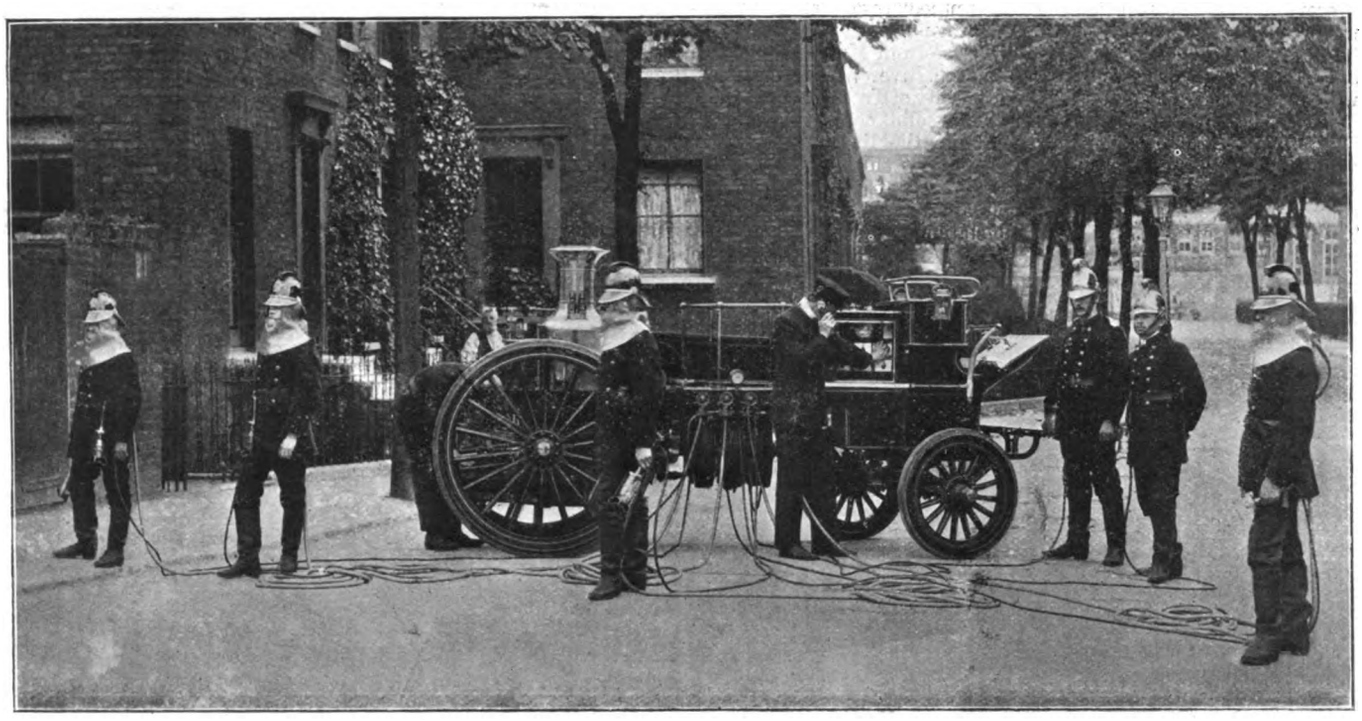

FIG. 1.—GENERAL VIEW OF ENGINE, SHOWING TELEPHONE AND ELECTRIC LIGHT LINES.

FIG. 2.—FIREMAN WITH SMOKE HELMET AND TELEPHONE, HOLDING PROTECTED INCANDESCENT LAMP.

Over the fore-carriage is placed a dynamo to supply eight 32 c.p. incandescent lamps. This machine is driven by a belt from the flywheel of the engine, and is provided with a voltmeter and six reels. The latter hold 200ft. of flexible insulated cable each, and are fitted to supply the lamps. A large cage is fitted in the centre of the machine for carrying six 60ft. lengths of flexible metal air hose in coils. In front, under the driver's footboard, is a box to hold batteries for the telephone service and also the smoke helmets.

Each helmet is of leather with a mask extending over the shoulders, the front under the peak being left open. The coupling for the air hose is at the back, and the draught is distributed round the wearer's head in front, so as to keep the eyes and nose clear of smoke. Inside the mask are the telephone receiver and transmitter, wires being led through the air valves, from whence wires are carried to a switchboard, so as to enable the officer in charge to communicate with his men working in darkness or smoke at a distance.

The Institution of Civil Engineers' Premiums.—Among the awards made by the Council of the Institution of Civil Engineers for Papers presented before the Institution during the session 1903-4 are:—A Telford premium to Mr. Alexander Millar for his Paper on "The Electrical Reconstruction of the South London Tramways on the Conduit System"; a Miller prize to Mr. Conrad Gribble for his Paper entitled "Notes on Automatic Signalling"; a Miller prize to Mr. John McFarlane Kennedy for his Paper on "The Relative Advantages in the use of Continuous and Alternating Current for Traction Purposes"; and a Miller prize to Mr. Harry Middleton for his Paper entitled "Notes on the Permanent Way of the Newcastle Corporation Tramways."

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POWER DISTRIBUTION IN ALBANY, TROY AND SCHENECTADY.*

Electrical supply in Albany and Troy, N.Y., is now drawn from Spier Falls on the Hudson, 40 miles up stream, and from the falls at Mechanicville, 15 miles away. This transmitted energy is supplied to the local companies in Albany and Troy by the Hudson River Water Power Co., and the contracts call for the immediate delivery of a maximum of 6,000 H.P. in each city. Two three-phase transmission lines from Spier Falls and one three-phase line from Mechanicville run to the Watervliet sub-station of the Hudson River Water Power Co., which is just across the Hudson from the City of Troy. Each of these three circuits is made up of three bare solid copper wires, size 3/0 B. & S. gauge. Energy delivered to the line at Spier Falls at about 30,000 volts reaches the Watervliet sub-station 35 miles away at about 26,500 volts, and the current from Mechanicville comes into the same sub-station at approximately 10,800 volts. Transformers at the Watervliet sub-station reduce the 26,500-volt current from Spier Falls to the 10,800-volt pressure, and the energy from both Spier Falls and Mechanicville is then transmitted from Watervliet at this latter voltage to the local sub-stations of the lighting and traction systems in Albany and Troy. The energy from Spier Falls is reduced in pressure from 26,500 to 10,800 volts at Watervleit because it is necessary to cross the Hudson River with a cable in order to reach Troy, and to run underground in entering Albany. It was not thought desirable to use as high a pressure as 26,500 volts in the submarine and underground cables necessary for these purposes. At Mechanicville the current is developed at a little above 10,800 volts, and the reduction of the 26,500-volt current to this lower voltage at Watervliet brings both sources of energy there to the same pressure.

At the Watervliet sub-station the equipment includes nine transformers rated at 1,000kw. each, which are arranged in three groups for the transmission circuits above mentioned, and reduce the voltage from 26,500 to 10,800. From Watervliet two 10,800-volt, three-phase overhead circuits run to another sub-station of the Hudson River Water Power Co. about 4 miles distant, near the city limits of Albany and called the Albany sub-station. The object of this sub-station is to regulate the pressure of the two 10,800-volt circuits, connect their overhead wires with underground cables, and to reduce the voltage of a part of the energy for local distribution. This sub-station is 55ft. 9in. by 31ft. 6in. on the ground, partly one and partly two storeys in height, and has a basement underneath its entire area. In structure the walls of this building are brick, the floor of the basement concrete, the upper floors concrete on steel I-beams, and the roof tile, also supported by I-beams.

The central portion of the basement forms an air-pressure chamber over which the transformers on the first floor are located. On this first or main floor there are also located two so-called I.R.T automatic regulators of General Electric make, rated at 300kw. each. Each of these regulators is connected to one of the 10,800-volt three-phase circuits, has capacity to raise or lower the voltage thereon by 7·5 per cent., and is designed to maintain a constant voltage to within one-half of 1 per cent. Room is provided over the air-pressure chamber for nine transformers of 500kw. each, these transformers to be arranged in three groups and reduce the voltage from 10,800 to 2,300 for local distribution. From these transformers the 2,300-volt circuits lead to a switchboard on the same floor that controls the local lines. Two motor-driven blower sets occupy a part of the floor space over the air-pressure chamber, and maintain the pressure that forces air through the transformers and the I.R.T. regulators.

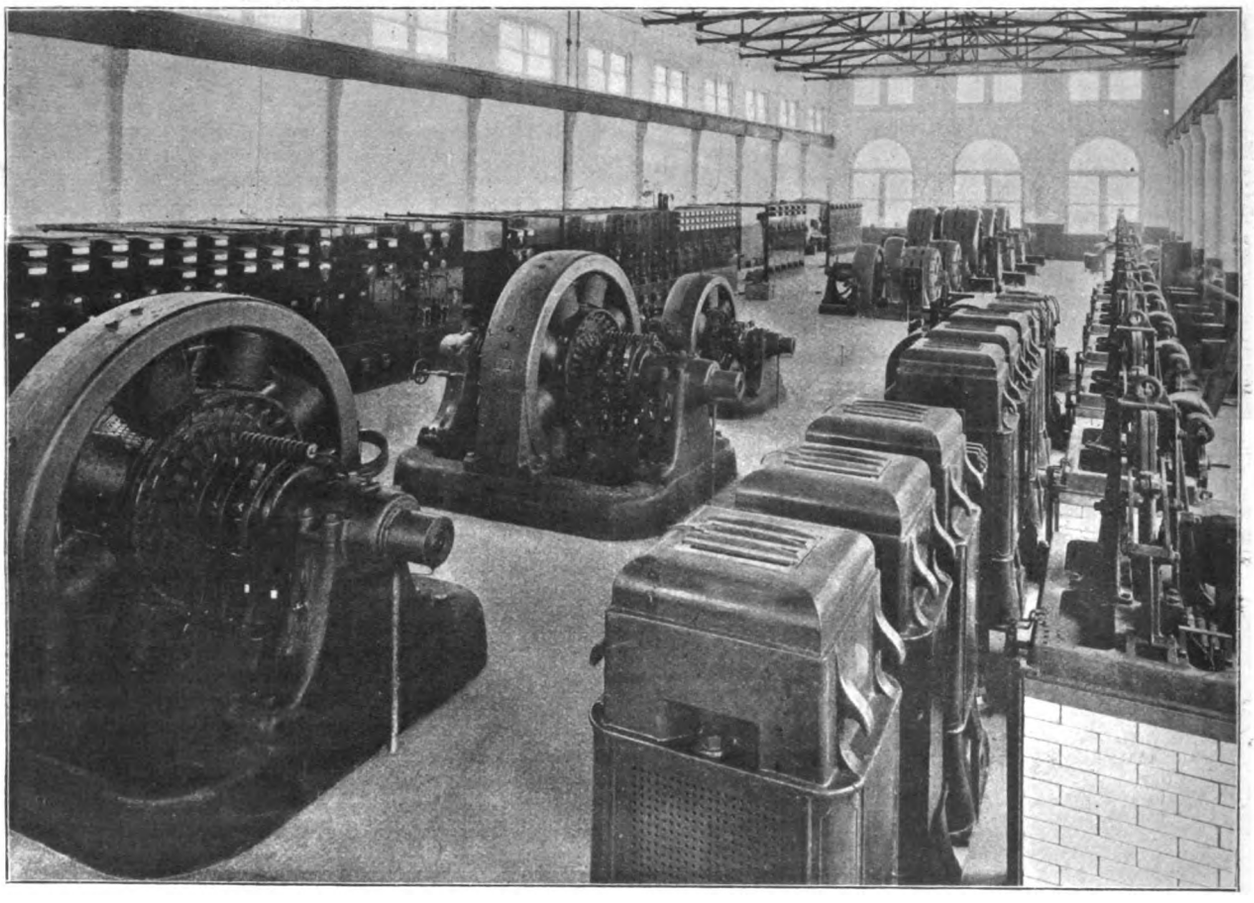

FIG. 1.—VIEW OF INTERIOR OF SUB-STATION OF SCHENECTADY RAILWAY.

In front the sub-station is two storeys high above the basement, and the two-storey portion is 10·5ft. wide between 12in. brick walls, and its length occupies the entire width of the building. Into this front end of the sub-station, which is thus separated by a brick wall from the remainder of the building, come the bare overhead transmission lines. For the entry of these lines, nine circular openings, each 15in. in diameter, were made in the brick wall along the same horizontal line and with centres 21½in. apart. These openings in the brick wall are protected from storms by an extension of the roof, which is about 2ft. above the openings, and by a cement wall 2in. thick and 2ft. outside of the brick wall that drops from the extended roof of the front part of the building to the lower roof of the rear part.

In this cement partition or wall there is a row of circular holes opposite to the holes in the brick wall, but each hole in the cement wall is only 10in. in diameter. After passing through these two sets of openings the nine wires of the three transmission circuits enter single-pole double-blade knife switches that connect each wire with a bank of lightning arresters and with a 10,000-volt type H oil

* Abstract of an article in the *Electrical World* of New York.

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switch of General Electric make. From these oil switches two of the three circuits go through other knife switches to the two I.R.T. regulators, thence through still other knife switches to 15,000-volt type K oil switches of General Electric make, and from these K switches to more single-pole double-blade knife switches that connect with static discharges and underground cables. The third 10,800-volt circuit, after passing through an H oil switch with knife switches on each side, goes to the transformers that lower the pressure to 2,300 volts for local distribution.

All three of the 10,800-volt circuits, after leaving the H oil switches, connect with duplicate sets of 'bus bars by means of which any one of these circuits can be joined to either I.R.T. regulator, or to the transformers. The lightning arrester cells, the static dischargers, and both the types of oil switches are all located in the front end of the sub-station on two floors, and are separated from the remainder of the sub-station by the brick wall already mentioned. The conductors between these several switches and 'bus bars are bare copper, and, like the knife switches, are supported at the tops of large porcelain insulators, like those used outside on the line. Each of these insulators is mounted on a wooden pin that is 9in. long above the shoulder, and that is cemented into the brick wall of the building. The clips of each knife switch are attached to a cast-iron cap that is cemented to the top of one of the insulators just named. This method of insulation is highly effective.

After leaving the K oil switches, the 10,800-volt circuits connect with underground cables that run to the station of the Albany Electric Illuminating Co. at Trinity-place. From the above sub-station of the Hudson River Water Power Co. to the station of the Albany Company the distance is about 2 miles, and 12 standard clay ducts, each 4in. in diameter, have been laid in Portland cement concrete between these two stations. For present purposes two three-phase cables have been laid in these conduits in order to deliver the 10,800-volt current at the Trinity-place station. Each of these cables contains three 3/0 stranded copper conductors, is insulated with paper and covered with a lead sheath $\frac{1}{8}$in. thick. At the station of the Albany Company a new fireproof addition has been built to receive the 10,800-volt underground cables and contain the high-tension switching and transforming apparatus. This addition adjoins the brick wall that forms one side of the main steam power station, has brick walls one storey high, measures 32ft. 4in. by 37ft. 4in. outside, and has a concrete floor and a concrete cemented roof, this latter being supported on steel I-beams. A 15-ton travelling crane sweeps the entire space included within the addition save what is devoted to the switching apparatus and 'bus-bar compartments.

On the distribution system of the Albany Company the load consists of open direct-current and of enclosed alternating arc lamps, incandescent lamps on two-phase circuits and of direct-current motors. The entire load has previously been carried by steam power at the Trinity-place station, and the plan in the application of transmitted water power in the system was to abandon the regular use of steam and yet make no changes in the character of the connected loads. To avoid any such change it was necessary to continue the operation of the 9·6 ampere direct-current arc dynamos and of two-phase 60-cycle alternators, also to substitute rotary converters for the abandoned direct-current 500-volt generators that had been used to carry the motor load.

On entering the new addition of the Trinity-place station the two underground cables connect with oil switches and high-tension 'bus bars of Westinghouse make. From these switches and 'bus bars connection is made with four banks of transformers all located in the fireproof addition to the old station. Each of two of these groups of transformers consists of three units rated at 200kw., making 600 for the group. These three transformers reduce the 10,800-volt three phase current to 375 volts for a 500kw. 550-volt rotary converter that is located in the main station. There are thus two of these converters with a combined capacity of 1,000kw. for the load of direct-current motors. Each of the other two groups of transformers consists of two units rated at 400kw. each, and connected Scott fashion, so as to change the current from three-phase to two-phase, while reducing its pressure from 10,800 to 2,300 volts. This 2,300-volt current passes to the switchboard for distribution lines in the main part of the station, which is separated from the transformers by a brick wall. With the 2,300-volt 40-cycle current thus obtained the distribution circuits for incandescent lamps and induction motors are supplied.

The old station contains a long main shaft to which the arc dynamos and 60-cycle 2,300-volt alternators have been connected by belts in the past, the shaft itself being driven by steam power. The steam engines have been uncoupled from this shaft, though the connection can be quickly re-made if it becomes desirable, but the arc dynamos and one 225kw. alternator remain belted to it. Near each end of this line of shafting and directly coupled therewith are synchronous motors, each rated at 550kw. 10,800 volts and 343 revs. per min. These motors draw their current from the high-tension switches and 'bus bars in the new addition to the station, and the same is true of a third motor of like voltage and capacity that is direct-connected to a 225kw. alternator at each end of its shaft. This third motor and the two alternators to which it is coupled operate at 480 revs. per min., and the alternators develop two-phase 2,300-volt 60-cycle current. These alternators are devoted to the circuits that operate commercial enclosed arc lamps. The transformers, rotary converters and synchronous motors just mentioned were all furnished by the Stanley Company.

Public street lighting in Albany is done entirely with open arc direct-current 9·6-ampere Brush lamps, and about 680 of these lamps are in use and connected to the station of the Albany Electric Illuminating Co. To the circuits of the company there are also connected direct-current motors of about 1,500 H.P. total capacity at 550 volts and arc and incandescent lamps of about 2,000kw. combined capacity on 2,300-volt two-phase lines.

In order to reach the electric lighting station in Troy from the Watervliet sub-station of the Hudson River Water Power Co., it is necessary that the 10,800-volt lines cross the Hudson River. A point about 1 mile down stream from the sub-station and nearly opposite to the lighting station in Troy was selected for this crossing, and a cable was laid in the bed of the river. Bare overhead conductors run from the Watervliet sub-station to the cable landing on the west bank of the Hudson, and there enter a small brick terminal house where they join the cables and have lightning arresters attached.

After crossing the river the cables enter a large manhole close to its east bank, and are there connected to underground cables that run to the lighting station a few hundred feet away. Two cables were used to cross the river, which was covered with a thick coating of ice at the time they were laid, in December, 1903. By means of horses the two heavy cables were dragged across the river on the ice, so that they lay side by side over the location on its bed, where they were to rest, which had been previously determined, and then the ice was sawed through on each side of the cables so that they sunk into position by their own weight.

Each of these two cables contains three No. 3/0 stranded copper conductors, is insulated with paper, enclosed within a lead sheath, and protected on the outside by a layer of galvanised steel wires that are laid in spiral form on a bed of jute that rests on the lead sheath. Between the 3/0 wires the thickness of paper is $\frac{1}{2}$in. to $\frac{5}{16}$in., and between each wire and the lead sheath the paper measures about $\frac{3}{8}$in. This insulation was tested with 25,000 and 50,000 volts applied for one hour. The lead sheath outside of the paper has a radial thickness of $\frac{3}{16}$in., and then comes the layer of jute or other fibrous material, which is $\frac{1}{16}$in. thick, and supports the armour of No. 4 Birmingham gauge steel wires. Outside of this armour the cable has a diameter of $3\frac{3}{8}$in. Both of the cables were made by the National Conduit and Cable Co.

At Troy the connected load on the electrical supply system includes about 15,000 incandescent lamps of nominal 16 c.p. rating, 296 enclosed arc lamps in commercial use, 427 direct-current open-arc lamps for street lighting that are rated at 2,000 c.p. each, 40 open arcs for stores, and 125kw. capacity in direct-current motors. Dynamos for the operation of these several loads have been previously driven by steam power through a long main shaft at the Troy lighting station. In the application of the transmitted water power to these loads the steam engines were disconnected from the main shaft, and synchronous motors were installed to drive it and the several types of dynamos. These dynamos include direct-current arc machines of 9·6 amperes, 2,300-volt alternators, and 500-volt direct-current generators for the motor load. The underground cables bringing the 10,800-volt three-phase current from the Watervliet sub-station enter the old lighting station at Troy, and this current, after passing through oil switches, goes to the 10,800-volt synchronous motors without transformation. In this way the old generating equipment at Troy is retained, and is driven by synchronous motors and water power instead of by steam engines. Besides the supply of transmitted energy to the local lighting systems of Albany and Troy, as above outlined, the Hudson River Water Power Co. also furnish a large part of the power used to operate the electric car lines of the United Traction Co. in and between these two cities. Power for this electric railway system is delivered in the form of 10,800-volt three-phase 40-cycle current at two sub-stations of the United Traction Co., one located near the Watervliet sub-station of the Hudson River Water Power Co. and the other at North Albany, some 4 miles away. At each of these railway sub-stations the 10,800-volt current from the water-power plants is transformed to about 375 volts and delivered to rotary convertors that supply direct current at about 550 volts. The contracts between the Hudson River Water Power Co. and the Albany lighting company, the Troy lighting company and the United Traction Co. look to the complete substitution of transmitted water power for steam in the entire public lighting and street railway systems in these two cities as soon as sufficient generator capacity has been installed in the great plant at Spier Falls to meet the maximum requirements at these and other points, when operated in conjunction with the water-power station at Mechanicville.

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The transfer of electric lighting and railway loads in Albany and Troy to the water-power system completes the substitution of energy drawn from the Hudson River for steam power in electric systems over a territory some 15 miles wide east and west, and 45 miles long north and south. This territory includes Glens Falls on the north, Troy on the east, Albany on the south and Schenectady, Ballston and Saratoga on the west. Probably no other single electric system in the United States serves an equal population over an equal area with an equal amount of power.

Transmitted water power from Spier Falls and Mechanicville also operates the electric railway and lighting systems of Schenectady, N.Y. Both of these systems are owned by the Schenectady Railway Co., and the energy for their operation is delivered through the main switchboard in the power station at the General Electric works. Energy from steam as well as from water power is available at the General Electric switchboard, so that certainty of continuous service on the railway and lighting systems is secured without auxiliary steam equipments in its sub-stations. As at present operated, the railway and lighting systems have three sub-stations, one on Dock-street, close to the General Electric works in Schenectady, one at Colone on the branch of the railway that connects Schenectady and Albany, and one at Latham's Corner on the railway between Schenectady and Troy. The Dock-street sub-station distributes light and power in Schenectady, besides delivering current to the railway, but the other two sub-stations carry only railway loads. When the branch of the Schenectady railway that connects that city with Ballston Spa is in operation, a fourth sub-station located at the latter place will supply power to that branch.

Between the power station at the General Electric works and the new sub-station on Dock-street there are three underground cables each containing three 3/0 stranded copper conductors. Each of these cables carries 10,000-volt 40-cycle three-phase current drawn from step-down transformers in the General Electric plant, and the current delivered by two of the cables is devoted to railway work, while the third supplies energy to the lighting system. From the Dock-street sub-station to that at Colone there are two circuits of three No. 1 B. & S. gauge wires each, and between the Colone and the Latham's Corner sub stations there is one circuit of three No. 2 B. & S. gauge wires. Between the Dock-street sub-station and the city limits of Schenectady, the two circuits of No. 1 wire are made up of two paper-insulated lead-covered underground cables, with three conductors each, but the remainder of these circuits, and that of No. 2 wire are bare overhead conductors. These circuits running to the Colone and Latham's Corner sub-stations transmit the 10,000-volt three-phase current delivered to the Dock-street sub-station from the General Electric works.

When the sub-station at Ballston Spa is in operation, its energy will be drawn directly from one of the two transmission circuits between Spier Falls and Schenectady, before they reach the General Electric works. At the sub-station just named, the electric railway equipment will include two 300kw. 550-volt 40-cycle rotary converters to operate at 800 revs. per min., three 220kw. air-blast transformers with double secondary windings, and two 45kw. air-blast reactive coils, all made by the General Electric Co. A 2 H.P. three-phase induction motor will drive a direct-connected 35in. blower, and a 20 H.P. motor of the same type will operate a Magan air compressor. At the Colone and

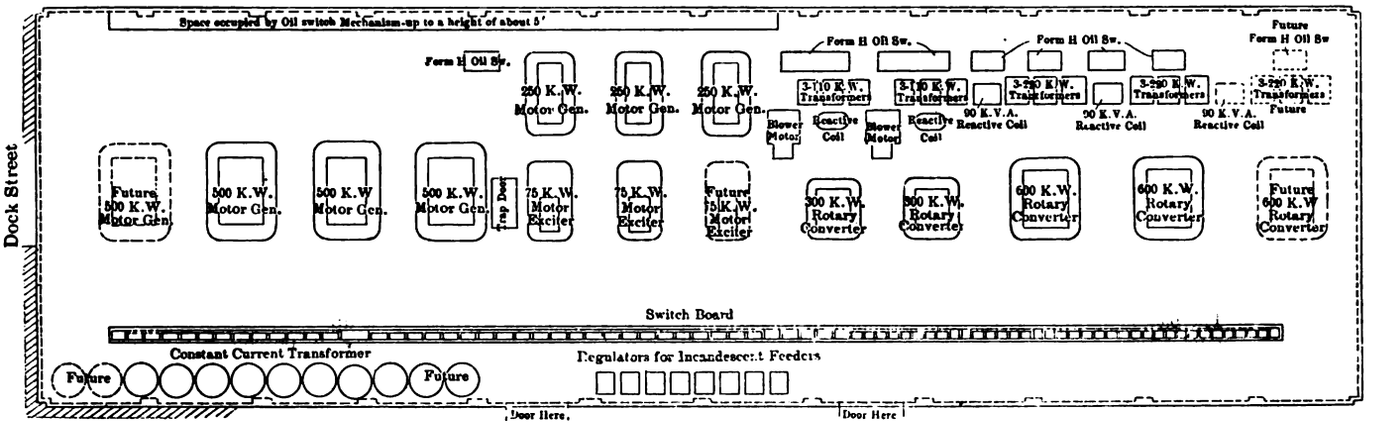


FIG. 2.—PLAN OF DOCK STREET SUB-STATION.

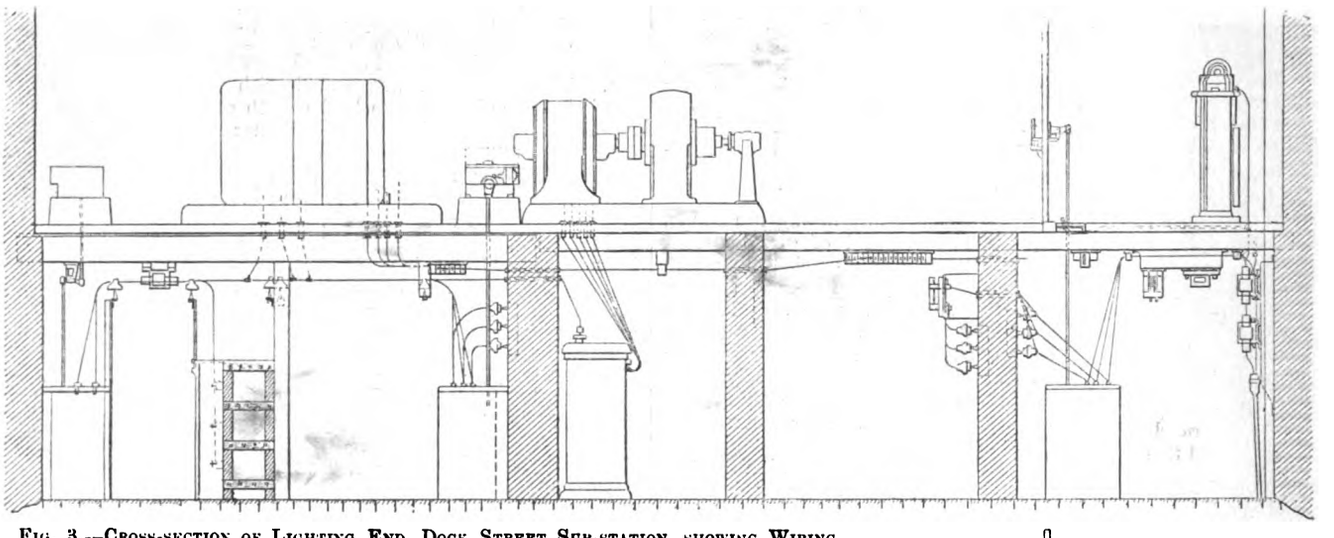
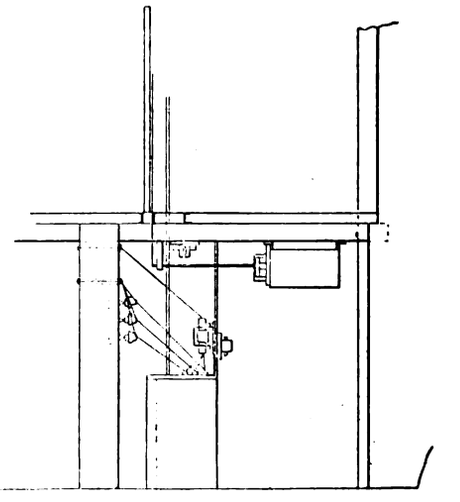


FIG. 3.—CROSS-SECTION OF LIGHTING END, DOCK STREET SUB-STATION, SHOWING WIRING.



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also at the Latham's Corner sub-station, both of which have been in regular operation for some time, there are three 300kw. rotary converters supplied with energy from the 10,000-volt line through transformers and delivering direct current of about 550 volts.

The new sub-station at Dock-street has recently been put into service to replace an old power house and sub-station near by and carries all of the lighting and stationary motor service at Schenectady as well as a large share of the street railway load. The ground area of the sub-station is 165ft. 8in. by 45ft. 2in., and its elevation includes a high basement, and a main operating room on the first floor above. The basement floor of this sub-station is slightly above the ground level outside, because the Hudson River and Erie Canal near which it is located are liable to overflow. From ground to coping the height of the sub-station is 40ft. 4in., from basement floor to main floor the distance is 10ft., and main floor to the lower cord of the steel roof trusses the distance is 24ft. In structure the sub-station is of stone, brick, concrete and steel, save for the 3in. plank that supports the slag covering of the roof. Up to the level of the main floor the outer walls are of brown stone and above this they are brick. In thickness the stone wall is 20in., increasing to 27½in. at buttresses, and the brick wall above is 12in. thick, increasing to 24in. at buttresses. The basement floor is formed by a 1in. layer of cement on 4in. of concrete, and the main floor is composed of concrete arches resting on steel I-beams, and all supported by the outer and by interior walls. The sub-station is lighted by large windows along three sides and small high windows on the fourth, and along the centre line of the roof are ranged four 36in. globe ventilators.

The basement is divided by interior walls into spaces for air pressure chambers, 'bus bar compartments and oil switch cells, and all 'bus bars and oil switches are located therein. Each of the 10,000 volt 'bus bars is located in a separate compartment of brick and concrete, and each pole of the 10,000-volt oil switches has its own brick cell. The entire main floor of the sub-station is swept by a 15-ton travelling crane, and this crane runs over an archway at one end of the building, where teams can drive in at the basement level. The 18in. I-beams on the side walls of the sub-station on which the crane travels are supported by the brick abutments, and these abutments are not reinforced by steel columns. On the main floor of the sub-station are located transformers, the operating gear of oil switches, rotary converters, exciters, synchronous motor-generators and the switchboard panels. Along one-half of the main floor the railway apparatus, and along the other half the lighting apparatus is located. Current is supplied to this apparatus in part by six transformers, each rated at 10,000 to 375 volts and 110kw., and of the air-blast type. These six transformers are connected in two groups with two rotary converters, each rated at 300kw., 40 cycles and 600 volts. Two other banks of transformers are made up of six units with a rating of 10,000 to 375 volts and 220kw. each, and each of these banks feeds a 600kw. 600-volt six-phase 40-cycle rotary converter. With each of the 300kw. rotary converters there is a 45-kilovolt-ampere reactive coil of the air-blast type, and with each 600kw. rotary there is a 90-kilovolt ampere reactive coil of the same type. Space has also been provided for three more 220kw. transformers and one 600kw. rotary converter with its reactive coil. Each group of three transformers is connected to the 10,000 'bus bars through a type H General Electric oil switch, electrically operated by current from a battery of 55 type E storage cells made by the Electric Storage Battery Co. The panels that carry the controlling switches for all the apparatus at the sub-station are of black enamelled slate, and the maximum pressure to which they are exposed is 15 volts. Of these panels three carry instruments for three incoming lines of 10,000 volts and 4,000kw. capacity each. On each of these three panels there is one horizontal edgewise ammeter, one voltmeter of the same type, one double-pole overload relay that indicates by lamps whether the oil switches are open or closed, one controlling switch for the type H oil switch, and a current and potential transformer and static dischargers. The two panels for outgoing lines are of 10,000 volts and 1,500kw. capacity each, and equipped like the incoming panels, with the addition of polyphase induction recording wattmeters. For each rotary converter the panel includes a recording wattmeter, power-factor indicator and overload relay, besides volt and amper-meters, controlling switches for the type H oil switch, indicating lamps and secondary transformers. Lamps in the sub-station may be operated from either the regular lighting circuits, the railway circuit or from the storage battery above mentioned.

Two 75kw. motor-driven exciters are already in use at the sub-station, and space has been provided for a third set when required. The lighting equipment at this sub-station includes synchronous motor-generators and constant-current transformers. Each of three of the motor-generators is made up of a 550kw. 10,000-volt 40-cycle three-phase motor, and a 500kw. 2,300-volt 60-cycle three-phase generator. Space for a fourth motor-generator of this capacity is also provided. Each of the other three motor-generators is of 250kw. output capacity, and converts the 10,000-volt 40-cycle three-phase current to 2,300 volts and 60 cycles. Each synchronous motor of these motor-generators is connected with the 10,000-volt three-phase 'bus bars through one of the electrically-operated type H oil switches. Series arc lighting is provided for by eight constant-current transformers of 4,000 volts and 6·6-ampere capacity each. These transformers are supplied with 2,300-volt 60-cycle current from the motor-generators. Current of 40 cycles was tried for arc lighting from the old sub-station, but its use has been abandoned As may be seen from this list of equipment, the sub-station sends out only two sorts of current for the general supply of light and power—that is, current of 60 cycles at 2,300 volts and constant current of 6·6 amperes and the same number of cycles as the other. Two automatic regulators are provided at the sub-station for the two most important 2,300-volt circuits that leave it for lighting service, and hand regulators are connected in the other 2,300-volt lighting feeders.

FIG. 4.—TRANSFORMERS, ALBANY.

Between the Dock-street sub-station and the main business parts of Schenectady the lighting and power circuits are composed of underground cables in Camp tile ducts. Feeder cables for the 2,300-volt circuits have three conductors each, and these conductors in most cases are each of 500,000 circular mils. For the constant-current arc circuits single-conductor cables are used. The general distribution system for light and power at constant pressure includes 2,300-volt, 60-cycle, single-phase primary mains, subway transformers in manholes and three-wire secondary mains at about 250 volts. In the outlying parts of the city the 2,300-volt underground feeder cables connect with overhead feeders, and these feeders supply banked transformers and secondary three-wire mains as far as is practicable. Separate transformers for single customers are used only in isolated locations. The connected load of the Schenectady electrical supply system includes constant alternating-current arc lamps, constant pressure alternating arc lamps, incandescent lamps on constant

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pressure circuits and induction motors at 550 or lower voltages. All arc lamps are of the enclosed type. Substantially all of the commercial service is supplied through meters, of which there are 5,306 in use with 5,309 customers. The number of arc lamps used for street lighting is 440 of the 6·6-ampere type on series circuits, with an estimated equivalent capacity of 4,400 incandescent lamps of 16 c.p. each. Commercial arc lamps on constant-pressure circuits number 519, with individual ratings of 4 to 25 amperes, their being 10 of the largest size, and the number rated at 6 amperes each is 482. Estimated on the basis of 16 c.p. incandescent lamps, the equivalent capacity of these commercial arcs is 10,030 in number. Commercial incandescent lamps number 84,572, and their equivalent capacity in lamps of 16 c.p. is 79,180. In candle-power these incandescent lamps range from 4 to 100, and the number of 10 c.p. lamps is 16,820, of 16 c.p. 63,769 and of 100 c.p. six.

All motors are of the induction type, and their total number is 173, with a combined rating of 671 H.P. These motors range from $\frac{1}{6}$ H.P. to 50 H.P. capacity, and there are five of the 20 H.P., five of the 30 H.P. and two of the 50 H.P. size. The equivalent rating of all the lamps and motors above named is 100,350 incandescent lamps of 16 c.p.

Besides the above connected load, the Schenectady Railway Co. has secured a 20-year contract, subject to confirmation at the end of each three-year period, to pump all of the public water supply for the city. This water is pumped into standpipes under a head of 110lb. and with a suction of 6lb. For the work of pumping there have been provided two vertical turbine centrifugal pumps with a daily capacity of 12,000,000 gallons. To each of these pumps there is direct-connected an 800 H.P. 40-cycle 550-volt induction motor. Each motor is supplied with current from the 2,300-volt 40-cycle three-phase line through three transformers rated at 250kw. each. Two pole lines and circuits extend from the Dock-street sub-station to the pumping station, and the supply of power is assured by the fact that not only the water-driven stations at Spier Falls and Mechanicville, but also the steam plants at the General Electric works can be drawn on.

THE REACTION OF THE RADIATION ON A MOVING ELECTRON.*

BY M. ABRAHAM.

The moving electron gives rise to an electromagnetic field, which exerts a force on the electron. For velocities small compared with the velocity of light, the expression for this force is

$$K_i = K_i' + K_i'' + \ldots, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where the first term $$K_i' = -\mu_0 \dot{v} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

is equal to the vector of acceleration multiplied by the electromagnetictic mass, the existence of which was first suggested by J. J. Thomson in 1881.

The second term $$K_i'' = \frac{2}{3}\frac{e^2}{c^3}\ddot{v} = b\ddot{v} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

first given by H. A. Lorentz, is a dissipative force, coming from the reaction of the radiation. Indeed, if you consider a motion of the electron, in which the vector velocity v is constant up till time t_1, and after the time t_2, but which has an acceleration during the interval $t_1 < t < t_2$ the work done during this interval by the force K_i'' is

$$\int_1^2 dt v K_i'' = b \int_1^2 dt v\ddot{v}.$$

As $\dot{v} = 0$ for t_1, t_2, integration by parts gives

$$\int_1^2 dt v K_i'' = -b\int_1^2 dt \dot{v}^2 = -W_{12}, \quad . \quad . \quad . \quad . \quad (4)$$

where W_{12} is the energy (calculated by J. Larmor and others) which the waves formed during the interval $t_1 < t < t_2$ carry with them. Therefore K_i'' may be called the dissipative force exerted by the radiation on a slowly moving electron.

The electrons emitted by radio-active bodies are moving with very high velocities. The experiments of W. Kaufmann show that the β-rays of radium are negative electrons moving with velocities greater than two-thirds of the velocity of light, and if F. Paschen is right, the so-called γ-rays contain electrons moving with nearly the velocity of light, and may be the velocity of light itself is obtained. The theory, therefore, must be extended to the general case of rapid motion, where $v/c = \beta$ is smaller than, but not small compared with, 1.

As to the first term, K_i', I have previously given the general value

$$K_i' = -\frac{dG}{dt}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where G is the vector of the electromagnetic momentum which the electron carries with it. From this formula I get the general expression for the electromagnetic mass. The "longitudinal mass" corresponding to acceleration in the direction of motion is

$$\mu_s = \frac{d\mathcal{G}}{d\,|\,v\,|}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$\mathcal{G} = |\,G\,|$, while the "transverse mass" which comes into play in the case of deviation of β-rays is

$$\mu_r = \mathcal{G}/|\,v\,|. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

For slow motion, in which the momentum is proportional to the velocity, the two masses are equal, but in general they are different.

The value of the momentum depends, of course, on the shape of the electron. I will not discuss this matter in detail, because the second force of which I will speak is independent of the shape and size of the electron. It is closely connected with the radiation of a point charge by the relations

$$\int_1^2 dt v K_i'' = -W_{12}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

$$\int_1^2 dt K_i'' = -G_{12}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

where W_{12}, G_{12} are the radiated energy and radiated momentum respectively. They are given by

$$W_{12} = \frac{2}{3}\frac{e^2}{c^3} \cdot \int_1^2 dt \left\{\frac{\dot{v}^2}{k^4} + \frac{(v\dot{v})^2}{c^2k^6}\right\}, \quad . \quad . \quad . \quad . \quad (10)$$

$$G_{12} = \frac{2}{3}\frac{e^2}{c^3} \cdot \int_1^2 dt \frac{v}{c^2} \cdot \left\{\frac{\dot{v}^2}{k^4} + \frac{(v\dot{v})^2}{c^2k^6}\right\}, \quad . \quad . \quad (11)$$

with $k^2 = 1 - \beta^2$.

I gave these values in *Annalen der Physik*, 10, p. 156, 1903, the Paper being sent in on October 23, 1902. The same formulæ have been found independently by O. Heaviside, *Nature*, 67, p. 6, November 6, 1902.

Now, the required force K_i'', substituted in (8) and (9), must give these values of W_{12}, G_{12}. We can show that with these conditions K_i'' is determined completely, if we take into consideration that the complete value of the reaction of the field can be regarded as an expansion in ascending powers of $\dot{v}$, $\ddot{v}$, $\dddot{v}$..., and that the genera value of K_i'' must be of the same dimensions as $b\ddot{v}$ without containing a power of the radius as factor. The most general expression of this sort is zero, if it gives zero both for radiated energy and radiated momentum. From this follows that the proposed problem has only one solution.

This solution is :

$$K_i'' = \frac{2}{3}\frac{e^2}{c^3} \cdot \left\{\frac{\ddot{v}}{k^2} + \frac{v(v\ddot{v})}{c^2k^4} + \frac{3\dot{v}(v\dot{v})}{c^2k^4} + \frac{3v(v\dot{v})^2}{c^4k^6}\right\}. \quad . \quad . \quad (12)$$

Indeed, you get

$$vK_i'' = b\left\{\frac{v\ddot{v}}{k^4} + \frac{3(v\dot{v})^2}{c^2k^6}\right\},$$

and, because $\dot{v} = 0$ for t_1 t_2, integration by parts gives

$$\int_1^2 dt \frac{v\ddot{v}}{k^4} = -\int_1^2 dt \left\{\frac{\dot{v}^2}{k^4} + \frac{4(v\dot{v})^2}{c^2k^6}\right\},$$

hence $$\int_1^2 dt v K_i'' = -b\int_1^2 dt \left\{\frac{\dot{v}^2}{k^4} + \frac{(v\dot{v})^2}{c^2k^6}\right\},$$

in agreement with (10).

On the other hand, you get by integration by parts

$$\int_1^2 dt \left\{\frac{\ddot{v}}{k^2} + \frac{v(v\ddot{v})}{c^2k^4}\right\} = -\int_1^2 dt \left\{\frac{v\dot{v}^2}{c^2k^4} + \frac{3\dot{v}(v\dot{v})}{c^2k^4} + \frac{4v(v\dot{v})^2}{c^4k^6}\right\}.$$

Therefore, the time integral of K_i'' is equal to $-G_{12}$.

Hence (12) is the general expression of the reaction of the radiation on a point-charge, moving with a velocity smaller than the velocity of light.

Consider some examples :

(a) Uniform Motion along a Circle.

You have $\dot{v} \perp v$, $\ddot{v} = -vv^2/r^2$, r being the radius of the circle. Equation (12) gives :

$$K_i'' = -b \cdot \frac{v}{k^4} \cdot \frac{v^2}{r^2}.$$

That is a frictional force opposite to the direction of motion. It is proportional to the square of the curvature, or to the square of the intensity of the transverse magnetic field producing the circular motion. Near the velocity of light, when k is very small, the force increases rapidly.

(b) Uniform Motion along a Helix.

Put $v = v_1 + v_2$, where v_1 is the constant velocity along the axis of the screw, v_2 the projection at v to a plane perpendicular to the axis. Consider, that $\dot{v} = \dot{v}_2$ is perpendicular both to v_1 and v_2, and that $\ddot{v} = \ddot{v}_2 = -v_2 \cdot v_2^2/r^2$. r = radius of the circle, which forms the projection of the helix to a plane perpendicular to the axis. You get

$$(v\dot{v}) = 0, \quad (v\ddot{v}) = -\frac{v_2^4}{r^2},$$

* Paper read before Section A of the British Association.

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hence $$K_i'' = -b\left\{\frac{v_2}{k^2}\frac{v_2^2}{r^2} + \frac{v}{c^2k^4}\cdot\frac{v_2^4}{r^2}\right\},$$

putting $$v_2/c=\beta_2,\quad v_1/c=\beta_1,\quad \beta_1^2+\beta_2^2=v^2/c^2=\beta^2,$$

you can write $$K_i = -bv_1\frac{v_2^2\beta_2^2}{k^4r^2} - bv_2\cdot\frac{v_2^2(1-\beta_1^2)}{k^4r^2}.$$

The first term gives a force, resisting to the rectilinear motion v_1 along the axis of the helix; the second term represents a force resisting to the circular motion v_2. When the electron moves rapidly through a homogeneous magnetic field in general both forces come into play.

METHOD FOR MEASURING THE OUTPUT OF INDUCTION MOTORS.*

BY E. ALEXANDERSON.

When induction motors are tested on a commercial basis, an accurate measurement of efficiency and power-factor would involve too much complication. In a commercial test as it is usually carried out, no direct measurements of the power are taken, the only instruments used being a voltmeter and an ammeter. The essential parts of the test are as follows:—Heat run with resistance measurements: slip readings; run without load; impedance test.

For load is used a direct-current machine, the output of which is measured. In special cases, when an exact measurement of the output is necessary the direct-current machine is submitted to a separate test in order to determine its efficiency under the running conditions when it was used in connection with the induction motor. In a rough test, however, when this would be too complicated, the output is simply estimated by assuming a certain apparent efficiency of the motor. In the case of a standard type of motor the apparent efficiency is known with sufficient accuracy; but when one deals with motors of special design the value of the test is diminished when dependence is placed upon mere assumption. In some cases, when the motor is designed for high overload capacity, it may have an exciting current 70 per cent. of full-load current, and in that case knowledge of the apparent efficiency would be of little use, because the intersections in the power triangle would be too inaccurate to measure the output.

In order to overcome these difficulties without complicating the measurements, I have developed a method which is now being used by the General Electric Co. (U.S.A.) in the commercial test of induction motors. By this method it is possible in every standard test to measure the output at any time while the machine is running. In the same way it would be possible, as will be explained later, to test the output of the motor, while in practical operation, for instance in a shop, without using any instrument or introducing any other complication. The method is based upon the very accurate way of measuring the slip which is offered by a well-known stroboscopic arrangement. A tin disc painted in black and white sectors is screwed to the end of the shaft. The number of sectors is equal to the number of poles of the motor. If an arc lamp fed from the same source as the motor is held near the disc while the motor is running, the sectors will apparently revolve with the speed of the slip. This speed ranges between 60 revs. per min. for small and 10 revs. per min. for large motors, and can be easily counted during one minute. Keeping in mind that 45deg. equals one-eighth of a revolution, it will be readily understood that the slip can be observed even to one-sixteenth of a revolution at lower speeds.

From time to time there are being proposed methods for measuring the slip of the induction motors. This is specially true in regard to the foreign technical literature. Some of the investigators observe the swinging of a needle or the sound in a telephone. Another has recently described a device consisting of several collector rings, a clock mechanism and a relay.† A common feature in all these methods is that only full, or perhaps half revolutions, can be measured, while the stroboscopic method allows a reading as close as the angular motion of a vector can be observed.

Within the limit of full load the slip is almost exactly proportional to the torque delivered by the squirrel-cage or armature winding of the motor. When the motor is loaded by a direct-current machine its output is partially consumed by the output of the generator, which output is measured by direct-current instruments, and partially by the losses in the generator with belt.

The output of the motor armature is, therefore, divided up as follows: 1. Bearing loss of motor. 2. Belt loss. 3. Bearing loss of generator. 4. Core loss of generator. 5. I^2R loss of generator. 6. Output of generator.

If the load of the generator is thrown off, but the excitation (which is taken from another source) is kept constant, the motor will carry the following load:—1. Bearing loss of motor. 2. Belt loss. 3. Bearing loss of generator. 4. Core loss of generator.

The torques corresponding to the losses 1, 2, 3 and 4 are the same in both cases, although the losses themselves vary slightly when the motor changes speed. If one slip reading is taken in the first and one in the second case, these readings will be proportional to the torques, and the difference between the slip readings proportional to the difference between the torques.

The quantities may be denoted as follows:—

	Full load.		D.C. load off.
Slip	S	.....	S_1
Total torque of armature	T	.....	T_1
Total output of armature	P	.....	P_1
Volt-ampere of generator	VA	.....	—

From the above proportion we get:

$$T/(T-T_1)=S/(S-S_1).$$

But the torques are proportional to the outputs at full-load speed. Hence: $P/(P-P_1)=T/(T-T_1)=S/(S-S_1)$.

The power, $P-P_1$, is known from the direct-current readings:

$$P-P_1=VA+I^2R,$$

$$P=\frac{S}{S-S_1}(VA+I^2R).$$

This power is the output of the motor armature and includes the losses by bearing friction and windage, P. The counter-torque of these losses correspond to the slip at light run, So.

As above, we find:

$$Po/(P-P_1)=To/(T-T_1)=So/(S-S_1).$$

$$Po=\frac{So}{S-S_1}(P-P_1)=\frac{So}{S-S_1}(VA+I^2R).$$

The useful output of the motor:

$$P-Po=\frac{S-So}{S-S_1}(VA+I^2R).$$

The constant losses of the generator with belt:

$$P_1-Po=\frac{S_1-So}{S-S_1}(VA+I^2R).$$

The quantity I^2R is so small that it can be either entirely neglected or estimated from the rated size of the direct-current machine.

When the constant losses of generator with belt have once been ascertained, the output of the motor at any load can be determined by adding these losses to the direct-current output.

If the revolving field had the shape of a perfect sine wave with uniform rotation, the slip at light run, So, would correspond to the bearing friction and windage only. In every motor the field is, however, distorted more or less by higher harmonics, which induce a current in the armature independent of the load. The energy consumed that way in the armature is also taken care of by the slip. The energy loss being proportional to the square of the current, this loss must be extremely small in a good motor, and the slip at light run for practical purposes can be considerd as proportional to the bearing friction and windage. This test, therefore, offers means to measure those losses by a direct reading, which is otherwise a rather complicated undertaking.

A number of experiments have been made in order to test the reliability of the new method to measure the output, and it appears that the results agree very closely with those obtained by the method which involves a separate test of the efficiency of the generator with belt. The table which is given below shows what can be expected of the method. These readings were taken during a time of about two months upon every motor of a certain type, and they can be considered as an average of a purely commercial test.

Output of Motor.

By separate test of D.C. machine.	By slip.	By separate test of D.C. machine.	By slip.
14·5	14·05	14·1	13·75
21·0	21·3	10 15	10·4
5·1	5·3	10·6	10·6
10·7	10·45	150·0	144·5
10·9	10·35	40·3	40·5
99·3	99·0	14·1	13·75
10·9	10·3	10·15	10 5
99·2	97·5	10·6	10·6
49·4	46·0	9·82	10·4
150·0	144·5	10·3	10·1
40·3	40·5	26·1	26·6

Practical instances:—

Full-load slip $S=52\frac{1}{2}$.

Volt-ampere of generator $VA=128\times22·6=2{,}890$ watts.

Direct-current load off: Slip $S_1=11\frac{7}{8}$.

Running light: Slip $So=2\frac{1}{8}$.

The machine used for load being a 15 H.P. 125-volt machine, its armature resistance can be estimated $=0·03$ ohm, and the I^2R loss $=0·03\times22·6^2=15$ watts. A mistake in this estimate would evidently

* From the *Electrical World* of New York.

† See an article by Bianchi, *Elektrotechnische Zeitschrift*, December 24, 1903, an abstract of which was published in *The Electrician*, Vol LII., p. 934.

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be of no importance when the I^2R loss (15 watts) is added to the output, 2,890 watts.

Full-load output of the motor:

$$P-Po=\frac{S-So}{S-S_1}(VA+I^2R)=\frac{52\frac{1}{2}-2\frac{1}{8}}{52\frac{1}{2}-11\frac{7}{8}}\times(2,890+15)=\frac{50\frac{3}{8}}{40\frac{3}{8}}\times 2,905$$

$=3,605$ watts $=4{\cdot}84$ H.P.

Constant losses of generator with belt:

$$P_1-Po=\frac{S_1-So}{S-S_1}(VA+I^2R)=\frac{11\frac{7}{8}-2\frac{1}{8}}{52\frac{1}{2}-11\frac{7}{8}}\times 2,905=700 \text{ watts.}$$

Bearing friction and windage of motor:

$$Po=\frac{So}{S-S_1}(VA+I^2R)=\frac{2\frac{1}{8}}{52\frac{1}{2}-11\frac{7}{8}}\times 2,905=15 \text{ watts.}$$

When the output per revolution of the slip has once been ascertained it is possible at any time, when the motor is in practical operation, to measure the output by means of a slip reading. All that is needed is to draw on the shaft end with a piece of chalk as many sectors as the motor has poles. If the light of an arc lamp fed from the same source as the motor is thrown on the shaft end, the sectors will appear to revolve with the speed of the slip, as stated above. If the motor is installed in a shop it is very likely that the lamps used for lighting purposes are fed with alternating current from the same power system as the motor, and then no other arrangements need be made. It would, therefore, be advisable to have the exact speed corresponding to the rated output of the motor stamped on the name-plate. To test the output one would only have to subtract the rated speed from the synchronous speed in order to obtain the rated slip. The actual output would then be:

$$=\frac{\text{measured slip}}{\text{rated slip}}\times \text{rated output.}$$

Practical tests of this kind might be valuable in many cases for finding out the power actually required for a certain class of work, and whether or not the motors installed are of the proper size.

THE EFFECTS OF RECEIVER DROP IN A COMPOUND ENGINE.*

BY JOSEPH W. HAYWARD, M.SC.

This Paper deals with the results of four experiments undertaken to demonstrate the effects of varying the point of cut-off in the low-pressure cylinder of a compound engine, other conditions being maintained constant. The tests were made at the Central Technical College. The engine employed was of the horizontal compound surface-condensing type, with cranks set at right angles; its high-pressure cylinder is fitted with an expansion valve, whose travel is controlled by the governor; its low-pressure cylinder is also fitted with an expansion valve, the lap of which was set to give the cut-off required for each experiment. The cylinder constants for this engine are as follows:—

Cylinder.	H.P.	L.P.
Diameter, inches	8·728	15·76
Stroke, inches	22	22
Mean volume described by piston per stroke, cubic ft.	0·7463	2·4485
Mean clearance volume, cubic ft.	0·076	0·1364

During the trials the barrel of each cylinder was jacketed with steam at boiler pressure, and the receiver was drained continuously through a steam trap. The shortest experiment lasted 1¼ and the longest 4¾ hours. A summary of the results appears in Table I.

Table I.

	Trial number	79	81	78	80
1	Cut-off in low-pressure cylinder, front	0·29	0·39	0·5	0·62
	,, ,, ,, ,, back	0·31	0·41	0·5	0·58
	,, ,, ,, ,, mean	0·3	0·4	0·5	0·6
2	Mean boiler pres., lbs. per sq. in. abs.	99·6	100·2	94·0	98·1
3	Mean back pres., lbs. per sq. in. abs.	3·0	3·8	3·7	3·3
4	Revolutions per minute	98·18	98·08	97·30	97·98
5	Indicated horse-power, high-pressure	18·52	20·85	22·93	26·12
	,, ,, low-pressure	39·24	36·07	34·11	30·00
	,, ,, total	57·76	56·92	57·04	56·12
6	Brake horse-power†	46·29	47·57	46·86	46·70
7	Mech. efficiency of engine, per cent.	80	84	82	83
8	Cylinder feed per stroke, lb.	0 0327	0·0824	0·0875	0·0865
9	Lb. of jacket steam used per lb. of cylinder feed	0·083	0·103	0·098	0·097
10	Foot-pounds of work done per lb. of total feed	108,450	105,400	100,600	99,550
11	Lbs. of steam used per I.H.P. per hr.	18·22	18·78	19·72	19·88
12	Lbs. of steam used per B.H.P. per hr.	22·8	22·6	24·0	23·9
13	Dryness fraction of steam at 80lb. pres.	0 61	0·625	0·63	0·64
14	,, ,, ,, 40lb. ,,	0·73	0·71	0·75	0·72
15	,, ,, ,, 19lb. ,,	0·83	0·88	0·86	0·85
16	,, ,, ,, 12½lb. ,,	0·86	0·91	0·88	0·88

* Paper read before Section G of the British Association, Cambridge.

† The resistance of a short line of counter-shafting is included in the engine friction.

Fig. 1 shows lines plotted between periods of admission to the low-pressure cylinder, as abscissæ, and the following as ordinates:—

(*a*) Work done upon the pistons per pound of steam used.

(*b*) Pounds of steam used per indicated horse-power per hour.

(*c*) Mechanical efficiency of engine.

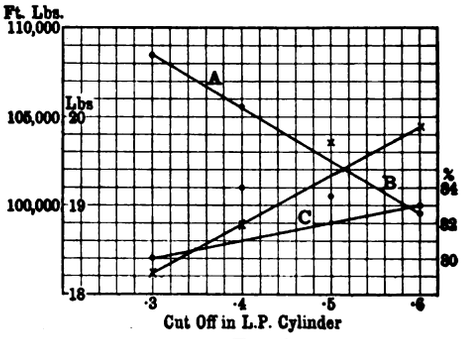

FIG. 1.

The work done upon the pistons per pound of steam decreases continuously as the receiver drop increases, but the consequent loss is partially counterbalanced by an increase in mechanical efficiency. It was quite noticeable that the engine worked more smoothly during trial 80 than during trial 79, and, even with the latest cut-off used, more than half the power was developed in the low-pressure cylinder.

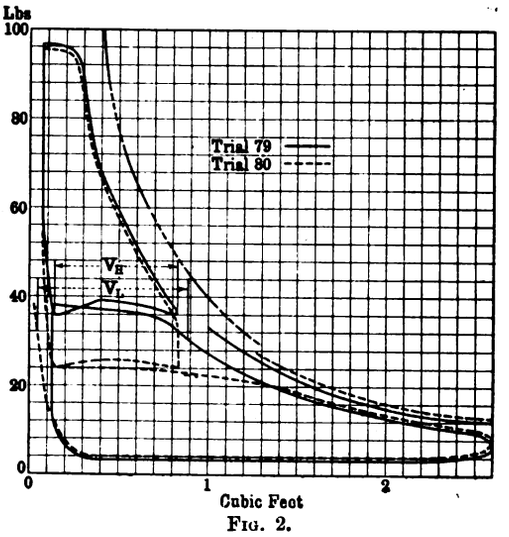

FIG. 2.

The mean indicator diagrams for the extreme trials, 79 and 80, are given in Fig. 2, and the same diagrams, reduced to a common scale of volume occupied per pound of working steam, are reproduced in Fig. 3. Although the range of temperature in the high-pressure cylinder was 88°F. in trial 80, as against 62°F. in trial 79, the steam was 3 per cent. drier at 80lb. pressure in the former case than in the latter. This increase in dryness appears to a smaller extent in the intermediate trials (see Table I., line 13). It may be

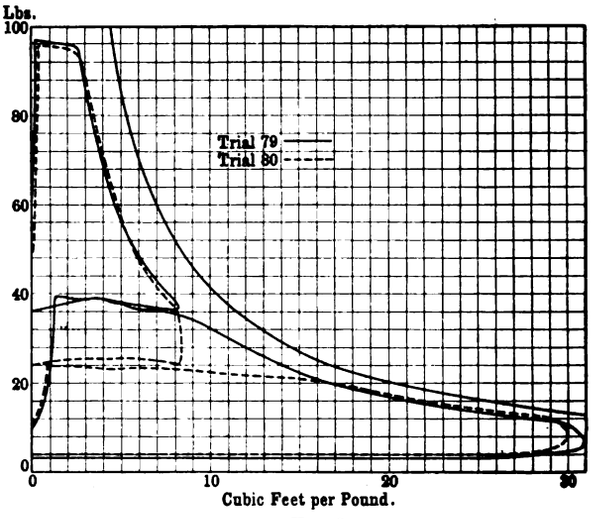

FIG. 3.

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accounted for by the fact that condensation in the steam pipe and high-pressure valve chest is a function of the time alone; consequently the greater the quantity of steam passing through these the drier a given weight of that steam will appear. In the low-pressure diagram for trial 80 the result of free expansion and reduction of temperature range is evident.

One of the chief difficulties in making comparable trials is to maintain the glands in the same condition throughout. Unfortunately the packing of these was excessively tight during trial 79 and excessively loose during trial 81. In the former case the back pressure was reduced to 3lb. per square inch with a hotwell temperature of 135° F., but the mechanical efficiency fell to 80 per cent. In the latter case the mechanical efficiency rose to 84 per cent., but the back pressure was 3·81b. per square inch, with a hotwell temperature of only 130°F.

In a recent Paper dealing with "receiver drop"—see *Proceedings* of the North-East Coast Institution of Engineers and Shipbuilders, Vol. XVI., 1900—Prof. Weighton states that "For maximum economy of consumption, steam must be cut off at a certain point in the stroke in the larger cylinders of multiple expansion engines. For any given cylinder this point depends solely upon the ratio between the capacities of that cylinder and the preceding cylinder R, and is expressed as follows, viz.:—

$$\frac{\text{Maximum economy cut-off}}{\text{Stroke}} = 0{\cdot}15 + \frac{1}{R}.$$

The general application of this conclusion to all engines is not borne out by the experiments under discussion. Prof. Weighton's formula gives the best point of cut-off at 0·46 of the stroke, whereas Fig. 1 shows that it is not later than 0·3 of the stroke. The author considers that the amount of clearance volume and the extent to which compression occurs in both cylinders of a compound engine must have an important influence over the receiver drop, and consequently over the best ratio of expansion in the low-pressure cylinder. For example, in trial 79 the volume V_H—see Fig. 2—of the working steam after its expansion in the high-pressure cylinder was 0·69 cubic ft. The volume V_L of the same steam at cut-off in the low-pressure cylinder was 0·83 cubic ft.

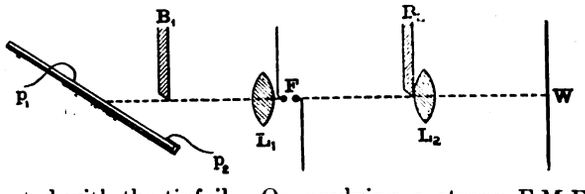
$$V_L/V_H = 1{\cdot}20.$$

Had there been no compression this ratio of free expansion would have become 1·15, and had there been neither clearance nor compression it would have become 0·99. A change in the above quantities in one cylinder only would have a still more marked effect. It is hoped that by further experiment evidence of the true extent of these influences may be obtained.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Spark Waves.—M. Toepler has devised an optical system for making the sound waves proceeding from a spark visible on a screen. He utilises the phenomenon of the "sliding spark." This is produced by sticking a strip of tinfoil on one side of a glass plate, while a point electrode is attached to the opposite side and another point electrode is placed near the edge and



connected with the tinfoil. On applying a strong E.M.F. to the insulated point, an "electric rose" is formed on the glass around it. This gives way before a "sliding spark" as soon as the E.M.F. exceeds a certain limit. It sometimes happens that this limit is only reached by the second or third wave emitted by the spark, and the radii of the waves, as made visible by the streak method *(Schlierenmethode)* are multiples of the half wave-length. The arrangement for throwing the image of the waves on the screen is shown in the diagram. The lens L_1 produces an image of the screen B_1 in the plane of B_2, and the lens L_2 produces an image of the spark-gap F on the screen at W.

[M. TOEPLER, *Annalen de Physik*, No. 9, 1904.]

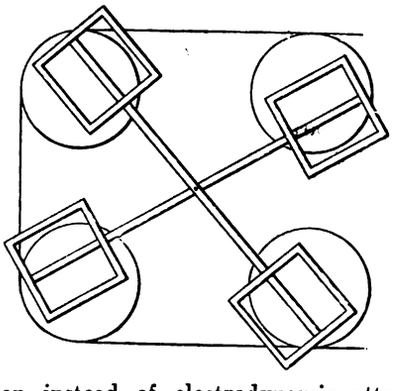
Villari Point in Nickel.—It is well known that when iron is stretched its magnetic susceptibility increases up to a certain point. It then begins to fall, and eventually shows a diminution on further tension. The point at which the sign changes is called Villari's critical point. Heydweiller claimed to have found such a point in nickel also, but this has now been shown to be erroneous by the researches of K. Honda and S. Shimizu. In iron the Villari point occurs in a strong field when the tension is sufficiently feeble. If, therefore, there is such a point in nickel it could only be expected to occur with an extremely feeble tension. The authors therefore used a rod 1cm. in diameter and stretched it with a force not exceeding 0·63kg. per square millimetre. The rod was very carefully demagnetised in order to avoid errors due to the feeble remanent magnetism. The tension was applied repeatedly. The first application resulted in an increase of the magnetic susceptibility, and, therefore, acted like a shock. Subsequent removal of the tension further increased the susceptibility, and a repeated renewal of the tension resulted in an oscillation between the second and third value, accompanied by hysteresis. At no point did the effect of tension become zero.

[HONDA and SHIMIZU, *Annalen der Physik*, No. 9, 1904.]

Magnetic Properties of Alkaline Metals.—A Bernini has investigated the magnetic properties of sodium, potassium, and lithium by the method used by Curie and Chenevau for studying the magnetic properties of radium, and has found that they are feebly paramagnetic. The fused metals were sucked into a glass bulb with very thin walls, and the latter was suspended by the arm of a torsion balance. The maximum deviation was observed by means of a telescope. Before sucking in the metal the bulb was filled with hydrogen, and in the case of lithium the bulb was oiled to prevent the glass being attacked. The results conclusively proved the paramagnetic character of these elements. The susceptibilities were $0{\cdot}5438 \times 10^{-6}$ for sodium, $0{\cdot}632 \times 10^{-6}$ for potassium and $0{\cdot}3836 \times 10^{-5}$ for lithium. The author also noted a slight increase in these coefficients on cooling. In spite of the oscillations due to external causes, he was able to prove that this increase is steady, and shows no abrupt change at the point of solidification. This marks a distinction from the case of bismuth, which shows a sudden change of susceptibility at the melting point.

[A. BERNINI, *Nuovo Cimento*, June, 1904.]

Dynamometer for Rapid Oscillations.—N. Papalexi has devised a dynamometer for rapid electric oscillations which is based



upon induction instead of electrodynamic attraction. Its principle is illustrated in the diagram. It consists of a needle made of squares of aluminium strips attached to a wooden cross and all lying in the same plane. The centre of the needle is attached to a thin wire bearing a mirror for reading the deflection and a piece of mica for damping. The wire, again, is attached to two cocoon fibres 32cm. long, and the needle hangs between two sets of four small coils, which can be used separately or together, so that the instrument can be used differentially. The sensitiveness may be varied by varying the distance between the two sets of coils. In the zero position, the aluminium squares are not directly above the coils. The author tested the instrument by means of oscillations of a frequency of 7 million per second, and found a good agreement with the indications of a bolometer used at the same time. It had the advantage of not requiring a supersensitive galvanometer.

[N. PAPALEXI, *Annalen der Physik*, No. 9, 1904.]

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THE LOCAL GOVERNMENT BOARD CURB.

Two recent decisions by the Local Government Board concerning loans for municipal electric lighting schemes should have a salutary effect in curbing the ambitions of small local authorities wishing to embark upon the business of generating electrical energy. The two cases in point are Stourbridge and Wood Green. Stourbridge adjoins the district supplied by the Midland Electric Corporation for Power Distribution, and it was owing to a favourable offer for the supply of current in "bulk" from that body that, notwithstanding the wish of the District Council to erect their own generating station, the Inspector of the Local Government Board has practically forced an agreement between the two parties. The inquiry was reported in our issue of April 22nd, since which date the progress of the negotiations has been duly noted in our columns. It is, however, to the case of Wood Green that we desire to refer more particularly on this occasion. We publish this week a letter addressed by the Local Government Board to the Wood Green Urban District Council refusing to grant sanction for a loan of £43,570 for the purposes of an electric supply scheme, on account of the unsatisfactory nature of the evidence tendered at the local inquiry in May and June last. The refusal of the Local Government Board in this instance will not come as a surprise to those familiar with the circumstances of the case, especially when account is taken of the organised opposition to the scheme from its inception. Before discussing the details of this latest refusal of the Local Government Board, it may be well to point out that the moral to be drawn from this and the Stourbridge case is that the more enlightened and broad-minded ratepayers of such districts do not interest themselves sufficiently in local politics. If this were the case little difficulty would be experienced in exposing the fallacious arguments which are invariably circulated as to the advantages of municipal electric supply. To mention only one point, comparisons are always instituted between the particular local district and such places as Liverpool or Glasgow. It requires little knowledge of electrical engineering principles to appreciate that no analogy can be drawn between the two cases. Liverpool and Glasgow are large, rich and populous

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cities, while Wood Green is a residential district of by no means a high class as far as rateable value is concerned. It is peopled almost entirely by working men earning only average wages; a large area of the district is occupied by an estate of small property consisting of houses and flats; the number of factories or premises likely to take a supply of current during the day is negligible and the possibilities of a development in the number of such consumers is remote. The estimate of 660 30-lamp consumers put forward at the inquiry is evidently far beyond the mark, and we feel confident that those who know the district will agree that we have not under-estimated the possibilities of electric supply in Wood Green. Having the interest of the industry at heart, we say without hesitation that the municipal scheme was not for the good of the community in a district where the burden of the rates is already well above the average.

It was to meet this identical combination of circumstances that the principle of "bulk" supply was conceived. Curiously enough, the advantages of a "bulk" supply were recognised by the Wood Green Council in 1901, when, in conjunction with four other neighbouring Councils, they endeavoured to launch a combined municipal scheme with a view to the cheapest possible production. This having fallen through, Wood Green, alone, attempted to convince an Inspector of the Local Government Board that in the matter of cost of production they could generate from a small continuous-current station as cheaply as the North Metropolitan Electrical Power Supply Co., which is already providing the power to work the huge system of electric tramways embracing Wood Green, and is already in possession of two generating stations capable of supplying an area many times greater than that provided for in the combined municipal scheme.

The question of the terms upon which the power company is willing to supply energy in such circumstances is of all importance, but sufficient experience has now been gained in such circumstances as to determine beyond doubt that it is to the advantage of such localities as Wood Green to deal with a power company. Mr. HAWTAYNE, the consulting engineer to the Wood Green Council, announced that he had refused to entertain any negotiations with the North Metropolitan Electrical Power Supply Co. unless he could get a supply for one penny or three farthings per unit, but a comparison with the total costs of other London electricity undertakings will demonstrate that Mr. HAWTAYNE'S figure was far too low, especially in view of the fact that the electrical energy would be supplied at a sub-station right at the central point of the Wood Green supply area. A comparison may be made with the case of the Willesden Urban District Council, who realise that they are doing a good stroke of business in taking current from the Company at a tariff which will work out between 1d. and 2d. per unit, delivered to them at the generating station, from which the cost of distribution in the area will be far greater than at Wood Green. The Stoke Newington Borough Council also have been recommended by their consulting engineers to enter into an agreement with the same power company for a supply at a price which will average 1·62d. per unit delivered, or, when the cost of transformation is added, 2·16d. per unit. Under such an agreement, of course, the electric lighting powers remain in the hands of the local authority, and the margin of profit would be always more or less a fixed and certain quantity. All over the country small local authorities of larger rateable values than Wood Green have recognised the wisdom of such a policy, and agreements are being concluded with the various "power" companies. For a small and highly-rated district such as Wood Green it is no little advantage to obtain a supply of electrical energy as cheaply as is now given anywhere under like circumstances, and—an important consideration—with no possibility of a call upon the rates, a risk which, we contend, would undoubtedly exist were a separate generating station erected. In fact, we believe we are not wrong in stating that Mr. HAWTAYNE'S estimates were based on an assumption that there would be a deficit on the undertaking for the first year or two.

There is one other matter in connection with the Wood Green scheme to which we feel bound to draw attention. When referring to the Stourbridge case last April, we pointed out to manufacturers the necessity of inquiring strictly into the circumstances of any case when accepting tenders in advance of the Local Government Board sanction. At Wood Green a similar thing occurred, a tender for cables having been let some months before the inquiry was held. If an agreement with the "power" company is arrived at, the order for cable will have to be reduced considerably, for Mr. HAWTAYNE'S proposed generating station was at the boundary of the area at a considerable distance from the centre of the district, while the Company's sub-station is central; thus the heavy feeder cables which must have been allowed for will not be needed. There is even a possibility of the Council's electric lighting scheme being dropped altogether for the present, and, in any event, the cable manufacturers will have the cable left on their hands for a considerable time.

Now that the Local Government Board is examining more carefully than hitherto the circumstances in which local authorities seek to obtain sanction for loans, it will not be inopportune to call attention to another point with regard to which some laxity has been shown in the past. There are innumerable instances in which small units of plant obtained, say, 10 years ago, have to be replaced by larger units of more modern design. The money originally spent on the obsolete machinery has been borrowed, say, for 25 years, and no depreciation fund is written off beyond the sinking fund on the 25 years' basis. Hence, part of the capital borrowed for the new plant is to be spent in replacing the old, an item which the local authority has no right at all to place to capital account if the original loan for the machinery has not been paid off. In fact, by replacing antiquated plant out of capital instead of out of revenue, local authorities are distinctly guilty of "watering" their capital. Occasional reductions by the Local Government Board in the amount of the loans sanctioned would impress local authorities with the necessity of observing this point, and would ultimately lead to a better provision of depreciation and reserve funds, a provision which is needed to place these municipal trading concerns on a proper financial footing.

ELECTRIC LIGHTING MATTERS IN DUBLIN.

During the last few weeks an interesting series of reports has been made with regard to the condition of the electricity supply undertaking in Dublin, culminating in an offer by Mr. Hammond, the consulting engineer to the Dublin Corporation, in which he proposes to relieve the Corporation of the control of the electricity works by undertaking the entire managment of it for 14 years, reimbursing them the annual capital charges and supplying current at rates to be mutually agreed upon. It may be remembered that in July, 1903, the Dublin Corporation appointed Mr. Hammond to the sole charge of the electricity undertaking there for a period of 12 months, which period expired on July 31st last. During this period Mr. Hammond has also had sole charge of the staff.

The first of the series of reports is by Mr. Mark Ruddle, the resident engineer, who is doubtful whether the present condition of the plant at Pigeon House Fort and the trunk mains between this generating station and the city are adequate to cope with the increased load which may be

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expected in the coming winter. He states that the Lancashire boilers are still in the same unsatisfactory state as during last winter, when the staff was unable to get the full steaming power from them. Mr. Knowles, the works superintendent, has reported to him that according to a test made by the contractors for the mechanical stokers, one of the boilers will only work at two-thirds its steaming capacity. He reports, also, that radical improvements are necessary in the ash-conveying plant to make it workable. He also refers to defects in one of the circulating pump engines, the feed pumps and steam range, and concludes the report with a consideration of the carrying capacity of the trunk mains referred to above. There are three trunk mains each limited to a carrying capacity of 1,000kw. and as one has to be held in reserve, he puts down the total carrying capacity at 2,000kw., a load which he expects will shortly be exceeded. He therefore considers it would be prudent to lay down three more trunk mains of the came capacity as the present ones, so as to provide for future increase in the load.

This report, which was dated August 8th, was laid before Mr. Hammond, who, replying on Aug. 22, asks for a more precise statement from Mr. Ruddle with regard to the capacity of the boilers. He thinks the difficulties with regard to the ash conveyor, circulating pump engine, and the feed pumps and steam mains are of a trifling character and can easily be overcome. With regard to feeders, he points out that the Board of Trade sanction of 1,000kw. per feeder allows a load of 3,000kw., but should it happen that one of the three mains broke down there could, he thinks, be no serious objection to raising the limit of 1,000kw. per cable for an hour or two. In the same report Mr. Hammond replies to a series of letters from the chairman of the Electricity committee, Mr. J. Irwin, in which it is stated that the question of the adequacy of the boilers for the coming winter is seriously agitating the committee. Mr. Hammond considers, however, that the boiler plant is quite sufficient with the addition of an extra feed pump, which has already been put in hand. Allusion is also made to defects in the motor-generator plant which the contractors have so far failed to remedy. Some of the committee's doubts as to whether tests on the arc light cables and switches have been made in accordance with the Board of Trade's requirements are also set at rest.

Mr. Ruddle replies to this report in a report dated August 31st. With regard to the Lancashire boilers, he states that the evaporation test which he referred to was made by a member of Mr. Hammond's staff, and he had not been furnished with the exact figures. Mr. Knowles had given it as his opinion, however, that the boiler only gave about two-thirds of its rated evaporation. He adds: "Mr. Hammond himself does not give the exact figure obtained by the expert he sent over, and who found himself unable to maintain sufficient steam to run one engine on the light day load." With regard to the question of the trunk feeders, Mr. Ruddle quotes answers given by Mr. Hammond at the Local Government Board inquiry, in which he stated that he only proposed to use two out of the three mains, the third being stand-by. Mr. Ruddle, therefore, again urges that the present three mains are insufficient.

In the meantime Mr. Ruddle had sent in, on August 19th, a number of extracts from a report made to him by Mr. Knowles on the condition of the generating plant at Pigeon House Fort station. He complains that the overhauling of the engines has not been proceeded with with sufficient rapidity, so that they would only be able to count on two out of the four engines being completely reconstructed by the time the winter load comes on, with the result that they may be seriously situated for dealing with it. He also points out that no spare field bobbins or spare brushes are provided for the exciters or fields of the alternators, that the oil pump is practically useless, and that there is trouble with the fire-bars and arches of the water-tube boilers, which will be a serious matter if some remedy is not found before the heavy load comes on. Referring to the Lancashire boilers, Mr. Ruddle points out that there are several details which require immediate attention. He further considers it unsafe not to have a spare motor for the automatic stokers, complains that the auto-exhaust valves have never been thoroughly satisfactory, that the steam range has always been leaky, that there are defects in the superheaters that require immediate attention and that certain details in the condensers "require urgent attention before the winter, if satisfactory running is to be achieved." The report of Mr. Knowles, he continues, as to the feed pumps, shows a very serious state of things as regards the general condition of the pumps, and as a matter of ordinary safety they have not sufficient feed pumps to deal with the full capacity of the boilers if one is to be kept in reserve. He next complains that there is no plan showing all the valves and pipes which have to be operated inside the Pigeon House station in connection with the feed water tanks, and that the pipe trenches under the feed tanks are in a very dangerous condition at present, and should be properly covered in at once. The intake screens for the feed water "have been in the experimental stage all along," and a breakdown which has occurred in the coal-conveying plant "is a striking example of the faulty construction and the damage that would be caused if it occurred during the heavy winter load." The ash conveyors, Mr. Ruddle says, also require radical alteration. The wharf crane is in a most dangerous condition owing to the track having subsided and spread, as the track has been improperly constructed. The cables in the cellars have never been properly fixed by the contractors and certain repairs in the buildings are necessary. He concludes by suggesting certain alterations that should be made in the switchboard.

It is only right to point out that a large number of the points above raised by Mr. Ruddle are matters of small detail.

Mr. Hammond replied in a report dated September 5th. He says that so far as the report schedules the various defects, the majority of which had already been reported by him to the committee, he was quite in accord. The report, however, was complicated by the introduction of a number of minor details such as would ordinarily be dealt with by the resident engineer in the course of his duties, and also by a suggestion for additional work on apparatus not included in any of the contracts. With regard to the Lancashire boilers Mr. Hammond says:—"Mr. Ruddle knows as well as I do that it is not the boilers which are faulty, but that it is merely a question of the speed of the mechanical stokers." The wrong size of pulleys had been provided and new ones had just been sent off from the makers' works. The test referred to by Mr. Ruddle had not been taken by a member of his (Mr. Hammond's) staff, nor was it a test of the boilers but a test of the mechanical stokers to ascertain the cause of their unsatisfactory working. Mr. Hammond then deals with the various points seriatim and gives a schedule of the retention money in hand in the various contracts.

There is then a further report from Mr. Ruddle, dated September 8th, replying to the above report of Mr. Hammond. Mr. Ruddle concludes this report as follows:—"I desire to say that it is with extreme regret that I have been obliged to report on the various shortcomings of the plant . . . . but having in view the short time left before the heavy winter's load comes on, and the little progress made in remedying the defects which have existed during the past 12 months, I consider it necessary to place the committee in possession of the actual facts as soon as possible after taking charge. . . . At the same time I do not wish to cause unnecessary alarm as to the future. The defects are all remediable and when removed the plant should be able to do excellent work in supplying the wants of the citizens, and I urge most strongly that energetic measures be taken at once to put it in order."

While the above series of reports and counter reports were under way, Mr. Hammond addressed a letter to the town clerk of Dublin of which the following is an abstract. The letter, which is dated Aug. 25, contains the offer to take over the electricity works which we have alluded to above and an alternative offer to run the works as manager on a remuneration depending on the resultant works costs. The report includes a brief description of the new system and the change-over from the old station to the new; this has been omitted, as a full description of the new works at Pigeon House Fort appeared in *The Electrician* a year ago (Vol. LI., pp. 920, 958 and 996).

The agreement entered into with me by the City Council for the supervision of the operations of their electric supply undertaking for a period of 12 months came to an end on the 31st ult. I am glad to feel at the conclusion of the 12 months that the work thereunder has proved so successful, and that, since the staff settled down to their duties, there has not been a single cessation of the city lighting. . . . In relinquishing the task of supervision it occurs to me that the Corporation may desire to receive from me a short report of my stewardship. The Council passed the resolution conferring the appointment upon me on July 29, 1903. On the following day I started the work thereunder, and since that date either I or other members of my firm have been in regular attendance in Dublin.

Staff.—It will be remembered that, prior to entering into the agreement to supervise the working of the undertaking for 12 months, I made it a *sine qud non* that I should be absolutely unfettered in the choice of staff, with power to appoint and to dismiss. That power was conceded to me by the Council, after a pledge on my part to give preference to Irishmen wherever possible. At the outset I took over the whole of the old staff; obviously, however, this staff was not numerous enough for the greatly-enlarged undertaking. The chief of the separate departments acting under the city electrical engineer are:—Office department, Mr. G. Archer (chief assistant); distributing system, Mr. E. A. Ellicott (distributing engineer); generating works, Mr. R. Knowles (works superintendent). Upon these gentlemen a large responsibility rests, and I consider that they are entitled to high commendation for the excellent way in which their departments have been controlled, especially during the period when they were deprived of Mr. Ruddle's guidance by his absence through illness.

Change-over of System.—I am glad to be able to report that the change-over was most successfully effected on September 20, 1903, without the slightest inconvenience to the consumers—indeed, with hardly a blink on the lights. Though the Fleet-street plant was kept as a stand-by for a short time it was never once used.

Administrative Department and Consumers' Records.—On turning my attention to the internal organisation of the administrative department at Fleet-street, I found that a considerable alteration was necessary in the method of dealing with the technical records of consumers and their installations. The system which has been specially devised for Dublin, so as to suit the special tariff of charges and the three-phase system, embraces the following:—*Consumers' Index Cards.*—An index for the complete system. *Meter Reading Cards*, upon which the meter readers record the registration of the meters and indicators. *Consumers' Ledger Cards*, upon which the details, technical and financial, of the consumer's quarterly accounts are set forth, these cards being regularly transmitted to the City Accountant's Department for the purpose of making up the quarterly bills and for entering into the consumer's ledger. *Ledger Cards (General Charges)*, dealing with private works and small works executed by the department for consumers, &c., other than for electricity supplied. *Installation Cards*, upon which all the technical records of each consumer's installation, including tests, number of lamps, &c., &c., are recorded. *Balancing Cards*, for entering up the demands in each street, so as to enable the engineer to preserve a good balance of the load on the mains. *Meter Test Cards*, for recording particulars of each meter, with results of its tests and its position from time to time on the circuits. *Demand Indicator Test Cards*, for exactly similar purposes to those of the meter test cards. *Guide Cards*, for the complete system by which the separate sections and classes are arranged for easy reference. *Cabinets*, embracing five special cabinets for filing the card records.

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Consumers.—The connecting on of new consumers has, under the new arrangements, proceeded smoothly and rapidly. At July 1, 1903, there were 350 consumers and 35,791 lamps connected to the mains, at July 1, 1904, the number of lamps had increased to 68,322 and the number of consumers to 790.

Working Costs and Financial Results.—The accounts of the undertaking which have recently been published are made up to March 31st last, but as this period covered 3½ months' running of the Fleet-street works alone, 2½ months of the Pigeon House works and the old works simultaneously, and only six months of the working of the new undertaking in the early portion of which the Fleet-street works were being kept as a stand-by, the results therein shown are no guide to what will be the result for future years. I am glad to report, however, that even for this period, with all the initial charges incidental to the starting of a large scheme, the cost of working was considerably reduced, the total amount, exclusive of the special fee paid to me under the supervision agreement, being 2·43d. per unit, as compared with 3·09d. per unit for the previous 12 months, and 3·75d. per unit for the year 1901-2. Notwithstanding adverse public criticism and the frequently quoted report made by Mr. Ruddle in March, 1901, in which he stated that the average cost of production and distribution for the first seven years would be 2½d. per unit, I have no hesitation in stating that the operations of the new undertaking have convinced me of the soundness of the estimate made by me in my original report of the possibility of generating and delivering electrical energy in Dublin at a cost, exclusive of capital charges, of 1½d. per unit.

Now that the undertaking has been so well established and is giving evidence of such success, I presume that it is unlikely that the Corporation would care to continue leaving the working of the undertaking in my hands. If, however there be those who are persuaded by the pessimistic criticisms which are in some quarters still rife that the undertaking cannot be worked within the above-named estimate, I desire to state that I am prepared to submit to the Municipal Council the terms of an arrangement for taking control of the working operations and assuring the Council for a period of seven years against a higher cost than the 1½d. per unit, my remuneration for my supervision and for my guarantee being the difference between 1½d. per unit and the lowest figure at which I may be able to generate and distribute, no special fee for my supervision or guarantee being paid to me at all.

I can quite understand that such an offer may not commend itself to those councillors and ratepayers who have formed the idea that the capital expenditure has been out of all proportion to the extent of the undertaking, and that even if the electrical energy can be generated and distributed at 1½d. per unit, the interest and sinking fund charges upon the present capital and upon that which will be required from time to time as the business develops will far exceed the profit on working and leave a heavy annual deficit to be borne by the ratepayers.

Under these circumstances, and having regard to the other financial obligations which the progress of the city has placed upon them, the Municipal Council may feel inclined to enter into an agreement by which they would be relieved of the capital charges on the electricity undertaking for a period of years. In this event I shall be prepared, as an alternative offer to that named above, to place before them the terms of an arrangement for taking over the working of the entire undertaking for a period of not less than 14 years and for substantially guaranteeing to the Council for that period the annual charges upon the loans raised or to be raised for the purposes of the undertaking, including the productive proportion of the Fleet-street works, the Clontarf scheme, and all extensions of the electric supply system.

This arrangement would, of course, include a guarantee that the supply would be provided at rates to be mutually agreed upon, which would certainly not be higher than those at present in force.

Under my first offer the Council would be relieved of all anxiety with regard to the working expenses. Under my second offer they would, by parting with the working of the undertaking for only a limited period, be relieved of all responsibility for the capital charges during the earlier years of the undertaking, while at the same time the citizens of Dublin would be assured of a supply of electricity at favourable prices.

Whether, however, my offers be accepted or not, I am glad at the close of my 12 months' supervision to be able to hand over to the city a concern that has for many months past been performing its work most satisfactorily from the point of view of the consumer and of the general public.

Councillor John Irwin (chairman of the Electricity committee) has reported as follows to his committee on Mr. Hammond's letter, and the committee have accepted the report and placed it before the Council :—

Working Costs and Financial Results.—Mr. Hammond states that the cost of working was considerably reduced as compared with the last previous whole year of the old Fleet-street station, the figures being, for cost of generation and distribution on the new scheme, exclusive of Mr. Hammond's 1,000 guinea fee for management, 2·43d. per unit, as against 3·09d. per unit at Fleet-street, or, say, a reduction of ½d. per unit.

In connection with this, it should be borne in mind that the Fleet-street plant was old-fashioned, non-condensing and hand-fired; coal supplies had to be delivered by the ton, in bags, from day to day by local merchants, and, owing to threats of injunctions, upon the grounds of smoke nuisance, the very best description of South Wales coals had to be used.

The average cost of coals during the last year of Fleet-street was 21s. 3d. per ton, as compared with 14s. 7d., the average over the past financial year for Fleet-street and Pigeon House combined, and the latter is only 7d. per ton in excess of the figure which Mr. Hammond stated at the original Local Government Board inquiry (1900) he had based his cost of 1·5d. per unit upon.

It must also be borne in mind that the salaries and wages paid to the staff during the year ending March 31 last were considerably less than the amounts as finally fixed by Mr. Hammond subsequent to the closing of the accounts, the rates of remuneration fixed by him upon taking over the management being, as he states, of a "provisional nature, and that their positions and ultimate remunerations would be taken into consideration after experience had been obtained of the manner in which their duties were performed, and of the value of their services to the undertaking."

No rent for the Pigeon House Fort premises has yet been debited against the undertaking, the sum suggested by the Improvements committee last year having been considered too high by this committee; negotiations are at present pending between the two departments.

Mr. Hammond's Offers.—These can hardly be taken seriously, and it is unlikely that the Corporation, having rejected the offers of a Dublin syndicate and a Dublin tram company, would for an instant entertain such proposals from Mr. Hammond. The first offer may be passed over without comment, as Mr. Hammond himself supplies a reason for its rejection. The second proposal is certainly a novel one for a professional consultant to make, and it is particularly strange, coming from a gentleman who has in the past strongly advocated the doctrine of municipalisation.

However, here again it is hardly likely that the Corporation would agree to hand the undertaking over to Mr. Hammond, assuming he would provide the necessary capital charges on, say, £400,000, for a term of not less than 14 years, with a guarantee that the rates to be charged to consumers would not be higher than those at present in force—viz., 7d. to 2½d. for lighting and 7d. to 1d. for motive power. If it would pay Mr. Hammond or his syndicate to work the undertaking from London, surely it will pay the Corporation of the City of Dublin.

In view of the position of affairs existing between the committee and some of its contractors with respect to penalties and so forth, and the recent reports of Mr. Knowles, whom Mr. Hammond appointed to the responsible position of works superintendent at Pigeon House, substantially endorsed as it is by the city electrical engineer, the Corporation cannot at this stage be taken as endorsing all the opinions expressed by Mr. Hammond in the second last paragraph of his letter regarding defects in the plant, interference with the supply, &c.

In conclusion, I would respectfully suggest that the committee do recommend Council to inform Mr. Hammond that they see no reason now for departing from their decision, to keep the control of the municipal electricity undertaking in their own hands, and to work it themselves in the interests of the citizens.

THE MAGNETIC RELUCTANCE OF AIR CORES IN SHORT COILS.

BY W. M. THORNTON, D.SC.

Air-core transformers and inductance coils are often useful in test room or laboratory practice. Their construction has been in most cases a matter of trial and error, for the inductance of coils whose winding depth is large compared with the radius cannot be calculated. Coils of this type have, however, definite magnetic constants. The reluctance of the circuit taken by the lines should remain the same under all conditions of excitation. The following experiments were undertaken to determine the constants for coils of common proportions the thickness and length of the windings of which placed them beyond the reach of ordinary mathematics.

If the distribution of magnetism along the axis of a short air-core coil is explored by means of a ballistic galvanometer and a narrow search coil, it is found that the magnetic lines diverge on either side of the centre so that the flux-density within the core falls rapidly towards the ends. Let $\mathbf{N}$ be the number of lines passing through the central section of the coil, let t be the number of turns and $\mathbf{R}$ the reluctance of the complete path taken by the lines. Then, by the definition of reluctance,

$$\mathbf{N} = 4\pi it/\mathbf{R}; \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

that is, the magnetomotive force divided by the reluctance, i being the current in the windings.

From this the reluctance can be found experimentally. If, now, this value is used in the calculation of the inductance by the usual formula

$$\mathrm{L} = 4\pi t^2/\mathbf{R}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

the result will be too large, since the assumption is here made that each turn encloses all the lines $\mathbf{N}$, which, by reason of the rapid divergence, is not the case.

To estimate the inductance of short thick coils, it is then necessary to know the flux, not only at the middle, but, in effect, at the ends of the winding also. So far as the flux-

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density **B** at the central section is considered, it can be calculated from the fact that what may be called the true reluctance of the whole magnetic circuit is numerically equal to that of the mean cylindrical air core enclosed by the coil. For **N** can be written in two ways, $4\pi it/\mathbf{R}$ and $\mathbf{B}A_c$, A_c being the average cross-sectional area of the core or $\frac{\pi}{8}(d_1^2+d_2^2)$, where d_1 and d_2 are the outer and inner diameters of the winding.

Since no iron is used, $\mathbf{B}=\mathbf{H}=4\pi it/l_c$, so that $4\pi it/\mathbf{R} = 4\pi it A_c/l_c$ or

$$\mathbf{R}=l_c/A_c. \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

in which l_c is the length of the coil.

What may be called the apparent reluctance $\mathbf{R}_a$ is that found from the impedance of the coil. If r is the resistance of the coil, e the alternating voltage applied to its terminals at a frequency n, and i the current in the windings, then, since

$$e/i=\sqrt{r^2+4\pi^2n^2L^2},$$

$$L=\frac{1}{2\pi n}\sqrt{\left(\frac{e}{i}\right)^2-r^2}, \quad . \quad . \quad . \quad . \quad (4)$$

from which, by (2),

$$\mathbf{R}_a=\frac{8\pi^2t^2n}{\sqrt{\left(\frac{e}{i}\right)^2-r^2}}. \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Writing $l_c/A_c=\mathbf{R}_c$, the ratio $\mathbf{R}_c/\mathbf{R}_a=\delta$, say, denotes the effect of the lines bending back through the winding and may be called the *dispersion coefficient* of the coil. This coefficient is the same for any given proportion of winding, whatever its dimensions.

Writing

$$\delta=l_c\sqrt{\left(\frac{e}{i}\right)^2-r^2}/8\pi^2t^2nA_c \quad . \quad . \quad (6)$$

it is seen that, so long as the impedance is constant, δ is also constant.

To find how the reluctance of the path taken by the lines of force is affected by the length of a coil, a set of coils was made, each having the same internal and external diameters, 2in. and 4in. respectively. Their lengths increased in steps until the ratio of the length to the external diameter was 3 to 1. They were wound with 18 S.W.G. double-cotton covered copper wire, and when connected to alternating-current mains having a close approximation to a sine voltage wave gave the following results:—

Table I.

l/d_1.	t.	r (ohms	e (volts.)	i (amps)	ei.	H.	$\mathbf{R}_a$ (obs.)	$\mathbf{R}_c$ (calc.)	δ.
0·25	360	1·32	32·5	7·45	4·36	1,360·0	0·217	0·0502	0·232
0·5	765	2·7	104·0	7·16	14·5	1,265·0	0·28	0·1004	0·358
0·75	1,134	4·02	93·0	3·45	27·0	648·0	0·325	0·1506	0·464
1·0	1,496	5·3	103·9	2·75	37·7	509·0	0·398	0·2008	0·505
1·25	1,865	6·62	103·0	2·13	48·3	438·0	0·484	0·2510	0·52
1·5	2,236	8·03	103·8	1·66	62·5	309·0	0·536	0·3012	0·562
2·0	3,001	10·73	103·5	1·19	87·0	221·0	0·692	0·4016	0·58
2·5	3,732	13·33	104·5	0·94	111·0	179·0	0·828	0·502	0·606
3·0	4,497	16·03	103·5	0·76	135·0	141·2	0·998	0·6024	0·605

These are shown graphically in Fig. 1, and it is seen that the impedance of coils whose length exceeds their diameter is strictly proportional to the length. Below this it is slightly in excess of the proportionate values. The reluctance line cuts the vertical axis about 0·19. This is, then, the reluctance offered to magnetic circulation around an annular current sheet whose breadth is equal to its internal radius, a result of some theoretical interest. It is, however, impossible that the impedance of a coil of finite breadth should be zero, and there must be, therefore, an upward curvature of the impedance line between the lowest point obtained here and the origin through which it must pass, a point worth further investigation.

It is only with the longer coils that there is much difficulty in obtaining exact calculations, and the experiments show that in these both impedance and reluctance are proportional to the length over the greater part of range examined. The inductance as shown by Fig. 2 is also proportional to the length beyond the point where the length equals the diameter, a result which simplifies the calculation of air core coils. The dispersion coefficient reaches a constant value at about the ratio 3:1, showing that in longer coils than this the effect of the ends can be ignored. For all coils of these relative diameters whose length exceeds three times the external diameter the inductance can be calculated by the

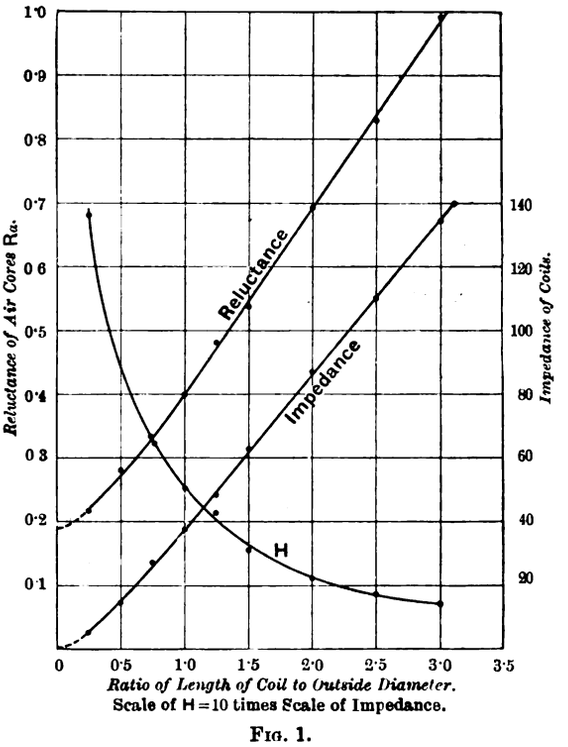
Reluctance of Air Cores Ra.
Impedance of Coils.
Reluctance
Impedance
H
Ratio of Length of Coil to Outside Diameter.
Scale of H = 10 times Scale of Impedance.

Fig. 1.

formula $L=4\pi l^2/\mathbf{R}$, where $\mathbf{R}=l_c/\delta A_c$, δ now having a constant value of 0·605. This may be expressed otherwise by saying that, instead of the mean area $\frac{\pi}{8}\cdot(d_1^2+d_2^2)$ being used with δ to find **R**, an area $0{\cdot}235\,(d_1^2+d_2^2)$ divided into the length of the coil gives its reluctance at once. For example, the inductance of a coil in which the conditions $L/D \geqq 3$, $D_1=2D_2$ are

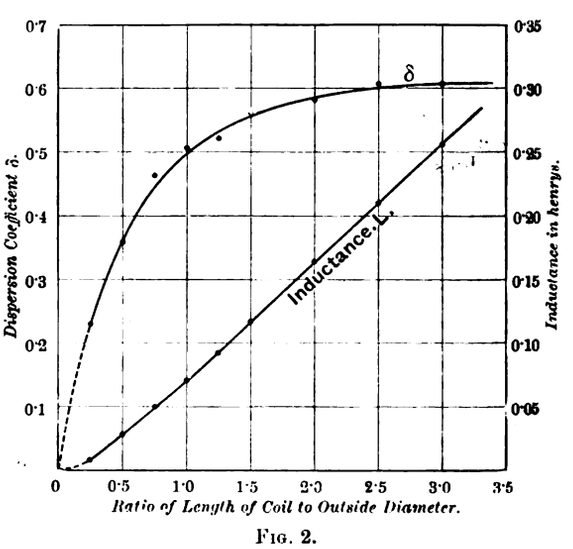

Fig. 2.

satisfied, which has 10,000 turns wound into a length of 30cm. at diameters of 5cm. and 10cm. inside and outside, will be $4\pi\cdot\frac{10^8}{10^9}\cdot 0{\cdot}235\times\frac{125}{30}$; that is, 1·23 henrys.

The inductance of the shorter coils can be calculated with considerable accuracy by means of formulæ derived in Chapters XIII. and XIV., Vol. II., of Maxwell's "Electricity and Magnetism." If t is the number of turns, a the mean radius of the

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coil, G the geometrical mean distance of the transverse section of the coil from itself, then (§ 706)

$$L = 4\pi l^2 a\left(\log\frac{8a}{G} - 2\right). \quad . \quad . \quad . \quad . \quad (7)$$

From this the apparent reluctance may be written

$$R_a = \frac{1}{a\left(\log\frac{8a}{G} - 2\right)}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

For a rectangle whose sides are b and c

$$\log G = \log\sqrt{b^2+c^2} - \frac{1}{6}\frac{c^2}{b^2}\log\sqrt{1+\frac{b^2}{c^2}} - \frac{1}{6}\frac{b^2}{c^2}\log\sqrt{1+\frac{c^2}{b^2}} + \frac{2}{3}\cdot\frac{c}{b}\cdot\tan^{-1}\frac{b}{c} + \frac{2}{3}\frac{b}{c}\tan^{-1}\frac{c}{b} - \frac{25}{12}. \quad (9)$$

Thus, when the rectangle is a square of side b,

$$G = 0{\cdot}4470b. \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

A more complete expression for L is given in Appendix III. to Chapter XIV.

The theory assumes that the wires fill the winding space. The effect of their circular shape and the insulation is, as shown in § 693, to increase the inductance. It is also assumed that the radius of curvature of the coil is large compared with the transverse dimensions of the winding space.

Using formula (8) the reluctance of the shortest coil in which $a = 3{\cdot}81$, $b = 2{\cdot}54$, $c = 2{\cdot}54$cm.,

$$R_a = \frac{1}{3{\cdot}81\left(\log\frac{30{\cdot}48}{1{\cdot}355} - 2\right)};$$

that is, $= 0{\cdot}203.$

When the insulation is allowed for this agrees with the mean value obtained by experiment from the impedance effect. In this case the conditions as to transverse size are approximately fulfilled, but when the axial length is increased the formulæ are no longer correct. Thus, for example, in the coil with 1,496 turns the calculated reluctance is 0·7, against 0·4 observed.

By inspection of (8), when $\log\frac{8a}{G} = 2$ the reluctance is infinite.

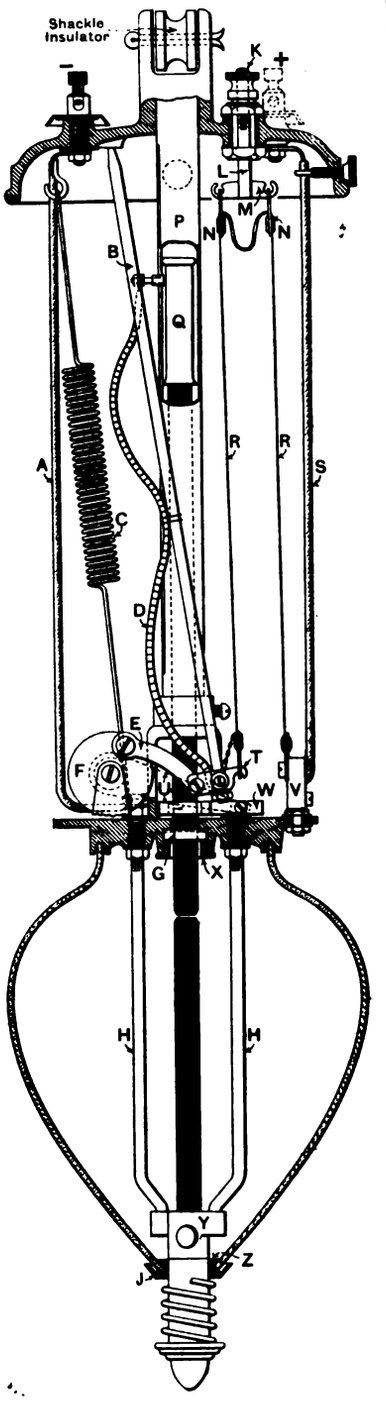
This condition depends chiefly upon b, the first and last terms of (9) being much the most important, so that as b the length of the coil increases, the accuracy of the formula decreases.

For the long thick sections characteristic of air-core impedance coils and experimental transformers in general the theoretical formulæ are of no use. The coincidence of the calculated and observed values when the coils are short indicate that the figures obtained by the experimental method can be taken as working values for the reluctance of ironless magnetic circuits of these proportions.

A NEW ARC LAMP WITH HOT-WIRE CONTROL.

The lamp which we illustrate in the adjoining column is the latest form of the Foster arc lamp, the distinctive feature of which is the hot-wire control in place of the ordinary solenoid control, thus enabling the same lamp to be used either on alternating or continuous-current circuits. The action of the lamp will be best understood by tracing out the course of the current in reference to the illustration, which shows all the working parts.

The current enters at the positive terminal, shown dotted, and passes down the lead S to the post V. To this post there is attached two pairs of metal strips, RR, the expansion and contraction of which controls the feed of the carbon. The upper ends of the strips are fixed to the stirrups NN, which are hung from the rocker M on the post L, the height of which is adjustable by the regulating screw K, so that the tension of the strip may be regulated. To prevent sparking at the rocker, the strips are also connected across just above the stirrups. The bottom ends of the strips are made off on a hook, T, from which connection is made by a flexible wire, D, covered with glass beads, to the upper carbon holder Q, which is free to slide in the tube P. This carbon holder is merely a split tube, and the positive carbon is simply pushed home into it. The circuit from the negative or lower carbon is through the carbon holder Y, the bottom rods HH, and the negative lead A to the negative terminal. When current is turned on, the strips expand; and, as the bottom hook T is fixed to the end of a rigid strut, B, pivoted at its top end, the hook is pulled over to the left by the spring C, acting through the disc F and the link E. As the disc rotates it moves the lever U, shown dotted in the drawing, and this brings into action the clutch W, lifting the positive carbon and striking the arc. There is a certain amount of play between the link U and the disc F, so that the wire is allowed to attain a fairly high temperature before the arc is struck. With a diminished current the heated strip shortens and the disc is turned back slightly, allowing the carbon to feed. Should the feed of the lamp prove to be too fast or too slow in working, this may be adjusted by turning the screw K, already referred to, by means of which the tension of the strip can be slightly varied. It may be noted that the lamp is entirely fireproof in construction, and that it contains no solenoid or dashpot. A steatite ring, G, held in place by the screwed bush X, guides the upper carbon N when the lamp is trimmed, and the clutch is lined with the same material. To facilitate trimming, the pointed end of the carbon is used uppermost.



Section through Lamp.
½ Full Size.

Up to the present time Messrs. Foster & Co., of Worple-road, Wimbledon, the makers of the lamp, have only placed enclosed lamps on the market. The lamp is of the single-globe pattern, the arrangement of the globe carrier Z and globe dish J to prevent air leakage being clearly seen in the drawing. The illustration being to scale, it is seen that the lamp is small and compact; its weight is only 12lb. We are informed that several of these lamps are now in use and working satisfactorily, both on continuous and alternating-current supply mains. Mr. Tomlinson Lee, the resident engineer of the Wimbledon Urban District Council electricity works, informs us that he has had 14 or 15 Foster lamps burning on his 50 ∿ alternating-current mains through compensators during the last 18 months, and that they have given such satisfaction that he has ordered 23 lamps of the latest type described above.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Year Book of the Michigan College of Mines," 1903-4. (Houghton: The College.)

"Modern Electric Practice." Vol. IV. Edited by Dr. Magnus Maclean. (London: Gresham Publishing Co.) 9s.

"Electricity in the Service of Man." By Dr. R. Mullineux Walmsley. New and revised edition. (London: Cassell & Co.) 10s. 6d.

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THE PROPAGATION OF ELECTRIC WAVES ALONG SPIRAL WIRES AND ON AN APPLIANCE FOR MEASURING THE LENGTH OF WAVES USED IN WIRELESS TELEGRAPHY.*

BY J. A. FLEMING, M.A., D.SC., F.R.S.

This Paper is concerned with an experimental and theoretical treatment of the propagation of electric waves along spiral wires. The subject has engaged the attention of several physicists. Hertz has described an experiment in which he established stationary electric waves on a spiral wire and compared the distance of the nodes with the corresponding distances when the wire was stretched out straight. Theoretical treatment has been given by H. C. Pocklington, and G. Siebt has devised lecture apparatus for exhibiting the propagation of stationary waves on spiral wires.

The first experiments described by the author were made with a long helix of insulated copper wire wound in one layer on a wooden rod. The helix consisted of 5,000 turns, the length being 200cm. If such a helix is placed in connection with an oscillating circuit consisting of a condenser or Leyden jar, a spark-gap and a variable inductance, stationary waves could be set up on the helix by adjusting the inductance in the oscillating circuit. In order to detect the nodes and anti-nodes of these stationary oscillations the author makes use of a vacuum tube, similar to that used in spectrum analysis, preferably one filled with the rare gas neon, which was kindly supplied to him by Sir William Ramsay. Rarefied neon seems to be extremely sensitive to the presence of variable electric force through it; hence, if such a tube is held perpendicular to the helix and moved parallel to itself along it, it glows brightly at the anti-nodes but not at the nodes. In this manner the internodal distances can be measured with considerable accuracy and the wave-length of the stationary oscillation measured.

The Paper also contains a theoretical analysis of the phenomena leading to the conclusion that the velocity with which the wave is propagated along the spiral is inversely proportional to the square root of the product of the capacity and inductance of the helix per unit of length. The author has perfected of late years methods for measuring very small capacities and inductances, and in the case of the above-named helix the inductance is equal to 100,000cm. per centimetre, whilst a capacity of the helix is $\frac{1}{40}$ths of a micro-microfarad. (1 micro-microfarad = 10^{-6} microfarad.)

From these data the velocity of propagation of electric waves along the helix can be shown to be 235,000,000cm. per second. This figure is confirmed in the following manner:—The capacity and the inductance in the oscillating circuit are both measured when the first harmonic oscillation is formed on the helix, and under those conditions the half wave-length was found to be 140cm., whilst the frequency in the oscillating circuit, as calculated from the capacity and inductance, was found to be $0{\cdot}847 \times 10^6$. Having, therefore, the wave-length and frequency, we find their product gives a velocity of 235,000,000cm. per second, which agrees with the figure determined from the constants of the helix.

It is shown in the Paper that the best form of inductance to be employed in connection with the oscillating circuit is a square of one turn of wire, and that the employment of spiral coils leads to errors due to a passage of a dielectric current from coil to coil. On the above lines an apparatus has been devised by the author for measuring wave-lengths in connection with Hertzian wave wireless telegraphy. It is a matter of considerable importance to be able to determine the frequency and wave-length of the waves sent out by any given transmitting arrangement. The author calls this instrument a "Kummeter." It is constructed as follows:—A long ebonite rod is wound over closely with silk-covered wire in one layer, and this is supported on insulating stands. On this long helix slides a metal saddle having some layers of tinfoil interposed to make good contact between the saddle and the helix. This saddle is connected by a flexible wire with the earth. One end of the helix is furnished with an insulated metal plate, which is placed in apposition to another metal plate connected to the oscillating circuit of the transmitter. The process of measuring the wave consists in sliding the saddle along until a neon vacuum tube indicates the presence of one node half-way between the saddle and the plate. When this is the case the distance from saddle to plate is one wave-length of the stationary wave on the helix.

From the constants of the helix the velocity of the wave along it can be calculated as above shown, and hence the frequency of the oscillating circuit becomes known. If this frequency is divided into the velocity of light, reckoned in feet, it gives the wave-length in feet of the wave radiated from the associated aerial, provided that the aerial radiating wire has been tuned to be in resonance with this oscillating circuit.

This instrument also provides the means of measuring small inductances and also the frequencies in oscillating circuits, which are much higher than those which can be determined by photographing the spark.

* Abstract of a Paper read before Section A of the British Association.

MEDIUM-SPAN LINE CONSTRUCTION.*

BY C. A. COPELAND.

In the past it has been the chief desire of electrical companies to get to the customer with some sort of a line and obtain a swift revenue, while the engineer has not considered it worth his while to spend more than a wisp of his time on line work. The result has been that more than 75 per cent. of the troubles experienced in the distribution of power, both as to number and cost, have occurred outside the central and sub-stations. The major part of the cost of these troubles has been due to lack of confidence in electricity as a power fund and convenience which does not always show on the books. These remarks apply as well to telephone and telegraph lines and distributing systems as those for light and power. Not only have lines been excessively troublesome, but they have cost too much. With a view to eliminating both of these faults on cross-country lines, the Edison Electric Co. of Los Angeles has been experimenting on several special methods of distributing-system design. The one immediately concerned may be termed medium-span cross-country construction.

The ordinary length of spans, say from 120ft. to 140ft., which have been used for the lines, have evidently been transplanted from early days and from localities where snow and ice load the wires to their breaking point even with 100ft. spans. The conditions obtaining around a newly contemplated line should be as carefully studied as those surrounding the hydraulic and central station installations. Transplanted engineering may not always thrive in new soil. The conditions encountered in the valley districts of Southern California are: (1) No snow and ice; (2) a temperature ranging from 20deg. at night in winter to 140deg. in the sun in the summer (that is, a wire will become that hot); (3) occasional severe dry north summer winds which blow hay and mustard stalks upon the lines; (4) frequent interference with lines by wild cats, buzzards, sandhill cranes, mudhens and owls—especially the May and June owls; (5) numerous and almost unavoidable hedges of eucalyptus trees from 50ft. to 150ft. tall, which, with the assistance of winds, shed twigs and long shreds of bark on to the lines; (6) rapid decay of poles, some rotting off in four years, while the average life is eight; (7) high cost of poles, the cheapest being cedar, and in 35ft. and 40ft. lengths, costing from $5 to $10 in the yard.

Experience with bare aluminium cable suggested to the writer that stranded copper cables might be used in long span construction. It was proposed to take good stocky 40ft. cedar poles, space them 225ft. apart, space the wires 45in. apart, and employ a sag of from 15in. to 24in., depending on the installation temperature. It was designed that a three-phase construction for a voltage as high as 40,000, with one or two circuits of Nos. 3, 4, 5 and 6 cable with single cross-arms, and Nos. 0, 1 and 2 with double cross-arms should be used. The longest continuous long-span work previously employed was in Europe on the Paderno–Milan transmission, with solid No. 1 wire and steel lattice work poles spaced 190ft. In the light of subsequent experience it would seem that if stranded wire had been used the poles could have been made a little heavier and taller and spaced twice as far apart. On the Vizzola–Ticino–Milan transmission, also, steel latticed poles about the same distance apart had been used.

These ideas were received with temerity. It was argued that in case a wire broke, so and so would happen. But if stranded and carefully installed they will not break. It was also argued that in case the poles rotted the line would be weakened more than if the poles were nearer together. But it would seem that a line should be kept in good repair, whether the poles were many or few, either by letting down 5ft. or stubbing. An engineer would not buy a boiler with more tubes in it than necessary and let them get in poor repair because there were enough tubes left to keep the boiler safe.

It was argued that in case the top of a pole burned off at the brace, as sometimes happens on the 30,000-volt line, No. 6 wire would not support the weight on a 450ft. span. Accordingly, two experimental spans of 250ft. were constructed and strung with bare solid "second-hand" medium hard-drawn copper, and while it is not necessary to go into great detail in regard to this test, it is sufficient to say that it was amazing the abuse these wires stood before breaking. No. 6 aluminium cable was also tested, and stretched so far before breaking that it also deserves much respect. The stretching factor of safety of copper wire is scarcely appreciated by engineers, and after these tests the writer very nearly recommended solid wire for 225ft. spans. In fact, a European steel pole line employs 246ft. spans with solid No. 2 and 00 wires on 40ft. poles.

The writer knows of no case where a good solid medium hard-drawn wire has broken without a good apparent excuse, such as a burn-off. He has known of such breaks on poor wire which did not come up to the company's standard specifications. The moral is that, with rigid specifications followed by tests, much longer spans with solid copper can be made. We have 8 miles of

* Paper read before the Pacific Coast Electric Transmission Association, Monterey, Cal.

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No. 5 line with 150ft. spans, with wire which did not stand a very good test, which has given no trouble.

Stranded copper, however, is superior for 225ft. span work in that:—(1) A careless lineman in nicking it reduces its strength less than by nicking a solid wire. A test was made on one cable, during which one strand broke at a 5in. sag on 225ft., but the cable still stood up. (2) Its strength is more uniform throughout its length, and therefore a less sag can be safely depended upon. (3) It has a higher strength per square inch because the wires are smaller and are individually stronger. (4) It has a spring effect or untwisting factor of safety. (5) It has a higher elastic limit. It is believed (but not proven) that stranded copper will not burn off so easily as solid wire on account of its radiating facilities, and because one or two strands will hold the cable intact if the other strands burn off. It costs from 8 to 12 per cent. more than solid wire of the same conductivity.

Following out these considerations, 4 miles of experimental line were installed in two sections, one in the Lytle Creek district, near San Bernardino, 2 miles long, of three-strand No. 5 copper, and the other at Anaheim, of No. 5 seven-strand copper. In the former a 500ft. span was inserted. Otherwise the constructions are identical, and have stood over a year and have passed through the most severe wind storms known in this section for many years. The poles and corner pins now stand perfectly straight, although another new line near by, with 140 ft. spans and six wires leans badly from the wind. These medium-span lines were, of course, installed with care and by trusty men who have been with the company for several years.

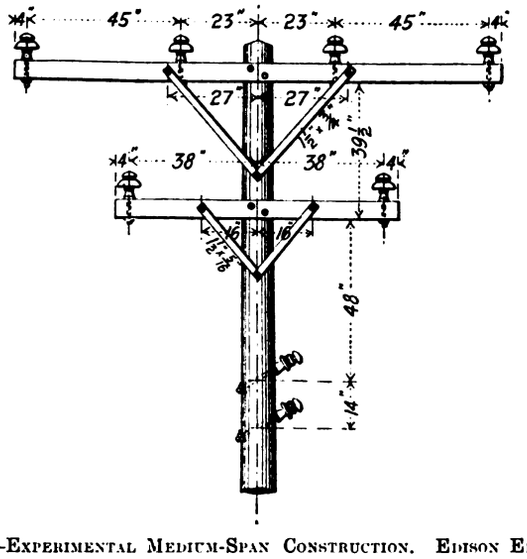

FIG. 1.—EXPERIMENTAL MEDIUM-SPAN CONSTRUCTION. EDISON ELECTRIC CO., OF LOS ANGELES, CAL.

The top cross-arm (Fig. 1), with three cables only; No. 13 Locke oak pins, with a bolt centre; 2¼in. washers under each pin and nut; ordinary deep-groove double-porcelain insulators (selected), with a piece of copper wire netting under each to prevent the burning of pins; three strands of No. 17 medium hard-drawn copper wires twisted together for a telephone cable, which was strung on transposition glass insulators and No. 13 Locke pins, and transposed every third pole, were some of the features of construction. Mogul paint was used on all threads, nuts and points of contact of iron and wood and in the gains, galvanised iron wrapped around the poles under the guy wires. The strand was not allowed to touch the ground, and was spliced by twisting with an annealed and flattened copper tube. A double lock tie of No. 8 wire was used with a wood-covered tie wrench; no pliers or come-alongs were allowed on the job. All kinks were eliminated with a splice.

They are both 10,000-volt lines, and the advisability of using deep-groove double-petticoat insulators will be questioned. Seven years' actual service, however, has shown them just as good as any. In fact, there are indications that they are better. They seem to discharge the line without burning the pins. Mechanically speaking, they are superior because the wire is let down closer to the cross-arm. They should, however, be used with caution, because the conditions on other systems and localities might not be similar.

The following are representative specifications used for stranded copper cables:—

1. This copper cable is to be used for long-span work with 225ft. to 300ft. span. The cable must be bare and composed of seven medium hard-drawn copper wires. The cable must have a resistance of 0·3944 ohm per 1,000ft.—that is, equivalent to No. 6 of 100 per cent. Matthiessen's standard conductivity.

2. The cable must have a lay not greater than 4in.—that is, one turn of each wire around the cable in 4in. of its length.

3. The cables are to be furnished in such lengths that no splicing of individual strands is necessary. When the length of one wire in the strand runs out, the whole cable is to be cut at this point by the manufacturer, to be eventually spliced by means of copper sleeves when the line is constructed,

4. The cable must be pulled through a non-corroding grease bath before being reeled, to prevent the chafing of the cable against itself in shipment. Paraffin is suggested.

The strength of the cable must be such that it can be pulled up to a 5in. sag on a 225ft. span. (To be strung with a 15in. to 24in. sag on the actual line). In accepting the cable, seven samples will be tested from various portions of the shipment and five must stand a 5in. sag, while two will be allowed to break at this sag. 25 samples of individual strands will be taken from the shipment and given a twisting test, twisted six times on and off its own diameter. In such a test the strands must show absolute uniformity of material and drawing. The surface of these individual strands must present a good lustre and be free from seams, drawing nicks and slivers.

5. Bids are solicited on this cable, manufacturers to specify weight and price per foot.

The writer lays great stress on the old twisting test, as it is found to be an extremely good gauge of uniformity of the product. It is not considered advisable to have a wire of 70,000lb., 50,000lb., 30,000lb., 65,000lb., 40,000lb. per square inch ultimate strength at various points along its length. It is more advisable to have it uniformly from 45,000 to 50,000lb. The twisting test determines this, and in a rough way the tensile strength.

Tests on the seven-strand Anaheim cable and the three-strand telephone cable showed an ultimate strength of 59,500lb. per square inch, corresponding to a 5in. sag of 225ft. An actual span was

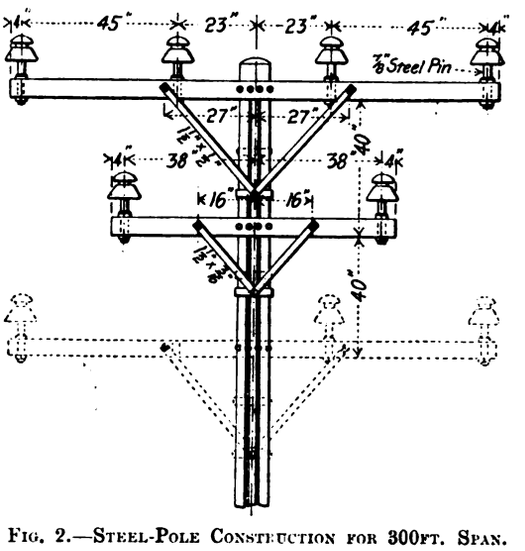

FIG. 2.—STEEL-POLE CONSTRUCTION FOR 300FT. SPAN.

used for the test and remarkably uniform results were obtained, the cable breaking at just 5in. sag each time. At 5½in. sag the cable had stretched 11in. in 225ft., and had a permanent set of 4·6in. Subsequent cables have broken uniformly at 63,250lb. per square inch.

After all, the important factor of this work is, has the engineer "done for a dollar what any fool can do for two?" which brings us up to a consideration of comparative costs. At the time when this matter was first being discussed, 5½ miles of 30,000-volt line was built from Mentone to the new Mill Creek No. 3 power house. The ground was exceedingly rocky, which made the cost of digging holes from $1.50 to $3.30 each, and the cost of stringing and hauling very great, with two three-phase circuits of No. 4 wire, and 125ft. and 120ft. spans. A saving of 16 per cent. could have been effected by 225ft. medium-span construction with cables, and the line would have been safer, because the wires would have been 45in. apart instead of 36in. With No. 6 the saving would have been 21 per cent., while with No. 3 wire, which is about the practical limit of this kind of work, a saving of 11 per cent. would have been obtained.

There is now being constructed 9½ miles or more of medium-span line in Lytle Creek, near San Bernardino, directly in the path of the severe north winds, of the 40ft., wood pole, 225ft.-span construction, with deep-grove double porcelain insulators on 10,000 volts. Half of it is to be strung with No. 5 and half with No. 6 cables, and a saving of 24½ and 26½ per cent. will be effected. This is a single-circuit line prepared for drawing in another one eventually. In single-circuit lines, where wire is a smaller percentage of cost, the greatest percentage of saving by the longer spans is secured.

The company is now building 14 miles of line from Los Angeles to Inglewood to connect the old United Electric Gas and Power Co.'s beach town, 38 miles, 17,300-volt transmission system, which the Edison Electric Co. has lately acquired, with the 30,000-volt Edison system. This is composed of six No. 4 seven-strand copper

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power wires (see Fig. 2) strung on a new special porcelain insulator and the three-strand telephone cable mentioned above. 30,000 volts will be impressed on the line. The 40ft. poles are of steel and placed 300ft. apart. The cross arms are of wood because of the danger of birds burning wires off by grounding, but special iron pins have been designed, and all pins are to be grounded together by a fine wire underneath the cross arm to prevent burning of the wooden parts. The soil is mostly sand, and a cylinder of cement, 5ft. deep, is used to set the poles in. Even then the cost is only $48 per mile more than a wood-pole line with 125ft. spans, because wood poles would have to be taller than 40ft. If, however, 45ft. wood poles and 225ft. spans had been used, the cost would mean an advantage of 20 per cent. over an ordinary 125ft. span cedar pole line.

The cost of a 40ft. tripartite pole make by the Franklin Rolling Mill, of Franklin, Pa., in this steel construction, is about $35 f.o.b. Los Angeles, as against $9 for a 45ft. cedar pole, so that the above figures are rather surprising. The excess cost of the 300ft. span steel line over the 225ft. span wood line is what the company pays in first cost to prevent depreciation. The advantage is gained that, should the line ever be changed or moved, the poles would be as good as new for a new place. Ordinarily, in such cases, even though the poles are not rotted badly, they are not worth placing again without sawing off. This principle, which is often lost sight of, is especially applicable to city distributing systems. It will be observed that this construction is especially advisable on lines with small wires—*i.e.*, telegraph, telephone and power lines of Nos. 3, 4, 5 and 6 wire. The percentage saving on single-circuit lines is especially great, and the percentage saving is greater the greater the cost of poles and digging holes, and particularly where the poles must be hauled a great distance and when the company must provide tents and eating facilities along the line in building. On high-voltage lines, where the insulators cost considerably, the saving is very patent.

Perhaps the principal mechanical, and therefore ultimate monetary, advantage in medium or long-span work is the greatly reduced trouble with insulators and pins and burning-off of poles, and, in fact, all the troubles which lines are heir to, by making the parts fewer and each better, which, by the way, greatly reduces the necessity for double-pole lines. In other words, make good porcelain eggs and make them larger and stronger than are usually laid, put them in one good strong basket, and watch the basket, and it will not cost so much to watch the basket, either, as it usually does. It will often be found, especially in this Western country, that, by building a line quickly, not only is money saved in construction, but revenue and profit is more quickly obtained or lost power more promply eliminated. Medium-span wood pole lines are built in 60 per cent. of the time usually employed on short-span lines.

Medium span construction would seem advisable also for long-distance telephone and telegraph work in certain sections, and where it is presupposed that a first-class line of long life, and of no trouble while it lives, is the more economical one in the end.

Only in rare instances does the 15in. to 20in. sag instead of 8in. make any difference in the height of poles. Private telephone lines should be at least 5ft. below the lowest power cross-arm, and at least 8ft. above the tallest trees, which usually dictates the height of poles. These methods may become important in case a double-pole line is considered advisable where small amounts of power are transmitted at high pressure or small distances. The question of the preservation of poles from decay is of some importance in this discussion. Granting that a good, cheap, practical method of preserving poles at from 75c. to $1 per pole can be found—and we are making rapid progress in this direction—the saving by using this medium-span construction is greater than cited above, and entirely removes the question of the greater weakening of the line by the decaying of poles in the longer-span construction.

In conclusion, it may be said that by effecting a saving of from 10 to 30 per cent. in lines ordinarily costing from $700 to $1,700 per mile, and having from three to 12 of the smaller sizes of wire, a slight advance has been made in the art in the field of light construction, where the the cost of poles, freight and haulage is great, especially as they are better and safer lines than are ordinarily built with more cost; or, stating it another way, they are as cheap as the cheapest allowable lines and twice as safe and free from trouble and danger.

North of England Institute of Mining and Mechanical Engineers.—The annual meeting of this Association will take place from September 17th—23rd, the head-quarters being Newcastle-on-Tyne. Among the works to which visits will be paid are the Carville and Neptune Bank power stations of the Newcastle-on-Tyne Electric Supply Co., the Manors power station of the Newcastle Corporation, and the North-Eastern Railway electrified lines.

CORRESPONDENCE.

SUBMARINE TELEPHONE CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your leader on "Submarine Telephone Cables" in *The Electrician* of September 2nd is somewhat sceptical as to the advantages of the new types of telephone cables. Their most important properties are paper insulation under lead and the covering of the copper conductor with a closed helix of fine iron wire. As to the first point, it seems you are in favour of it, with the reservation that it be doubtful if such a cable can stand deep sea pressure. It is a misunderstanding of the sentence quoted from my Paper that I was generally against paper-insulated cables for this purpose, as this sentence relates only to the question of impregnated-paper *v.* gutta-percha cables. On the contrary, we adopted air-space cables with paper later than the one with impregnated paper. As our cables were to be laid in shallow water, we did not make experiments as to their behaviour in great depths.

On the second point you say that "it is really doubtful whether the advantages gained [by the iron coating] are sufficient to outweigh the disadvantage of increasing the diameter of the core and thereby increasing the capacity, weight and cost of the cable." Of course, that is a most important point, but thorough attention was given to it. Before the first cable was ordered for construction, several tests were made on trial cables with and without iron, in order to determine whether the iron was advantageous or not. I do not think it necessary to publish the results of these tests, as the advantages can readily be seen from some figures which are contained in your abstract of my Paper on p. 789.

The Danish–Swedish cable contains over a copper strand of 2·4mm. diameter an iron coating of 0·2mm. wire, which gives a conductor of 2·8mm. diameter, which is surrounded by gutta-percha to a diameter of 8·2mm. Taking the copper strand without iron and insulating it to the same diameter, which means a little increased weight of gutta percha, the capacities of the two cables would be in the proportion

$$\frac{D}{2\log\frac{8\cdot2}{2\cdot8}} : \frac{D}{2\log\frac{8\cdot2}{2\cdot4}} = \frac{0\cdot534}{0\cdot467}.$$

The supposed cable without iron would, therefore, have a capacity of 0·153mfd. per kilometre against 0·1745mfd. of the cable D_{II}. It would have a greater resistance and a greater capacity per unit length than the English-Belgian cable, which is already inferior to the existing cable D_{II}. The same would be the case with the air-space cables, but I think it is not necessary to go into further details. The curves in Fig. 6 show that the increased capacity was more than balanced by the increased inductance, as the damping per unit length of these new cables is considerably lower than that of any cable manufactured hitherto. But I accentuated in my Paper that this beneficial effect was only available on heavy conductors, with great copper section and low resistance, as in conductors of great resistance the resistance component of the impedance is no longer great enough compared with the resistance component.

It may be mentioned that before the cables were ordered for manufacture, all their properties were well established within certain limits, so that no risk was run as to their full success. The contractors guaranteed directly a certain upper limit of damping constant for 1,000 periods, and in the case of the Heligoland cable even specified details, such as the maximum increase of working resistance at this frequency. So it can be claimed that the success of these cables is not a result of a good chance, but of the thorough investigation of the behaviour of their various electrical qualities.

You have two other doubts against the new cables—increased weight and cost. Of course, these two items are not to be neglected in working out a new type of cable, but they are of a less serious importance than the electrical properties of the cable. If a cable is wanted in a trunk line of a given distance, this defines the maximum damping constant per unit length of the cable in order to get a good commercial

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speech over the whole line. A cable whose damping constant is higher than the calculated figure is not practicable for that line, since it would give only a poor communication. If it is impossible with the means at hand to build a cable with a sufficiently low damping constant, this fact is prohibitive against the construction of a well-working line. Weight and cost can only be prohibitive when they are so excessively great that neither safe laying nor an economical maintenance would be possible. The far higher price of copper was in earlier days of telephony no reason against the introduction of copper wires instead of iron wires when this was necessary for progress. But now neither the weights nor the cost of the cables described exceed to an extraordinary degree the weight and cost of the cables of the old type, although they are much better in their electrical properties. The following table represents in rough figures weight in kilogrammes and cost in marks per metre for the most modern cable of the old type, the English-Belgian cable, and two of the newer cables, those to Borkum and to Heligoland :—

Cable.	Weight.	Cost.
English-Belgian	7·2	6·78
Borkum	6·8	4·78
Heligoland	8·5	6·38

These figures include all expenses for the completely-laid cables. As shown in Fig. 6 of the abstract, the Borkum cable has a damping constant, which from 400 up to 1,400 periods is nearly one-half of that of the English-Belgian cable. The Borkum cable has four conductors, just as the other cable. Weight and price being lower, and the qualities being better, the new form can be claimed superior.

The Heligoland cable contains, as described, only two telephone conductors and two smaller conductors for telegraph purposes. It is difficult to compare it with the English-Belgian cable. As here an extraordinarily low damping constant has been attained, one can scarcely say that weight and price are too high even for a two-core cable. I should add that the new cables had to bear extra costs for laboratory work and trials for the novelty of their construction, while the gutta-percha cables could be manufactured on well-known lines.

Having shown, as I think, that the new cables are successful, not only from the merely scientific, but also from the technical and commercial point of view, I should like to say some few words on the proposal in your article of a single conductor cable. Before the first German-Atlantic cable was ordered, Messrs. Felten and Guilleaume made for test purposes different types of single-core cables, the self-induction of which was measured. I referred to these tests in *Elektrotechnische Zeitschrift*, 1899, p. 842. For convenience, I tried at first to measure with frequencies up to 450, and found on one cable the following figures for 1km. :—

Periods.	Working resistance.	Self-induction.
234	1·390	0·000788
314	1·476	0·000630
450	1·480	0·000498

The copper resistance, as measured by continuous current, was only 0·548 ohm, and the self-induction at low frequencies, measured on similar cable, was nearly 0·00262 henry. The cable contained some iron wires stranded with the copper wires of the conductor. One cannot say that these were guilty of multiplying up to nearly threefold the working resistance and diminishing the self-induction to a fraction of its original value, since in the new cables, which contain more iron, even at higher periods no effect of such magnitude is shown. It must be the losses by eddy currents generated in the armouring wires which cause this effect. It is impossible to eliminate these effects in a single-core cable. Such a cable must show at high frequencies an elevated resistance and diminished self-induction, and the result is poor transmission.

I said in my Paper that a damping constant of 0 006 per kilometre is near the limit which can be attained by the methods described. I am in accordance with your article in accentuating the great importance of working out a good mechanical form of an inductance coil which has a sufficiently high time-constant and is adapted to be inserted into a cable and to pass with it at practical speeds through the cable machinery. It is very difficult to satisfy all these conditions, but only with such coils is it possible that cables should be constructed with damping constants equal to those of aerial lines with heavy conductors. But there remains a broad field for cables, for which no lower damping constants than those of the cables described are necessary. In my opinion it is doubtful whether for such purposes a Pupin coil cable can be manufactured and laid at lower cost than an equally good cable with continuously distributed self-induction.—Yours, &c.,

Berlin, Sept. 7. Dr. F. BREISIG.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : The writer recently received a letter from Count Arco, of the Slaby-Arco Company, with reference to a note published by this company in a recent issue of *The Electrician*, taking exception to some statements made therein. As Count Arco has given publicity to this letter (*The Electrician*, August 5th), it will be sufficient if I subjoin a copy of my reply. While I feel that the statements were in the main justified, it is only proper to acknowledge the fact that Count Arco and his associates have done a great deal of most excellent experimental work, and that the members of the National Electric Signalling Co. have the highest respect not only for their scientific work, but for their honourable methods of doing business.

With reference to the statement made in the postscript we feel strongly that Prof. Braun is absolutely and entirely without justification in attempting to claim that his patent specifying the use of a condenser (on the ground that sufficiently long waves cannot be obtained from radiating conductors, and stating that radiating conductors to be used in conjunction with the condensers "should be as long as possible") discloses the method of using a radiating conductor and a local condenser circuit tuned to the same frequency. Whatever else Prof. Braun's patent means it certainly means that the condenser circuit should have a much longer natural period than that of the antennæ, and we consider his attempt to take credit for the invention of a local circuit and an antennæ tuned to each other, to be quite reprehensible. Moreover, Braun was not the first to use a condenser in an untuned circuit in shunt to a spark-gap, as Tietz had disclosed this previous to Braun. As was pointed out in a communication published in your issue of June 3rd, the authorship of which Mr. de Forest subsequently repudiated, Prof. Braun never made any mention of this combination, which now forms a feature of all successful wireless systems, until several years after December 15, 1899, the date of application of our patent. I may say that this date is confirmed by affidavits in the U.S. Patent Office by Prof. Kintner, of the Western University of Pennsylvania, to the effect that he witnessed and assisted in the use of this combination by the writer at a date earlier than September, 1899.

With reference to Count Arco's remarks on sharp tuning, I would say that the ability to cut out interfering stations whose wave frequencies differ only 5 per cent. from that of the station whose messages it is desired to receive is a quite creditable performance, and two or three years ago would doubtless have been considered very good. Since then, however, matters have progressed very considerably. In this connection I would mention the fact that the commercial stations which we are now installing work entirely by means of throwing slightly in and out of tune, and that it is quite possible to operate these stations by changing the tune by an amount considerably less than 1 per cent. This will be readily understood, by anyone who has had practical experience, from the following measurements made on the amount of interference at our New York station caused by the Navy station at the Brooklyn Navy Yard, less than 5 miles away, as follows :—

The following measurements were made at our New York station, having an antennæ 135ft. high, during a period when the Navy Yard was employing a very powerful sending system, using, we understand, approximately 5 H.P. With aerial disconnected from ground so that the antennæ consisted only of the short wire running from the ground plate to the table in the station, a height of approximately 3ft. only, and with no capacity on the upper side of the receiver, messages from the Navy Yard

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could be read with the current in receiving instrument shunted to half its value.

With the antennæ connected, no measurements were made with an untuned antennæ.

With the old style of tuning—*i.e.*, tuned antennæ and tuned secondary—the messages could be plainly read when the indicating receiver was shunted to one 650th of its value—*i.e.*, to less than one-sixth of 1 per cent.

With the new style of tuning, which has now been used at these stations for nearly a year, it was impossible to obtain any effect whatever from the Navy stations. In other words, what we call the new style of tuning cuts down the interference to certainly less than the one 2,000th part of what it is when the usual tuned antennæ and tuned secondary circuit are used.

Yours, &c.,
REGINALD A. FESSENDEN.

Washington, D.C., August 18, 1904.

[COPY.]

Washington, D.C., August 11, 1904.

Count Arco,
Gesellschaft für Drahtlose Telegraphie,
Lindenstrasse 3, Berlin, S.W., Germany.

DEAR SIR: Yours of July 29th received. I have examined the article you refer to, and have come to the conclusion that your criticism of it is justified. I am, therefore, writing to the London *Electrician* and correcting some of the statements made in the original article. This conclusion is not made as a result of your statement that if your request is not complied with the arrangement for long-distance tests will be cancelled, as we expect to have one of our own stations operating over a distance of approximately 1,700km. within two months. We make the correction because we think you are justified to a certain extent in your criticism.

With best regards, I am,
Yours very sincerely,
REGINALD A. FESSENDEN.

P.S.—You will note that in my communication to *The Electrician* I refer to Mr. Braun's claim for a combination of a local tuned circuit with a tuned vertical. I regret that I must take exception to Mr. Braun's claim for having had anything to do with the invention of this combination, but trust you will appreciate the fact that I believe I have good reasons for my opinion.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Dartford District Council require a resident electrical engineer to take charge of their electricity supply undertaking. Commencing salary £250 per annum. Applications to the clerk (Mr. W. Kay), Council offices, Dartford, Kent, by Oct. 6. See also advertisement.

Heston and Isleworth Urban District Council require a chief assistant engineer with experience in running a central station on low-tension three-wire system. Also a clerk. Further particulars in an advertisement. Applications to the clerk, Mr. H. J. Baker, by Sept. 24.

Messrs. Vickers, Sons & Maxim require a thoroughly qualified travelling representative for the sale of continuous and alternating-current generators, motors, &c. Applications to electrical department, River Don Works, Sheffield. See advertisement.

A wiring inspector is wanted by the Durban (Natal) Municipality chiefly for testing, inspecting and reporting upon house wiring. Salary £300 per annum. Applications to the agents of the Corporation (Messrs. Webster, Steel & Co.), 5, East India-avenue, Leadenhall-street, London, E.C., by Sept. 26. See also advertisement.

An experienced electrical engineer, with thorough knowledge of mechanical engineering, is required for Durban as manager of the electrical department of Messrs. Rogers Jenkins, agents of the A.E.G. Electrical Co. of South Africa (Ltd.). Applications to A.E.G. Electrical Co. of South Africa (Ltd.)., 125, Charing Cross-road, London, W.C. See also advertisement.

Messrs. W. H. Allen, Son & Co., Bedford, require a shorthand writer and typist for the correspondence department of their works. Applications to the secretary. See advertisement.

Applications are invited for the position of lecturer and demonstrator in electrical engineering at the school of engineering, electricity and technical science, Canterbury College, University of New Zealand. Salary £300 per annum, with saloon passage to New Zealand. Particulars of qualifications and forms of application from the Agent-General for New Zealand, 13, Victoria-street, London, S.W., to whom applications by Oct. 19. See also advertisement.

There is a vacancy for the Postmaster-Generalship of the British Central Africa Protectorate, which carries a salary of £325 per annum, rising by increments of £20 to £425. Candidates (not less than 30 nor more than 40 years of age) must have had experience of both postal and telegraph duties. Free passage to and from the Protectorate is given. Candidates, who must be in the British postal and telegraph service, must send in their applications through their superior officers by 27th inst.

A lecturer and demonstrator in physics is required at University College, Nottingham. Commencing salary £130, rising to £180 per annum. Applications (on forms to be supplied by the Registrar) by Sept. 20.

A demonstrator and assistant lecturer in electrical engineering is required in October at the Heriot Watt College, Edinburgh. Salary £150 per annum. Applications to Principal by 24th inst.

An assistantship in the Metrological Division of the Physics Department of the National Physical Laboratory is vacant. Salary £200 per annum. Applications to the director (Dr. R. T. Glazebrook, M.A., F.R.S.), Teddington, Middlesex, by Oct. 1.

The Council of Durham College of Science invite applications for the Principalship. Salary £1,000 per annum. Applications to Secretary by Sept. 30.

An assistant lecturer and demonstrator is required at the Northern Polytechnic, Holloway, London, for physics and electrical engineering. Salary £150. Applications by Sept. 28.

A science lecturer is wanted at Oldbury Technical School. Applications to Mr. H. A. Anderson.

An instructor in civil and mechanical engineering is required for the Technical College, Colombo. Salary Rs.4,200. Applications to the private secretary, Colonial Office, London, S.W.

Mr. T. Medcalf, chief clerk of the electricity department, has been appointed tramways traffic superintendent at Swindon, in addition to his present position, at an additional salary of £30 per annum.

Mr. P. E. Hale, of Blackburn, has been appointed engineer-in-charge at Southport electricity works.

Mr. Frank Lord has been appointed chief instructor in mathematics at Northampton Institute, Clerkenwell, London. Mr. Lord is a graduate of Victoria University, with honours in mathematics and engineering, and was recently a student under Profs. Horace Lamb and Osborne Reynolds.

Mr. A. J. Makower, of the alternating-current designing department of the British Thomson-Houston Co., Rugby, has been appointed to the post of head of the electrical engineering department of the South-Western Polytechnic, Chelsea.

Croydon Education committee on Monday appointed the following teachers for the ensuing session:—

For the Central Polytechnic.—Electrical engineering: Messrs. G. F. Mansbridge, E. C. Price, J. H. Robinson and W. Claypoole. Mechanical engineering: Messrs. R. H. Cabena and G. B. Morgan. Chemistry: Messrs. S. Field and J. E. A. Adcock. For the South Norwood branch.—Electricity and magnetism: Mr. W. Jacobs.

Mr. J. R. Myers, of Ilford, has been appointed station superintendent at the Ilford Council electricity works.

EDUCATIONAL NOTICES.

University of Glasgow.—The next session begins on Oct. 13, and continues to the end of March. After that date the students enter engineering works or offices for the six summer months, returning to the University for the next winter session. Particulars of classes and regulations for the degree of B.Sc. in engineering may be obtained from the syllabus, which will be supplied on application. The new James Watt engineering laboratories for students in civil, mechanical, electrical and mining engineering are in full working order, and are thoroughly equipped for experiment and research in most branches of engineering.

University of Liverpool.—The session 1904-5 commences on Oct. 3. The courses of study in the faculty of engineering leading to the ordinary B.E. degree or the certificate in engineering are so arranged as to afford a general scientific training for those intending to become engineers or to enter any allied profession. There is an honours course for students who desire to specialise in some branch of the profession and opportunities are afforded for post graduate work and research. Prospectuses from the Registrar. Included in the staff of professors and lecturers are Mr. A. Bromley Holmes (who is associate professor in municipal electrical engineering) and Mr. J. A. Brodie (associate professor in municipal engineering).

Victoria University of Manchester.—Special equipment, including experimental electric furnaces, is provided in the physical laboratories for instruction and research in electro-chemistry and electro-metallurgy. Particulars from the Registrar.

University College, Bristol.—There are courses here for civil, mechanical, mining and electrical engineers, architects and surveyors. Special facilities are offered in the way of college scholarships and engineering works scholarships, favourable arrangements being made with firms in or near Bristol for practical training to be obtained in works concurrently with the college course. A diploma is awarded to students who pass the qualifying examination. Applications for vacancies in October should be made to the registrar and secretary, Mr. James Rafter.

Durham College of Science (Newcastle-on-Tyne).—Courses are provided at this college for students proceeding to the degrees in Science, and special facilities are offered for the study of agri-

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culture, chemistry, mining, engineering and naval architecture. Matriculation and exhibition examinations begin Sept. 26, and lectures Oct. 4. Prospectuses from the secretary.

Birkbeck College, London.—The new session begins on Monday, Oct. 3. There are day and evening classes and systematic courses of instruction (lectures and laboratory) for the degrees of Science and Engineering of the University of London. Further information can be obtained from the Principal.

Sir John Cass Technical Institute (London).—The new session begins on Sept. 26. There are advanced classes in chemistry, metallurgy, physics and mathematics. Facilities are afforded for special and advanced practical work in well-equipped laboratories, both in the afternoon and evening. Courses of instruction will be given in glass blowing during the session by Mr. A. C. Cossor. The Institute is readily accessible, being adjacent to Fenchurch-street, Liverpool-street, Broad-street, and Metropolitan Railway stations. Particulars from the Institute or by letter to the Principal (Mr. Charles A. Kohn, M.Sc., Ph.D., F.I.C.)

Northampton Institute.—Full day courses in the theory and practice of mechanical, electrical and horological engineering will commence on Oct. 3. Entrance examination, Sept. 28 and 29. The courses for mechanical and electrical engineering include periods spent in commercial workshops and extend over four years. Students also prepare for the degree of B.Sc. in engineering at the University of London. Particulars as to fees, &c., can be obtained at the Institute, St. John Street-road, London, E.C., or on application to the principal (Dr. R. Mullineux Walmsley). The evening technical classes in all branches of electrical and mechanical engineering commence Sept 26. There are well equipped laboratories for all kinds of electrical testing.

Borough Polytechnic Institute, London, S.E.—The 1904-5 session commences on Oct. 3. There are evening classes (lectures and laboratory work) in inorganic and organic chemistry, electrochemistry, electricity and magnetism and electrical and magnetic measurements. Prospectuses from the Principal (Mr. C. T. Millis). The course in electrical and magnetic measurements is intended for electrical engineers, instrument makers and others engaged in electrical work. See also an advertisement.

South-Western Polytechnic, Chelsea.—We have received copies of (*a*) the calendar and prospectus for the session 1904-5 of the day college for men and women, (*b*) the prospectus of evening classes and (*c*) the prospectus of the day school for boys and girls at this Polytechnic. The day college is intended for students above 16 and the courses of study are suited for technological and university purposes. There are courses of study, extending over three years, in mechanical engineering, electrical engineering, mathematics and physics, chemistry, &c. The entrance examination commences on Monday next, September 19. Students of the college are either matriculated or occasional, the former being those admitted to a course of study of 10 to 30 hours a week. The laboratories of the electrical department have been recently improved and enlarged and are capable of accommodating 100 students at one time. There is also a workshop fitted with light electrically-driven tools. The evening classes commence 26th inst. and the day classes on Oct. 3. Copies of the prospectuses from the Polytechnic, Manresa-road, Chelsea, S.W.

Hackney Technical Institute.—The session commences on Monday, Sept. 19. There are special courses and laboratory work in electrical engineering, including electrical measurements, dynamo and motor design and telephony. Prospectus from the secretary, Dalston-lane, London, N.E.

Belfast Municipal Technical Institute.—The 1904-5 session commenced on Monday, and the lecturer on physics and electrical engineering (Mr. R. Stanley, B.A., A.M.I.E.E.) delivered an interesting preliminary lecture on the 5th inst. on "Electrical Engineering as a Profession."

Electrical Standardising, Testing and Training Institution.—Mr. W. R. Cooper, M.A., B.Sc., M.I.E.E., will commence on Monday, Sept. 19, a course of lectures to the senior students of this Institution upon "Secondary Cells."

L.C.C. School of Photo-Engraving, &c.—We have received a prospectus of the 10th session (1904-5) of the London County Council School of Photo-Engraving and Lithography, which is established at 6, Bolt-court, Fleet-street, London, E.C. The course of practical instruction given at this school appeals exclusively to craftsmen in every branch of photo-mechanical, photographic, designing, illustrative, engraving and printing branches of industry. There is now so much illustrative work carried out in connection with the decorative side of electric lighting illumination that, assuming the school to embrace such sections of work, the instruction obtainable here so cheaply should have interest for some of our readers.

Aberystwyth.—The Council have invited the Aberystwyth & Chiswick Electricity Supply Co. and the local gas company to tender for public lighting for three, five, seven or ten years.

Aberdeen.—The annual report of the city electrical engineer and manager (Mr. J. Alex. Bell) and the accounts of the electricity department for the year ended July 31 have been issued. An abstract of the accounts appeared in our issue of 2nd inst.

In his report, Mr. Bell states that during the year 183 additional consumers were connected to the mains, making the total 1,342. In the same period 106 motors of an aggregate of 559 H.P. were connected, 51 being hired out by the Corporation. The total motor connections are 408, representing 1,719 H.P. The units sold for motive power during 1903-4 were 388,570, compared with 275,038 and 137,486 in 1902-3 and 1901-2 respectively. Electrical heating has increased by an equivalent of 2,498 c.p. lamps, and 72 private arc lamps have been added, making the total 422. Eight public arc lamps have been coupled up, making a total (including the harbour) of 289. The total number of connections on the mains for lighting, heating, cooking and motors (but not including traction) represents an equivalent of 154,000 8 c.p. lamps. Since June 18 the Aberdeen Suburban Tramways Co. has been a consumer. Extension of mains has given an additional frontage of supply of 2·84 miles. Two 23kw. sets and four boilers have been disposed of by sale from the Cotton-street works during the year, leaving the capacity of the Cotton-street station at 714kw. and of Dee Village 2,100kw. A 1,200 H.P. set is on order for Dee Village, and will be delivered during September. The total costs per unit sold were 1·07d. per unit, compared with 1·25d. in 1903. The load-factor worked out at 19·42 per cent. against 17·4 last year. Mr. Bell recommends that the charges for electric energy be reduced, after the first hour's maximum demand, from 2½d. to 2d. per unit for private lighting and from 2d. to 1½d. for public lighting. (These recommendations have been approved by the Corporation.) Mr. Bell also advised that the two serviceable generating sets (390kw. and 180kw. sets) be removed from Cotton-street to Dee Village works, that condensing plant be obtained for the two sets, and that the capacity of the cooling water tank for condensing be increased by the addition of a further tier of plates, The total estimated cost of the alterations and additions is put at £1,870.

Argentina.—The "Review of the River Plate" states that the proposal to take a concession for the acquisition and conversion to electric traction of all the tramways in Rosario, to which we referred in a recent issue, was made by the Cia. Alemana Transatlantica de Electricidad (Buenos Ayres), in co-operation with Messrs. Dick, Kerr & Co. of London. A concession of 99 years is asked for.

Electricity works are being erected in the town of Rio Cuarto.

Aspull.—The Board of Trade have deferred for 12 months the question of revoking the electric lighting order obtained in 1901.

Barnsley.—The following scale of salaries has been fixed for officials of the electricity department:—

Chief assistant, first year, £150; second year, £160; third year, £170. Shift engineers, first year, 35s. Mains superintendent, first year, 30s. per week; second year, 35s.; fourth year, 40s. Improvers, first year, no salary; second year, 20s. per week; third year, 30s.

Barrow.—107 tradesmen, who are consumers of electric current, recently petitioned the Electricity committee for a reduction in the price from 6d. per unit to 4½d., the figure charged to other private consumers. The committee cannot see their way to make a reduction as "the system of charging for electricity has been based on the principle of charging each consumer on actual cost of supply, and that this cost is much greater in the case of shops than for private houses."

Batley.—The Council have decided to reduce the price of current for lighting, after the first hour's maximum demand per day, from 3d. to 2d. per unit, flat rate of 4½d. is provided for places of worship.

Battersea (London).—The Council decided on Wednesday, on the recommendation of the Lighting committee, to increase the charge for the supply of electric energy to the 356 electric lamps for street lighting from £16 to £18 per lamp per annum. Application has been made to London County Council for a loan of £11,350 for electric lighting extensions.

Berwick.—The Council have decided to adopt side instead of centre posts for their street electric lighting.

Brentwood.—Though the Council will not apply for a provisional order, the clerk has been instructed to secure protective clauses should application be made by a company.

Bury (Lancs.)—The Tottington section of the electric tramways is to be officially inspected to-day (Friday).

Caerleon.—The South Wales Electrical Distribution Co. has informed the Council that they cannot supply electricity in the district except in bulk, and recommend the Council to obtain a provisional order to enable them to act as distributors.

Carnarvon.—The Council have decided to enter into an agreement with the National Electric Construction Co. for the wiring of premises in the district on the hire-purchase system.

Consumers will have the option of having their premises wired and supplied with fittings and lamps ready for connection to the mains at a rental of 4½d. per lamp per quarter (lamp to mean incandescent lamp of any standard candle-power up to 32 candles), provided they agree to use the installation for one year certain, but after the expiry of one year to have the right to determine the arrangement by three months' notice. The consumer could purchase his installation at any time at original cost plus 20 per cent. and less 2½ per cent. per annum for depreciation. Should the Council take over the undertaking, they would have the option of purchasing all installations at cost

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price—*i.e.*, 15s. per lamp, plus 10 per cent. and less 2½ per cent. per annum for depreciation. If the Council did not exercise their option of purchasing the installations they would pay to the company for all unpurchased installations a rental of 4¼d. per lamp per quarter (in respect of each installation) for such period as may be required to complete 25 years from the date of each installation, and on the expiry of this period the installation would become the property of the Corporation. All applications for wiring on the hire purchase system, together with a statement of the prime cost of each installation, are to be submitted to the Council, and all "free" wired installations not purchased by consumers must be in a satisfactory working condition when the electricity undertaking is taken over by the Council.

Caversham.—The Council will apply for a provisional electric lighting order.

Ceylon.—In a report just issued on the mineralogical survey of Ceylon, commenced in 1903 under the direction of Prof. Dunstan, it is announced that already two discoveries of practical importance and scientific interest have been made. In the province of Sabaragamuwa a mineral has been found to exist in small black cubical crystals which on analysis was found to be oxide of thorium to the extent of more than 75 per cent. It is proposed to call this mineral thorianite. It is radio-active, and is expected to prove an important source of radium or radio-active earths and will probably furnish helium. Another mineral found in the same district has been identified as thorite, and consists chiefly of thorium silicate.

The rubber industry of Ceylon is making great strides. About 45,000lb. were exported in 1903, the quality being reported as of the first class. Much attention is being given to rubber planting both in the wet and dry zones. Estimates of the future possibilities of the rubber industry are of a very sanguine character, and anticipate annual shipments of rubber to the extent of from 1,500,000lb. to 2,000,000lb. It is pointed out that the opportunities for investing capital in this industry are very promising.

39 miles of additional overhead telegraph lines were erected in 1903 for the postal telegraph service and 54 miles for the railway service. The telephone system added 46 miles of over-head lines, and the increased number of calls was equal to 48 per cent. over 1902.

In the Governor's report on Ceylon for 1903 the following paragraph occurs:—

An important event was the appointment of a consulting electrical engineer to advise the Government and the Colombo Municipality in all electrical questions. With the continuously-increasing use of electricity, not only for telegraphs and telephones, but also for tramways, lighting, and power supply, it has become important that the Government should have an expert officer available for purposes both of advice and supervision. The officer selected by the consulting electrical engineers to the Crown Agents arrived in May, 1903, and has already been able to afford both Government and the Municipality valuable assistance. As regards the former, his work consists in advising Government and local bodies on all undertakings involving the use of electricity, in enforcing the rules for protection of person and property under the Electricity Ordinance and in supervising the plans and estimates and general work of the electrical branch of the Government factory. His chief municipal duties are to advise the Council as to the regulations for electric lighting and power, to conduct the necessary electric tests from time to time in connection with such regulations and to advise upon any proposed electrical installation.

Cheriton (Kent).—The Board of Trade have revoked the Cheriton provisional electric lighting order, 1899.

Clydebank.—The Electric Lighting committee have received from the Clyde Valley Electrical Power Co. an inquiry whether the Council would take a supply of electricity for public lighting, and explaining that, as the alternating current at 50 cycles will be more suitable for the district, the company are prepared to bear the expense of altering the wiring in the municipal buildings.

The committee decided to adhere to the direct-current system, as stipulated in the agreement with the company, but to allow a rotary transformer to be placed within the municipal buildings alongside the present dynamos, provided the company take over the dynamos at a valuation. The company's suggestion to introduce concentric wires was agreed to, provided the company undertake to have the alterations, &c., made by Feb. 15 next.

Companies Struck off Register.—The following have been removed from the register of joint stock companies:—

Colwyn Bay Elec. Light & Power Co.	Hedges, McKrell & Taylor.
Elec. Maintenance & Accessories Synd.	Italian Elec. Light & Power Co.
Electrical Navigation Protection Co.	Leeds, Wakefield, Dewsbury & District Elec. Tramways.
Fermoy & District Electricity Co.	Pollard Elec. Engineering Co.
Fleet & District Electricity Co.	Tramway Trolley Co.

Conway.—The Council propose to apply for a provisional electric lighting order, and negotiations have been opened with the North Wales Power & Traction Co. for supply of electricity in bulk.

Dalkeith.—The Town Council on Monday decided to seal the agreement with Crompton & Co. and the Electric Supply Corporation for the erection and equipment of electricity works.

Devonport.—The question of extending the electricity generating plant in order to keep up with the continually increasing demand for current for lighting and power was discussed by the Electric Power committee on Friday, when it was pointed out that the need for extension was urgent. The chairman (Mr. H. Banbury) and the borough electrical engineer (Mr. J. W. Spark) were deputed to inspect a number of engines and report to the committee, with a view to one being purchased and laid down in time to augment the supply for the coming winter The extensions are said to involve an expenditure of several thousand pounds.

Durham.—The Corporation have decided to oppose the application of the British Electric Traction Co. to the Board of Trade to prolong the time limited for the completion of the light railways authorised by the Durham & District Light Railways Order, 1901, until Oct. 4, 1905, unless the company undertake to carry out the work in a specified period, and to pay an indemnity for all time occupied in excess.

East Barnet.—In a report on electricity supply recently prepared by the consulting engineer (Mr. F. J. Warden-Stevens) it is stated that a fair demand for electricity is likely to arise, and the Council are advised to undertake the distribution of electricity in the district. At the outset distributors would be laid in the compulsory area and in the principal thoroughfares of the other portions of the district.

East Ham.—On Wednesday the Council were advised by the electrical engineer (Mr. W. C. Ullmann) that the delivery and fixing of the new machinery was progressing satisfactorily.

The accounts of the electricity department for the year ended March 31 show total income £18,415. 6s. 3d., including £7,490. 19s. 7d. from private consumers, £3,518. 16s. 10d. for public lighting, and £6,873. 8s. 2d. from current supplied to the tramways department. The annual expenses were £9,901. 19s. 3d., leaving gross profit, £8,583. 7s., to meet interest (£1,998. 18s. 4d.) and instalment of principal repaid (£1,511. 6s. 1d.) and also interest on temporary loans (£36,320), amounting to £1,362, and proportion of interest and sinking fund on loan for purchase of site (£25. 2s. 3d.), making in all £4,897. 6s. 8d. for capital charges. £2,542. 6s. 4d. was set aside for repayment of capital pending permanent borrowings, and £235. 1s. 1d. as reserve for renewals, leaving a net profit of £908. 12s. 1d. The capital outlay at end of year was £97,153. 19s. 11d., an increase of £9,678. 6s. 1d. The works costs were 1·02d. per unit sold, compared with 1·19d. in 1902-3; the total costs being 1·33d., compared with 1·50d. The equivalent of 33,847 8 c.p. lamps was connected, against 22,957; 1,774,163 units were sold (private supply 457,210, public lighting 396,257, and traction 920,696), against 1,264,666. The units sold per 8 c.p. lamp were 30, against 33·5; the maximum load on the feeders was 880kw., against 690kw.; and the load-factor was 25·78 against 20·92 per cent. The average price obtained was 4·12d. for private supply, 2·13d. for public lighting, and 1·75d. for tramways. The charge for public lighting is £18 per arc lamp per annum, and for incandescents (32 c.p. each) £4. 6s. 3d.

The traffic and other receipts of the tramways for the year to March 31 amounted to £35,299. 7s. 5d. Operating costs were £24,262 (excluding £950 set aside to meet liability in respect of accidents, &c., pending settlement of claims), leaving gross profit £11,039. Interest came to £4,856, and principal repayment to £2,385, leaving £2,898, or 2·5 per cent. on the average capital outlay, compared with 1·9 per cent. in 1902-3. There are 11 miles 3 furlongs of single track in operation. 807,002 car-miles were run, and 12,950,269 passengers were carried, an average of 16·04 passengers per car-mile. The traffic revenue per car-mile was 10·20d. (0·63d. per passenger); operating cost per car-mile 7·21d. (0·45d. per passenger); 1·14 units were used per car-mile. Of the surplus £950 was set aside for legal expenses, £976 for repayment of capital pending permanent borrowing, £380 placed to reserve and renewal account, and £592 to repayment of initial expenses account.

Electric Lighting of the Pyx Chapel.—The work of wiring and fitting up the old Pyx chapel in Westminster Abbey is now completed.

Farthing Tram Fares.—Douglas (Isle of Man) Corporation have decided to issue coupons on the Corporation tramcars at 3d. per dozen for school children during certain hours of the day.

Fulham (London).—The architect to the Board of Guardians is preparing a scheme for a complete electric bell system in the Nurses' Home.

Glasgow.—A cross-connecting tramway route from Stobcross Ferry (Finnieston) to Keppochhill-road was opened for traffic on Wednesday.

Golborne.—The Council have received a notification from the Lancashire Electric Power Co. of intention to apply for a provisional electric lighting order, but have themselves decided to apply for an order.

Govan.—Application has been made for sanction to borrow £47,000 for extensions of the electricity supply undertaking up to end of financial year 1906-7.

Hackney (London).—The Finance committee have approved estimates for £2,121 for substituting electric street lighting for gas in three thoroughfares.

Halifax.—Sowerby District Council have decided, in consideration of Halifax Corporation extending their tramways from Sowerby Bridge to Stiles (Sowerby) to undertake, so far as they legally can,

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to indemnify the Corporation for five years from payment of any district rate levied by the District Council in relation to the extension, and to assist the Corporation at their expense in obtaining an insertion in any bill which the Corporation may promote of such clauses as may be necessary for the carrying out of the agreement.

Heckmondwike.—The borough electrical engineer (Mr. G. H. Carter) has withdrawn his resignation in consequence of the Council's offer to increase his salary from £200 to £250, on condition that he continues in the Council's service two years.

Hitchin.—Messrs. Crompton & Co. have taken over the Council's electric lighting order.

Holyhead.—The inauguration of electricity supply will take place to-day (Friday).

Hospital and Asylum Lighting.—The authorities of the Eastern Counties Asylum for Idiots have decided to adopt electric lighting, and a contract has been entered into with Colchester Corporation for the supply of current.

Lanchester Joint Hospital Board have asked Bowes & Partners to tender for the electric lighting of the Tanfield Isolation Hospital.

At the Leeds Corporation's new fever hospitals, which have been erected at a cost of £200,000 on the Marston Hall estate, an independent electric generating plant has been put down.

Hove District Electricity Supply.—Portslade, Southwick, and New Shoreham Councils have decided to take supply of electricity from the Hove Electric Lighting Co.

India.—It is stated that the Cauvery Falls power transmission scheme has proved highly successful, as on the first year's working the net profits were 31·86 per cent., and it is calculated that in five years the total cost of the plant (6,500 H.P.)—just over £500,000 sterling—will be more than recouped, while the probable net profit for the first nine years is put at £750,000.

Proposals are under consideration for electric lighting and tramways in Mysore and Bangalore.

Darjeeling Municipality have recently been granted a licence under the Indian Electricity Act, 1903. This is only a formal procedure, as electricity supply has been available in this district for some years past.

The Indian Government have, it is stated, sanctioned an expenditure of 50,000 rupees for the purchase of electric transporters for use at Shalimar.

Kearsley.—Negotiations are proceeding between the Council and Messrs. Foote & Milne in regard to the erection and working of an electricity generating station. Mr. G. V. Fowler has given notice of intention to apply for a provisional order for the district.

Lancashire Electric Power Co.—The generating station for this company at Radcliffe is rapidly approaching completion, and negotiations are progressing for the supply of energy in bulk to Rawtenstall, Bacup, Haslingden, Swinton and Pendlebury and other local authorities. The supply of energy in bulk to collieries promises to be a feature in the working of the company.

Leicester.—The Aylestone tram route has been officially inspected and opened for traffic.

Leigh (Lancs.).—The Council are applying for sanction to a loan of £16,115 for extensions of the electricity undertaking.

Liverpool.—On the presentation of the Tramway committee's minutes at the Corporation meeting on Wednesday,

Mr. WALKER moved an instruction to the committee to introduce a universal 1d. fare forthwith. An amendment was moved in favour of "having a 1d. fare in ½d. stages."

The Chairman of the committee (Sir CHARLES PETRIE) said that tramways were not going to relieve overcrowding. At present the committee carried the public 2½ miles for 1d., which was not surpassed by any town in the kingdom. He reminded the Council at the last meeting that £800,000 of the expenditure was practically watered stock. Before long a great deal of money would have to be provided for depreciation. Some parts of the system were in a bad condition, and a great deal more money would have to be spent on equipment in future than in the past. Last year 113,015,738 passengers were carried, and the traffic receipts amounted to £524,321. If the universal 1d. were adopted, nearly 12,000,000 more passengers would have to be carried to bring up the receipts to that amount, and large additional expense would have to be incurred for extra cars, &c. Until the committee had a large reserve, it would be a plunge in the dark to adopt 1d. fares.

After discussion the motion and amendment were withdrawn on the understanding that the committee would report upon the advisability of 1d. fares before 8 a.m. with the privilege of workmen taking return tickets.

A motion by Mr. Utley that the committee be instructed to have five or 10 cars fitted with permanent tops, as an experiment, was carried.

Lombardy (Italy).—Mr. Consul Towsey notifies that contracts are occasionally placed by the Mediterranean Railway Co. with manufacturing firms outside Italy for the various requirements of the company. Public calls for tenders are not issued, invites being confined to the manufacturers on the company's list. British firms desirous of being added to this list should communicate with the "Direzione Generale delle Strade Ferrate delle Mediterraneo," Milan. A similar course is followed by the Adriatic Railway Co., whose headquarters are at Florence. Mr. Towsey considers the Italian market well worth cultivating by British manufacturers. A British Chamber of Commerce has recently been established at Genoa, Mr. A. O. Edwards being the delegate selected to represent Milan, the chief industrial centre of Italy.

In the Lombardy district the cotton industry is rapidly developing. At Dec. 31, 1900 (the latest date obtainable), electric power to the extent of 4,539 H.P. was in use in the 727 mills established at that date.

In connection with the International Exhibition which is to be held in 1906 at Milan (postponed from 1905), an important international section has been added which is described as a "Working Hall for Industrial Arts," and includes the artistic manufactures of metals and woods, and the industrial arts generally. Applications for space have to be sent in before May 31, 1905, and for the erection of detached exhibits, sales, &c., before Feb. 15, 1905. Machinery and other heavy exhibits have to reach the exhibition grounds by Dec. 1, 1905.

The population of Milan at Dec. 31 last was 513,493, and the number of tickets issued by the City Tramways Co. during 1903 reached 77,667,497.

London County Council Tramways.—Electric cars commenced running on Monday between Westminster and Tower Bridge, superseding horse cars on the whole length of Tower Bridge-road, which extends from the junction of New and Old Kent-roads to the Tower Bridge.

Londonderry.—The inauguration of electricity supply for private lighting took place on Thursday last.

The Corporation are promoting a bill for the extension of the borough boundaries, for additional electric lighting powers, &c.

Lourenco Marques.—The progress made with the extensive new harbour works here includes the erection and working of electric cranes (of German manufacture) and Temperley transporters for handling cargo. The construction of an electric tramway under a concession secured by a British company has reached completion. The company owning this concession has also acquired the interests of the existing telephone companies.

4½ tons of "telegraph material" were imported in 1903, all from the United Kingdom.

Lynn.—Sanction to a loan of £2,756, out of £2,834 applied for, has been obtained by the Council.

Mexico.—In 1902 3 electric lighting apparatus and accessories were imported from the United Kingdom into Mexico to the value of £48,886, comparing with only £1,536 in the previous year and £571 in 1900-1.

The electric lighting company which supplies current for lighting and power in Mérida (Yucatan) is a German undertaking.

The importance of the Mexican markets to British manufacturers has often been stated, and in a report recently issued by Mr. Consul Leay, judicious advertising in Mexican journals is recommended as a means of pushing British-made goods. It is pointed out that the American trade journals are sent broadcast throughout Mexico by the manufacturers of that country. Mr. Leay further recommends that correspondence where possible should be conducted in Spanish and values expressed in gold dollars (5 = £1 sterling). Mr. Leay's report is interesting reading, and is published price 3d., post free 4d.

It may be added that the Mexican Government are about to establish an Information Department in London.

Montrose (N.B.).—Mr. A. Cameron will move at the next meeting of the Council that the question of the purchase of the Angus Electric Light & Power Co.'s undertaking be considered by a committee.

Nagasaki (Japan).—In the imports from the United Kingdom for 1903 into Nagasaki are included electrical machinery and motors £3,589 and submarine cables and underground telegraph wires £22,257.

Natal.—A bill has passed the Natal Legislature authorising the Corporation of Pietermaritzburg to contract a loan of £150,000 on account of electricity supply and £50,000 for tramway extensions.

Newcastle-on-Tyne.—Mr. A. E. Le Rossignol has resigned his position of engineer and manager of the Corporation tramways.

Newport.—On Tuesday the Tramways committee recommended that Mr. G. H. Winsor, tramways traffic inspector, be asked to resign and be paid three months' salary from date of resignation.

Mr. HUNT objected to the recommendation, and asked why, if Mr. Winsor was in the wrong, they proposed to give him three months' salary?

Ald. MORDEY contended that it was most improper for Mr. Winsor to make complaints about the cars, &c., to members of the committee before pointing out the alleged faults to the borough electrical engineer and tramways manager (Mr. H. Collings Bishop).

Ald. GOLDSWORTHY said when two officials could not work together, and the work of the Corporation suffered, it was time for one to go.

Ald. GREENLAND said the fact was that Mr. Winsor, who was manager of the tramways when they were worked by horses, thought he was

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capable of managing the whole concern now the service had been converted to electric traction. Mr. Bishop was an expert electrical engineer, and yet Mr. Winsor went over his head and made complaints to the committee.

The Chairman of the Tramways committee (Mr. W. H. BROWN) said that if the recommendation was not accepted the committee would not be further responsible for the tramway undertaking. The reason why the committee recommended that Mr. Winsor should be paid three months' salary was because his dismissal was not due to incompetence.

By 18 votes to 11 the committee's recommendation was adopted.

Messrs. Cordes (Dos Works), Ltd., who require electrical energy for power (estimated at 1,400,000 units per annum), have asked the Electricity committee for special terms, but the committee are unable to entertain the offer at less than the scale rate for power.

Ormskirk.—An unsuccessful attempt was made at the meeting of the Council on Wednesday to rescind a former resolution to enter into an agreement with the National Electric Construction Co. for the erection and maintenance of electricity works.

Paignton.—The Council have asked Mr. J. Enright to advise them as to the selection of a site for an electricity generating station.

Paisley.—The Council decided on Tuesday to increase the salary of the burgh electrical engineer (Mr. C. F. Parkinson) to £400 per annum.

Paraguay.—Senor J. Lapido, of Monte Video, is seeking an electric lighting concession for Asuncion.

Pembroke (Dublin).—The Local Government Board have declined to extend the period allowed for the repayment of the loan (£25,000) sanctioned for extending the electric lighting undertaking from 27 to 37 years, and a deputation has been appointed to wait on the Board to urge them to grant an extension of the period in similar manner to the recent case of Dublin Corporation.

Perth.—A meeting of the Tramway Reconstruction committee was held on Thursday last week to consider the report of the consulting engineers (Messrs. Kincaid, Waller, Manville & Dawson) on the tenders recently submitted for the reconstruction and electrical equipment of the tramways. No decision was arrived at by the committee.

Pontypridd.—The Council have decided to appoint a resident electrical engineer.

Poplar (London).—Last week the Electricity committee reported upon the dismissal of an employé at the electricity works, and recommended that the question be discharged.

Ald. SUMNER moved, as an amendment, that the man be reinstated.

Ald. WHITE said he did not think they would uphold their dignity by reinstating the man.

The amendment was lost by 22 votes to 15.

Councillor LANSBURY then moved that the report be referred back, with instructions that on the man apologising other work be found for him.

On being put to the vote this amendment was carried.

Portpatrick (N.B.).—The formal inauguration of electricity supply took place on Monday.

Portsmouth.—On the recommendation of the Electric Lighting committee the salary of the engineer and manager of the electricity department (Mr. W. S. Foale) has been increased from £325 to £400.

Presentation.—Mr. Wm. A. Brown, distributing engineer of St. Pancras, was presented by his colleagues, on Friday evening last, with an oak spirit cabinet on the occasion of his marriage.

Pudsey (Yorks.).—An inquiry was held here on Tuesday into the application of the Council for sanction to borrow £5,000 for electric lighting.

It was explained that electricity in bulk would be supplied by the Yorkshire Electric Power Co., and the Council would distribute. £3,000 is to be spent on cables, &c., leaving £2,000 for extensions. The company's generating station is at Thornhill, near Dewsbury, between 8 and 9 miles distant, and the company is to join their mains up to the Pudsey transforming station at their own cost. Judging from the applications for current, the Corporation calculate that they can make the undertaking a paying concern. Evidence was given by the town clerk (Mr. B. Dulton), by the consulting electrical engineer (Mr. T. S. Watney), by the mayor (Ald. M. Walker), by the chairman of the Electric Lighting committee (Councillor Vickers), &c. There was no opposition.

Reading.—The Corporation have instituted a system of parcel delivery in connection with their tramway department.

Rhyl.—In forwarding sanction to borrow £2,610 for electric lighting extensions the Local Government Board state that before sanctioning any further loans they will require a detailed statement as to how the amount previously sanctioned has been expended.

Saffron Walden.—An inquiry was held here last week into the application of the Council to borrow £9,950 for electricity supply works.

The town clerk (Mr. W. Adams) stated that an arrangement had been made with Messrs. Foote & Milne for erecting and running the works for 14 years, when the undertaking would be transferred to the Council.

St. Anne's-on-the-Sea.—The electrical engineer (Mr. J. H. Clothier) reports that 175,030 units were sold in the first half of the current year, compared with 104,489 in the corresponding period last year. At July 31 there were 268 consumers, against 194 12 months previously.

School Lighting.—The lighting of Byron-road school, Gillingham, by electricity in lieu of gas has been referred to the School Management committee for consideration.

Southwark (London).—The Council decided on Wednesday to advertise for a chief engineer and manager of their electric light undertaking at a salary of £300, rising by annual increments of £20 to £400.

In the course of the discussion on the subject, Councillor CHELL moved that the matter be referred back for further consideration, and argued that they did not want an electrical engineer to manage the concern, but a commercial man who would go out and canvass for customers, whilst a mechanical man should manage the electric light station.

Ald. BOYD warmly supported the suggestion of Councillor Chell. They did not want an electrical engineer, he said, with a lot of letters after his name, but a good business man to manage the concern outside the station, and a smart mechanical engineer to manage the station itself. Properly speaking, he said, there was no such thing as an electrical engineer. Any person of ordinary intelligence could read up in a month all that an electrical engineer knew. There was nothing in it. It was all a lot of theory. What they wanted was a good mechanic to supervise the station.

Councillor ATTENBOROUGH said he did not think it was any good for the Council to issue advertisements for a qualified electrical engineer. The Council had treated the late chief of their electric lighting department (Mr. Blaikie) so disgracefully that no member of the Institution of Electrical Engineers would be likely to apply for the post.

Councillor HILL advised the representatives of St. George's, Christchurch, and St. Saviour's, in which parishes the Newington electric lighting order does not run, not to take any part in the voting, but to leave Newington to "stew in its own juice."

Ultimately the committee's recommendation to advertise for a chief engineer and manager was carried.

Stockport.—Negotiations have been re-opened for the purchase by the Corporation of the lines of the Stockport and Hazel Grove Tramway Co. The company ask £24,000, and the Corporation have offered £23,500.

Sunderland.—On the recommendation of the Tramways committee, the Corporation decided on Wednesday to adopt top covers for the tramcars. The work is to be done by the tramway staff, and machinery is to be purchased for making the covers at a cost of £50.

In reply to the mayor, the chairman of the Electricity committee (Ald. Bruce) said that the machinery which the committee were advertising for sale was not old or obsolete. It was only a small quantity, and was part of the original installation in the Dunning-street station. It was excellent plant for a small concern, but in a business as large as that of the Corporation it was scarcely worth standing room. If it were retained it would have to be changed over from 110 to 220 volts, but the committee hoped to sell it at no loss to the Corporation.

It was agreed that for the purpose of meeting the increased demand for power at Messrs. Doxford's shipyard, alterations and extensions of plant should be made at Hylton-road station at an estimated cost of £3,000.

Swindon.—It has been decided to supply electric energy to the tramways at 2½d. per unit until March next, when the charge will be reconsidered.

The electrical engineer (Mr. J. G. Griffin) is to report upon the advisability of providing additional tramcars.

On the recommendation of the electrical engineer it has been decided to allow local wiring contractors to hire out the Corporation's testing instruments at a charge of 2s. for the first hour and 9d. per hour for every subsequent hour, subject to conditions to be prepared by Mr. Griffin.

Swinton and Pendlebury.—The chairman of the Tramways and Electricity committee (Mr. Pownall) announced at the meeting of the Council on Monday that negotiations were proceeding with the Lancashire Electric Power Co. for the supply of electricity in bulk, and he hoped the district would soon have the advantage of electricity supply.

Telephonic Communication at the Dockyards.—It is stated that the Admiralty propose to establish telephonic communication at the various dockyards, the latter being also put into communication with the Admiralty.

Tottington.—The Council will not oppose the application of the Lancashire Electric Power Co. for a provisional electric lighting order.

Tramway Bye-Laws.—A modification of the draft bye-laws for regulating the Wakefield and district tramway traffic has been agreed upon at a conference of representatives of Wakefield Corporation, the Wakefield and District Light Railways Co. and the Board of Trade. The amended bye-law as to excess passengers reads:—

That during inclement weather, and on public holidays and such other times as the Council may specify, any number of passengers, not exceeding eight in excess of the number for whom sitting accommodation is pro-

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vided as aforesaid, may, with the express permission in each case of the conductor of the car, first obtained, stand in such part of the interior of such car as the said conductor may direct.

Tramway Provisional Orders.—The report of the Board of Trade as to their proceedings under the Tramways Act, 1870, during the 1904 session states that

The number of applications was 15, all except two being promoted by local authorities. Twelve of the orders included power to construct new or extension tramways, the remaining three being to continue powers. (A full list of the applications for orders appeared in *The Electrician* for Jan 8 last.) The aggregate length of the proposed tramways was 6 miles 72 chains of double line and 28 miles 30 chains of single line, and the estimated expenditure was £307,380. The Folkestone and Penarth applications were not proceeded with. Thirteen applications were granted by the Board, and the provisional orders made were included in two Confirmation Bills, which were introduced into the House of Lords on May 3. In the House of Lords the Altrincham and Calverley Orders in No. 1 bill were petitioned against by the Manchester South Junction and Altrincham Railway Co. and two frontagers, but opposition was removed by the insertion of agreed amendments. The following orders in No. 2 bill were petitioned against —viz. (1) Bishop Auckland, Shildon and Spennymoor Order by N.E. Railway Co.; (2) Dewsbury Order by G.N. Railway Co. and the Yorkshire Electric Power Co.; and (3) Ossett Order by G.N. Railway Co. and Yorkshire Electric Power Co. The opposition of the N.E. Railway Co. to the Bishop Auckland, Shildon and Spennymoor Order and of the G.N. Railway Co. to the Dewsbury and Ossett Orders was unsuccessful. The petition of the Yorkshire Electric Power Co. against the Dewsbury and Ossett Orders resulted in their amendment by the Select Committee. In the House of Commons the Dewsbury and Ossett Orders in No. 2 bill were petitioned against by the G.N. Railway Co., but the opposition was withdrawn on the insertion of agreed amendments. No. 1 bill was unopposed. Both bills received Royal assent on Aug. 15.

Tunbridge Wells.—Early in 1904 Mr. Horace Boot, the Corporation consulting and resident engineer of Tunbridge Wells, prepared a report on the municipal electricity undertaking with special reference to the supervision of electric lamps. It is pointed out in the report that incandescent gas lighting has made some progress in the municipal area, and Mr. Boot suggests that if the Corporation will enable the electricity department to compete with the gas company on the same terms this competition can easily be neutralised or overcome. The electricity works are equipped with a first-rate modern plant, efficient and economical in working, so that all that is required to overtake any loss occasioned by competition with incandescent gas is that the department should come into more intimate touch with consumers. To this purpose Mr. Boot recommends that particular attention should be given to the following points:—

1. The supply and maintenance of consumers' lamps. This is most important, and the advantages to be derived would be: (*a*) An efficient and satisfactory light, (*b*) the use of good and economical lamps, (*c*) advice with respect to economising or installing additional lamps, (*d*) the means by which a consumer can reduce his bill, (*e*) the undertaking will be in constant touch with consumers.

2. The department should endeavour to obtain powers to wire property, particularly leasehold, as it is difficult to persuade leaseholders to spend their money on wiring houses or shops for the landlords' benefit when they leave.

3. Powers should be obtained to purchase electric motors, electric heating radiators and cooking apparatus and to let same out on hire.

4. Powers should also be sought for to extend the area of supply, as it would then tap districts where gas is more expensive than in Tunbridge Wells.

The following particulars show the progress of the Tunbridge Wells undertaking:—

	Capital.	Income from private consumers.	Units sold to private consumers.
1897	£23,923 8 6	..... £3,422	 174,053
1898	31,275 0 6	 4,740	 194,763
1899	37,817 18 7	 5,971	 249,627
1900	42,843 6 2	 6,767	 332,273
1901	56,012 13 3	 7,592	 374,220
1902	65,934 10 1	 8,910	 447,403
1903	71,465 17 0	 9,242	 475,961

Twickenham.—The Council will not consent to the erection by the Twickenham & Teddington Electric Supply Co. of a cooling tower at the electricity station, or enter into any agreement with reference thereto, unless the consent of the owner of the adjoining property is first obtained.

Uruguay.—Electricity supply works are to be established at Fray Bentos.

Valuation of Electricity Works.—A valuation appeal court for the burgh of Hawick was held on Monday, when the Urban Electric Supply Co. appealed against the valuation of their premises at £1,316, and asked that it be reduced to £421.

The Solicitor for the company said that this was a matter of considerable importance to his clients because they had numerous stations, and probably might have more, in Scotland. He submitted that the wiring department was no part of the electrical plant, and he also desired that an average annual sum should be allowed for repairs instead of what was actually expended.

The assessor (Mr. Scott) said that the wiring department was part and parcel of the business. Their profit was stated at £2,142, which included the wiring account, and that account was in the same position, for instance, as a gas company whose balance-sheet included such items as sale of gas tar, lime, &c.

After discussion, the assessor agreed provisionally to take out the wiring account on the estimated amount for repairs being taken out, and the basis of assessment fixed at five-twelfths on mains and seven-twelfths on works. The Court was adjourned sine die with a view to adjustment.

Victoria Falls Electric Transporter.—Early last month the electric conveyor started running on the cableway over the Zambesi, which is to be used in connection with the construction of the permanent railway bridge. The conveyor, which weighs 6 tons, is designed to carry a maximum load of 10 tons, and is operated by a 30 H.P. electric motor, which takes current from a bare copper conductor. The contractors for the erection of the cableway were the Cleveland Bridge & Engine Co., Darlington.

Wandsworth (London).—The General Purposes committee have been authorised to engage an electrical engineer to prepare specifications for wiring the Council House and for the ventilation of the chamber by electric fans.

Willenhall.—The clerk has been instructed to serve notice on the Midland Electric Corpn. for Power Distribution, requesting them to lay down distributing mains for general electricity supply throughout the whole of the streets in the area of the Willenhall Urban District Council, and, if necessary, to enter into an agreement with the corporation for the supply of electricity for street lighting for three years. The clerk is, further, to serve notice upon the gas company to determine the present agreement as to public lighting.

Wisbech.—An inquiry was held here last week into the application of the Council for permission to borrow £25,000 for electricity supply.

Mr. Ellis Griffith, for the Council, gave an outline of the steps taken to establish electricity supply and technical details of the scheme were supplied by Mr. G. W. Spencer Hawes (Messrs. Robert Hammond & Son, consulting engineers). The scheme provided for the erection and maintenance of works for 25 years by the National Electric Construction Co. Evidence in support of the application was given by the borough surveyor (Mr. A. H. Plowright), the manager and secretary of the National Electric Construction Co. (Mr. W. B. Cownie), the mayor of the borough (Mr. H. C. Elgood) and the chairman of the Electric Lighting committee (Mr. Southwell). There was considerable opposition, all parties being legally represented.

Wood Green (London).—The following letter has been received by the District Council from the Local Government Board relative to their recent application for sanction to an electric lighting loan:—

I am directed by the Local Government Board to state that they have had under consideration the report made by their inspector, Mr. Hooper, after the inquiry held by him with reference to the application of the Urban District Council of Wood Green for sanction to borrow £43,200, since increased to £43,570. The Board have very carefully considered all the information placed before them by the District Council, and it appears to them, upon that information, to be extremely doubtful whether the scheme, if carried out, would be likely to prove a financial success. The evidence given as to the probable demand for current was of an unsatisfactory character, for it was first stated that the demand was estimated to be equivalent to 330 consumers at 60 8 c.p. lamps per house; but when it was pointed out, and admitted by the engineer, that the number of lamps estimated for was far too high considering the class of property to be supplied, the estimate of the demand was altered to 660 consumers at 30 8 c.p. lamps per house. It does not clearly appear in what manner either estimate has been arrived at. The Board consider that the District Council, before undertaking a scheme of the magnitude proposed, should obtain more reliable information as to the extent to which the electric light is likely to be taken up. Moreover, the Board are by no means convinced by the evidence submitted to them that the District Council are acting prudently and in the best interests of their district in proposing to erect a generating station for the supply of electricity, and they think that the whole question, including methods of supply, should be reconsidered by the District Council. Noel Kershaw.

Wrexham.—Rhos Parish Council have decided to support the proposal to extend the electric tramways to Rhos, and a committee has been appointed to approach the Wrexham District Electric Tramways (Ltd.) to further the project.

Yarmouth.—The question of constructing electric tramways from Southtown bridge through Gorleston, including the erection of a car shed and the purchase of 10 cars at an estimated cost of £46,762, is to be discussed by the Council on 30th inst.

Negotiations with the National Telephone Co. as to placing the company's lines underground are proceeding.

York.—Negotiations for the purchase of the undertaking of the City of York Tramways Co. have been re-opened.

Zante (Greece)—The electric lighting of this city was inaugurated last year, and owes its introduction to the Mayor of Zante. The station is, on the whole, working in a satisfactory manner.

Sports.—An excellent programme has been prepared for the athletic sports of the Brush Athletic Club, which will take place to-morrow (Saturday) on the Rugby Football Ground, Meadow-lane, Loughborough, commencing at 2 p.m. Lady Vaux of Harrowden will present the prizes, which are numerous. A military band will perform a selection of music on the ground.

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TRADE NOTES AND NOTICES.

TENDERS INVITED.

Ilford District Council invite tenders for supply and erection of balancer and switchboard panel, reversible traction booster and switchboard panel. Specifications, &c., from the clerk, Mr. J. W. Benton, Town Hall, Ilford, after 19th inst. Further particulars from the electrical engineer (Mr. Arthur H. Shaw), electricity works, Ley-street, Ilford. Tenders (addressed to chairman of Council) by noon Oct. 4. See also advertisement.

Edmonton District Council are desirous of entering into an arrangement with a company for the exercise of powers under their provisional order. Particulars and forms of tender of the clerk (Mr. W. F. Payne), Town Hall, Edmonton, to whom tenders by noon Sept. 27.

Tenders are invited by the *Postmaster-General* until noon of Sept. 26 for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles. Forms of tender from the controller of stores (Mr. S. C. Hooley), Stores Department, G.P.O., 17-19, Bedford-street, London, W.C.

Edinburgh District Lunacy Board require tenders by 28th inst. for wiring their existing and projected buildings at Bangour for lighting, telephones and bells. Particulars from the architect (Mr. H. J. Blanc), 25, Rutland-square, Edinburgh.

Leyton District Council invite tenders for the electric wiring and fittings required at Newport-road School, Leyton. Tenders to be delivered at meeting of Education committee at 7 p.m. Sept. 23.

Tynemouth Corporation invite tenders for a 600kw. steam dynamo. Tenders to the town clerk (Mr. Horatio A. Adamson) by first post Sept. 30.

Aberdeen Tramways committee invite tenders for 20 top-deck car covers. Tenders to city electrical engineer (Mr. J. Alex. Bell), electricity works, Millburn-street, Aberdeen, by Sept. 27.

Limerick Electric Lighting committee require tenders for cast-iron tank, electrically-driven pump, pipe valves, &c. Specifications, &c., after 17th inst. from the town clerk.

Burton-on-Trent Corporation want tenders by noon of 22nd inst. for steam exhaust and circulating pipes, &c.

Salford Electricity committee invite tenders (until Oct. 6) for paper-insulated cables.

Hackney (London) Council invite tenders by 29th inst. for 55,000 pairs of arc lamp carbons.

Erith District Council invite tenders by noon of Oct. 3 for erection of car-sheds, workshops and offices.

The Secretary of State for India in Council invites tenders by 2 p.m. 27th inst. for supply of rails and fishplates, spikes and dogs and electric power and hand-power cranes. Particulars from Director-General of Stores, *India Office*, London, S.W.

Tenders are invited by *Shanghai* Municipality for the construction and working of 24 miles of electric tramways on the trolley system, double or single. Conditions of contract, plans, &c., may be seen on application to Messrs. J. Pook & Co., 63, Leadenhall-street, London, E.C. Tenders by March 31 next.

Tenders will be adjudicated on Oct. 12 for the construction and working of a system of public electric lighting for the town of *Espinar* (Segovia, Spain). Particulars and conditions are obtainable of the Alcaldia Constitucional, Espinar.

Tenders are required by Jan. 15 by the municipality of *La Paz* (Bolivia) for concession for electric lighting for 12 years.

TENDERS RECEIVED AND ACCEPTED.

The tender of Hughes & Stirling (the lowest received) has been accepted by Bootle Corporation for alteration of and additions to offices and stores at electricity works. The Electric Power and Lighting committee recommended the higher tender of a local firm (G. H. Woods & Son) for acceptance, but the recommendation was not adopted.

Salford Council have accepted the following tenders:—

Geo. Leek & Sons, iron castings; Heap & Co., wiring Pendleton Town Hall, &c., £19. 10s.; Rock Bronze (Ltd.), trolley heads and trolley wheel globes.

Hackney (London) Electric Lighting committee has placed an order for cables with the British Insulated & Helsby Cables (Ltd.) at £1,200.

Hove Corporation have accepted the tender of the St. Helens Cable Co. for supply and laying of low-tension cables, conduits, boxes and meters at £7,113. 8s. 8d.

Colchester Town Council have accepted the tender of Davey, Paxman & Co. for the supply and erection of two boilers at £950. 10s.

Ipswich Guardians received five tenders for wiring the Union offices, and that of Martin & Newby has been accepted.

Plymouth Town Council have accepted the tender of W. J. Corse & Co. for wiring the Western Law Courts at £89. 10s.

Southport Electrical committee have placed an order with James Proctor (Ltd.) for a mechanical stoker at £219.

Dorking Council have accepted the tender of C. Lakin-Smith for wiring the baths.

Belfast Corporation have accepted the tender of R. Laidlaw & Son for cast-iron spigot and socket pipes.

Swindon Town Council have accepted the tenders of Dempster, Moore & Co. and Pollock & Macnab for tools for the tramcar depot.

BUSINESS NOTICES.

Messrs. Ed. Bennis & Co. (Ltd.) have removed to their new works at Little Hulton, Bolton, where all communications should be addressed. Messrs. Bennis' telegraphic address is "Bennis Little Hulton," telephone 13 Farnworth. The firm's London address remains at 28, Victoria-street, Westminster, S.W., telegrams "Bennis London."

W. T. Henley's Telegraph Works Co. (Ltd.) have transferred their Argentine agency from the Cia. de Fabricantes Extrangeros to Messrs. Buxton, Cassini & Co., 454, Calle Cuyo, Buenos Ayres.

Mr. F. S. Worsley, who was about eight years with Messrs. Johnson & Phillips, and for the last 5½ years head of the manufacturing and technical branch of the Brockie-Pell Co. has joined the staff of Veritys Limited as manager of their arc lamp department. We understand that Messrs. Veritys have given Mr. Worsley complete control and the reorganisation of their arc lamp manufactures. This firm are putting on the market for the coming winter a new enclosed lamp for which simplicity and excellence of design is claimed. This lamp is for either alternating or continuous-current circuits. Messrs. Veritys are also supplying a twin-carbon enclosed lamp, which, like the other lamps above mentioned, are from Mr. Worsley's design.

Messrs. William James and Wm. St. Just Clarke (trading as W. S. Clarke & Co.), electrical engineers and instrument makers, 174, Pentonville-road, E.C., and 16, Camden-road, N.W., London, have dissolved partnership. Debts received and paid by Mr. W. St. Just Clarke at 16, Camden-road.

Messrs. G. F. Matthews and A. H. Spalton, electrical and mechanical engineers, 64 and 80, West-street, Sheffield, have dissolved partnership. Debts of the mechanical department by Mr. Spalton and of the electrical department by Mr. Matthews. The entire undertaking will be continued by Mr. Matthews as "Matthews & Spalton."

BANKRUPTCIES, LIQUIDATIONS, &c.

At Leeds Bankruptcy Court on Tuesday, James William Hunter, 8, Norwood-road, and Albert Clapham, 289, Kirkstall-road, trading at 101, Kirkstall-road, Leeds, as the Yorkshire Motor Car & Electrical Engineering Co., should have come up for public examination. Only Clapham appeared. Liabilities £3,415, deficiency £1,367. 14s. 8d. Hunter has absconded, and Clapham alleges as the cause of failure his partner's conduct in disposing of goods and absconding with money and goods. Debtors commenced business in January, 1904. Clapham had no capital, and Hunter's capital seems to have consisted of a block of four houses at Bradford, the bank holding the deeds for an overdraft of £682. After a few months execution was put in. At a meeting of creditors a composition of 5s. was rejected, and it was resolved that debtors should be required to file their petition. The deficiency was explained by bad debts (£70. 14s. 5d.), money and goods abstracted by Hunter (£845. 19s. 7d.) and depreciated stock (£457). Examination adjourned.

Mr. W. H. Platts, 1, Oxford-row, Leeds, has been appointed trustee in the above failure.

H. B. Binko, electrical engineer, 34, Leadenhall-street, London, E.C., has been adjudicated bankrupt.

Electrical Stores for Sale.—Messrs. Horne & Co., 8, Delahay-street, Storey's-gate, London, S.W., will sell by public auction (by order of the Secretary of State for War) at the Royal Arsenal, Woolwich, on Sept. 22, at 11 a.m., a quantity of old and obsolete stores, including electrical stores, electric cable, gutta-percha, tools, metals, &c. Further particulars are given in an advertisement. Catalogues at the War Office, Pall Mall, London, S.W.; at the Ordnance Office, the Tower, E.C., and at the Ordnance Office, Royal Arsenal, Woolwich.

Plant for Sale.—Messrs. Neil McLean & Co., 227, Main-street, Gorbals, Glasgow, have for sale some electric lighting plant, including five Edison-Hopkinson, three Siemens, one Kapp and some Brush dynamos, and steam engines by Galloways, Marshall and other makers. See also advertisement.

Mr. M. M. Henderson, 4, Stirling-street, Airdrie, N.B., has electric lighting plant for sale. See advertisement.

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Advertising Sheets.—We referred in our last issue (p. 851) to an excellent example of illustrated work issued by the Electric Construction Co., London and Wolverhampton. We have made a reduction from this large hanging sheet, which we print below.

This will do more to acquaint the trade with the artistic character of the company's advertising sheet than much letterpress.

A New Ammeter.—Messrs. Nalder Bros. & Thompson, 34, Queen-street, Cheapside, London, E.C., have recently placed on the market a new cheap type of ammeter. Fig. 1 shows the general appearance of the instrument, which is constructed on the soft-iron principle. The makers inform us that special precautions have been taken to ensure that the instrument is thoroughly suitable for direct or alternating currents, and to guard against any errors due to variation in periodicity or wave-form. The instrument is completely screened, and is fitted with a modified form of air damping, making it practically dead beat. Fig. 2 illustrates this damping arrangement. It is claimed that the square form of damping chamber has

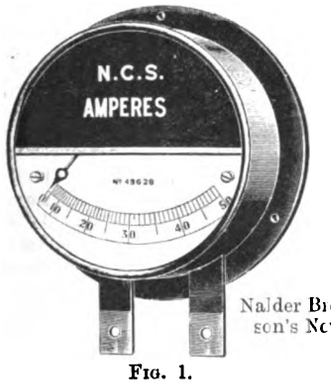
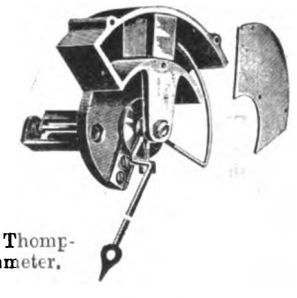


Fig. 1.



Nalder Bros. & Thompson's New Ammeter.

Fig. 2.

the advantage that the top can at any time be removed and the instrument inspected.

New Editions.—Messrs. Charles Griffin & Co. will publish in a few days the 6th edition of Prof. Jamieson's "Manual on Applied Mechanics." The 14th enlarged and revised edition of Prof. Jamieson's text book on "Steam and Steam Engines," is also in the press.

Messrs. Harper & Bros. are publishing in a few days "The Diseases of Electric Machinery" (1s. 6d. net) by Mr. C. Kinzbrunner, Manchester School of Technology. The book is designed to assist those who have charge of electric generators or motors.

Testing Laboratory Fees.—We have received from the Westminster Electrical Testing Laboratory, York Mansion, York-street, Westminster, London, S.W., a revised scale of fees for testing all classes of lamps, accumulators, measuring instruments, safety devices, resistances, wires, alloys, insulating materials, machinery, plant and apparatus, &c., carbons, coal, oil and water, the inspection of installations, and other expert work for which the laboratory has been specially equipped with all necessary modern laboratory apparatus. Copies of the new scale of fees can be obtained on application.

Catalogues, &c.—The Cambridge Scientific Instrument Co. have prepared for publication a comprehensive catalogue and textual description of electrical resistances, thermometers, thermo-electric thermometers, continuous-current temperature recorders, &c., under the title of "Technical Thermometry." The pamphlet illustrates a large variety of apparatus manufactured by the company, and is in reality a revised edition of a catalogue issued some time ago entitled "The Measurement of Temperature by Electrical Means." We are asked to state that the company will be pleased to send a copy of the pamphlet (No. 25) on request.

Electric hoists, winches and capstans for direct or alternating currents are listed by the C. W. Hunt Co., Staten Island, U.S.A., and a number of special types of these machines are illustrated in a pamphlet to hand.

A new list (B) of J.P. direct-current electric motors is issued by Messrs. Johnson & Phillips. These motors are built on a uniform plan from ¼ H.P. up to 100 H.P. to the British standards issued by the Engineering Standards Committee.

Switch fuses for pressures up to 500 volts are described, priced and illustrated in a sheet list issued by Ernest F. Moy (Ltd.), Camden Town, London, N.W.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Sept. 7 to 13, with the ports of destination:—

Africa—Alexandria, £155; Cape Town, £2,130 (including £2,113 telegraph material); Delagoa Bay, £37; Durban, £2,429 (including £550 telegraph material); East London, £15; Port Elizabeth, £60; Suez, £47 (telegraph material). *Argentina*—Buenos Ayres, £28. *Australasia*—Adelaide, £46; Melbourne, £216; Otago, £175; Sydney, £484 (including £225 telegraph material); Wellington, £47. *Belgium*—Ostend, £180 (including £100 telegraph material). *Brazil*, £135 (telegraph material); *Burma*—Rangoon, £12. *Canada*—Montreal, £60; Toronto, £540 *Ceylon*—Colombo, £72 (including £50 telegraph material) *Colombia*—Santos, £98 (telegraph apparatus). *Cuba*, £226 (including £60 telegraph material). *France*—Rouen, £18. *Germany*—Hamburg, £35. *Gibraltar*, £510 (telegraph wire). *Holland*—Amsterdam, £35; Rotterdam, £1,018 (including £1,000 telegraph cable). *Hong Kong*, £12. *India*—Bombay, £297; Calcutta, £505. *Japan*—Nagasaki, £1,470; Tokyo, £6,760; Yokohama, £912. *Norway*—Christiania, £19. *Russia*—Helsingfors, £47 (telegraph material); St. Petersburg, £150 (telegraph cable). *Straits Settlements*—Singapore, £8,450 (including £7,010 telegraph material). *Sweden*—Stockholm, £80 (telegraph wire). Total, £27,510 against £12,553 in the corresponding week last year (Sept. 9 to 15).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

July 16, 1904.

15,869 Siemens Brothers & Co. (Siemens & Halske A.G., Germany). Electrically operating railway points.*

15,872 G. Viarmé. Arc lamps.

15,874 H. Ruppert. Electrical fire extinguisher.*

15,879 A.E.G. Alternating-current meters. (Date applied for, July 17, 1903, date of application in Germany.)*

July, 18, 1904.

15,932 M. Sommer. Incandescent lamps.

15,942 Union Elektricitäts-Gesellschaft. Alternating-current electricity meters. (Date applied for, July 18, 1903, date of application in Germany.)*

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15,952 K. L. Berg. Electrode for accumulators. (Date applied for, July 18, 1903, date of application in Sweden.)*

July 19, 1904.

15,981 M. G. Brownell. Telephone directories.*
16,026 E. A. Carolan (G.E. Co., U.S.). Vapour electric apparatus.

July 20, 1904.

16,038 B. Brander. Germany. Telephone system.
16,059 T. W. S. Hutchins. Manchester. Generation of electricity for electric lighting of trains.
16,063 J. J. Smith. Stockton-on-Tees. Electric safety fuses.
16,108 B.T.-H. Co. (G.E. Co, U.S.). Alternating-current electric motors.
16,109 B.T.-H. Co. (G.E. Co., U.S.). Reverse-current switches.
16,110 B.T.-H. Co. (G.E. Co., U.S.). Electromagnetic mechanism.
16,113 L. Calvert and W. A. Snape. Treating incandescent lamp filaments to increase their density and also the density of the carbon deposited upon them during flashing.

July 21, 1904.

16,155 H. Curwen. Newcastle-on-Tyne. Economising space over the third-rail.
16,161 F. Thomas. Electric candle nozzle.
16,166 T. M. Trumble and J. P. Trumble. Surface-contact systems.
16,169 D. D. Esson and A. Cruikshank. Mechanism actuated by radium and the like.
16,171 J. T. McCoy. Prevention of injury by contact with "live" rails.
16,179 J. S. Peck and C. L. G. Fortescue. Transformers. (Date applied for, Aug. 8, 1903, date of application in U.S.)*
16,205 A. Endelmann and N. Wallin. Electric furnaces and the extraction of zinc by same. (Date applied for, July 23, 1903, date of application in Germany.)*
16,210 E. du Bois. Electric winding and switching mechanism.

July 22, 1904.

16,241 J. Brockie. Arc lamps.
16,242 H. Beck. Germany. Electric lights. (Date applied for, July 24, 1903, date of application in Germany.)*
16,256 and 16,257 E. Weintraub. Systems of electrical distribution. (Date applied for, July 23, 1903, date of application in U.S.)*
16,258 E. Weintraub. Transforming energy of electric currents. (Date applied for, July 23, 1903, date of application in U.S.)*
16,260 B.T.-H. Co. (G.E. Co., U.S.). Electrical controllers.
16,261 B.T.-H. Co. (G.E. Co., U.S.). Electrically heating liquids.
16,267 F. W. Gauntlett. Deposition of zinc or other metals by electricity.

July 23, 1904.

16,311 W. Andrews, F. Allcock and W. Keyworth. Electric signalling for railways.
16,312 L. H. Walter and J. A. Ewing. Detection of electrical oscillations.
16,324 S. G. Visker and P. C. Kaz. Galvanic elements or batteries.
16,326 W. McDonald. Apparatus for use in teaching telegraphic and other signalling by the Morse or similar codes.
16,340 W. C. Lea. Electric couplings.
16,346 I. B. Birnbaum and F. G. Bell. Selective switches.

July 25, 1904.

16,393 E. J. Javaux. Automatic cutout switch.
16,395 C. E. Hunter. Combined switch and lamp-holder.*
16,408 B.T.-H. Co., Warwick Machinery Co., and F. Samuelson. Electric circuit controllers especially applicable in governing elastic fluid turbines.
16,409 and 16,410 B.T.-H. Co. (G.E. Co., U.S.). Electric measuring instruments.
16,418 A. Raky. Electric winding engines.
16,422, 16,423 and 16,424 Electric Equipment & Securities (Ltd) and C. Ruzicka. Resistances.
16,425 Electric Equipment & Securities (Ltd.) and C. Ruzicka. Incandescent bodies.
16,426 F. R. Butt and H. W. Cox. Contact breakers for induction coils.
16,447 J. Y. Johnson (Voigt & Haeffner Akt.-Ges., Germany). Switches for use in pole changing.

July 26, 1904.

16,461 D. L. Crawford. Scotland. Electric locomotive.
16,479 G. W. Kretzinger. Telephone repeaters.*
16,483 J. Brockie. Arc lamps.
16,489 Humber Ltd. and S. H. Halford. Controlling electric ignition currents of internal combustion engines.
16,509 F. Drowns. Telephone directories. (Date applied for, Jan. 29, 1904, date of application in U.S.)*
16,529 M. Callow. Compressed air-cooled rheostats.

July 27, 1904.

16,578 R. Wolters. Morse telegraph transmitters.*
16,579 R. A. Gill. Liverpool. Incandescent lamps.
16,581 M. Bouchet. Binding screws or terminals. (Date applied for, Feb. 15, 1904, date of application in France.)*
16,595 S. G. Leach and E. Bergtheil. Supporting devices for electric fans.
16,601 G. Lambert. Telephone central station systems.

July 28, 1904.

16,603 A. D. Jones and Jandus Arc Lamp & Electric Co. Arc lamps.
16,608 S. H. Heywood. Manchester. Electrically operating typewriting machines.
16,613 D. J. Steele and C. Kratt. Glasgow. Electric time switches.
16,619 G. W. Somerville. Accrington. Electric ignition apparatus for exploding gases in rotary or reciprocating engines.
16,637 W. Liebert. Method of forming electromagnetic coils.
16,639 C. Smith. Switches.
16,648 Rudge Whitworth (Ltd.), J. V. Pugh and H. L. Heathcote. Electroplating.
16,653 Stothert & Pitt (Ltd.) and W. Pitt. Starting switches.
16,662 B.T.-H. Co. (G.E. Co., U.S.). Electric motor control systems.
16,663 B.T.-H. Co. (G.E. Co., U.S.). Electric meters.
16,664 B.T.-H. Co. (G.E. Co., U.S.). Starting resistances for electric motors.
16,667 W. R. Ridings. Arc lamps.
16,675 J. Phillips. Apparatus for trimming commutators.

July 29, 1904.

16,718 A. Berkshire and P. B. Walsh. Self-acting guide for trolley wheels.
16,728 A.E.G. Compounding dynamo-electric machines for three-wire systems. (Date applied for, July 31, 1903, date of application in Germany.)*
16,729 B.T.-H. Co. (G.E. Co., U.S.). Contact shoes for electric vehicles.
16,746 B. J. B. Mills. (A. Pocheron, F. Cellery & Co., France.) Electric automatic stop motion for lace machines.
16,751 H. P. R. L. Porscke and G. A. Wedekind. Accumulators.*
16,758 C. O. Bastian. Electrolytic electricity meters.
15,760 H. Gercke. Device for balancing like poles. (Date applied for, July 31, 1903, date of application in Germany.)*
16,762 G. E. Schmidmer. Joining ends of telegraph wires and the like.*
16,764 J. Y. Johnson. (Voigt & Haeffner A.G., Germany.) Switches.

July 30, 1904.

16,789 F. Edwards. Aston. Trolley wire cutout.
16,801 G. H. Freeman and B. Pearce. Birmingham. Self-restoring inter-communication telephone.
16,814 D. Perret. Electric installation for transmitting the time. (Date applied for, Aug. 11, 1903, date of application in Switzerland.)*
16,815 J. Geyer. Germany. Armature-connection for motor electricity meters.*
16,820 J. B. J. Sullin. Electric winding for clocks and other chronometrical instruments with or without clockwork.*
16,837 J. Y. Johnson. (Hartmann & Braun A.G., Germany.) Connections for electric conductors more especially intended for use with "earthed" pipes.

August 2, 1904.

16,842 G. W. Owen. Lancashire. Convertible electric cable connecting box for twin and single-cored or wired waterproof cables.
16,846 J. G. Statter. Time element devices applicable to electric circuit breakers and other apparatus.
16,853 G. Wright. Nottingham. Signalling for electric tramcars and the like.
16,871 C. R. Underhill. Receiving telegraph instruments.*
16,875 F. Cochrane. Chesbire. Indicating stopping places of electric cars by day and night.
16,879 C. M. Holmquist. Semi-reclining electric light bath.
16,884 E. M. Ginders. Birmingham. Safety cable and suspender for the transmission of electric currents.
16,894 Siemens Brothers & Co. and L. M. G. Ferreira. Electrically indicating the position of railway signals, points or other gear.*
16,910 A. F. Spooner (Magnetic Ore Separating Co. Proprietary (Ltd.), Victoria). Wet magnetic ore separators.
16,932 E. Kramer. Electromagnetic brakes for vehicles. (Date applied for, August 7, 1903, date of application in Germany.)*

August 3, 1904.

16,964 G. Hill. Cheshire. Lighting and extinguishing gas by electricity.
16,968 W. E. Cook. Manchester. Enclosed arc lamp.
16,978 C. R. Underhill. Electrical signalling.
16,985 F. de Z. Bermudez. Arc lamps.
17,000 E. Tyer, F. T. Hollins and F. W. Leake. Electromagnetic relays.
17,001 P. Delafon. Voltaic cell or element.
17,016 and 17,017 B.T.-H. Co. (G.E. Co., U.S.). Electric motor control systems.
17,018 B.T.-H. Co. (G.E. Co., U.S.). Electro-pneumatic control systems.
17,019 B.T.-H. Co. (G.E. Co., U.S.). Alternating-current motors.
17,020 B.T.-H. Co. (G.E. Co., U.S.). Emergency devices for brake systems.
17,021 B.T.-H. Co. (G.E. Co., U.S.). Electric motor control systems.
17,022 B.T.-H. Co. (G.E. Co., U.S.). Electricity meters.
17,023 B.T.-H. Co. (G.E. Co., U.S.). Switches.
17,024 B.T.-H. Co. (G.E. Co., U.S.). Controllers for electric circuits.
17,029 R. Shaw. Guards for trolley wheels.
17,041 S. Garlake (W. R. Portingale and H. W. Godwin, Cape Colony). Insulators for telegraph and other wires.
17,043 S. A. Bhisey. Electric bells, indicators and domestic telephones.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

20,163 Bloxham (Dillan). Treatment of liquids with ozonised air or other gaseous ozone mixtures.
21,742 Watters. Ships' telegraphs.

1904.

8,414 Gibbs. Safety devices for electric railways.
12,439 Hubber and Higgs. Electric fire alarm and signalling apparatus.
12,449 Reiss and Klemm. Small motor for alternating current.
13,724 Duntley. Electric drills.
13,758 Hubbell. Portable electric lamps. (Date applied for, July 2, 1903.)
13,908 Weintraub. Means for producing electric arcs from alternating currents, also applicable for rectifying alternating currents. (Date applied for, June 20, 1903.)
13,933 Boult (Dodge). Storage battery separators.

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NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANY.

"**SIMPLEX**" **ARC LAMP SYND.** (**LTD.**) (82,017.)—Reg. on Sept 9 with a capital of £16,000 in £1 shares, to adopt certain agreements and to carry on the business of manufacturers of and dealers in arc and other lamps, brackets, globes, shades, glasses, burners, galvanometers, electricity meters, carbons, cutouts, switches, motors, batteries, turbines, pipes, wires and all appliances and things used in connection with electricity or any other illuminant, suppliers of electric and other light, electrical and general engineers, &c.

STATUTORY RETURNS.

ELECTRIC AND GENERAL INVESTMENT CO. (**LTD**).—The return to July 20 gives capital as £200,000 in 20,000 ordinary, 100 founders' and 19,900 preference shares of £5 each, all of which have been taken up. £5 per share has been called up and paid on founders' and preference and £1 per share on ordinary. Mortgages and charges, nil.

ELECTRICAL POWER STORAGE CO. (**LTD.**)—The return to July 28 gives capital as £100,500 in 100 founders' and 20,000 ordinary shares of £5 each, of which 66 founders' and 18,592 ordinary have been taken up. £5 per share has been called up on 66 founders' and £4 per share on 3,132 ordinary shares, and £13,332. 5s. 1d. has been received, including £474. 5s. 1d. paid on four founders' and 405 ordinary shares forfeited. £77,300 is considered as paid on 15,460 shares. Mortgages and charges, £28,400.

LANCASHIRE DYNAMO & MOTOR CO. (**LTD.**)—According to return to April 25 (filed June 30), the capital is £100,000 in 700 ordinary and 300 preference shares of £100 each. 700 ordinary and 249 preference had been taken up. £100 per share had been called up and £94,150 had been received, leaving £750 in arrears. Mortgages and charges nil. A list of allotments made up to July 4 shows a further issue of six ordinary shares, payable in cash, and a list made up to Aug. 8 shows that six more were then allotted, also payable in cash.

SLOAN ELECTRICAL CO. (**LTD.**)—In return to Aug. 3 the capital is £15,000 in 5,000 "A" preference, 5,000 "B" preference and 5,000 ordinary shares of £1 each, of which 5,000 "A" preference, four "B" preference and 2,750 ordinary have been taken up. £1 per share has been called up and paid on four "B" preference and 1,250 ordinary shares. 6,500 shares are considered as fully paid. Mortgages and charges nil.

MORTGAGES AND CHARGES.

PLADBURY ELECTRIC LIGHT AND POWER CO. (**LTD.**)—Issue on Aug. 29 of £150 Five per cent. debentures, part of series created Oct. 31, 1903, to secure £300, charged on company's undertaking and property, present and future, including uncalled capital. Holders, J. W. Wagstaff and S. H. Deakin. No trustees. Previously issued of same series, £150.

SCOTTISH HOUSE-TO-HOUSE ELECTRICITY CO. (**LTD.**)—A mortgage or charge, dated Sept. 1, 1904 (supplemental to charge dated March 31, 1904), to secure an additional £1,250 has been registered. Property charged, company's undertaking and property, present and future, including uncalled capital. Holders, County of London Electric Supply Co.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26 5/16d. per oz. (Sept. 15). Consols 88⅜—88¼, for money, 88 7/16—88 9/16, for account; 2½ per cent. annuities 87¼—87¾. Consols Pay Day, Oct. 5; Stocks and Shares Continuation Day, Sept. 27; Ticket Day, Sept. 28; Pay Day, Sept. 29.

BRITISH INSULATED & HELSBY CABLES (**LTD.**)—Warrants for the interim dividend on the ordinary shares have been posted.

CANADIAN ENTERPRISE IN BRAZIL.—The "Canadian Gazette" states that a Dominion charter has been obtained for the formation of the Rio de Janeiro Tramway, Light & Power Co., with a capital of $50,000,000, to acquire and operate all the existing lighting, power and tramway undertakings in Rio. Some reports put the capital at $25,000,000, half-paid up. The promoters include the financiers who floated the Sao Paulo Tramway, Light & Power Co. and the Mexican Light & Power Co., and amongst them are Sir William Van Horne, the Hon. G. A. Cox and Messrs. Wm. Mackenzie, E. R. Wood, Frederick Nichols and F. S. Pearson.

CHELSEA ELECTRICITY SUPPLY CO. (**LTD.**)—The warrants for the ordinary share interim dividend have been posted.

COMMERCIAL CABLE CO.—The regular quarterly dividend of 1 per cent. on the preferred shares of "The Mackay Companies" will be paid on Oct. 10. The transfer books will be closed from Oct. 1 to 8 inclusive.

HOVE ELECTRIC LIGHTING CO. (**LTD.**)—The directors have declared an interim dividend on the paid-up share capital at the rate of 3½ per cent. for the six months ended June 30. The dividend (the same as last year) will be paid on the 15th prox.

OXFORD ELECTRIC CO. (**LTD.**)—The company has just offered 2,000 new ordinary £5 shares at par to the existing shareholders.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have been asked to appoint a special settling day in a further issue of 12,000 £5 ordinary shares (fully and partly paid) of the *United River Plate Telephone Co.* (*Ltd.*).

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept. 10	1,458	+ 208	14	24,671	+ 4,659
Airdrie	,, 2	227	...	10	5,975	...
Ayr Corporation	,, 10	311	+ 45	17	7,015	+ 271
Barnsley	,, 2	168	- 2	35	5,973	- 422
Barrow	,, 2	260	...	30	5,811	...
Bath Electric Trams, Ltd.	,, 7	889	...	36	28,075	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 12	1,095	- 21	...	...	...
Birmingham Corporation	...	...	...	...	...	...
Birmingham Tramways Co.	,, 10	5,282	+ 94	10	54,272	+ 2,688
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 8	2,011	+ 330	22	32,904	+ 4,480
Blackpool and Fleetwood	,, 10	1,188	+ 48	10	15,285	+ 8
Blackp'l, St. Anne's & Lytham	,, 8	730	+ 141	45	17,477	+ 6,996
Bolton Corporation	,, 11	1,918	+ 91	24	45,563	+ 362
Bournemouth Corporation	,, 7	1,461	+ 70	‡28	28,029	+ 1,544
Bradford Corporation	,, 10	4,404	+ 858	23	111,344	+ 19,254
Brighton Corporation	,, 11	1,218	+ 207	23	26,400	+ 2,686
Brisbane Tramways	July 27	2,333	+ 176	4	8,796	- 130
Bristol Trams & Carriage	Sept. 9	5,295	+ 155	16	87,060	+ 788
Buenos Ayres & Belgrano	Aug. 14	2,815	- 315	17	55,128	+ 2,486
Burnley Corporation	Sept. 10	1,157	+ 181	24	25,753	+ 5,817
Burton Corporation	,, 11	372	- 54	¶23	8,725	+ 2,044
Calcutta Tramways Co.	,, 10	R37,751	+ R5,091	11	R359,946	+ R42,429
Camborne-Redruth	,, 5	127	- 6	19	2,258	- 117
	,, 12	119	+ 5			
Cardiff Corporation	,, 10	2,057	- 40	23	49,857	+ 1,598
Carlisle Tramways Co.	,, 10	211	- 3	36	7,277	+ 270
Central London Railway	,, 10	5,880	+ 343	10	58,062	- 1,614
Chatham & Dist. Lt. Rys.	,, 8	652	- 5	36	21,451	+ 2,152
City & South London Rly.	,, 11	2,556	- 77	11	25,760	- 1,145
Colchester Corporation	,, 8	326	...	6	2,305	...
Cork Electric Trams Co.	,, 8	509	- 144	36	16,962	- 2,267
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 2	681	+ 140	35	18,941	+ 3,178
Dover Corporation	,, 10	272	+ 2	24	5,984	- 152
Dublin & Lucan Railway	,, 9	127	- 38	10	1,455	- 15
Dublin Southern District	,, 9	1,010	- 2	10	57,119	- 3,849
Dublin United	,, 9	4,033	- 49			
Dudley—Stourbridge	,, 2	1,016	+ 75	35	30,772	+ 1,229
Dundee Corporation	,, 7	971	+ 102	...	...	...
East Ham Council	,, 10	748	+ 88	23	18,188	+ 1,409
Gateshead & Dist. Trams	,, 2	954	+ 65	35	31,817	+ 1,414
Glasgow Corporation	,, 10	14,871	+ 741	†15	210,640	+ 13,250
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 2	292	- 21	35	9,184	+ 758
Gt. Northern & City Rly.	,, 10	1,169	...	30	28,487	...
Greenock & Port Glasgow	,, 2	713	+ 68	35	20,270	+ 1,006
Halifax Corporation	Aug. 31	1,723	+ 45	23	37,012	+ 3,034
	Sept. 7	1,634	+ 168			
Hartlepool Tramways	,, 2	356	+ 51	35	10,552	+ 995
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 10	2,200	+ 266	23	50,927	+ 6,988
Ilford District Council	,, 10	488	+ 7	¶23	11,988	+ 656
Ilkeston Corporation	,, 7	148	- 35	...	...	...
Ipswich Corporation	,, 10	605	...	23	12,769	...
Isle of Thanet Co.	,, 10	1,589	+ 247	¶50	32,294	+ 1,176
Kidderminster & District	,, 2	165	+ 29	35	4,680	+ 16
Kirkcaldy Corporation	,, 7	229	- 45	16	8,338	...
Lanarkshire Trams Co.	,, 8	693	+ 48	36	28,046	...
Leeds Corporation	,, 10	6,242	+ 583	24	143,879	+ 9,400
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	,, 8	10,749	+ 532	36	372,818	+ 12,807
Liverpool Overhead Rly.	,, 11	1,521	- 151	†11	18,484	- 422
*London County Council	,, 8	13,709	+ 2,977	§28	284,181	+ 58,016
Lowestoft	,, 10	353	+ 21	...	...	...
Maidstone Corporation	...	...	...	...	...	...
Manchester Corporation	,, 10	12,589	+ 450	23	289,678	+ 11,924
Mersey Railway	,, 10	1,416	+ 128	10	14,388	+ 969
Merthyr	,, 2	213	- 3	35	7,112	+ 129
Metropolitan Elec. Trams	,, 9	2,691	+ 707	10	19,664	+ 4,385
Middleton	,, 2	474	+ 79	35	11,791	+ 199
Nelson Corporation	,, 10	150	+ 9	24	2,925	+ 1,000
Newcastle-on-Tyne Corp.	,, 10	3,591	+ 79	10	37,052	+ 2,412
Newport (Mon.)	,, 10	520	+ 62	23	12,441	+ 2,221
Oldham, Ashton & Hyde	,, 2	668	+ 45	35	19,424	- 845
Oldham Corporation	Aug. 28	1,364	...	...	...	...
	Sept. 4	1,305				
Perth (W. A.) Elec. Trams.	,, 9	1,194	+ 67	36	47,148	+ 5,788
Peterborough	,, 2	185	+ 9	35	5,420	- 106
Poole and District	,, 2	198	- 30	35	10,814	- 50
Portsmouth Corporation	,, 11	2,324	+ 210	...	...	...
Potteries	,, 2	1,771	+ 103	35	59,618	+ 5,041
Reading Corporation	,, 8	695	+ 61	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 2	274	+ 31	35	5,716	- 84
Salford Corporation	,, 12	4,045	+ 109	23	98,276	+ 7,048
Sheerness	Aug. 31	92	- 14	35	2,264	- 471
Sheffield Corporation	Sept. 11	4,690	+ 278	§24	114,194	+ 2,952
Southampton Corp'ation	,, 8	1,317	+ 112	...	...	...
Southend Corporation	,, 7	513	+ 6	23	10,010	+ 1,228
Southport Tramways	,, 2	450	+ 33	35	11,870	+ 658
S. Staffordshire Trams.	,, 2	159	- 307	35	27,069	- 4,235
Stockport Corporation	,, 9	592	+ 195	23	14,427	+ 6,083
Sunderland Corporation	,, 11	1,892	+ 200	23	31,674	+ 926
Swansea Trams	,, 2	631	+ 14	35	19,470	+ 1,025
Taunton Trams	,, 2	64	- 10	35	2,000	- 190
Tynemouth and District	,, 2	386	+ 4	35	10,740	- 798
Tyneside Trams Co.	,, 7	455	+ 46	16	14,019	+ 2,184
Wallasey District Council	,, 10	801	+ 54	§23	18,899	+ 1,192
Walsall	,, 10	489	...	35	17,5 9	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 8	1,133	...	28	25,003	...
Weston-super-Mare	Aug. 31	350	+ 77	35	4,923	+ 349
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	Sept. 2	428	+ 36	35	13,820	- 55
Worcester	,, 2	382	+ 213	50	9,730	+ 4,786
Wrexham	,, 2	127	- 17	35	3,947	- 75
Yorkshire Woollen District	,, 2	737	+ 215	35	21,169	+ 7

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 8 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Sept. 14	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to Sept. 14. High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c					
5	..	Anglo-Argentine Ordinary Shares	6½—6¾	..	April, Oct	6⅝	6½
5	2/6	Do. 5% Cum. Pref.	5⅝—5⅞	4 8 10	..	5½	5⅜
St.	6%	Do. Permanent 6% Deb. Stock	137 —141	4 5 0	..	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	100 —102	4 19 3	..	100	..
10	6%	Barcelona Tramways Ord.	9 —10	3 0 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 0	..	..	..
100	5%	Do. 5 per Cent. Debs.	98 —101	4 19 6	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	⅛—¼	..	..	..	..
1	..	Do. 5% Cum. Pref.	¾—1	..	..	..	..
5	..	Brisbane Electric Trams, Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96 —101	4 9 3	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107 —109	3 13 4	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	97 —100	6 2 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	100 —103	4 18 0	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	104⅝—106⅞	4 6 7	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 —100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	9 —9½	6 6 3	..	9½	9
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—11	5 9 1	Feb, Aug	10⅞	10⅛
St.	5/0	Do. 5 per Cent. Perpetual Debs	117 —120	4 4 9	..	118½	..
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	94 —97	..	..	94½	94½
5	3/0	Buenos Ayres and Belgrano Ord.	2½—2⅝	4 10 2	..	2⅝	2½
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5½—5¾	5 4 4	..	5⅝	5½
5	3/0	Do. "B"	5 —5½	5 9 1	..	..	..
St.	5%	Do. 5 per Cent. Debs.	105 —108	4 12 8	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102 —105	4 16 3	..	..	..
5	3/6	Calcutta Tramways	7½—8	3 15 0	..	7⅝	7½
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 4 0	..	107	105½
1	1/0	Cape Electric Tram Shares	1⅝—1¾	5 6 3	..	1¾	1⅝
St.	4%	Central London Ordinary Stock	86 —88	4 10 11	June, Dec	87½	86
St.	4%	Do. 4 per Cent. Pref. Stock	100 —102	3 18 3	..	102	101
St.	4%	Do. Deferred Stock	79 —81	4 18 9	..	80⅜	80½
100	4%	Do. 4 per Cent. Debs.	106 —109	3 13 5	..	107½	107
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	44 —46	4 17 10	Feb, Aug	47⅛	42⅝
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	121 —124	4 0 8	Feb, Aug	..	..
St.	5%	Do. (1896)	117 —120	4 3 6	..	..	..
St.	5%	Do. (1901)	115 —118	4 5 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	105 —108	3 14 9	May, Nov	108½	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	101 —104	4 18 0	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13 —14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	3 0½	Gt. Northern & City Rly. Prf. Ord. (4%)	5 —5½	..	..	5½	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 —20	4 10 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—14¾	4 1 4½	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109 —111	4 1 0	Jan, July	..	..
5	2/6	†Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89 —91	4 7 11	..	..	..
10	1¾%	†Liverpool Overhead Railway Ord	8⅜—9⅜	3 15 9	Feb, Aug	..	..
10	5%	† Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11½—11	4 10 11	..	10½	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —105	3 16 4	..	104⅜	104⅛
St.	..	Madras Elec. Trams 5% Deb. Stk.	102 —105	..	Jan, July	103	102⅜
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅝—¾	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	..	⅞	¾
St.	13/7	Do. 4½% Deb. Stock	98 —100	..	..	99⅜	..
100	5%	Montreal St. Ry. Stg 5% Mrt. Dbs.(1908)	100 —103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs.(1922)	103 —105	4 5 9	..	102½	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 —2	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	101 —104	4 7 3	..	.02½	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	103½	102½
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	86 —89	3 7 5	June, Dec	87½	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance E'lec. Co. 5% Cum. Pref.	½—¾	6 13 4	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	¾—⅞	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾—6¼	6 8 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¾—6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 7	..	..	..
St.	4½%	British Thome'n-Houst'n 4½% 1st Mt. Db.	99 —101	4 9 1	..	..	..
5	3/0	British Westinghouse 6% Pref.	3⅝—3¾	9 4 6	..	3⅛	3
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	86 —89	4 10 9	..	88	..
2	..	Brush Electrical Engineering	½—¾	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1 —1½	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	94 —97	4 12 10	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	70 —75	6 0 9	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½—10½	5 14 3	Jan, July	9⅞	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	101 —105	4 5 8	Nov, May	..	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 16 10	..	..	..
1	1/2½	Chadburn's (Ship) Telegraph Ord.	¾—1½	8 0 0	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—2	3 15 0	Jan, July	1½	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	90 —95	5 6 5	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7½—8	..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5¾—5¾	5 4 4	..	..	..
St.	4½%	Do. 4½% Deb. Stock	103—106	4 5 9	..	104½	104½
5	..	Edison & Swan United ("A" Sh.) (£5 pd.)	½—¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 —82	4 18 1	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 —83	6 8 8	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6 —6½	5 12 0	H'lf-yearly	6⅜	6⅛
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 16 0	..	6½	6⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105 —108	4 3 10	..	..	..
2	1/7½	Electric Construction Co.	1 —1½	6 8 0	July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2 —2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	96 —99	4 0 9	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 —9½	5 5 3	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	9/0	Henley's Telegraph Works Ord.	10½—11½	6 10 6	Feb, Aug	11½	10⅜
5	2/8	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.	107 —111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 6	Feb, Aug	19⅛	18⅜
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.	100 —103	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Maintenance	84 —87	6 9 11	Mar, July	86½	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 6	Jan, July	..	..
5	..	Willans and Robinson Ord.	2 —3	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3 —4	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	75 —80	5 1 0	May, Nov	..	..

Share.	Last Dividend	Name.	Price Wed., Sept. 14.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to Sept. 14. High-est.	Low-est.
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord. (f.p.)	¾—1	..	..	..	..
1	0/8½	Do. 7% Cum. Pref.	1¼—1½	4 13 4	..	..	..
St.	..	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	12	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 —106	4 5 9	..	..	104
5	..	Bromley (Kent) El. Lt. & Power Shares	5½—6	..	..	..	..
St.	4½%	Do. Do. 1st Debs	101 —104	4 8 3	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10¾—11½	4 8 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7½—8	4 7 6	..	7⅝	7½
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	107 —110	3 18 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7⅜—8½	4 17 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 1 10	Feb, Aug	5⅝	5½
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	..	..	..
5	2/3	Do. Do. (19.3)	4¾—5	..	..	..	4⅝
St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 0	..	..	..
5	3/6	Chelsea Electric Supply Ord.	6½—7	4 2 2	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 2 6	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10½—10¾	4 13 0	Feb, Aug	10⅝	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	120 —125	4 0 0	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 5 9	..	104	104
10	4/0	County of London Elec. Supply Ord.	8 —9	4 8 11	..	8⅜	8⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—12	5 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	105 —108	4 3 6	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —104	4 7 10	..	..	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 —93	5 7 6	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5¾—6¼	4 8 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 —102	4 8 9	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
5	5 0	Hove Electric Lighting Ord.	7½—8¾	5 0 0	..	..	..
St.	4½%	I of W. Elec Lt. & Power 4½% Db St (red.)	101 —103	4 7 6	..	..	.01
St.	4%	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅛—¼	..	..	..	..
10	5/0	Kensington & Knghtsbdge Ord.	12 —13	4 12 4	..	..	..
100	6%	Do. 6 per Cent. 1st Pref.	6¼—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	..	..
5	..	London Electric Supply Ord.	1¾—2½	..	..	..	..
5	3/0	Do. 6 per Cent. Pref.	5 —5½	5 9 1	..	..	5
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 —99	4 1 6	Mr, Je, S, D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	16 —16½	5 0 0	April, Oct	16⅜	16
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅜—5⅝	4 0 0	Jan. July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —115	3 18 11	Jn, Dec ..	..	..
St.	3¾%	Do. 3¾ per Cent. Mrt. Db. Stock (red.)	96 —99	3 10 6	..	..	..
100	4¼%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93 —96	4 18 9	..	..	..
10	6/0	Notting Hill Electric Ord.	14½—15½	3 17 6	March....	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	100 —103	3 18 3	..	..	..
5	4/0	Oxford Electric Ord.	5¾—6½	5 4 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	97 —100	4 0 0	..	..	..
1	..	Rand Electric	1 —1½	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 —103	4 7 9	April, Oct	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	14½—15½	4 13 7	Feb, Aug	14⅝	..
5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 2	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¾—3½	6 3 1	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 —88	4 10 11	..	..	..
5	2/0	South London Electric Supply Ord.	4 —4½	3 6 8	..	4⅛	4
5	2/6	Urban Electric Supply Ord.	4¾—5¼	4 15 3	..	..	..
5	6/6	Do. 5% Cum. Pref.	4¾—5¼	4 15 3	..	..	..
5	6/6	Westminster Electric Supply Ord.	12 —13	5 8 9	Mar, Sept	12⅞	..
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	..	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	97 —101	3 19 2	Jan, July	..	..
10	..	Amazon Telegraph	2¾—3¼	..	Jn. Dec ..	..	..
St.	12/6	Anglo-American	50 —53	5 5 9	F, My, Ag, N	54⅛	..
St.	25/0	Do. Preferred	95 —97	5 13 6	F, My, Ag, N	97	96
St.	2/0	Do. Deferred	8 —8½	3 3 6	F, My Ag, N	8⅝	..
100	£2	Commercial Cable Capital Stock	170 —190	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 —96	4 3 6	Jn Ap, Jy, O	94½	..
10	5/0	Cuba Submarine Ord.	7 —8	7 10 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅝—101⅝	4 9 2	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10½	5 14 3	Ja, Ap, Jy, O	10⅝	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 —101	4 9 2	Jn, Dec ..	..	..
St.	65/0	Eastern Ordinary	126 —131	5 6 9	Ja, Ap, Jy, O	131	129½
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —90	3 18 6	Ja Ap, Jy, O	89½	88
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 6	May, Nov	..	..
10	2/6	Eastern Extension	12 —12½	5 12 0	Ja, Ap, Jy, O	12⅝	12½
St.	4%	Do. 4 per Cent. Deb. Stock	103 —106	3 15 6	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	99 —102	3 18 9	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100⅞—103⅞	3 18 6	May, Nov	104	..
10	5/0	Gt. Nrthn. (of Copenhagen)	27½—28½	5 5 3	Jan, July	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 —101	4 9 2	June, Dec	..	..
25	87/6	Indo-European	43 —46	5 8 9	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	103	..
10	6/0	West African Telegraph Shares	6 —7	5 14 3	..	..	..
5	..	West Coast of America	⅛—¼	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 6	Jan, July	..	..
10	..	West India and Panama	¾—1	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½—6¾	8 17 9	May, Nov	6⅝	..
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 17 10	Jan, July	..	..
10	3/0	Western Telegraph	12 —12½	5 12 0	Mr, Jn, O, D	12⅝	..
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 16 3	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	100 —103	3 18 0	..	..	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid,	5 —5½	6 7 3	August ..	..	..
1	..	Monte Video Telephone Ord.	1/16—⅛	..	..	..	..
St.	6%	National Co. Pref. Stock	104 —106	5 13 9	..	106	104
St.	5%	Do. Def. Stock	92 —95	5 5 6	..	98½	94
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 8	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	6⅛	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5¾—5¾	4 13 0	Feb, Aug	5⅞	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 —99	3 10 8	June, Dec	10⅛	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104 —106	3 15 9	..	67⅛	..
..	5/9	Dc. Do. Prov. Certs, 35% to be pd.	65 —68	..	..	..	..
1	0/6½	Oriental	1⅛—1⅜	6 6 3	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	6 4 6	..	..	..
5	5/0	United River Plate	6 —6½	6 3 3	July.....	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 —106	4 14 4	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 14 4	..	..	..
5	2/0	Globe Telegraph and Trust	8½—9¼	5 19 0	Ja Ap, Jy O	9⅜	..
5	3/0	Do. 6 per Cent. Pref.	13½—14	4 5 8	Ja Ap, Jy, O	14⅛	..
100	6%	Submarine Cables Trust (Cert.)	118 —123	4 18 9	April, Oct	..	..
..	86/7	Underground Elec. Rys. Co. of London 5% Profit Sharing Secured Notes	97½—98½	..	..	..	..

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NOTES.

THE Institution of Electrical Engineers' party in America has by now practically completed its programme, after over a fortnight's enjoyment of the hospitality of our electrical engineering friends in the United States. Our correspondent with the party has, with some difficulty, we do not doubt, found intervals in the round of sight-seeing to send us an account of the progress of the tour in Boston and New York, and it is evident that the members who have taken part in it are being accorded a splendid reception. Although but a short time can be accorded to each individual works, a good general impression will be obtained as to the position of the electrical engineering industry in the United States, and the directions in which progress and invention are tending. We trust also, that the educational value of the tour will be reciprocal, and that American electrical engineers may find that there are still some ideas and lines of thought emanating from the old country which are not without value to its more energetic and pushing offspring in the new hemisphere.

BY applying the few fundamental yet simple laws of electromagnetism to the case of plunger electromagnets, Prof. S. P. THOMPSON has derived a series of practical formulæ for which the designer of such apparatus will be thankful. It is comforting to see from the Paper, which is published elsewhere in this issue, how easily the subject may be treated mathematically and how simple are the final equations. According to the author, the degree of accuracy obtainable in the predetermination of plunger electromagnets is quite comparable with that customary in dynamo design. This remark, however, applies rigidly to enclosed coils only. In the case of plunger electromagnets without an external iron casing the mathematical treatment is incomplete, and, so far, a predetermination of the properties of such apparatus is still more or less a matter of experience and conjecture. Fortunately, this class of electromagnets is not of great practical importance.

COMPLAINTS are occasionally heard that the descriptions of new electricity works in the pages of technical journals frequently amount to nothing more than catalogues of plant. This reproach cannot be levelled at the description of the Willesden electricity works of the North Metropolitan Electrical Power Supply Co. commencing in this issue, for the station possesses many features of novelty and interest. Besides being the first works in this country to employ "double current" generators, its design in matters of detail offers many suggestions which may be followed with advantage in other electricity works. The steam range, the disposition of the economisers, the addition to the Ferranti switchboard, and the sub-station arrangements all represent departures from the prevailing fashions, and we make no apology for describing the works at some length.

IN another column of this issue will be found an account of some excellent work in connection with the Clark cell which has been done at the Board of Trade electrical standardising laboratory. As guardian of the electrical standards of the country, the Board of Trade has a laboratory enabling it to carry out tests of a certain class with a far greater degree of accuracy than can be attained in laboratories intended primarily for commercial testing or scientific research. It is surprising how little known the laboratory is in certain circles, and to what a slight extent its services are requisitioned for the testing and certification of electrical sub-standards.

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THE letter from Prof. FRANCIS BAILY, which appears in our correspondence columns, and relates to the 40,000-volt scheme for the Loch Lomond valley, is worthy of careful consideration. His suggestion that the familiar phenomenon known as "Scotch mist" may be the cause of considerable leakage at insulators is not to be despised, and it will be interesting to learn from Mr. ADDENBROOKE, consulting engineer to the scheme, whether any experiments relating to the matter have been carried out. Prof. BAILY hazards the idea that the very finely-divided particles of water which form the mist may possibly be caused to coalesce when in the neighbourhood of a substance charged to 40,000 volts. As he says, this would be a consummation devoutly to be wished. It must not be forgotten that considerable experience has been gained with overhead transmission lines at extra high pressure on the American continent, and in this connection an article in another column of this issue is not without interest. The installation described therein was worked at 80,000 volts, and no trouble was experienced during fogs and light and heavy rains. Although, taken as a whole, the climatic conditions on the other side of the Atlantic are more favourable to the maintenance of high insulation resistances, yet there must be some districts where the equivalent of a "Scotch mist" is not unknown. The ubiquity of the Scotsman is proverbial.

THE motor cars for several of the English electric railways, both underground and surface lines, have been constructed in this country; but, of course, it may easily happen that a large contract for this type of rolling-stock may be awarded abroad. This has, in fact, happened in the case of a contract for 100 cars recently let by the Underground Railways Co. of London, as will be seen in our "Tenders Accepted" column. Yet we can hardly credit the statement, published in the *St. James's Gazette* last night, that the reason for this was the inability of our own car builders to manufacture cars of the special design required and wholly constructed of steel. Mr. CHAPMAN, chief engineer to the Company, is reported to have stated that attempts to place the order in England were in vain, the English manufacturers having refused to tender, on the ground that they had not the necessary tools to do the work. We cannot credit this explanation, and agree with our contemporary that a statement from the manufacturers in question would be opportune. Perhaps, however, the *St. James's Gazette* representative has misunderstood Mr. CHAPMAN during a snatched interview.

University Intelligence.—The University of Leeds has decided to confer the honorary degree of Doctor of Science upon a number of distinguished persons, including Lord Kelvin and Sir Arthur Rücker.

Radium a Dutiable Import.—According to the *Daily Telegraph*, a tube of radium valued at £200, imported into the United States from Europe, was observed by the Customs authorities, and a duty of £50 was collected on it.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Cayenne—Paramaribo	July 13, 1904
Cap Haitien—Mole St. Nicholas	Aug. 20, 1904
Bundaberg—Gomen (New Caledonia)	Aug. 30, 1904
Marseilles—Barcelona	Sept. 16, 1904

Sleet Troubles on the Third-rail.—Some experiments conducted by the engineers of the Connecticut Railway and Lighting Co. relate to the prevention of the formation of sleet on the third-rail by means of electric heating. A 70lb. T rail 30ft. in length was used, and was heated by means of a steel wire carried under the head of the rail and insulated from it by porcelain bushings. The rail was shielded from draught, and its losses were, therefore, confined to radiation. With surrounding air at 15deg. the temperature of the rail was raised through 19deg. in 15 minutes, and with surrounding air at 21deg. the temperature rose 19deg. in 12 minutes. Calculations based on these data show that no less than 90kw. would be required to obtain these results if a mile of line had been employed.

Fire at the Leeds Electricity Works.—The *Yorkshire Post* states that a huge stack of coal stored at the Leeds electricity works was discovered to be on fire on Tuesday night. The outbreak was due to spontaneous combustion, the coal having been stored in a wet condition, and the firemen had great difficulty in dealing with it. They worked on the stack for a couple of hours, and then left a hose on the spot in case the smouldering cinders should give further trouble. The store consisted of about 1,000 tons, and was housed over the boilers. Two men who were engaged in shovelling the coal down to stokers below were greatly troubled by fumes that arose from the pile during the afternoon and one labourer was nearly asphyxiated. He was so ill that he had to be taken to the infirmary, where proper treatment brought him round, and he was then taken to his home.

A Small Scotch Water-power Station.—A small water-power station erected by the Portpatrick Electric Supply Co. was put into operation on Saturday last. The undertaking, which owes its inception to the late Mr. C. L. Orr Ewing, M.P., is a non-statutory one, the company being private and the shareholders consisting of seven of the chief residents of the town. Mr. J. Gordon, of Glasgow, acted as consulting engineer to the scheme, which utilises the waters of Craigoch Burn, on the south side of the town. The power house is a quarter of a mile from the water power, and a steel pipe line has been constructed between the two. From the power house the current is conveyed, by means of underground cables, to the distributing station in the centre of the district. In this distributing station is also erected a battery of 216 cells. At present the largest amount of public lighting is at the harbour. The charge for public lighting is 3d. per £ on the valuation of the area supplied.

Electro-Harmonic Society.—Arrangements have been made to hold the society's concerts for the ensuing season in the King's Hall, Holborn Restaurant, on the following Fridays:—*Smoking Concerts:* October 14, December 9, 1904, January 20, March 24, 1905. *Ladies' Nights:* November 11, 1904, February 24, 1905. In view of the success of those concerts that were held in the King's Hall last season, the committee have engaged this hall for the whole of the concerts during the coming session, and they hope that the heavy extra expense involved will be justified by a corresponding increase in membership. Mr. Augustus Stroh, who has acted as hon. treasurer to the Society since its commencement, has resigned this office on the ground of advancing years. Mr. Robert Kaye Gray has kindly consented to accept the position of hon. treasurer in succession to Mr. Stroh. All communications regarding the Electro-Harmonic Society should be addressed to Mr. W. E. Lane, hon. secretary, at 123, Cannon-street, London, E.C.

Opening of the Swindon Electric Tramways.—The Swindon Corporation's electric tramway system, consisting of 2¼ miles of single and 1 mile of double-track, was inspected by representatives of the Board of Trade last Tuesday, and the official opening was fixed for yesterday (Thursday). A provisional order for the construction of the lines was obtained in 1901, and Messrs. J. G. White & Co. secured the contract for the track construction. The following are some of the chief data with regard to the track:—Gauge, 3ft. 6in.; maximum gradient, 1 in 15; sharpest curve, 32ft. radius; weight of rails (girder type) per yard, 105lb. Current at about 500 volts is conducted to the cars by means of overhead wires of hard-drawn

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copper, No. 00, suspended, as a rule, from brackets, but occasionally, also, from span wires. The feeders consist of B.I. & H. lead-covered cable laid in Doulton conduit beneath the footway. Messrs. Dick, Kerr & Co. supplied the cars, of which seven are at present running. They are of the single-truck double-deck pattern, weigh approximately 8¼ tons and accommodate 48 passengers each. Hand brakes and the Westinghouse magnetic brake are both provided. Messrs. Lacey and Sillar have acted as consulting engineers.

Extraordinary Accident to a Water-power Installation.—At midnight, on August 12th, a serious break occurred in the pipe-line of the Electra plant of the Standard Electric Co. in California, causing considerable damage to the power house and equipment. According to the *Electrical World* of New York, the ordinary pressure under which the five dynamos have been operated is 1,400ft. This is over 250ft. less pressure than a full head. The full head was turned on for the first time early in the morning of August 12th. The stoppage of street car service in Oakland and San José at midnight and the consequent shutting down of one or more of the generators put an extra strain upon the pipeline, part of which is composed of cast-iron pipe, ¾in. in thickness. The strain upon this pipe caused a piece of it, 8ft. long and 13in. wide, to blow out. An enormous volume of water rushed down the hillside for 1,400ft., and struck the power house at the bottom. The wooden pipe above the break collapsed owing to the formation of a vacuum when the water was turned off from the head of the line. The power house was covered 2ft. or 3ft. deep with mud and debris, and its galvanised-iron siding was driven in where the force of the water struck it, and the dynamos were covered up in the mud sluices.

Experiments with Single-phase Traction on the Valtellina Railway.—It appears from a note in the *Elektrotechnische Zeitschrift* of September 15th that comparative tests between the Ganz system of three-phase traction and the Finzi system of single-phase working are to be carried out shortly on the Valtellina Railway. These tests have been prompted, according to our contemporary, by the successful trials of the Finzi system on the tramway system of Milan (see *The Electrician*, Vol. LI., p. 692). One of the standard motor cars of the Bologna-Modena line is to equipped for the purpose stated with four 100 H.P. single-phase motors, working at from 200 to 400 volts, and, as no starting resistances are to be used, it follows that the speed control is to be effected by transformers with variable ratios of transformation. The power is to be transmitted from the motors to the car axles by gearing, and the motor car is intended to haul a train weighing 100 tons between Lecco and Sondrio at a speed of 44·6 miles per hour. Single-phase current at 3,000 volts is to be fed into the trolley line, and will be conveyed to the motor car by means of trolleys of the same design as used at present in connection with the three-phase service. A description of the Valtellina Railway as operated on the Ganz three-phase system will be found in *The Electrician*, Vol. LI., pp. 19 and 68.

International Telegraph Convention and Service Regulations, 1903, and the Preliminary Conference on Wireless Telegraphy, 1903.—We have received a copy of the International Telegraph Convention and Service Regulations, including the International Telephone Regulations, as revised by the Conference held in London last year. The original French text and an English translation are given in parallel columns. This important semi-official publication is issued every five years, and is in constant reference until its successor is published. All the alterations in the French text are clearly shown, and the work is specially designed to enable those who send or are interested in international telegrams or in the international telephone service to understand the conditions under which messages are transmitted and the rules as to charges, refunds, &c. Mr. C. E. J. Twisaday, of the India Office, and Mr. Geo. R. Neilson, of the Eastern Telegraph Co., are responsible for the translation of the work, which been officially accepted by H.M. Postmaster-General, The published price is 6s. net. We have also received a translation of the proceedings of the Preliminary Conference on Wireless Telegraphy, which took place at Berlin in August, 1903. Mr. Geo. R. Neilson has also been responsible for this work, which does not give the French text, but only a full English translation. The Final Protocol is, however, given in both languages, in parallel columns. This work has also been officially accepted by H.M. Postmaster-General. The published price is 8s. 6d. net.

Work done by the Physikalisch-Technischen Reichsanstalt during 1903.—In the *Elektrotechnische Zeitschrift* of September 8th there is an interesting account of electrical work done by the Physikalisch-Technischen Reichsanstalt of Charlottenburg during 1903. During the period referred to, a large number of tests were made on alternating and continuous-current voltmeters, current meters, wattmeters, electricity meters, &c. Continuous and alternating-current motors and transformers were also tested. Various materials, including oils, varnish, porcelain insulators and tubes, wires and cables were subjected to tests. Of 107 Clark cells, 36 deviated from the standard voltage of 1·4328 by amounts varying between nothing and 0·0004 volt; 48 showed variations between 0·0004 and 0·0007 volt; 13 between 0·0007 and 0·0010 volt, while in five cases the errors were more than 0·0010 volt. A large number of metals used in the construction of electric machinery were tested as to their magnetic properties. Several firms have now succeeded, it appears, in producing iron with excellent magnetic properties, but having at the same time a comparatively high electrical resistance (0·5 ohm for a rod 1 metre long and a section of 1 sq mm.); such iron would have, of course, relatively small eddy current losses. It was also observed that a sample having a maximum permeability need not necessarily show a high permeability at the foot of the permeability curve. Photometric tests of various kinds of lamps and accessories were carried out. The lowest consumption per mean-spherical candle-power (German unit) amongst the arc lamps with coloured arcs was found to be 0·37 watt. Osmium lamps were tested at 38 volts and showed very economical figures, which, moreover, varied but little with time. In June, the lighting commission, which was formed at the time of the Paris Exhibition, held a meeting at Zurich, and the most interesting subject with which this commission occupied itself was the fixing of the relative values of the light units employed in various countries. Although investigations with regard to this subject are still going on, it was decided to fix the relative values temporarily as follows:—One Carcel lamp = 10·9 Hefner candles; one 10 c.p. pentane lamp = 11·4 Hefner candles.

Some German Steam Turbine Tests.—Reference was made in *The Electrician*, Vol. LII., p. 399, to a 4,000 H.P. Brown, Boveri-Parsons turbo-generator installed at the Frankfort Corporation's electricity works, and the results of some tests with this set were given. Herr Singer, the manager of the station, conducted some time ago another set of tests, the turbo-generator then having been in service for 1½ years. The results were communicated to the Elektrotechnische Gesellschaft in Frankfurt, and recently published in the *Elektrotechnische Zeitschrift*. The data furnished by Herr Singer are of some importance as indicating that the efficiency of the turbo-generator had improved in the interval, although, it is true, not to a very marked extent. We give the gist of Mr. Singer's communication. Between no load and an output of 3,000kw. the hourly quantity of steam consumed increased in a linear manner from 6,210lb. to 50,800lb., the boiler pressure being 143·4lb. per square inch and the steam temperature 230°C. At the same boiler pressure, but with a steam temperature of 300°C., the corresponding figures were 4,760lb. and 45,600lb. At a pressure of 201lb. per square inch and a temperature of 300°C. the steam consumed increased from 6,440lb. to 42,900lb. In all cases the vacuum recorded was 90 per cent. of the barometric pressure. The figures quoted make no allowance for excitation and energy expended in operating the condenser. It is evident from the figures quoted that the efficiency of the set for outputs below 1,200kw. is greater for a pressure of 143·4lb. than for the higher pressure of 201lb., the temperature being in both cases the same—namely, 300°C. Above 1,200kw., however, the higher pressure conduces to greater economy, the divergence increasing with the load. For an output of 3,000kw. the steam consumption in the three conditions outlined above amounted to

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16·9lb., 15·2lb. and 14·4lb. per kilowatt-hour respectively. Of considerable interest are the figures given by Herr Singer relating to the cost of oil consumed in the station. In 1901, when the station was running with reciprocating engines only, the cost was 0·0156d. per kilowatt-hour; in 1902, during four months of which turbines were run, the corresponding figure was 0·0097d.; while in 1903, when turbines were the only prime movers employed, the cost figure had sunk to 0·005d. These figures relate to the total cost of oil used in the station. The turbines themselves require a quantity of oil costing only 0·002d. per kilowatt-hour. With regard to the variations in speed, it is remarked that this did not exceed 2 per cent. when 2,000kw. were either thrown off or put on the generator.

Erith Electricity Supply Accounts.—The accounts of the Erith electricity supply undertaking for the year ended March 31, 1904, have just been published. In presenting his annual report, Mr. G. E. Heath, electrical engineer to the Urban District Council, calls attention to the improvement in street lighting which has been effected during the year. This he attributes to the substitution of incandescent for Nernst lamps. However, in justice to the latter, he admits that they were worked "under extraordinary and adverse conditions." It appears that, as the load on the Erith station is only a comparatively light one, there are considerable variations of pressure in the three phases owing to the use of motors. In these circumstances Mr. Heath considers the use of Nernst lamps impossible but when the load has grown to such an extent as to render motor-starting currents inappreciable, then it may be possible, to reconsider the Nernst lamp question. The number of 8 c.p. lamps connected on March 31st was 13,588, the lamp connection at the beginning of the year being 3,088, thus showing an increase of 10,500 8 c.p. lamps during the year. The aggregate horse-power of motors connected is 189 H.P., all of which has been connected during the past year. On December 18, 1903, the maximum load of 233kw. was recorded. Per unit sold, the figures are as follows:—Coal and other fuel, 0·771d.; oil, waste, water and stores, 0·095d.; wages at generating station, 0·540d.; repairs and maintenance, 0·238d.; works costs, 1·644d.; costs, including distribution and management costs, 2·563d. Total costs, including capital charges, 3·75d. The number of units generated was 421,971, while that sold was: Public lamps, 148,530; private consumers, 216,133; total, 364,663. Taking 11,543 as the quantity used on the works, there remain 45,763 units unaccounted for, which, of course, include cable and transformer losses, estimated at 39,420 units. The average price obtained per unit was: Private lighting, 4·887d.; power, 1·501d.; street lighting, 1·511d. It will be observed that the wages costs are high, the total amounting to no less than 1·001d. per unit sold. During the year a gross profit of £1,020 8s. 5d. was made, but as interest and redemption charges amounted to £1,801. 16s. 8d., there was a net deficit of £781. 8s. 3d.

Wireless Telegraph Notes.—The second Berlin Wireless Telegraph Conference, which was originally called for October 6, has been postponed until the spring of next year.

We have received from the American De Forest Wireless Telegraph Co. particulars of their exhibits at the St. Louis Exhibition. Apparatus is exhibited in the Electricity Building, Transportation Building, Government Building and in various structures especially erected by the company for show purposes in the grounds, there being, in all, 10 sets of working instruments in seven different stations. Most prominent of all is the "De Forest Observation Tower," 300ft. high and equipped with two electric lifts, from which from 3,000 to 5,000 words are transmitted daily, at a rate varying between 25 and 35 words per minute, to two newspaper offices. Current for the wireless telegraph plant is generated by a 2kw. motor-driven alternator at 60 cycles and 110 volts. A transformer increases the voltage to 20,000 volts. Messages, it is stated, have been received as far as Springfield, Ill., a distance of 105 miles. Over 3,500 incandescent lamps have been employed for illuminating the tower at night. The wireless telegraph exhibits in the Government Building comprise two sets in operation, displayed by the U.S. Signal Corps and three other exhibits. In the Electricity Building two stations have been rigged up. One is erected in connection with the Fort Wayne exhibit, while the other is installed in the main De Forest booth. In the latter three slender wooden towers, 75ft. high, have been erected, and three screens of fine wire depend from the tops, converging at the bottom to the bright helix on top of the transmitting instruments. Current for working these sets is supplied at a voltage of 110 volts and a frequency of 60 ∿ per sec. from the Machinery Buildings. A 2kw. transformer is employed for increasing the voltage up to 20,000 volts, the secondary circuit being connected to 18 jars of 0·013mfd. capacity, to the helix, air-wire and to earth. The operator at the main booth can, at will, attune his receiver to the messages from the Fort Wayne station in the same building, about 400ft. away, from the Tower station or from the Long Distance station, erected on Art Hill, at an approximate distance of half a mile. The last-named station boasts of the largest air wire of all that have been erected on the exhibition grounds, this being hung at a height of about 210ft. from a 40ft. cross-arm supported by a wooden structure. A horizontal wire is stretched along the cross-arm mentioned, and 20 vertical wires, each averaging 250ft. in length, are suspended from it. The vertical wires are curved outwards by means of cord spreaders. The antennæ enter the roof of the building in two portions of 10 wires each, and from these wires the messages are sent, the receiving antennæ being entirely distinct in a building near the foot of the mast. The earth-plate consists of a copper plate with a surface of 140 sq. ft., buried at a depth of 8ft. Means are provided for keeping the soil around this plate constantly damp. Messages have been sent from this station to Springfield, Ill., where the communications were received with the aid of a telephone, and a similar overland service with Chicago and Kansas City is to be inaugurated as soon as the receiving stations at these two places have been completed. Two electric motor cars, fitted with wireless telegraph apparatus, are also on view. The same battery which propels the car is used for operating the wireless telegraph instruments. They have, it is stated, been successfully employed for sending stock quotations from the New York Curb Exchange to the brokers' offices in Broad and Wall Streets.

According to a Reuter message, overland communication by wireless telegraphy between St. Louis and Chicago, a distance of 300 miles, has now been established, Mr. W. E. Goldsborough, the chief of the department of electricity of the St. Louis Exhibition, having sent, on August 14th, the following telegram:—"I have the honour to announce that the jurors report that every message sent from St. Louis has been received in Chicago with perfect accuracy. I heartily congratulate Dr. de Forest and his co-workers."

It is stated that the Marconi Wireless Telegraph Co. are working wireless stations between Banana and Ambrizette for the authorities at Angola, a Portuguese West African possession.

It is announced that the U.S. Congress has sanctioned a project whereby all telephonic and wireless telegraph companies which join up Washington with a province, or two provinces between themselves, or any part of the Republic with a foreign country, shall come under the National Telegraph law of October 7, 1875.

The Paris correspondent of the *Daily Telegraph* states that Gen. André, Minister of War, has authorised experiments of a new kind to be made by the military experts who have been of late using wireless telegraphy for communication from the Eiffel Tower with Dijon and other provincial towns. The aeronauts attached to the War Office are to make experiments from a captive balloon, which will ascend from the Champ de Mars, and go much higher than the top of the tower. It will be an interesting sight for those who have not seen such aerostats at the manœuvres. Further official recognition of the value of wireless telegraphy will be shown by its approaching installation on the island of Ushant. Messages will be sent from the island to ships at a distance of 200km., or 124 miles, from shore. Posts or stations of wireless telegraphy are also to be placed soon at Porquerolles, the westernmost of the Hyères Islands, in the Mediterranean. Later on there will be stations at Cape de la Hague, near Cherbourg, and at La Coubre Point, on the Bay of Biscay.

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THE AMERICAN TOUR OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

BY OUR SPECIAL CORRESPONDENT.

In response to the long-standing invitation of the American sister institution, about 50 members, accompanied by a few ladies, left Liverpool on August 25th by the ss. "Republic" of the White Star Line en route for Boston. A list of the members who took part in the tour was published in *The Electrician* of August 19th, p. 700. The president and secretary had travelled to New York the previous week in order to help the American committee with the detailed arrangements for the tour, the party on the "Republic" being under the guidance of Col. Crompton and Mr. Robert Hammond. The voyage was a pleasant one in every respect, primarily because of the excellent weather. The members soon fraternised together, and formed a nucleus for the social life on board, so that time did not hang at all heavily on our hands. With the assistance of some of the Americans a series of sports of varied and amusing description was organised. The last two evenings on board were devoted to a concert and dance, both of which were thoroughly successful. A handsome sum as the result of these social diversions was contributed to the seamen's charities of Liverpool and Boston.

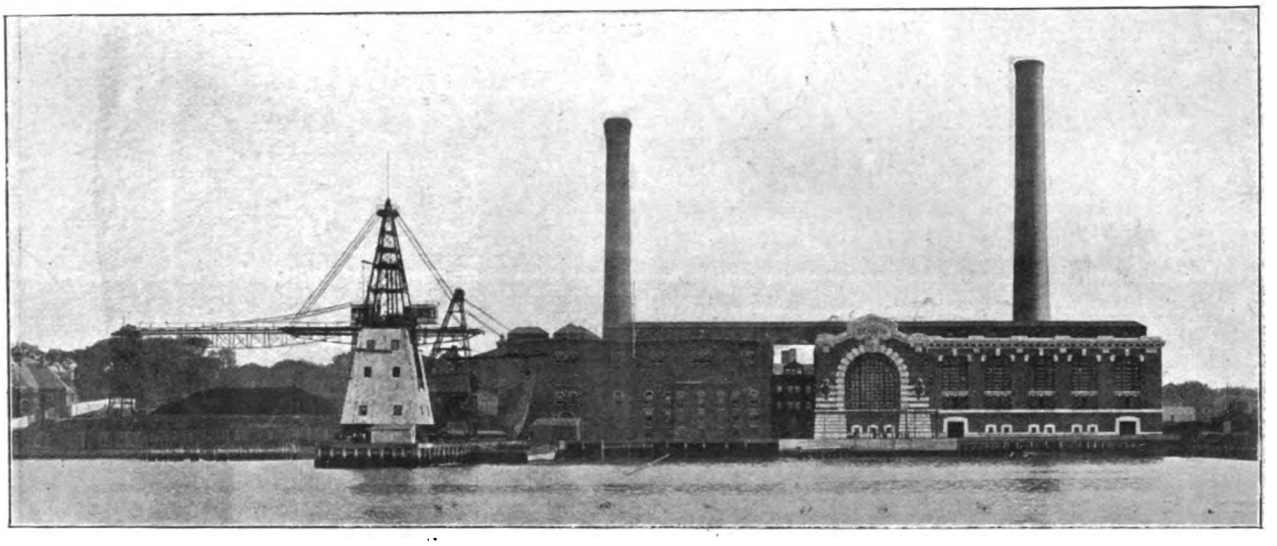
Friday, September 2nd.

One result of the fine weather in the Atlantic was to make our arrival about half-a-day earlier than the reception committee had anticipated. Consequently, we were all comfortably installed at the Hotel Vendome before the president, Mr. Chas. L. Edgar, and his fellow-workers had time to alter their plans. They were, however, soon on the spot, and it was evident that they had spared no pains to make our short stay in Boston as instructive as possible. Each member was presented with an accurate programme of the party's movements, together with a well-bound volume containing a large amount of information on matters of electrical interest in the city, with an introductory history of Boston and its principal buildings. A similar guide-book for each city is to be distributed a day or two before our arrival, so that the chief electrical features may be studied, thus rendering the inspection of the actual apparatus and installation of greater value. Our early arrival gave most of the party the opportunity of seeing a baseball match between Boston and Cleveland, which took place in the afternoon. This initiation into the mysteries of the national game was much appreciated. The official reception was given in the evening at the Hotel Vendome, where the whole party were located. Mr. Edgar, president of the Boston Edison Co. and of the Reception committee, received the guests, while the gathering was honoured by the presence of the Governor of Massachusetts, his Excellency L. Bates.

After formally welcoming the English engineers and a number of members of the Associazione Elettrotecnia Italiana, who had joined them from New York, the president introduced Mr. Bates, who made a stirring speech. He referred in particular to the associations which Boston had with the early developments of electrical science as the birthplace of Benjamin Franklin, Morse and Cyrus Field, and as the original home of the telephone invented by Graham Bell. Suitable replies to the welcome of our hosts were made by the president, Mr. Gray, and by Prof. Ascoli, on behalf of the Italians. Later in the evening a supper was given, which was attended by many American electrical men. To those of us who had taken part in the Continental trips of the Institution, it was interesting to observe the quick way in which the English and Americans at once began the rapid interchange of their respective views on the practice of each country without the drawback of trying to express themselves laboriously in a foreign language.

Saturday, September 3rd.

In order to make the most of our one day in Boston, the committee provided a number of automobiles for the conveyance of the whole party. The first destination was the power house of the Boston Edison Co., situated in L-street, the larger of the two which supply the whole city. There is only one undertaking in Boston, and practically no isolated plants, on account of the attractive prices the company is enabled to offer. The capital investment is now about £2,200,000, and the customers number nearly 20,000.



General View of L-Street Station, Boston.

The new extensions to L street station are designed for an ultimate output of 60,000kw., the plant to consist of 12 5,000kw. Curtis turbine sets generating three-phase current at 7,500 volts, but later the pressure will be increased to 15,000 volts. The frequency is 60 ~ per second. The installation is all laid out on the "independent unit" principle, with a separate boiler equipment and chimney shaft for each 10,000kw. The machine room itself is to be divided into three sections, so as to minimise the effects of a possible breakdown. The building is a steel frame filled in with brick, the engine room and boiler house running parallel to each other and to the older works, seen on the left of the general view. The coal is conveyed direct from the wharf by means of an endless belt type conveyor, and is distributed to the storage yard or direct to the hoppers feeding the Rodney type mechanical stokers. The boilers are of the Babcock make, and in the basement below there has been placed a most convenient plant for handling and removing ashes.

The Curtis turbines naturally came in for the closest inspection; but, as only one was put down and had not run more than a fortnight, and that on a special load, not much could be ascertained regarding their efficiency and behaviour in operation. Those in process of erection, however, gave

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excellent opportunities for studying the details of construction. They are all of 5,000kw. capacity, with four stages for the steam expansion, and run at 514 revs. per min. The floor space occupied by them is less than one-half of that required for one of the 1,500kw. units in the older station.

The lubrication of the footstep bearing for the vertical shaft is done by water under high pressure. An auxiliary pumping engine produces the pressure necessary to maintain the film of water underneath the end of the shaft, but as an additional safeguard against the failure of the lubrication, an hydraulic accumulator has been put in which can keep up the flow of water for 10 minutes. This can be seen on the right-hand side of the turbine in the illustration.

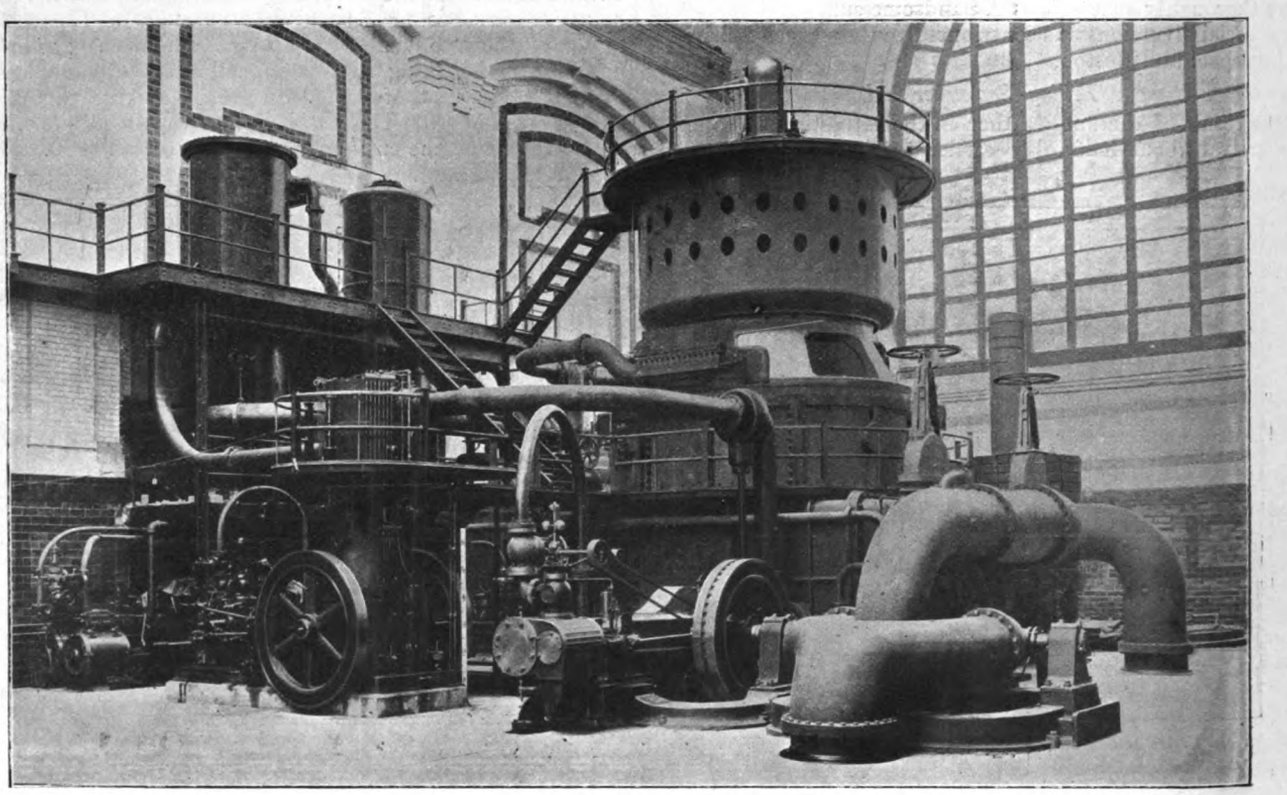
Although from its general appearance, the machine might be regarded as complicated, it is not so in reality, as in the picture there are seen also the centrifugal circulating pump, a dry-air pump and the feed pump for the boiler units associated with the turbine. The switch room occupies a large space between the old and new stations. Its main features of novelty are the adoption of the oil-break type of switch throughout, each element of which is placed in a separate brick cell. A similar arrangement is adopted for all the 'bus bars, feeders and connecting links, each part being supported on glass insulators and walled off from all other live conductors.

Incidentally, it may be mentioned that the 'bus bars are of aluminium. The whole of the switching operations are controlled by a system of relays placed in a room above the actual apparatus. Each switch is worked by means of an electric motor, but indirectly. In point of fact, the relay circuit, when made in one direction, releases the trigger of a powerful spring, which thereupon closes the switch with a rapid snap action, thus rendering synchronising an easy matter. The motor (whose circuit has also been completed) revolves until another spring has been fully compressed, when it stops automatically. The reverse movement of the relay switch releases this second spring and the switch opens with a quick break.

The situation of the power house on the harbour affords a supply of condensing water to an unlimited extent, while the direct unloading of the coal and transference to the boiler house helps to bring the works costs down to 0·3d., which, I was informed, has already been obtained in the old station with coal at 15s. per ton.*

Later in the forenoon the whole party visited the central exchange of the New England Telephone Co. In Boston and the immediate suburbs alone there are 19,000 subscribers, so that the switchboards, testing arrangements and trunk cable connections are all on a very large scale. More than two-thirds of the lines have been placed underground. The lamp signal system is in use throughout, and the whole equipment is an example of the highest type of telephone engineering, and an honour to the birth-place of the invention.

After leaving the company's premises a drive was taken through the magnificent park system of Boston, which extends for miles round the city. An opportunity was also afforded of visiting Harvard University, Cambridge, and of inspecting the physical laboratory under the guidance of Dr. Kennelly. Finally, we stopped at the Union Building, where we were entertained at lunch by the Reception committee and a formal welcome was given to us on behalf of the university by Prof. Walcott. In the afternoon special cars were placed at our disposal for our return to Boston, where most of the short time available was devoted to the electrical and mechanical engineering laboratories of the Massachusetts Institute of Technology. These occupy separate buildings, the electrical alone covering 45,000 sq. ft., and, as far as one could judge, in both there are opportunities for experimenting with almost every possible method of testing machinery and materials known to engineering science. The electrical department was famous for its complete equipment 14 years ago, and it is in the front rank still, but our most recently-founded laboratories, such as those of the Central Technical College and the Manchester School, need not fear comparison.



View of Interior L-Street Station, showing Curtis Turbine Set.

The journey from Boston to New York was begun at 5:30, when the party took train for Fall River. The rest of the journey was completed in one of the palatial steamers of the Fall River Line, which landed us in New York about 7 o'clock on Sunday morning.

Sunday, September 4th.

Despite the early hour, Mr. J. W. Lieb, the chairman of the local Reception committee, had arranged for automobiles

* We think there must be some mistake about this figure.—Ed. *E.*

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to be in attendance to take us to our respective hotels. In the afternoon arrangements had been made, by the invitation of J. G. White & Co., for a sail up the Hudson River and a visit to Coney Island, and a large number of American engineers accompanied the trip. This part of the programme was admirably carried out, and a pleasant afternoon was spent, the fine scenery being greatly admired. When it was beginning to get dark we moved towards Coney Island so as to witness the lighting effects of this remarkable pleasure ground. The illumination is on a lavish and gigantic scale, the ballroom buildings, towers, water-chutes, &c., being studded with thousands of lamps, picking out every detail and throwing a light of almost noonday brightness everywhere throughout the grounds. One newly-opened pleasure park called "Dreamland," in which most of us spent the evening, actually takes about 2,000kw. from the Brooklyn Edison Co., and has a special sub-station of its own.

Monday, September 5th.

After the frivolities of the trip to Coney Island on Sunday evening, the substantial programme of electrical sight-seeing for Monday was in marked contrast. Nevertheless, the majority of the members appeared at the point of departure at 9:30, prepared to grapple with the colossal task of inspecting all the principal generating stations in New York City in one day. The first installation to be visited was the subway and its plant. The subway system is ultimately intended to traverse the whole city along the principal traffic routes, but in the meantime only that running under Broadway has been completed, and even this is not yet open to the public. In fact, the train conveying the party of foreign and American engineers was the first that had passed through, except for the ordinary trial runs.

Its construction was mostly done by opening the roadway, there being only the thickness of girders and arch between it and the surfaces. There are four tracks for the greater part in the same subway, on two of which there is a local service to every station and on the inner tracks an express service, with stoppages at four principal stations. The local trains will run with a one-minute and the express trains with a two-minute headway.

During the journey much interest was displayed in the fireproof car constructed of aluminium, but, curiously enough, fitted with wooden window frames and bamboo seats. The party were safely conveyed to Fifty-ninth-street, at the North River end of which is situated the power house. It is designed for a capacity of 60,000kw., of which nine 5,000kw. sets are already installed. They are of Allis-Chalmers-Westinghouse build, and furnish three-phase current at 11,000 volts and 25 ~.

The boilers are arranged in independent sections, with a smoke stack to each, of which five are already erected. They number 60 in all, placed in two parallel rows in one boiler house having a central firing aisle. The coal conveyor runs through a tunnel direct to the wharf.

The condensers are of the barometric type seldom seen in Great Britain, but apparently very popular in the United States. In this condenser there is a column of about 34ft. of water supported as a barometer in a closed pipe, and above its surface the Torricellian vacuum chamber is expanded out into a conical shape. Into this chamber are led the exhaust steam and the circulating water pipes. The condensing water practically rises to the necessary height owing to the vacuum, and only a small pump is required to give it the requisite flow. The steam and cold water spray mix in the vacuum chamber and as the resultant condensed volume tends to increase the height of water supported in the pipe by barometric pressure, a corresponding quantity of water is expelled at its lower end into the hot well.

In the engine room itself the arrangement of the Allis-Chalmers sets is well worth noting. Each has a straight shaft with crank discs at each end, and with the revolving field-magnet mounted centrally between the two halves of the engine. A high-pressure piston working horizontally and a low-pressure piston working vertically are attached to each crank disc, the connecting rods being attached side by side to one crank pin. The crank pins at each end are placed at 135deg. from each other and thus the impulses tend to give a very uniform rotative effort. The alternator frame is made in six sections bolted together, having a small removable segment at the top of the ring to enable the field coils to be individually removed, if necessary. The 11,000-volt windings are insulated with micanite, paper, &c., and placed in partially closed slots, there being four slots per pole per phase and three bars in each slot.

The rotating field-magnet wheel is built of steel discs, the diameter to the outside of the poles being 32ft. The windings consist of copper strip wound on edge, one layer deep, with insulation cemented between the turns. The electrical efficiency is 96·7 per cent. at half-load, 97·87 per cent. at full load, and 98·15 per cent. at 25 per cent. overload.

The switchboard operating room was inspected with the keenest interest by the members. The general arrangement employed is the oil switch of the G.E.C. make, similar to that seen in the Boston station, together with a system of relays for releasing the working springs and a motor for recompressing them. Here, however, the apparatus was actually at work, and could be traced out in detail more intelligibly. Two small indicating lamps placed on the operating board are provided for each oil switch, and are wired to its contacts so that a red light shows the switch to be closed and a green light its open position. In accordance with the best modern practice, each phase of the circuit is isolated in a brick cell, the switch consisting of two brass cylinders partly filled with oil. A double break is made on each phase, while auxiliary contacts carry the heavy working currents and the oil-break portion only comes into operation when the switch has to be opened or closed.

It would be quite impossible to give details of value connected with all the power houses we visited in New York, but the above notes on the Fifty-ninth-street station may be taken as representative of the limits of progress at present reached there in the laying out and equipment of large power houses. Our next move, according to the programme, was to take a steamer up the Hudson river to the Kingsbridge central station, from which the electric street trams are driven. On the way up a very fine exhibition was given by one of the harbour fire steamers of the length and strength of its numerous water jets. The Kingsbridge plant is placed near a wharf on the Harlem river, through which our steamer now passed. This joins the Hudson and East rivers, and completes the waterway surrounding Manhattan island. Some time was spent in going round this station, and then the steamer proceeded on its way via the East river to the Seventy-fourth-street station belonging to the Interborough Rapid Transit Co., who own the subway. It is chiefly used for driving the electric trains on the elevated railways, but interchange of current as occasion demands can be made between all power houses of the Interborough Company. Our hosts, with the kind intentions of the town resident who wishes his country cousin to see "all the sights" in one day, had planned a visit to yet another power plant of the tramway company at Ninty-sixth-street. This they mercifully decided to omit, and our steamer proceeded as far as Seventy-sixth-street, where we disembarked to make a rapid examination of the equipment. This is practically identical with that installed in the more recent station at Fifty-ninth-street, of which we have already given as much detail as is possible. It certainly was an impressive sight, however, to see the eight 5,000kw. Allis-Chalmers sets in full service.

Those of the party who were not yet satiated with these big things in central station practice continued their journey by water to the Thirty-ninth-street station of the Edison Company, where, like most of those bearing Edison's name in Chicago, Boston, &c., it has now been decided to instal in it three 5,000kw. Curtis turbines. Probably more uniformity in this direction might have been secured, but the rapid development of the business necessitated some vertical engines being installed before the successful evolution of the Curtis turbine.

In the evening all the visiting members from England, Italy, France and Germany were invited to a banquet in the Waldorf-Astoria Hotel. The arrangements were carried out with the

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greatest care, and culminated in a most successful and enjoyable evening. Many of the most eminent men in matters electrical on the American continent were present, including Mr. Bion J. Arnold, the president of the American Institute of Electrical Engineers, Profs. Elihu Thomson and Crocker, Messrs. C. A. Coffin, T. C. Martin, Chas. F. Scott and J. W. Lieb. The menu cards were artistically got up to remind us of Franklin's historic kite, string and key experiment, and later in the evening each guest was presented with an excellent little bust of the great philosopher. President Arnold proposed the health of the delegates from abroad, this being replied to by Mr. R. K. Gray, Prof. Ascoli, and Herr von Siemens, in their respective languages. Further complimentary speeches were made by Prof. Elihu Thomson, Mr. C. A. Coffin, and Mr. J. W. Lieb, while Prof. John Perry, in a racy and humorous fashion, replied on behalf of the toast of the progress of electrical science, in which he did not fail to have a thrust at his arch-enemy 4π.

This closed our doings in New York, the successful character of which was largely due to the earnest and hearty efforts of the chairman of the Reception committee, Mr. J. W. Lieb.

Tuesday, September 6th.

The following morning an early start was made for Schenectady. In fact, the lateness or the conviviality of the evening is not made any excuse by our hospitable entertainers for any curtailment of our programme of instruction and amusement. A special train, consisting of Pullman cars, was assembled for us at the New York Central station, and this is designed to be our moving headquarters for a whole week. The journey to Schenectady, taking us, as it did, through some of the most beautiful scenery in the Eastern States along the banks of the Hudson river, proved most enjoyable, especially as the hot weather experienced in New York had changed to a much lower temperature. In about three hours we arrived at the town of Schenectady, where from the railway we could see the extensive area of the G.E. Co.'s works. Further mention of them must, however, be postponed until another issue.

(*To be continued.*)

THE WILLESDEN POWER HOUSE OF THE NORTH METROPOLITAN ELECTRIC POWER SUPPLY CO.*

Although the Willesden power house, which we are about to describe in this article, now forms one of the two large stations furnishing the "bulk" supply of the North Metropolitan Electric Power Supply Co., it was originally built for the requirements of the Willesden Urban District Council only. The Council obtained a provisional order in the ordinary course in 1898, with the intention of carrying out its own electric lighting. There was some delay for local reasons in the early days of the scheme, but finally Mr. E. T. Ruthven-Murray, who was appointed electrical engineer to the Council, succeeded in obtaining the Council's approval of the station and distributing system designed for serving the large area of Willesden. Mr. Ruthven-Murray's original scheme included an extensive network of tramways, but these were not sanctioned by the ratepayers. Although at the time this appeared to be short-sighted policy, Willesden being a scattered district in which tramway communication is badly needed, the action of the ratepayers has proved in the end to be beneficial to the district, for now it is to have tramways, but these are to form a part of the large network laid down by the Middlesex County Council and leased to the Metropolitan Electric Tramways (Ltd.). Towards the end of 1902, shortly before the works were completed, the Willesden Urban District Council were approached by the North Metropolitan Electric Power Supply Co., who offered to take over the new works on favourable terms, and, while utilising them for other portions of the company's area, to supply the Willesden Urban District Council "in bulk" on very favourable terms. The offer, particulars of which will be found in *The Electrician*, Vol. L., p. 1,073, was accepted by the Council, and the works were transferred to the company in February last.

The Willesden Urban District covers about 7 sq. miles, and is, roughly, in the form of an equilateral triangle. In one-third of this area, still entirely rural, there is as yet no demand for electrical supply, while the remainder may be divided into two parts of maximum density, separated by a purely residential district. As there was a good site for the electricity works in the centre of one of the dense sections of the area, the "double-current" system of generation and distribution offered an excellent means of supplying the district efficiently. The works have been erected at Taylor's-lane, Willesden, and supply Willesden proper and Harlesden with continuous current on the three-wire system. High-pressure three-phase current is transmitted to a large rotary converter sub-station in Salusbury-road, Kilburn, which is approximately at the centre of the second area, comprising Cricklewood, Willesden Green, part of Kilburn and Brondesbury. As the day loads are small, and a single 300kw. machine is sufficiently large to deal with them for several hours of the day, the generators are of the "double current" pattern, capable of supplying continuous or alternating current simultaneously. The continuous current is generated directly at a pressure of from 490 to 540 volts, suitable for the 2×240-volt network surrounding the works, and this fixes the average pressure at the alternating-current terminals of the same generator at 316 volts, the machines being, as it were, rotary converters driven by engines. Step-up transformers with a ratio of 1 : 9 are employed, raising the pressure to an average of about 2,850 volts, at which it is transmitted to the sub-station. There variable-ratio step-down transformers and rotary converters once more reduce the pressure down to that suitable for a 2×240-volt three-wire continuous-current distribution.

Having now briefly outlined the general system, we will describe the generating station in detail, as there are many interesting novel features in connection with it. The site, 3¼ acres in extent, adjoins the Midland and South-Western Junction Railway, to which access can be gained from all the great northern lines. In Fig. 1 it is seen that there is large space available for extensions, representing 2½ times the present length of the engine room. At present the boiler house is on one side of the engine room, while the offices, battery room, workshops, testing room and stores occupy the opposite wall. If, as is not improbable, future extensions will be by means of turbo-driven units, boilers will be placed each side of the extended engine room, the boilers on each side being connected to alternate engines. In this way the entire boiler house on one side could be shut down at light loads. The buildings are of pressed red brick with blue brick and stone dressings, and present a handsome appearance without any unnecessary ornamentation. The walls of the boiler house, engine room and battery room are lined with white glazed bricks throughout, and the boiler house and engine room are both lighted from extensive skylights extending the entire length of the rooms. The engine room has a lantern light in addition, and there are end windows both in the engine room and boiler house. The latter is exceptionally well lighted. The switchboard gallery runs along the side of the engine room, opposite the boilers, and can thus be approached independently from the offices. It is entirely of fireproof construction, the concrete platform being carried on a steel framework.

A siding for coal trucks branches off from the railway line, and coal is shot straight from the railway trucks into the three bunkers seen in Fig. 1. The bottoms of the bunkers, which are just above the level of the boiler house floor, are closed by sliding doors. Coal is taken from these as required into trucks, which run along an 18in. tramway into the boiler house, and deposited on the floor of the stoke-hold for immediate use. The labour involved in this operation is so small that the addition of a coal conveyor is not warranted. The bunkers store about 100 tons of coal, and the spare space in the boiler house is at present utilised for the storage of large coal which would deteriorate if exposed to the weather. Mechanical stokers are not provided either, but the boilers are arranged so that chain-grate stokers can be fitted at a subsequent date if desired. Beneath the boiler house a subway

* Descriptions of the Brimsdown power house of the North Metropolitan Electric Power Supply Co. and of the electric tramways in the North of London, to which they supply energy, were published in *The Electrician* for July 29th, August 12th, 19th and 26th and September 2nd.

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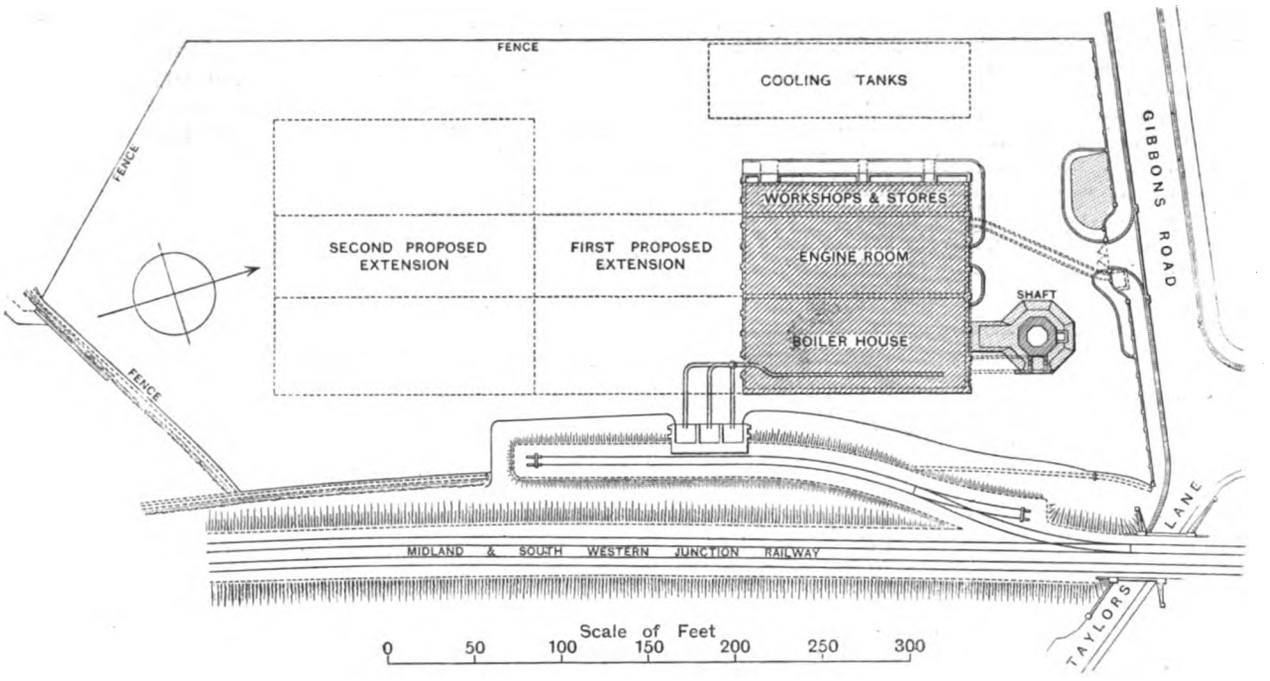

FIG. 1.—GENERAL GROUND PLAN OF WORKS.

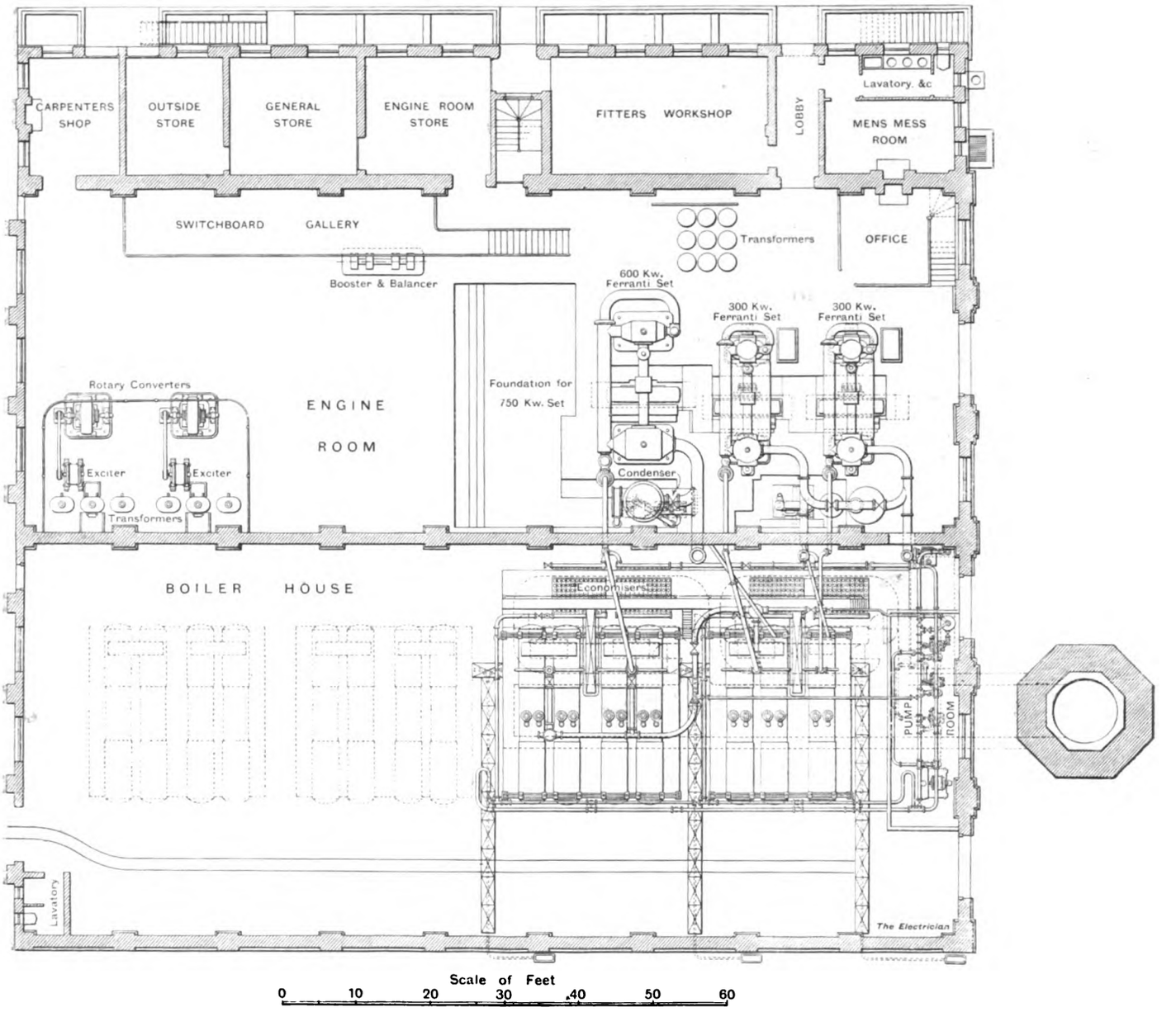

FIG. 2.—PLAN OF BUILDINGS, SHOWING POSITION OF PLANT, ARRANGEMENT OF STEAM MAINS, &C.

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has been built which will be utilised at a later date for the removal of the ashes, and from here also access to the main flue is obtained for cleaning purposes.

There are four Babcock and Wilcox boilers, arranged in pairs. Three are double-drum boilers with an evaporative capacity of 12,500lb. per hour each, from and at 212°F., and the fourth is a smaller boiler, with an evaporative capacity of 5,800lbs. per hour. They are built in glazed brick settings, the extra capital cost of which, Mr. Ruthven-Murray contends, is far more than compensated for by the decrease of air leakage and radiation. The boiler pressure is 180lbs. per square inch. Superheaters of Messrs. Babcock and Wilcox's usual pattern are fitted within the boilers.

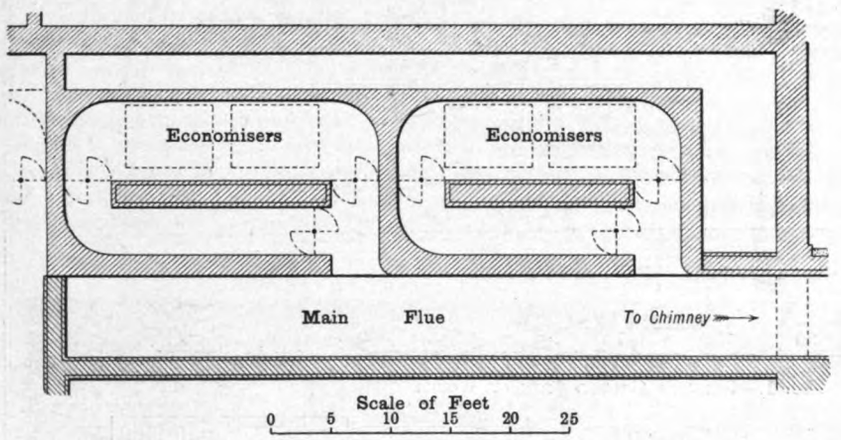

FIG. 3.—SKETCH OF ARRANGEMENT OF BRANCH FLUES FOR ECONOMISERS.

The arrangement of the economisers and flues calls for special mention. Instead of grouping the economisers all together in the main flue, a small economiser (of 192in. tubes) is placed in a branch flue in connection with each boiler. The disposition of these flues is dotted in Fig. 2, which has been specially prepared for this article with the assistance of Mr. Ruthven-Murray, and the sketch Fig. 3 makes the arrangement quite clear. By means of the swivel dampers, dotted in Fig. 3, any one of the economisers can be put out of commission for cleaning or repairing while its boiler is still in use, and in the meantime the connection of the other economisers with the boilers remains undisturbed. The economisers are by Messrs Green & Sons.

Each boiler is fitted with a draught gauge (supplied by Messrs. Wallach Bros.), which is of considerable assistance to the stoker in enabling him to keep his furnaces in good condition.

Another useful accessory is an "Ados" registering CO_2 recorder (supplied by Messrs. Sanders, Rehders & Co.), which is connected to the main flue or to any boiler at will. This apparatus, which was illustrated in our issue of November 13, 1903 (p. 145), depends on the fact that CO_2 is absorbed by a solution of caustic potash, while the other gases are not. A "motor," which is practically a miniature gasometer and valve driven by the partial vacuum in the chimney, raises and lowers a bottle of glycerine every five minutes and also pumps some of the flue gases into a measuring tube, in which exactly 100 cubic cm. of the gas is trapped with each stroke by the rising and falling of the glycerine. This gas is then driven into a vessel containing the caustic potash solution where the CO_2 is absorbed, the remainder displacing a corresponding volume of the solution. This increases the pressure in a third vessel and raises an inverted cylindrical vessel or "bell" within it, causing a motion of the pen through a simple lever. A chart revolves by clock-work and the pen traces a line on it every five minutes corresponding in length to the proportion of residual gases after the CO_2 is abstracted. Thus the curve so formed, if the chart is inverted, shows the proportion of CO_2 in the flue gases. The apparatus, although somewhat complicated, appears to work well, and the results are of considerable utility in effecting economy in the boiler house.

Two Hall steam feed pumps and one Mather and Platt electrically-driven pump are placed in the pump room, which is partitioned off from the boiler house by a glazed screen. The Hall pumps are capable of supplying 3,500 gallons per hour, and the Mather and Platt pump 2,000 gallons per hour. The latter is driven by a 6½ H.P. electric motor at constant speed, and the regulation is effected in an ingenious manner. The pump itself has three cast-iron cylinders mounted radially on a cast-iron frame at angles of 120deg., like the cylinders of a Brotherhood engine, the plungers, which are of gunmetal, being driven from a common crank-pin through mild steel connecting rods and ball and socket joints. Regulation is effected by varying the stroke of the pump, as explained in the diagram Fig. 4. The crank-pin A is fixed excentrically on a disc, B, fitting into a recess in the hub of a toothed driving wheel, C, which is driven by a pinion, D, on the shaft of the electric motor. This recess is itself placed excentrically to the periphery of the toothed wheel C, and thus, when the disc B is rotated by means of gears situated in the hub, the crank-pin A is caused to move in a circle (0—1, 2, 3, 4); at one point (the highest in the diagram) of this circular course the crank-pin will be at its maximum distance from the centre of revolution of the toothed wheel, and the plungers will, therefore, perform their full length of stroke; at the opposite point of the circle (0) the crank-pin will be concentric with the centre of revolution of the toothed wheel, and, consequently, will have no action on the connecting rods of the plungers.

The gear which turns the crank disc, as explained above, is an essential feature of the pump. The crank-pin is hollow and there are two brake drums at the end. These move excentrically, parallel to the crank disc, but by tightening the brake strap on either brake drum it revolves in relation to the crank-pin. The inner periphery of each disc is connected by "sun-and-planet" gear to a spindle within the hollow crank-pin, so that this spindle will revolve within the crank-pin to the right if one brake strap is tightened, and to the left if the other is tightened. This spindle gears into the disc at its other end, and thus causes the latter to turn. The brake straps are controlled by the same lever, which, if moved upwards, tightens one of them, and if moved downwards tightens the other.

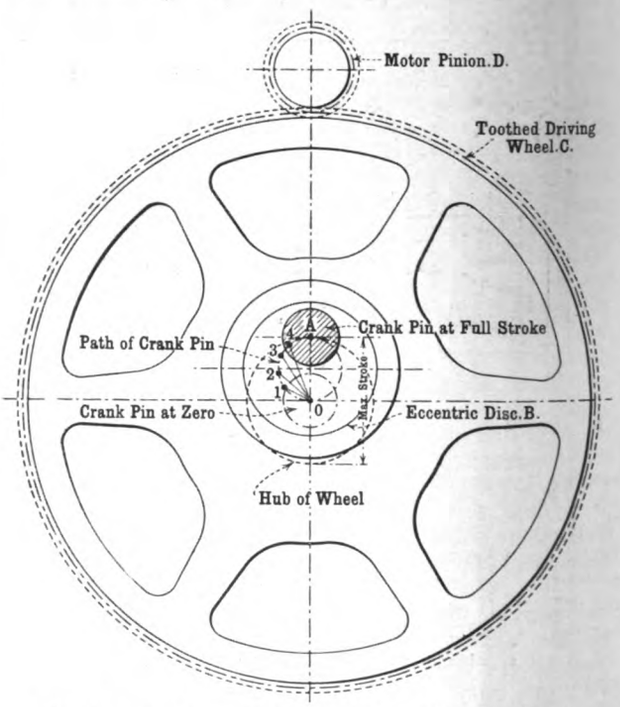

FIG. 4.—DIAGRAM SHOWING PRINCIPLE OF REGULATION ON MATHER & PLATT FEED PUMP.

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The motor is shunt-wound and runs off the 240-volt continuous-current circuit, its speed being 550 revs. per min. and that of the pumps 80 strokes per min. The feed pumps were all supplied through Messrs. Babcock and Wilcox, who were contractors for the whole of the boiler house plant and the steam range. A duplicate feed range has been erected, and the practice followed is to keep both ranges under pressure, one hot and one cold.

The arrangement of steam mains is novel, and is clearly shown in the plan (Fig. 2) and the photographic view (Fig. 4). Each boiler serves one engine directly, with the exception of the two new boilers which are destined for the new 750kw. Brush set that has not yet been erected. The equaliser main does not run straight across the boilers, however, but is made up of separate lengths serving two boilers, one above the back of the boilers, the next over the centre, and so on. These are joined by a connecting piece at right angles to them through wide bends. This allows ample room for expansion of the pipe without the intervention of expansion bends, and it is the regular practice at the works to shut off the equaliser main when it is not required, in spite of which no trouble is experienced with the joints. To guard against water-hammer, a separator is placed at each connection between the equaliser main and the boiler, in addition to the separator placed, as usual, at each engine. The piping is of steel throughout, the main pipes being 6in. or 7in. in diameter, and the equaliser 7in. Together with the boilers they are completely lagged in a very neat manner with slag wool enclosed in steel sheet coverings, Messrs. Jones & Horsfield having been the contractors for this work.

Fig. 6 is a general view of the engine room taken before the erection of the 600kw. set, and Fig. 7 shows one of the 300kw. sets. These three sets consist of compound Ferranti engines driving Westinghouse double-current generators. It will be noticed that, contrary to the usual arrangement, the low-pressure cylinders instead of the high-pressure cylinders are nearest the boiler house. This puts the condensers in a convenient position against the wall of the boiler house, and there is, moreover, practically no extra length of steam main, as this is carried from the separator to the high-pressure cylinder through the receiver between the two cylinders, which is thus heated with live superheated steam. The engines follow in other respects the standard lines adopted by Messrs. Ferranti. An even turning moment was specified, the irregularity not to exceed $\frac{1}{2}$ of one per cent. per revolution, and a specially heavy flywheel has been provided, weighing 11 tons in the case of the smaller sets and 15 tons on the 600kw. set. The engine speeds are 250 and 214 revs. respectively, the number of poles on the generators being 12 and 14 respectively for a frequency of 25 ~ per second. The generators resemble continuous-current machines rather than alternators, but, of course, the pole-pieces are laminated, and they are also fitted with damping coils. The armatures (which are slot-wound) revolve, and the field magnets are fixed. At present the machines run as shunt machines, but there is a compounding series winding which can be included in the circuit. The switch for this is placed on the frame of the machine in the generator pit. Separate exciters are provided, but at present it is found that the machines work well with shunt excitation. In fact, it it were not for the three slip-rings adjoining the commutator, the machines might be taken for ordinary continuous-current railway generators. They are amply dimensioned, and one of the 300kw. machines has been run at over 400kw. last winter for several hours at a time every evening without giving the least trouble, and supplying both continuous and three-phase alternating current simultaneously. A fourth set (750kw.) made by the Brush Electrical Engineering Co. will be put in shortly.

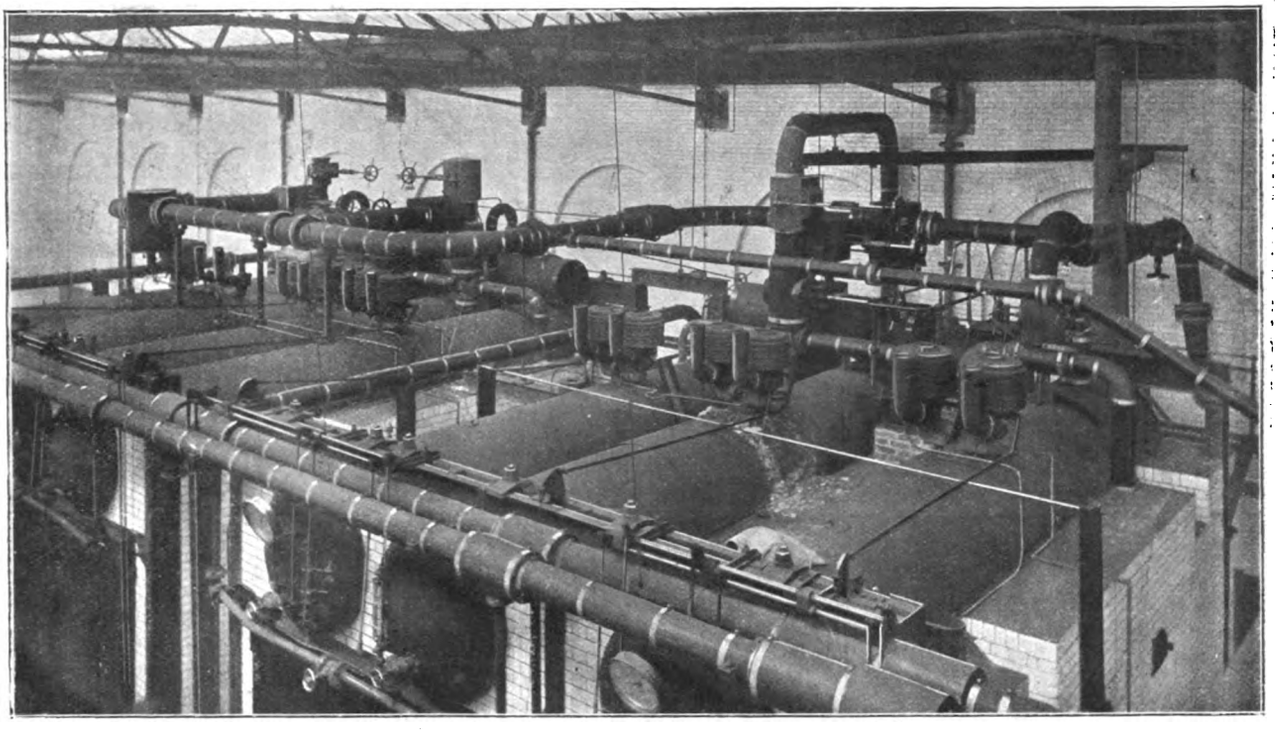

Fig. 5.—View of Steam Range.

A jet condenser (supplied by Messrs. Ashton, Frost & Co.) is provided for the two 300kw. sets, while the other sets will each have their own surface condenser. The jet condenser is capable of dealing with 12,000lb. of steam per hour, or 15,000lb. on emergency. The engine exhaust passes through a baffle-plate oil-separator into the condenser. Thence the water passes to a cooling plant, supplied by Körting Bros., on which there are four lines of spraying jets. The surface of the pond is 30ft. × 200ft., and it is capable of dealing with 100,000 gallons of water per hour, which is the storage capacity of the pond. The feed-water is taken from the outlet from the condenser to the hot well. A Kennedy water-meter is connected on the pressure side of the feed pumps. All the water is softened in a Bruun-Lowener water softener (supplied by Messrs. Lassen and Hjort) placed in the boiler house. In this apparatus the water is treated with milk of lime and soda. The water first passes to a receiving tank in two compartments. It fills one of these and then the tank tips over, bringing the second compartment below the water pipe. This

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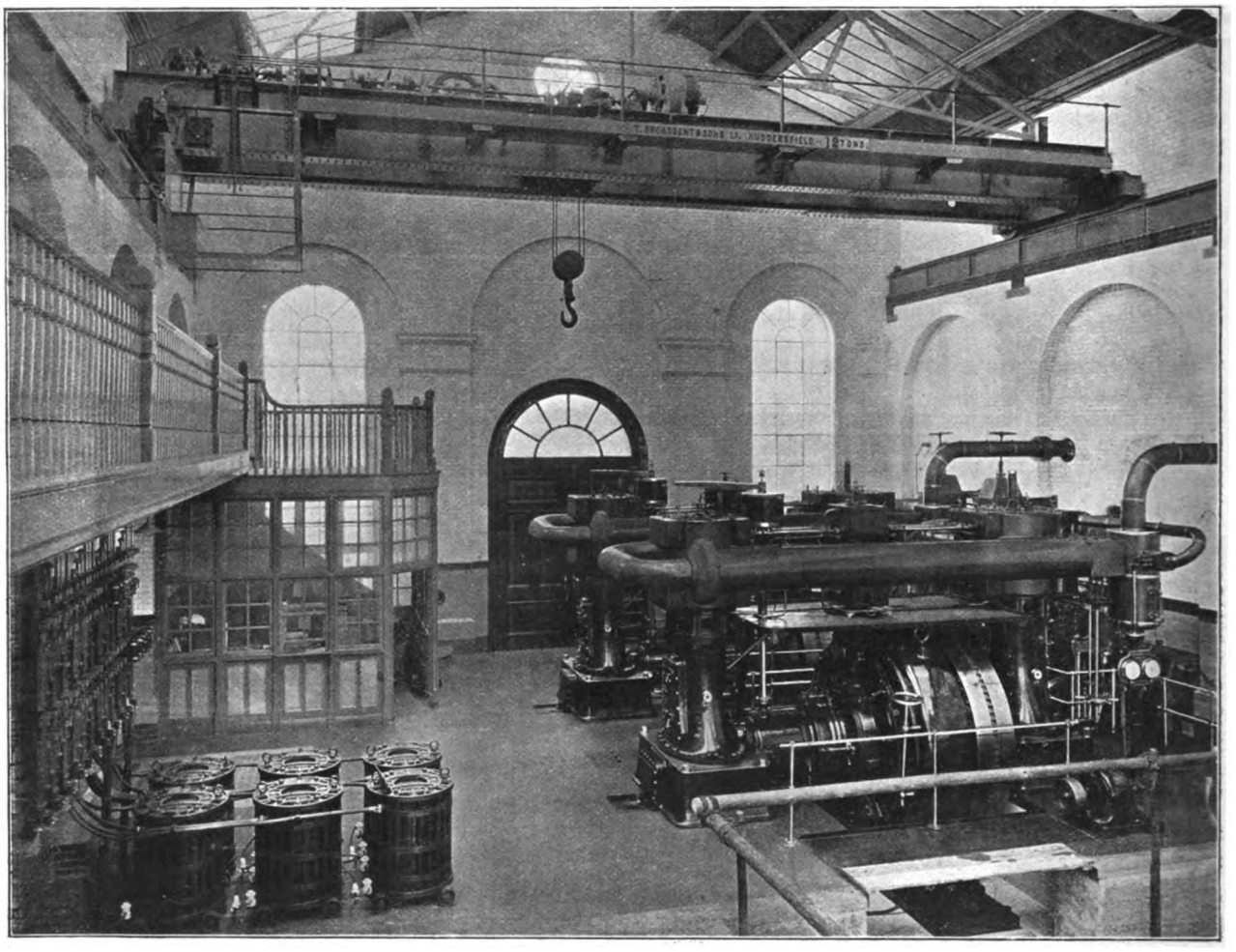

FIG. 6.—GENERAL VIEW OF ENGINE ROOM.

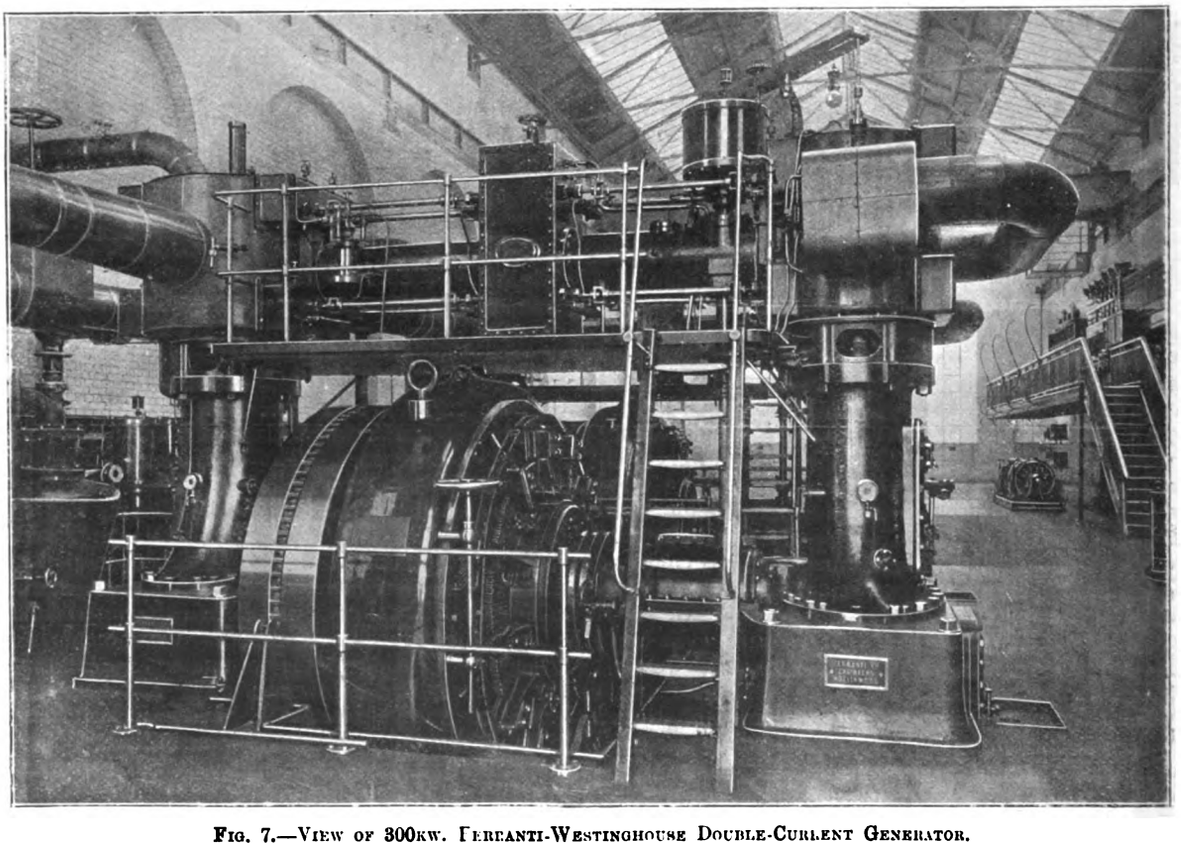

FIG. 7.—VIEW OF 300KW. FERRANTI-WESTINGHOUSE DOUBLE-CURRENT GENERATOR.

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$r=0$ the rise is the perpendicular at $t=0$. The value e becomes then instantaneously established, but in all other cases this is not reached before $t=\infty$. The student will find it alike interesting and instructive to construct other examples for himself, plotting the curves with the aid of the table given.

For the speed with which the displacement of electricity into the cable occurs, or in other words the current, we have fundamentally

$$C=\frac{e}{r+\left(\frac{R}{Sp}\right)^{\frac{1}{2}}}.$$

There is, however, no occasion for the development of this, since we have already ascertained the potential V at the beginning of the cable, and obviously $C=(e-V)/r$. At $t=0$, when the key is depressed, the value, as V then $=0$, is simply e/r. It thereafter decreases as V rises, so that it is evident, on Fig. 2 being inverted, the curves become illustrative of the current in percentages of its commencing value e/r. It is, however, preferable to plot the curves independently. Thus, the ordinates in Fig. 3 being percentages of e/r, curve 2 illustrates

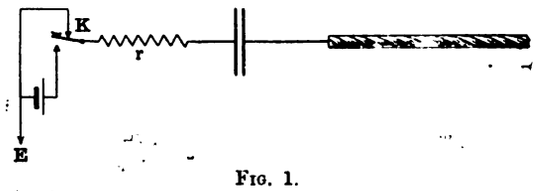

Fig. 1.

the current entering the cable in cases where $Sr^2/R=0{\cdot}00031846$, as, for example, when r has the value of 100ω with cable A, 41·137ω with B, and 618·18ω with C. Curves 3 and 4 show the result when r is increased to $2r$ and $10r$. Curve 1 is given for purposes of comparison, it is representative of the current when $r=0$, in which case the values fall simply from the commencing one of ∞ with the square root of the time.

The quantity of charge that has entered the cable in a given time is dependent upon the mean current during that time. The areas enclosed therefore by the limiting ordinates and the curves illustrate the quantity of charge in the cable at

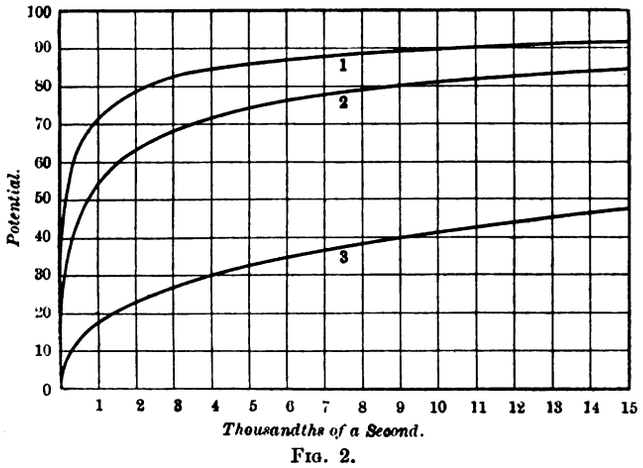

Fig. 2.

$t=0{\cdot}015$ sec. On comparison of those bounded by curves 1, 2 and 3, it is now to be observed that, notwithstanding that the commencing speed of entry varies inversely as the resistance r, the quantity of charge at $t=0{\cdot}015$ sec. is not very greatly affected, and, at still later periods, it becomes less and less so. In the foregoing examples the resistance r may be regarded as being inserted either between the battery and the cable, or the earth and the battery, or, again, as appertaining to the battery itself. It may be, therefore, justifiably concluded that in cases of signalling where the periods of battery contact exceed that illustrated, the battery resistance is not of much moment. Indeed, under such circumstances, as a matter of practice one might say that, instead of reducing the battery resistance to a minimum, as it has sometimes been the custom to do, a moderate amount may be actually beneficial, since by this means the commencing output is reduced. For, although this is of but momentary duration, and, consequently, not of much account as regards a single contact, when, as in signalling, there are a great number rapidly succeeding each other for a protracted period, the polarising effect upon a primary battery and the resultant loss of E.M.F. may, and does, require to be considered. While, as is seen from Fig. 2, the resistance has some additional slight advantage in that it reduces (with a limited period of contact) the potential value reached, and the stress, therefore, to which

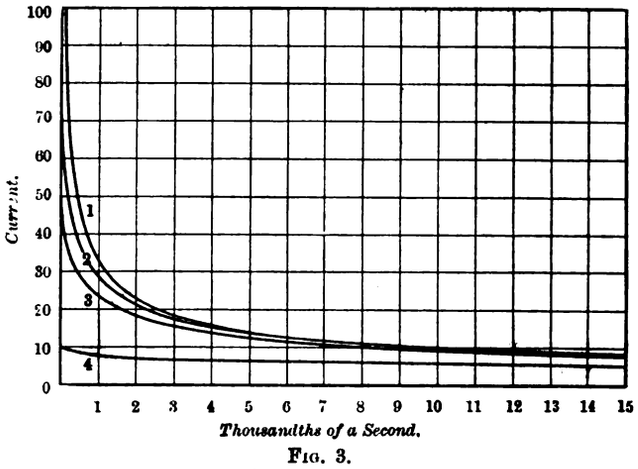

Fig. 3.

the cable's dielectric is subjected. Should the battery resistance be of the value ρ while the resistance r remains, we have, of course, simply to substitute $\rho+r$ for r in the expressions above.

In balancing two cables one against the other, on the resistance-bridge principle, as shown in Fig. 4, in order that the instrument through which the beginning of the one is connected with that of the other, may not be affected after depression of the key, we have to arrange that the potential values at these points shall be at all times equal. Calling V the potential at the junction of ρ, r and r_1, v that at the beginning of the upper cable, and v_1 that at the lower, we have (following the ordinary laws)

$$v=\frac{V}{\left(\frac{Sr^2p}{R}\right)^{\frac{1}{2}}+1} \quad \text{and} \quad v_1=\frac{V}{\left(\frac{S_1r_1^2p}{R_1}\right)^{\frac{1}{2}}+1}.$$

But to effect a balance it is necessary that $v=v_1$, consequently matters must be so adjusted that

$$r/r_1=(RS_1/SR_1)^{\frac{1}{2}}.$$

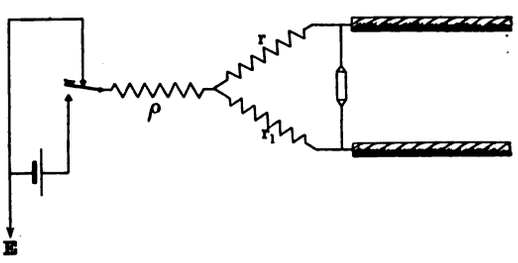

Fig. 4.

The resistance in the battery circuit being ρ, if we express v in terms of e, we now have

$$v=\frac{e}{\left(\frac{Sp}{R}\right)^{\frac{1}{2}}\left\{\rho\left(1+\frac{r}{r_1}\right)+r\right\}+1}.$$

Were the lower cable and r_1 disconnected from the circuit we should have

$$v=\frac{e}{\left(\frac{Sp}{R}\right)^{\frac{1}{2}}(\rho+r)+1}.$$

Their presence in the circuit in the manner shown has the effect accordingly of reducing the speed with which the potential rises to the same extent as a simple increase of the resistance ρ to $\rho\left(1+\frac{r}{r_1}\right)$ would have when they are absent.

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When both cables are of the finite lengths l and l_1, and have their distant ends to earth, the final values of v and v_1 would be respectively $\frac{V}{\frac{r}{Rl}+1}$ and $\frac{V}{\frac{r_1}{R_1 l_1}+1}$, and for the preservation of the balance these also must equal each other. We must so arrange, therefore, that $r/r_1 = Rl/R_1 l_1$. In practice, the lower, or balancing, cable would probably take the well-known "artificial" form.

To effect a perfect balance under such circumstances we have, accordingly, to observe two conditions:

1. That the resistances before the cable and artificial line are directly proportional to the square root of their respective core ratios.

2. That they are also in direct proportion to the total resistances of the cable and artificial line beyond them.

The relative importance of these conditions in signalling varies according to the values of the core ratio R/S and the length l. If, as is generally the case in submarine telegraphy, the former is small and the latter great, then (1) is of the higher significance; on the other hand, as with overhead land-lines, if R/S is great and l small then (2) requires to be more closely complied with. Obvious practical requirements necessitate that r should be of some magnitude, so that the satisfaction of 1 will be effected by the adjustment of r_1, while that of 2 will be obtained by the employment of a suitable length of artificial line.

The resistance of the cable in the commencing moments (or at any time if of infinite length) we have hitherto regarded as $(R/Sp)^{\frac{1}{2}}$, signifying that at $t=0$, when the key is depressed, it is of zero value. Were there no property present beyond those of resistance and capacity, this would be strictly correct. Of the existence of a third we seem, however, in duplex balancing to have practical evidence. No matter with what care the two foregoing conditions may have been conformed to, it is invariably found that the potential at the beginning of the artificial line will not commence its rise as quickly as that at the beginning of the cable. It seems likely that this results from the resistance of the cable being not truly $(R/Sp)^{\frac{1}{2}}$, but more accurately $\left(\frac{R+Lp}{Sp}\right)^{\frac{1}{2}}$, where L is the inductance per unit length. It follows, therefore, that not only must the potential at its beginning acquire a finite value to start from at $t=0$, since the resistance is not then $=0$, but $(L/S)^{\frac{1}{2}}$, but it also rises more quickly than it does at the beginning of the artificial line, the inductance of which is relatively negligible.

To quicken the rise on that side of the instrument, it is a general practice to insert a resistance (customarily of the order of tens of ohms) either before the beginning of the line, or—what has the same effect—between its "sheathing" side and the earth. Since this hastening of the rise on the artificial line side is found thus necessary, it will be understood that the desired result may be equally well achieved by correspondingly delaying that on the cable side of the instrument. This may be done by connection of a condenser of small capacity in parallel with the beginning of the cable. It is, however, questionable whether a better approximation to a *perfect* balance would not be obtained if, instead of the adoption of either of these expedients, a small amount of inductance were incorporated into the beginning of the artificial lines.

(To be continued.)

Opening of Holyhead Electricity Works.—These works, which have been erected in conjunction with a refuse destructor by the National Electric Construction Co. under an agreement with the local authority, were formally opened on Friday last. A provisional order was obtained in 1902, and the total cost of the undertaking has been about £16,000. Lord Stanley of Alderley switched the light on and declared the works open after an address had been read by Mr. Robert Roberts, chairman of the Urban District Council. Mr. Price White, electrical engineer to the Bangor Corporation, has acted as consulting engineer on behalf of the Holyhead Urban District Council, and Mr. P. Williams is resident engineer.

ELECTRIC LIGHTING MATTERS IN DUBLIN.

Last week we gave an abstract of the various reports and letters written by Mr. R. Hammond and Mr. Mark Ruddle to the Corporation of Dublin relating to the condition of the electricity supply works of that city. Other reports relating to the supply in the original distribution area have subsequently reached us, and we give the gist of them below.

At a meeting of the Lighting committee, held on August 9, 1904, a report was submitted by Mr. Ruddle, city electrical engineer, calling attention to the urgent necessity of immediately taking into consideration the question of dealing with the old area, and stating that the question had been before the committee from time to time during the past four years. It appears that the committee instructed the consulting engineer to deal with the matter on November 17, 1903, also on March 31, 1904, and on May 31, 1904, and it was in view of the very short time at their disposal in which to make the necessary reconstruction, and to the well-known delays which always have to be allowed for in obtaining the various plant necessary, that Mr. Ruddle urged the matter upon the committee. On reading this report the committee ordered that a copy should be sent to Mr. Hammond, with the request that he should submit as early as possible a full report upon the various matters, and inform the committee what steps he advised in order to cope with the state of things referred to by Mr. Ruddle, and the following is an abstract of Mr. Hammond's report, dated August 22, 1904:—

OLD AREA.

When the Fleet-street works were in operation a supply of electricity was given only in what we now call the old area. Feeder mains radiated from the works to sub-stations at which transformers were installed for converting from 2,000 to 200 volts. At these sub-stations the distributing network was supplied. As the low-tension distributors became loaded up it was found necessary to reinforce them with additional mains, and a number of low-tension sub-feeders were put in. When the Pigeon House scheme was drawn the problem arose as to the best way to continue the supply in the old area, the old supply being a single-phase supply, while, of course, the new scheme involved three-phase distribution. If three-phase distribution had been introduced throughout the old area the whole of the existing mains would have been rendered useless, new mains would have been necessary, and a heavy capital expenditure would have been incurred. Such a course was out of the question and the utilisation of the old single-phase network was imperative. It was accordingly decided to divide the whole of the old area network into three sections and to connect one of the three-phases of the new supply to each section. Transformers installed at Fleet-street now take the place of the old generating plant. They receive their 5,000-volt supply from Pigeon House and transform it to 2,000 volts; transformers are connected in each phase, and they supply their corresponding section of the old area with single-phase current. The mains remain as they were before, so that under this arrangement no increase in capacity was made. The demand has increased in the old area to a most satisfactory extent, so much so that at the present time the old mains are more than fully loaded, and the transformers supplying them can also only deal with a small increase. Not only is this the case, but there are a number of further consumers who require a supply, and during the coming winter there is no doubt that it would be impossible to cope with the load with the old mains and their Fleet-street transformers.

I am glad to state, however, that there is no necessity for the least disquietude. The solution of the whole problem is not without complication, but if my recommendations are carried out there will be no difficulty in dealing, with not only the winter's load, but with the farther increase in the demand which will no doubt arise in the future, I may add, at this point, that my recommendations do not involve a heavy expenditure of capital, on the contrary, the expense will be small so far as provision for immediate requirements is concerned. In view of the fact that the transformers and the sub-stations are fully loaded, it is useless to increase the capacity of the old network by laying additional distributors or sub-feeders. However, provision has already been made by which a considerable load in parts of the old area may be supplied from the three-phase networks. Four-core distributors have been laid in some of the streets in which the old mains are overloaded. It would obviously be an extravagant policy to attempt to increase the capacity of the old mains by laying additional cables while there are new cables already laid in the old area which are at present but slightly loaded and in some cases quite idle. The solution of the whole difficulty is, in my opinion, as follows:—

1. To relieve the old mains of a part of their present load by transferring it to those three-phase distributors which are already laid (thus removing the congestion on the old distributors).

2. To deal with every new demand by three-phase mains.

In order to do this in the future, extensions of the three-phase system will, of course, be required, since the mains at present available can deal with a portion only of the old area. New sub-stations will be necessary as well as new distributors, and I refer further to these exten-

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sions below. These extensions will only be required when the demand has increased further, and the existing mains and sub-stations, with slight additions, will suffice not only for the coming winter but also for a few additional consumers. The solution of the difficulty outlined above, although simple in theory, will require some care in practice. The first point which must be decided in considering such a scheme is the way in which the old network should be treated. Should the existing arrangement of single-phase feeders and sub-stations be retained or not? I think that when the three-phase system of sub-stations and distributors is made to embrace the whole of the old area the better course would be to link up the existing low-tension mains with the three-phase mains, and so gradually eliminate the old single-phase feeders and sub-stations altogether.

In the preparation of a more detailed report it is essential that I should have access to all data bearing on the question of the mains, such as the records of the distribution of the load, lamps connected on consumers' premises, details of existing disconnecting boxes, sub-stations, maps, &c. The local knowlege of Mr. Ruddle and his staff would also be of great assistance to me. I shall be obliged, therefore, if the committee will duly authorise me and my partners to have access to all records bearing on the question, and to permit us to consult Mr. Ruddle and his staff as occasion may require. I need hardly add that I have no doubt Mr. Ruddle will be glad to give me every assistance, in order to conduce to the success of the undertaking, and I merely proffer the above request as a matter of form in order that it may be regularised by the committee's sanction.

In a further report (September 5th) Mr. Hammond states that—

It is essential that the load on the old mains should be lightened before the winter. The transformers which supply the old mains from Fleet-street were heavily loaded last year, and since then 2,671 lamps have been connected to the mains. It is true that the full capacity of the old sub-stations has not yet been reached, but, on the other hand, the distributors and sub-feeders which radiate from these sub-stations are more than fully loaded, and they can barely cope with the existing demand. In order to utilise to the full the transformer capacity of the old sub-stations it would be necessary to put down boosting apparatus to compensate for the heavy drop in the old sub-feeders and distributors, and also to instal additional transformers at Fleet-street. The expense would be greater than that involved in my recommendations, and I do not think that it is worth while spending money in this direction, in view of the fact that ultimately the old sub-stations will be supplanted, as already stated. The proper course, in my opinion, is to deal with the immediate requirements in such a way that the steps taken will form part of the complete scheme, and not to attempt to deal with the problem by means of temporary measures. Proceeding on this basis, it is necessary to begin the work of taking over the old area load on to the three-phase main at once, transferring a sufficient amount not only to correspond to the additional lamps connected during the year, but also sufficiently to relieve the old mains, that they will be able to cope with new consumers in streets where no three-phase main is yet available.

Mr. Hammond then proceeds to describe, in detail, his scheme for the transference of consumers from the old single-phase mains to the new four-core distributors, at the same time taking care that the balance is not upset thereby. He suggests cutting the old distributor and considers the laying of new four-core distributors necessary in certain instances, some of which appear to be extremely urgent.

A point has been raised as to whether the cost of the transfer of consumers from the old to the new mains, as proposed in Grafton-street and St. Stephen's-green, can properly be charged to capital. I think that the Local Government Board would permit it to be so charged, since the work is required in order that the new distributors may be fully utilised, and also in order that new consumers may be connected in streets not supplied by three-phase at present. A number of house services were made by the cable contractors under their contract, and these included similar transfers. However, the point is not of much importance, as the cost of the transfers would be small. The expenditure of £1,000 will suffice for present requirements, but there is no doubt that the satisfactory increase in the demand which has taken place will be continued in the future. In order to cope with the constantly increasing business, further expenditure on mains will have to be made year by year. A large expenditure in the immediate future is not required, and the work should be carried out, piece by piece, in proportion to the increasing demand.

Upon this report Mr. Ruddle has made the following comments:—

From the general tone of Mr. Hammond's reports it might be thought this problem was a new one, but the past records of the Lighting committee will show that the congested condition of the old area has been known to Mr. Hammond during the last four or five years, and it is therefore a matter for regret that he did not either make sufficient provision in transformers at Fleet-street for dealing with the natural demand, or that he did not from the first provide for three-phase mains, &c., being laid in this area sufficient to cope with the work, instead of leaving the matter practically untouched until the question has become serious. The question is serious from a financial and engineering point of view and the proposals now made are not a very satisfactory solution of the problem. Mr. Hammond considers it would be an "extravagant policy" to lay additional mains in the old area while there are new four-core cables already laid and at present lightly loaded, but I must point out that the four-core cables laid in Grafton-street, Sackville-street and Dame-street, were specially provided for the purpose of supplying three-phase motors in the old area instead of consumers in that area being confined to the use of single-phase motors only; his present proposals mean, practically, that these cables will be loaded up with transfers from the old single-phase cables instead of being free to supply additional consumers, and that before any appreciable number of fresh consumers can be taken on still further new mains must be laid.

The proposed patchwork method of cutting up the old cables is, in my opinion, a very wrong proceeding unless there is absolutely no other course open, as the result will be a most undesirable complication in the mains network, with consequent increased liability of breakdown and difficulty in maintenance, and it will not provide a permanent remedy.

Although the old mains are fully loaded in several districts, the immediate inconvenience to the consumers has been the extreme variations of pressure at times of heavy and light load which at present we have no means of obviating, and, therefore, as Mr. Hammond acknowledges, we cannot work up to the full capacity of the old sub-stations. Mr. Hammond would, in my opinion, have done better to have provided adjustable "boosting" apparatus as mentioned in the opening of his report of 5th inst., and the necessary transformers in Fleet-street to deal with the full capacity of the old sub-stations. Indeed, apart from the old area, this question of the variation of pressure and its regulation will have to be dealt with in connection with the entire distributing system, for at Fleet-street distributing station we have no means of knowing the pressure at any of the new sub-stations or the networks fed by them, nor any apparatus for adjusting the pressure when found necessary. The consequence is that, if the standard pressure is maintained on the heavily-loaded sub-stations, the pressure on the lightly-loaded ones is much too great, as the pressure on the 'bus bars at Fleet-street cannot be adjusted for the individual distributors. It is, therefore, essential that provision shall be made for maintaining the standard pressure in all parts of the area supplied, irrespective of the load at any point or at any period. It is to be regretted that Mr. Hammond has not been able to submit his proposals for dealing with the future requirements of the old area on permanent lines, as it would have been easier to judge how far his proposals for dealing with the present congestion would fit in. As, however, in his report he contemplates "eliminating the old single-phase feeders and sub-stations altogether," it is evident that to meet the future requirements of the old area a very large expenditure must be expected, and if, as I anticipate, some £25,000 at least must be expended in the near future for this purpose, it is important that whatever steps are taken now should not involve the expenditure of money which will not be permanently reproductive.

During the term of Mr. Hammond's supervision the necessity of dealing promptly with this matter has been pressed upon him by the committee and myself, and, had he taken the necessary steps, we would have had ample time to carry out the reconstruction in the most efficient manner. As it is, when his proposals are received we are within a month of our winter load coming on, a position we should not have been placed in. The carrying out of these proposals is not an easy task at this time of year. Almost the whole of the work will have to be executed at night, and the cutting out and joining up of the various sections will certainly have to be done after midnight, as it will be impossible to deprive sections of consumers of their supply during lighting hours. Special boxes will have to be designed in most instances to deal with the two classes of cables, and considerable difficulty will be experienced in finding room for these boxes in the already congested condition of the streets at the points required. The supply of cables, boxes, &c., cannot be expected in less than a month from the time of ordering, and the great care which must be exercised in the execution of the work must entail slow progress. It will, of course, be necessary to engage temporary technical assistance to supervise the detail carrying out of the work (especially as it must be mostly done at night), as the present distributing staff have their full work cut out in the service work for new consumers (which we have now taken over from the contractor's staff) and in the regular maintenance work of the undertaking, which, naturally, is heaviest during the winter months. In conclusion, I must say that had I been the consulting engineer in charge of the work I should have dealt with the problem upon different lines; but, as the responsibility rests upon Mr. Hammond, the committee will, I presume, in view of the short time now intervening before the winter's load comes on, carry out as much of the proposed work as is feasible under the circumstances.

After the consideration of these reports the committee recommended that they be empowered to carry out, under the directions of the city electrical engineer, the whole or such portions of the proposed works as might be absolutely necessary to safeguard the supply during the coming winter. The committee further recommended that they be authorised to apply to the Local Government Board for sanction to a supplemental loan of £1,000, being the estimated cost of the works set forth in Mr. Hammond's report.

The Osmium Lamp.—It is reported in the *Elektrotechnische Rundschau* of September 1st that the Auer Incandescent Gas Co., of Vienna, discontinued on August 1st the manufacture of osmium lamps, the reason alleged being that it was found impossible to overcome certain technical difficulties which prevented the lamp from becoming a commercial success.

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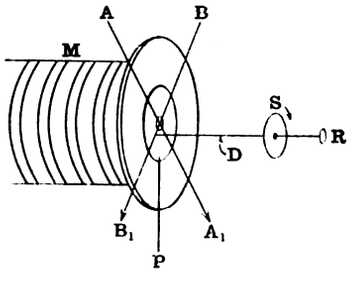
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Volta Effect.—W. Gaede describes a number of experiments designed to elucidate the dependence of the Volta effect upon chemical processes happening in the superficial layers of moisture or condensed gas attached to the metallic surfaces. He shows that the phenomena appearing in the electric battery, such as polarisation by the current, depolarisation by the chemical action of the medium surrounding the electrode, storage of electricity at the electrode, polarisation capacity, and electric double layers, may also take place at the surface of a metal exposed to air or other gases. The most obvious explanation is that based upon a film of water. The existence of a film of water has been made very probable by exact weighings, but Warburg and Ihmori have shown that on platinum this film must be thinner than 10^{-7}cm. The author's results show that there is a discontinuity of potential between a metallic surface and the surrounding gas, and that the difference of potential is of the same order as the Volta effect. In this way the results support the chemical theory. The author is investigating the effect of point discharges in modifying the Volta effect.

[W. GAEDE, *Annalen der Physik*, No. 9, 1904.]

Turning Moment in an Alternating Field.—H. Axmann has observed that when a soft-iron rod or wire, D, is placed in the field of a straight alternate current magnet, M, traversed by a current of some 15 amperes at 110 volts, in a horizontal position parallel to the lines of force, so that it approaches the pole P, but does not touch it, and is then fixed at R, it is subject to a certain turning force, which may be transferred to light objects attached to it. Thus a disc of cardboard, S, some



10cm. in diameter, loosely strung on by means of a pulley of diamagnetic material, is set in rapid rotation as soon as the current is turned on. If the free end of the wire is displaced in the direction AA′ the motion is left-handed, if in the direction BB′ it is right-handed. The speed is zero at the zero and beyond the circumference, and a maximum near the latter. The explanation must be sought in vibrations of the rod under the influence of the magnetic field.

[H. AXMANN, *Physikalische Zeitschrift*, September 1, 1904.]

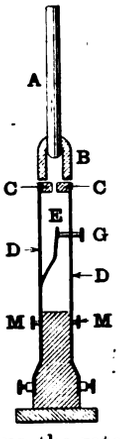
Permanent Electric Breath Figures.—H. Axmann has produced a new kind of electric breath figures by discharging from a metallic matrix on to a glass plate. One pole of a spark-gap of 50cm. discharging distance is connected with the edge of the glass plate, and the other with the metallic matrix. The direction of the current is immaterial. The matrix is pressed against the glass by means of a soft spring. The author thus succeeded in obtaining glass plates from which the figures could not be removed by any known cleaning process, and they have retained the same figures for 10 years. Under the microscope, the figures are seen to consist of numberless small drops of water clearly separated from each other.

[H. AXMANN, *Physikalische Zeitschrift*, September 1, 1904.]

A Slow Interrupter.—K. R. Johnson has devised an interrupter somewhat resembling Simon's electrolytic interrupter, but based upon a pure Joule effect. An inverted funnel, having a tube 7mm. in diameter and 10mm. long, is cemented to the lower part of a cylinder 75mm. in diameter. The whole is plunged into a vessel filled with a mixture of alum and sulphuric acid. Two plates of aluminium serve as electrodes, one in the cylinder and the other in the outer vessel, and these are connected with the terminals of a 110-volt circuit. On closing the circuit a bubble is formed in the tube of the funnel. It escapes upwards, and is rapidly condensed. The circuit is broken when the bubble forms and closed when it escapes. The interrupter works more slowly than Foucault's, but has the advantage of working independently of the dimensions of the circuit and without an induction coil or solenoid, whereas Wehnelt's and Simon's interrupters require an inductance which can only be varied within narrow limits.

[K. R. JOHNSON, *Comptes Rendus*, September 5, 1904.]

New Magnetic Contact Maker.—J. C. Shedd has devised a new magnetic control for clocks, which is less liable to failure than the mercury contact and more easily repaired than the ordinary mechanical contact. A is the lower end of the clock pendulum, B is a permanent magnet made up of 42 laminæ separately magnetised before assembling. The dimensions of this magnet are: Height, 25mm.; pole area, 6 × 6mm.; distance between poles, 11mm. CC are soft iron armatures laminated and measuring 9 × 6 × 5mm. They are mounted on springs DD, which are adjustable by screws MM. The contact point is at E, and consists of a platinum point playing against a small gold plate. This is adjustable by the screw G. The clearance between the magnet and the armatures is about 1mm. Magnet B has its plane perpendicular to the plane in which the pendulum swings. Since the action is continuous, the rate of the clock, once adjusted, is not further affected.



[J. C. SHEDD, *Physical Review*, August, 1904.]

The Singing Arc.—S. Maisel brings out some novel facts with regard to Duddell's singing arc (see *The Electrician*, September and October, 1903). He totally denies the validity of Duddell's rule that to produce a singing arc the ratio dv/di must be negative. This condition is only fulfilled in the case of homogeneous carbon electrodes, and even in this case the ratio becomes positive, according to Duddell, as soon as the frequency exceeds 100,000 per second. This latter contention was shown to be erroneous by Wertheim-Salomonson, who obtained singing arcs with frequencies of 400,000 ∿ per second. Corbino showed that the oscillations are not necessarily sinusoidal, but adhered to the condition $dv/di < 0$. The author bases his researches upon the recent observation made by Thomson, Stark and others that at the end of every oscillation the arc is extinquished, and that the starting of the arc is purely a question of the temperature of the cathode, and independent of the temperature and material of the anode. The author corroborated this by using an iron anode, which sang and hissed. On reversing the current, a feeble singing was also heard, and the author even succeeded with both electrodes of iron, but the note was not clear. The period was about 0·0008 second. In order to be quite sure of a positive ratio, dv/di, the author finally adopted a mercury anode in a vacuum of 3mm. The arc sang, and continued singing on reversing the current. A pure mercury arc also sang. The author, therefore, claims that the condition $dv/di < 0$ is not essential. Going back to the origin of the condition, he points out that it was based upon the supposed sinusoidal character of the oscillations, in other words, upon the supposition that the whole of the energy is furnished by the condenser circuit. The author produces curves showing that for about a third of each period the current is zero. When that is the case, energy passes into the condenser. It follows that musical arcs of any frequency and with any electrodes are theoretically possible. But the cathode must either possess a high temperature or must be "actuated" by a subsidiary arc. The period depends upon the main current, and the feebler the current the lower is the frequency. The fact that with iron electrodes the distance apart must be very small, and the singing only lasts a few seconds, is due to the rapid cooling of the electrodes. The iron arc may be kept up by heating them artificially.

[S. MAISEL, *Physikalische Zeitschrift*, September 1, 1904.]

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TRADE UNIONS AND THE PREMIUM BONUS SYSTEM.

In spite of the fact that the success of the premium bonus system of wages has long been established, and that men who have worked under it are perfectly satisfied, a Committee appointed by the Engineering and Shipbuilding Trades' Federation to inquire into and report on the matter have nothing but condemnation for it. The premium bonus system was adopted some time ago by agreement between the Amalgamated Society of Engineers and the Employers Federation, and, the engineering employers having found its working so satisfactory, it was deemed desirable to extend the system to other trades. A perusal of the report at once conveys the impression that the Committee commenced their deliberations with the firm determination to declare against the system. Instead of an honest attempt to better the conditions of trade and make it possible for the workman to earn more money, the Committee are evidently under the delusion that the proposal is only another move towards the suppression of labour and the elevation of capital. They are "unanimous in condemning any system of labour except by the hour or, in cases where it is recognised by mutual agreement between the workmen and their representatives and the employer, by piecework." The report continues: "The general adoption of any such (premium bonus) system will be disastrous not only to the interests of the workmen concerned, but to the reputation of sound and honest workmanship, which, we trust, will be pre-eminently the characteristic of British manufactures throughout the world." Sentiments of this kind have more than a suspicion of cant, and we trust that working men will be sufficiently alive to their own interests to disregard them.

The premium bonus system is not, as the committee allege, a complicated one, nor are the calculations involved beyond the intelligence of the average fitter or turner. Different forms of it are adopted in different shops, but, in principle, it is exceedingly simple and is beneficial both to employer and employed. From experience, the foreman or works manager is able to ascertain the time that should be occupied in completing

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a particular piece of work, and he fixes that time as a limit inside which the workman is paid a premium or bonus if he complete the work. If, on the other hand, he is only able to finish the job in the specified time he is still paid his regular hourly wage, so that he cannot possibly be a loser. In any case, the work must, of course, be done thoroughly, and any omissions or defects have to be made good within the time limit. Briefly, the system is one which encourages workmen to increase the earning capacity of their employers' works, and, at the same time, to increase their own wage-earning capacity. The committee argues that the standard is set by the best workman in the shop, and that the weaker goes to the wall. But if the standard were fixed by the best workman working at his best, no premium bonus would ever be paid, the system would revert to simple payment by time, and there would be no need for discussion. The difference of opinion really turns on the question whether each man's work is to be considered of equal value. Apart from this being an unsound basis from the political economist's point of view, it is absolutely unfair to the average workman, who is thus degraded to the level of the most inefficient of his colleagues. The encouragement of "malingering" or "ca-canny" is the greatest dis-service that the trade unions can do to the engineering industries and to themselves, for the acceptance of the doctrine that the more expert men must not work at their best would eventually lower the whole standard of British workmanship as compared with that of foreign competitors. Were we not so accustomed to the peculiar actions of trade unions it would appear incredible that a working men's organisation should take exception to a system of payment by which no man is paid under the standard rate of wage, and the more expert men receive extra remuneration for their better proficiency. In fact, an impartial consideration of such matters as these unfortunately leads back to the old, old question: Is the employer master, or is the trade union to manage the employer's works? Interference by the trade unions as to what the master is entitled to pay over and above the agreed rate of wage will inevitably result in a wholesale extension of piecework rates (to which all the objections raised by the committee against the bonus system apply with double force), for—*pace* Jean Jacques Rousseau and the American Declaration of Independence—the doctrine that all men are equal cannot be accepted as a principle which is to govern the industrial activity of nations.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Magnetism and its Elementary Measurement. By W. Hibbert (London: Longmans, Green & Co.) 1904. 2s.

It seems to be fashionable nowadays for authors of electrical text books to commence their writing and, after they have proceeded a little way, to find that, instead of publishing a single large book, they have the material for two volumes. The result is usually an elementary work leading up to another and more advanced treatise. Mr. Hibbert is in the fashion, and the book whose title is given above is the forerunner of a later and larger effort.

The matter which it contains is admirably suited to elementary students, and knotty points which are only appreciated by those having great teaching experience are carefully explained. There are expresssions to which purists might object; for instance, in describing the effect produced by a wire cutting a magnetic line, the author says: ". . . magneto-electric rubbing is unavoidable, and the impulse thrusts the electricity along the wire." It is to be hoped that this and a few other expressions will be avoided in the more advanced book. The magnetic balance which bears Mr. Hibbert's name is described in some detail.

Traité Général de l'Emploi de l'Electricité dans l'Industrie Minière. By N. Lapostolest. (Paris: Ch. Dunod.) 7fr. 50c.

A good book dealing with the employment of electricity in mines ought, in course of time, to attain considerable popularity amongst mining and electrical engineers. M. Lapostolest's work is an exposition equally suitable for both classes of engineer, and although it contains debateable points these do not detract seriously from the value of the book. The author, with whom the majority of British electricians are now in agreement, practically ignores continuous current and says, in effect, that three-phase current is the only rational means of conveying electrical energy down a mine. He suggests the employment of a generating voltage of 240 where the radius of distribution does not exceed 200 to 300 metres, but for 6km. to 8km. he advocates 5,000 or even 10,000 volts, qualifying this statement by the remark that 5,000 volts will be high enough in most cases. We fail to see any necessity for even so high a voltage as this, as the comparatively slight saving in copper would be more than balanced by other considerations inseparable from work with very high pressures. It might be possible, but it would not be wise, to run cables charged at 5,000 volts beyond the bottom of the pit shaft. But even ignoring this point, there are very few mines whose workings extend 8km. from the shaft because other shafts are subsequently sunk. Hence, it would probably serve the purpose better to erect separate generating stations on the pit banks and put down low-tension and, perhaps, comparatively inefficient plant.

Several pages are taken up with matter descriptive of typical generating and sub-stations, as well as by instructions for calculating sizes of conductors and the theory of alternating-current machines. A brief description of coal cutters and firing appliances is followed by a somewhat lengthy discussion of the pros and cons of locomotives. There is no doubt that locomotives do possess certain advantages over ordinary methods of rope haulage, but there is also the exceedingly serious objection that the only successful type demands the employment of bare live conductors. The author, in this instance, is forced to confess that three-phase work is out of the question, owing to the frightful confusion of wires which would ensue, and he comes to the conclusion that the only solution to the difficulty is the adoption of continuous current at a voltage not exceeding 65. But obviously this suggestion still leaves serious difficulties; perhaps we may look to accumulators as a solution of the problem in the distant future. After dealing with ventilation and the electrical transmission of signals, the book concludes with a reprint of certain French and Belgian official regulations for the use of electricity in mines.

Jahrbuch der Elektrochemie: 1902. (Halle-a-S: Wilhelm Knapp.)

With all the will in the world the reviewer can find little to say. The "Jahrbuch" is the same voluminous, elaborate, ill-considered and indispensable product that it has always been. Every tiny pseudo-research is chronicled, every insignificant patent is sent down, each being allotted its space, and judgment on the items withheld except in those cases when the compiler's feelings get the better of him. In that instance his remarks are punctuated by a ?

The time has come when the purely academical part of the "Jahrbuch" should be separated from the other portion recording technical progress. The writers of the former stuff may be kept within reasonable bounds, and the writers of the latter should be encouraged to expand, not in the direction of recording what they can obtain from patents, but what they, as technichists, believe to be good. If we were intent on filling columns it would be a simple matter to set down clause by clause all the various merits and defects of our idol We prefer to appraise it. The "Jahrbuch der Electrochemie" is a compilation of all work related to electro-chemistry, whether theoretical or technical, prepared with the utmost care and learning, destitute of intelligence.

Preliminary Practical Mathematics. By S. G. Starling, B.Sc., and F. C. Clarke, B.Sc. (London: Edward Arnold.) 1s. 6d.

This is a very elementary book on algebra and geometry. It is divided up into convenient sections, each representing one lesson. Beginners will find a good many difficulties clearly explained, and the chapters on logarithms merit careful study. We can recommend it to the class of student for whom it was written.

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THE STARTING OF THE HEYLAND SINGLE-PHASE INDUCTION MOTOR.

BY A. BOYD, B.Sc., B.E. (Syd.), 1851 Exh. Sch.

The starting of the ordinary single-phase induction motor is usually accomplished by a split-phase arrangement in which two separate windings on the stator are employed, and an external inductance is inserted in one of these circuits to cause the necessary lag of phase. In the Heyland motor no external inductance is required. There are two windings on the stator, a running winding and an auxiliary winding. These are in parallel at the start, and the auxiliary winding is cut out when the motor has attained a speed sufficient to enable it to run as a single-phase motor. The running or main winding is inserted in slots in the ordinary way, but the auxiliary winding passes through rectangular holes and is displaced 90 electrical degrees from the main winding.

The experiments described in the following were carried out with the object of showing the distribution of the flux in the air-gap before and after the rotor circuits are closed, and to explain how the latter distribution is brought about so that a torque is produced in a definite direction.

The motor experimented upon was a 6 B.H.P. machine made by Witting Bros., London. It has four poles and is designed to run at 1,440 revs. per min. with 34 amperes at 200 volts and 50 frequency, the slip being 4 per cent. when at full load. The stator and rotor (Fig. 1) are built up of iron plates 0·5mm. thick. The stator plates have an external diameter of 36·4cm. and an internal diameter of 26·5cm., with a length of 15·57cm. over the iron. There are 32 slots for the main winding

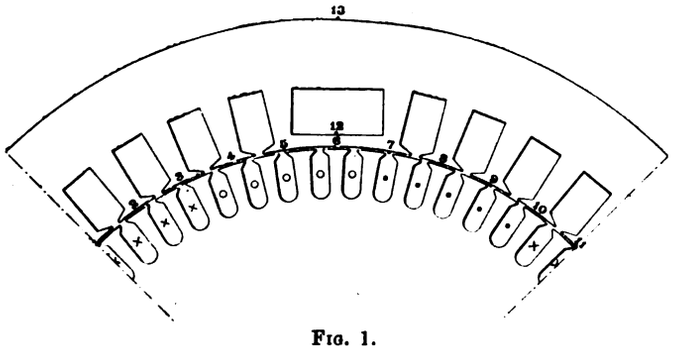

Fig. 1.

2·5cm. deep and 1·4cm. wide, and four rectangular holes for the auxiliary winding 3·6cm. wide by 1·8cm. deep. These slots and holes are not parallel to the axis of the stator, but have a "stagger" of 1cm. in their whole length.

The main winding consists of copper wire 3·5mm. diameter, insulated up to 3·8mm., with a resistance of 0·211 ohm. It is a lap winding with an average of 9·5 conductors in each slot, there being nine conductors in each of the four slots nearest the rectangular hole and 10 in the other four.

The auxiliary winding is concentrated in four holes, there being 57 conductors in each hole connected in series and having a resistance of 0·476 ohm. The thickness of the iron neck between the rectangular hole and the air-gap is 5·2mm. in its narrowest part, so that its sectional area = 8·09 sq. cm., and the width of the air-gap is 0·75mm.

The rotor has a diameter of 26·35cm. and a length of 15·5cm. There are 60 slots 21mm. deep and 8mm. wide, shaped as shown in Fig. 1. The winding is an ordinary three-phase one, star-connected, the ends being brought out through the shaft to brass slip-rings. The wire is of copper 2·8mm. diameter, insulated up to 3·1mm., two wires being in parallel. There are 10 wires per slot—*i.e.*, five effective conductors per slot. The resistance of each circuit, including copper brushes (which were substituted for the carbon brushes to make the resistance more uniform), is 0·062 ohm. Leads are brought from the slip-rings to a rheostat with graduated resistances up to 2·98 ohms in each circuit. On this rheostat is a switch by means of which the auxiliary circuit is broken when about two-thirds of the resistance has been cut out. The motor then runs as a true single-phase motor.

The power was supplied by a Siemens W 12 alternator giving a wave-form with the fifth harmonic very pronounced, and whose $\sqrt{\text{mean}^2}$ value = 0·66 maximum. The impressed $\sqrt{\text{mean}^2}$ volts were kept as nearly as possible to 200 all through, and the frequency 50 periods per second. The relative position of rotor and stator, as shown in Fig. 1, was kept constant throughout the tests.

In order to examine the distribution of induction in the air-gap 11 No. 36 double silk-covered copper wires (see Fig. 1, Nos. 1 to 11) were stretched on the bored face of the stator along the centre lines of the teeth, their mean distances apart in centimetres, centre to centre, being as follows: 1—2, 2·04; 2—3, 2·07; 3—4, 2·07; 4—5, 2·09; 5—6, 2·07; 6—7, 2·10; 7—8, 2·027; 8—9, 2·064; 9—10, 2·07; 10—11, 2·05. Exploring wires, numbered 12 and 13, were stretched through the rectangular hole and outside the stator iron as shown in Fig. 1. In addition to these, another wire, No. 14, was stretched in the air-gap under the centre of the next rectangular hole and corresponded to No. 6. These wires were all soldered together at one end, and the other ends brought out to numbered terminals. Since any current in these wires would tend to mask the effects, the variation of P.D. at their terminals was measured by an electrostatic method, a Kelvin quadrant electrometer being used, with a contact maker on the shaft of

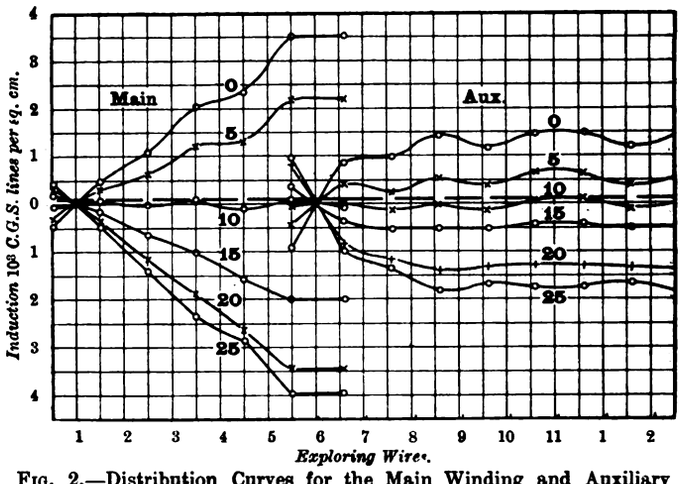

Fig. 2.—Distribution Curves for the Main Winding and Auxiliary Winding. Rotor Circuits open.

the alternator in order to measure the P.D. at definite intervals of time. The electrometer was calibrated by means of two Clark cells. Measurements were made every 18deg. (and sometimes closer) over a half period in time and curves plotted. From these curves integral curves were plotted, giving the average total induction at any instant between two wires. From these curves, the distribution of induction on the stator face at any epoch was obtained.

The curves on the left of Fig. 2 give the distribution of induction over the stator face when the main coil was in action alone, and those on the right when the auxiliary coil was in action alone, while those in Fig. 3 give the distribution when both coils were working together, the rotor circuits being open in each case. The curves are numbered to indicate the epochs in $\frac{1}{20}$ths of a period at which the distributions take place. The applied volts were 202 at a frequency of 50·3, with a current of 6·6 amperes and power-factor of 0·148 for the main coil, 4·04 amperes and power-factor of 0·184 for the auxiliary coil, and 15·9 amperes and a power-factor of 0·11 when both in action together.

The curves for the main coil confirm the result obtained by Prof. E. Wilson*—viz., that for a distributed winding the distribution of induction on the stator face may be represented approximately by "roof curves," by which it is assumed that the induction varies uniformly from zero to a maximum value at the innermost turn of the coil. In this particular form of motor the maximum average value of the induction at the innermost turn is greater than would be the case in an ordinary

* *Proc.* Inst. Elec. Eng., Part 139, Vol. XXVIII.; also *The Electrician*, Vol. XLII., pp. 729, 801, 824 and 861.

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induction motor, because of the continuity of the iron under the rectangular hole. This causes a dip in the side of the "roof curve," as seen in Fig. 2. The maximum average value of flux-density **B** obtained from the curves is 3,930 C.G.S. lines per square centimetre for the main coil, between exploring coils 5—6.

The curves for the auxiliary coil show that the induction is almost uniform over an angle of 90deg. The maximum average value of **B** for this coil is 1,840 C.G.S. lines per square centimetre.

The distribution curves obtained when both coils were running together (Fig. 3) show a large oscillating flux, which crosses the axis at approximately a fixed point in space. Thus, unlike the ordinary polyphase motor, there is no rotating field produced on open circuit of the rotor. The maximum average value of the induction between two exploring wires when both coils were running was 4,930 C.G.S. lines per square centimetre, making the density in the narrowest (0·7cm.) part of the teeth 14,500 lines per square centimetre.

The curves of induction for the search coils 6—12, 6—14, 12—13, giving the flux across the neck, the air-gap and the total flux for the auxiliary coil, when the rotor is on open circuit, are represented by the full line curves in Fig. 4. The total flux at any instant is equal to the algebraic sum of the

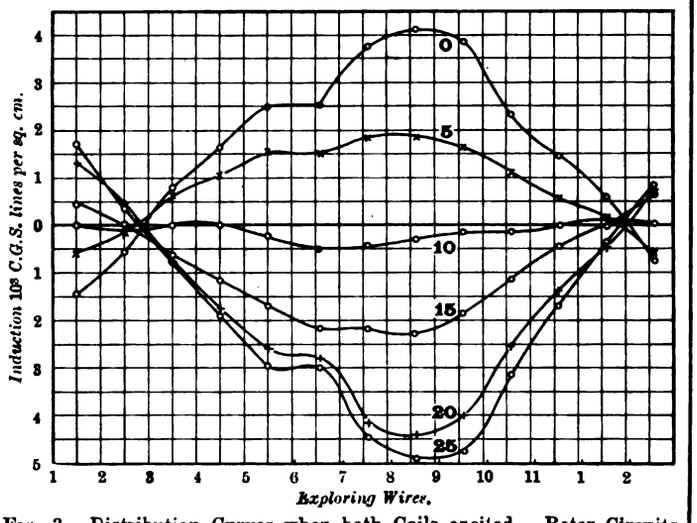


Fig. 3.—Distribution Curves when both Coils excited. Rotor Circuits open.

fluxes through the neck and half the air-gap flux between wires 6—14, and the three curves are in phase. The induction through the iron neck reaches a maximum value and remains constant at that value over a considerable part of each half period, **B** being 17,700 C.G.S. lines per square centimetre. The value of B in the iron above the rectangular hole is 9,500 C.G.S. lines per square centimetre.

On closing the rotor circuits through a resistance of 2·74 ohms per phase, the distribution of induction at different epochs with both coils running is given by a series of curves which cross the axis at different points in space, showing a definite progression along the face of the stator (Fig. 5). The field produced evidently consists of a rotating portion and a large oscillating portion.

In Figs. 6 and 7 are shown the distribution of induction in the air-gap due to the auxiliary coil and the main coil when running separately with the rotor circuits closed. On comparison with the curves in Fig. 2 it will be seen that the distribution for the main coil is slightly altered, but that for the auxiliary coil is very greatly altered, the induction being changed in sign at certain epochs. These curves in Figs. 6 and 7, when combined, give resultant curves in close agreement with those observed when both coils are in action at the same time (Fig. 5). When the coils were in action together the current was 38·25 amperes and power-factor 0·71, while for the main coil and auxiliary coil, acting singly, the currents were 20 and 12·1 amperes and power-factors 0·88 and 0·53 respectively, the impressed volts being 202 and frequency 50·2 in each case.

The broken curves in Fig. 4 show the total flux, neck flux and half the air-gap flux for the auxiliary coil, acting singly with the rotor circuits closed through a resistance of 10·96 ohms in each circuit; the full-line curves in Fig. 8 represent similar fluxes

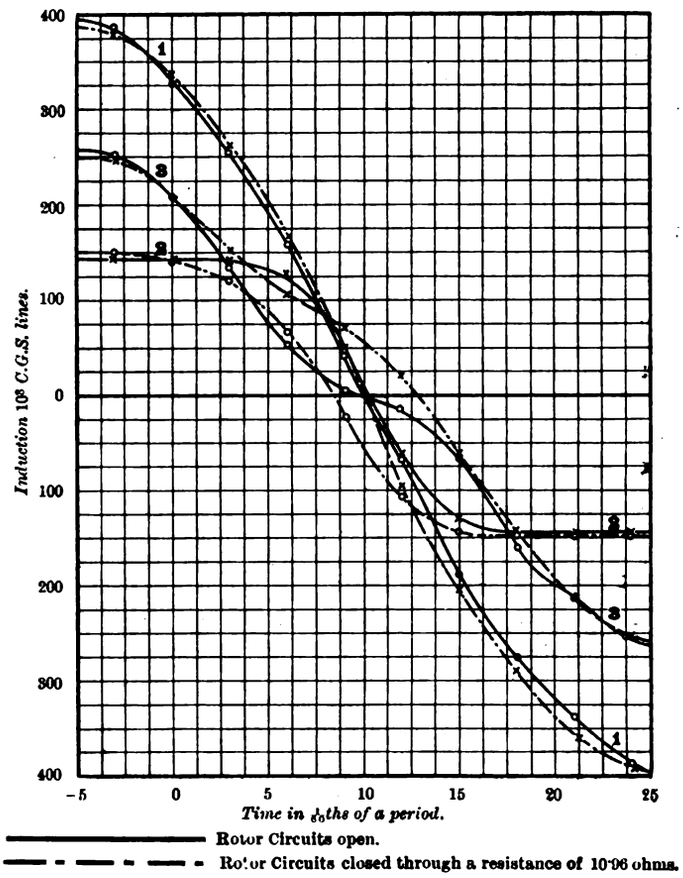
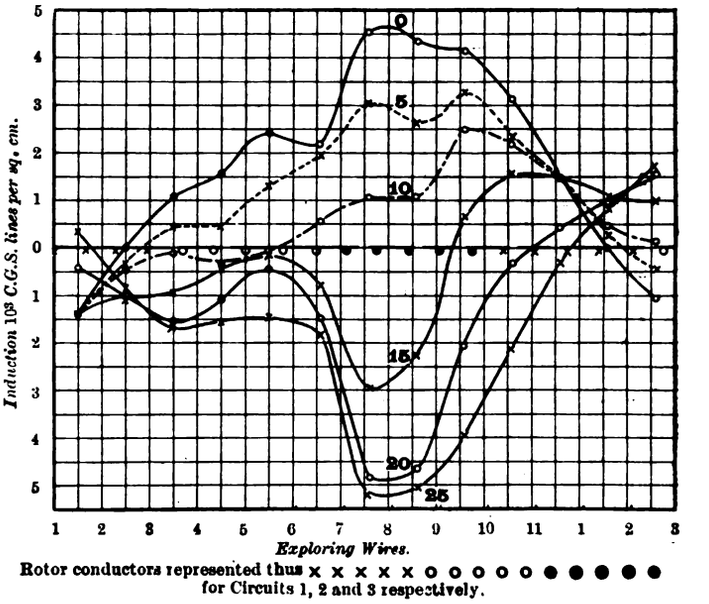

Induction 10⁸ C.G.S. lines.
Time in 60ths of a period.
Rotor Circuits open.
Rotor Circuits closed through a resistance of 10·96 ohms.

Fig. 4.—Curves showing Total Induction (No. 1) and Induction through the Iron Neck (No. 2) and Air-gap over an arc of 45 deg. (No. 3) Auxiliary Coil only excited.

when the inserted rotor resistance was 2·74 ohms per phase, the $\sqrt{\text{mean}^2}$ volts being 200 throughout. It will be seen from these curves that when the rotor currents are started, the neck



Rotor conductors represented thus × × × × × o o o o o ● ● ● ● ● for Circuits 1, 2 and 3 respectively.

Fig. 5.—Curves of Distribution when both Coils excited, Rotor Circuits closed.

and air-gap fluxes become displaced along the axis, this displacement increasing with the rotor currents. The neck flux leads and the air-gap flux lags behind the total flux, which remains practically fixed in position. When the resistance

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inserted in the rotor circuits is 2·74 ohms, the air gap flux crosses the axis of time 26·5deg. behind the main flux, while the neck leads it by 18·7deg. The neck flux has increased in amplitude, the maximum value of **B** being now 20,100 C.G.S. lines per square centimetre, while the gap-flux has decreased in amplitude.

The curves of current in the rotor circuits have been obtained by measuring the fall of potential across the non-inductive resistances in the rotor circuits, reducing ratios being used in order to obtain the proper difference of potential for the quadrants of the electrometer. These curves are shown in Fig. 9, the rotor circuits being numbered 1, 2 and 3.

The manner in which the displacement of the fluxes through the iron neck and the air-gap is brought about may be easily

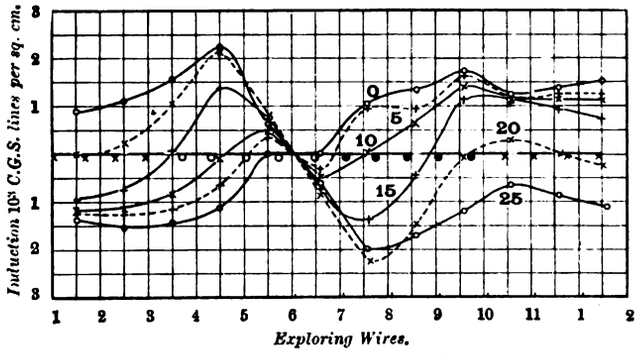

Fig. 6.—Distribution Curves. Auxiliary Winding only excited. Rotor Circuits closed on 2·74 ohms Resistance.

understood by considering the action of the rotor currents. For example, consider epoch 15 for the auxiliary coil running singly. On open circuit of the rotor (Fig. 2) the flux at this epoch is a uniform downward or negative flux of 500 C.G.S. lines per square centimetre, but on closed circuit of the rotor (Fig. 6) it will be seen to have partly a negative and partly a positive value. At this epoch the currents in the coils 2 and 3 of the rotor (Fig. 9) are large, whereas the current in coil 1 is small, since it is in such a position with regard to the auxiliary coil that it embraces almost equal amounts of positive and negative induction. The values of the current at this instant

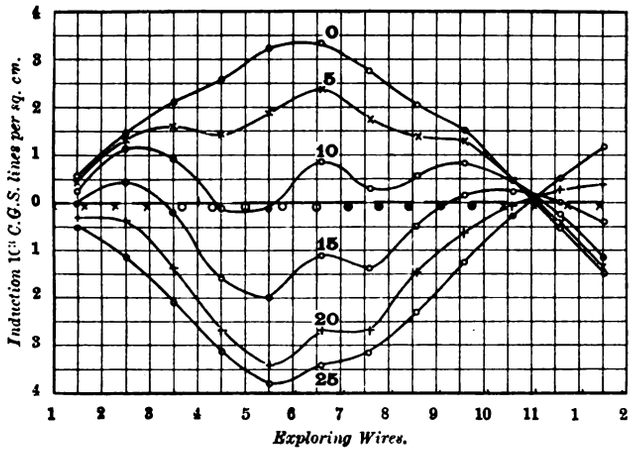

Fig. 7.—Distribution Curves. Main Winding only excited. Rotor Circuits closed on 2·74 ohms resistance.

are − 3·5, + 21·7 and − 18·9 amperes in coils 1, 2 and 3 respectively. Now, by considering the directions of the currents and the fluxes caused by them in a three-phase star-connected winding of this kind, it will be found that the rotor coils 2 and 3 assist each other in causing a flux in a positive direction to the right of exploring wire No. 8 (see Fig. 6) while the small current in coil No. 1 assists this action in the region of wires No. 9—11, and tends to counteract it to the right in the region of wire No. 13. The magnetomotive force due to these currents is sufficiently great to create a positive flux to the right of wire No. 9 (see Fig. 6). By taking the difference between the positive and negative fluxes at this epoch, it will be found that the net flux is a negative one of the total value of $15{\cdot}6 \times 10^8$ C.G.S. lines. This should agree with the ordinate of the air-gap curve in Fig. 8 at epoch 15. The value found from this curve is -15×10, so that the agreement is close.

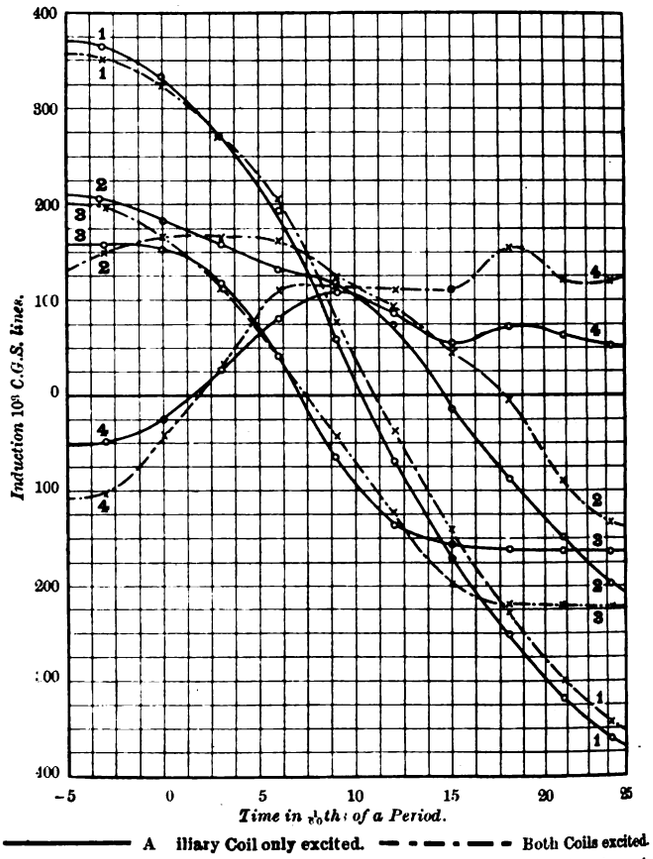

Fig. 8.—Curves showing Total Induction (No. 1) and Induction through the Iron Neck (No. 2) and Air-gap over an Arc of 45 deg (No. 3), and Cross Flux due to Rotor Currents (No. 4). Rotor Circuits closed through a Resistance of 2·74 ohms.

At epoch 10·25 (see Figs. 2 and 8) the value of the total flux is zero, while the currents in the coils 1, 2, 3 of the rotor are − 1·25, + 8·0 and − 6·75 amperes respectively. These cause a positive flux as before, and since there is no flux due

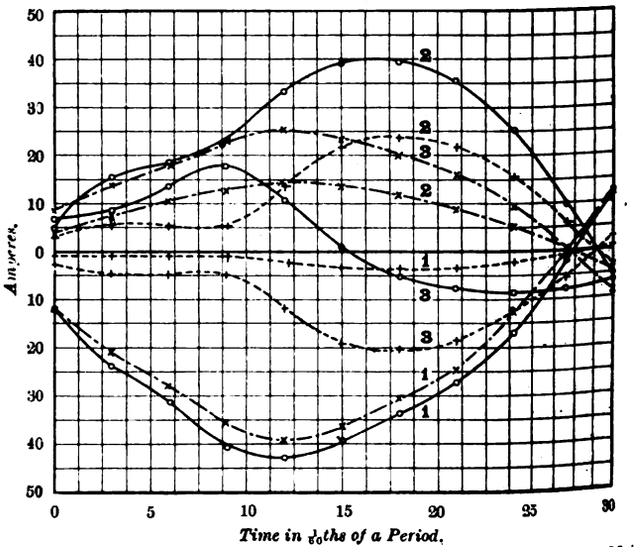

Fig. 9.—Curves of Current in Rotor Circuits 1, 2 and 3, with Main Coil (— — — — —), Auxiliary Coil (— — — — —) and both Coils (————) Excited.

to the auxiliary coil, this cross-flux attains a large value at this epoch. The total flux through the auxiliary coil is governed by the impressed voltage, so that it must remain unaltered excepting in so far as it is affected by the fall of voltage due

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to the CR drop, and since there is a large positive flux in the air-gap at this instant, there must be, for equilibrium, an equal negative flux through the neck (Fig. 8). The effect of this is to cause the flux through the iron neck to cross the axis of time at an earlier epoch, while the flux through the air-gap crosses at a later epoch.

A curve has been plotted in Fig. 8 whose ordinates are equal to the difference of the ordinates of the full line air-gap curves in Figs. 4 and 8 when the rotor circuits are open and when closed. This curve represents the cross-flux in the air-gap due to the rotor currents. The maximum ordinate of this cross-flux occurs at epoch 9·0 and amounts to 109×10^3 C.G.S. lines.

The dotted curves in Fig. 8 represent the total flux, air-gap flux and neck flux when both coils were in operation at the same time. The fluxes between the exploring wires 6—12 and 12—13 were observed, and the air-gap flux obtained by taking their differences. The rotor currents are greatly increased and cause the air-gap flux to cross the axis of time 41deg. behind the total flux. The flux in the iron neck now attains a maximum value of 25,100 C.G.S. lines per square centimetre, and is represented by the broken curve No. 2.

Curves showing the phase displacement of the currents in the running and auxiliary coils are given in Fig. 10 on open

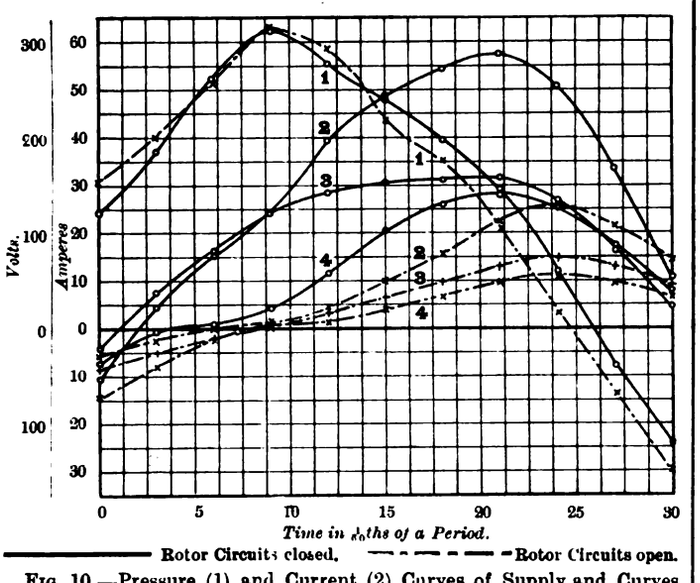

Fig. 10.—Pressure (1) and Current (2) Curves of Supply and Curves showing Displacement of Currents in Main (3) and Auxiliary Coils (4).

and closed circuit of the rotor. The following table gives the values of current, watts and angle of lag of current behind E.M.F. for each case :—

Conditions.		Frequency	Volts.	Amp.	True watts.	Cos ϕ.	ϕ^0.
Rotor circuits open	Supply	50·3	202	15·5	360	0·115	83·4
	Running coil.....	50·3	202	9·25	200	0·107	83·9
	Auxiliary coil	50·3	202	6·25	146	0·114	83·5
Rotor circuits closed	Supply	50 3	202	38 25	5,500	0·715	40·5
	Running coil.....	50·3	202	22·5	3,800	0·84	32·8
	Auxiliary coil	50·3	202	15 5	1,540	0·493	60·5

We see from these figures that when the rotor is on open circuit the currents in both the running and auxiliary coils are practically in phase with each other and with the current of supply. But when the rotor circuits are closed, the current in the running coil leads that of supply by 7·7deg., and that in the auxiliary coil lags 20deg. behind supply and 27·7deg. behind the current in the running coil.

In an ideal induction motor with a pure rotating field—*i.e.*, one with sine variation of current and sine distribution of flux in space—the watts in the rotor circuits are a measure of the torque. In this particular motor the torque as estimated in this way is 2·6 times the measured torque, showing the large preponderance of the oscillating flux over the rotating flux. Consequently, the torque was calculated from the product of the current C in each conductor and the value of **B** at that conductor. The force in dynes on the circumference of the rotor at any epoch $= \mathbf{B} \times C/10$ per centimetre of conductor.

This was carried out for each of the three rotor circuits at six equidistant epochs over a half period and the average taken in order to obtain the average force. As the stator conductors are not parallel to the rotor conductors, the value of **B** used was a mean between the values at each end of a conductor. The length of each conductor over the iron is 15·5cm. and there are five conductors per slot and four poles, so that force on each winding $= \frac{4 \times 5 \times 15{\cdot}5}{10} \Sigma\mathbf{B} \,.\, C = 31\Sigma\mathbf{B} \,.\, C$ dynes, where ΣB = sum of the induction densities over the five slots of one winding. To bring to pounds we must divide by 981×454.

The calculated force is 21·7lb. and the observed force 20·5lb. at the radius of the rotor. The latter was very carefully measured by means of a beam and a Salter's balance at a radius of 45cm., care being taken to keep the rotor in the same position by raising the balance. The beam was tapped upwards and downwards and the mean of these readings taken. The above values are only approximate, since it is impossible to say what is the reduction of the force on the conductors due to

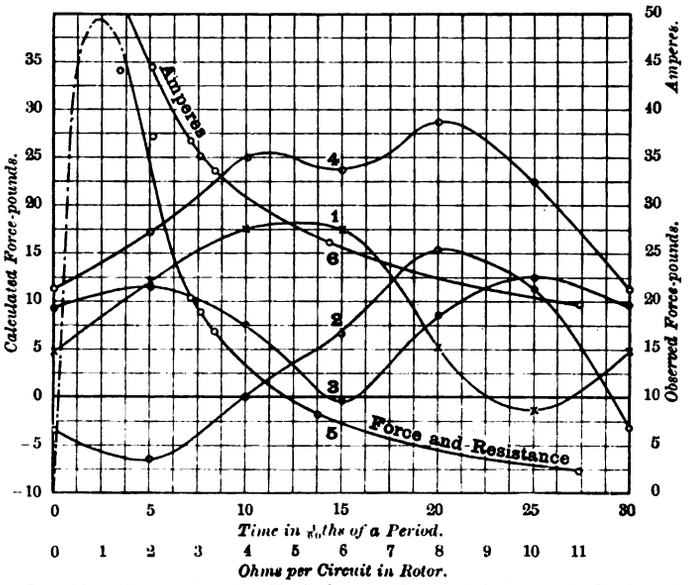

Fig. 11.—Curves showing Variation of Calculated Force at Radius of Rotor on Circuits 1, 2 and 3 and Total Force (4) with Time. Also Curves of Observed Force (5) and Amperes (6) supplied with different Resistances in Rotor Circuits.

leakage; moreover, it is difficult to measure the force to a great degree of accuracy by this method on account of friction. The total calculated force and the forces on each of the rotor circuits at each epoch are plotted in Fig. 11. The maximum force is 28·6lb. at epoch 20. On inspection of Figs 5, 9 and 11 it will be observed that the greater part of this is contributed by circuit No. 2, in which the current is 37 amperes and the average value of **B** 1,040 C.G.S. lines per square centimetre at this epoch. The minimum force is 11·2lb. at epoch 0, this value being 39 per cent. of the maximum.

The torque and supply current were measured with various resistances in the rotor circuits, the impressed voltage being kept at 200 as nearly as possible. The curve in Fig. 11 shows that the torque continues to increase as the resistance is reduced, but when the resistance was below 1·37 ohms sufficient power was not available to keep the pressure at 200 volts. On short-circuit of the rotor no torque could be obtained, so that the remainder of the curve is most probably as shown by the broken line.

The full-load torque of this motor is represented by a force of 50lb. at the radius of the rotor (13·175cm.). This torque would be attained if the supply current reached about 70 amperes. The maximum rheostat resistance supplied with this motor is designed so that the total rotor resistance is 3·2 ohms, which limits the starting current to the full load current of 34 amperes, the force on the rotor circumference then being 18lb.

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To the above the writer would like to add a remark on the "load losses" in this motor. From the curves of current and pressure the watts supplied to the motor were calculated, with the rotor circuits open, and when closed through the resistance of 2·74 ohms—*i.e.*, starting conditions as before. The total watts in the rotor circuits were calculated from the current curves, and the curves of pressure between the centre of the star and the slip rings. If the watts supplied to the motor be reduced by the C^2R losses in the stator windings, and if the watts delivered by the rotor to its external circuit be increased by the C^2R losses in the rotor windings, then the difference between these corrected quantities should give the total hysteresis and eddy current losses, and should correspond with the watts supplied (less C^2R losses) to the motor on open circuit of the rotor. In common with other experimenters,* the writer has found that the losses are greater when the rotor circuits are in operation, the increase amounting almost to the iron losses on open-circuited rotor. This increase occurred also when the stator coils were in action singly.

In conclusion, I wish to thank Prof. Ernest Wilson for advice during the course of these experiments, which were carried out in the Siemens Laboratory, King's College, London

THE ELECTROMOTIVE FORCE OF THE CLARK CELL.

At the recent meeting of the British Association there appeared, in connection with the Report on Electrical Units, a statement with reference to an experimental determination of the E.M.F. of a Clark cell which had been made at the Board of Trade Electrical Standards Laboratory. Inquiries at the Electrical Standards Laboratory enable us to give the following detailed account of the matter:—

Towards the end of 1902 it was observed that certificates issued by the Reichsanstalt included an intimation that the E.M.F. of a normal Clark cell was taken as "1·4328 volts at 15°C." Since this differed by 12×10^{-4} volts from the value, mentioned as a reference, in the Order in Council establishing the British electrical units, and generally adopted in this country, it was decided, as a matter of interest, to take an early opportunity of ascertaining the E.M.F. of the Clark cell in terms of the British ohm and ampere. The British standard for pressure—the hekto-volt—is obtained from the ohm and ampere by Ohm's law, hence any change in the accepted value of the Clark cell does not affect the British electrical standard units.

In the press of work, official and public, for which the Board of Trade Laboratory is responsible, the time and opportunity for such a special test as that in question were not easy to secure. However, in January, 1903, a first attempt gave as the result that a certain Clark cell, No. 1,712 (Wolff, Berlin), had an E.M.F. of 1·4325 at 15°C. The difference between this value and that of the Reichsanstalt being only about 1 in 5,000, it was not deemed necessary for laboratory purposes to do anything further at that time. A year later, in January, 1904, the test was repeated with one of two new Clark cells (Wolff Nos. 2,530 and 2,531) just received from Berlin, and for which there were Reichsanstalt certificates of quite recent date. The method of the test and the apparatus used, both in this and in the previous experiment of January, 1903, may now be briefly described.

There was available a manganin coil, Elliott No. 343, constructed to have a resistance of 1·434 ohms at about 15°C. The comparison of this coil with the standard ohm was effected as follows:—A set of manganin coils, 1 + 1 + 2 + 3 ohms, permanently connected in series, and of such form that each coil could be readily compared with the standard, was formed into a closed circuit by means of a $\frac{1}{10}$th ohm, also manganin, whose value was known to something less than 1 in 1,000. It will be seen that the resistance between the points A and B (Fig. 1) of this grouping of the coils is approximately 1·434 ohms and the arrangement could be readily adapted to form one of the comparison resistances on a Carey Foster bridge. The coils being in frequent use their value was already well known but a check was made for each of them for the purposes of this experiment, and the resistance between the points named was found to be $1{\cdot}4367_3$ at 15°C. A Carey Foster comparison of this grouping with coil No. 343 was very easily made and gave the result that No. 343 had a resistance of $1{\cdot}4343_6$ ohms at 15°C.

This No. 343 coil was inserted in the standard ampere balance circuit, so that the ampere could pass through the coil and its value be determined by the standard balance. The E.M.F. at the ends of No. 343 was then, by means of a Crompton low-resistance potentiometer and a sensitive galvanometer, directly compared with the E.M.F. at the terminals of Clark cell No. 2,530 (Wolff). It is evident that the sole use of the potentiometer in this case is to give two comparative readings, and, on the Clark cell side, to provide facilities for making certain that the current in the potentiometer remains constant throughout the period of the test.

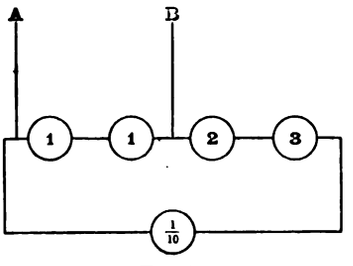

FIG. 1.

The readings recorded for the Clark cell show that this constancy was very perfect throughout the whole experiment. A sample of the recorded readings is quoted below:—

Sub-standard No. 283.	Clark cell No. 2,530.		Coil No. 343.	
	Temperature °C.	Potentiomtr. reading.	Temperature °C.	Potentiomtr. reading.
1 ampere	15·7	$1{\cdot}4332_0$	22·8	$1{\cdot}4353_4$
1 ampere		$1{\cdot}4332_6$		
1 ampere	15·7	$1{\cdot}4332_0$	22·8	1·4351
1 ampere		$1{\cdot}4332_5$		

Three tests in all were made, one in the morning and one in the afternoon of January 27th, and one in the morning of January 28th, the result in each case giving the E.M.F. of Clark cell (Wolff) No. 2,530 as 1·4328 at 15°C. Clark cells are always kept in the constant-temperature room at the Board of Trade Laboratory, and the cell in this case had not varied in temperature by more than one-twentieth of 1°C. for 48 hours before the comparison.

This is a marvellous coincidence with the Reichsanstalt value, and, when taken in conjunction with the earlier experiment of January, 1903, it may be considered to show that the British electrical units are in close agreement with those of the Reichsanstalt.

The Order in Council of 1894, which established the ohm, the ampere and the volt as new denominations of standards, declared that the limits of accuracy attainable are, for the ohm, within one-hundredth part of 1 per cent.; for the ampere and volt, within one-tenth part of 1 per cent. The volt is defined in that Order as the electrical pressure that, if steadily applied to a conductor whose resistance is 1 ohm, will produce a current of 1 ampere, "and which is represented by" $0{\cdot}6974\left(\frac{1{,}000}{1{,}434}\right)$ of the electrical pressure at a temperature of 15°C. between the poles of the voltaic cell known as Clark's cell. It is hardly necessary to inform our readers that higher accuracy than the limits officially stated is frequently attained and largely exceeded when suitable instruments are sent to the Board of Trade Electrical Standards Laboratory for verification. But *de minimis non curat lex*, and until the figures given in the Order in Council are found to be wrong by greater quantities than those which we have quoted, it need not be expected that the Board of Trade will take any official action in the matter.

The practical limits of accuracy at this Laboratory depend greatly on thermometry. Differences of one part in a million are discernable in comparing ohms, and readings to within three or four parts in a million could be given, were it not that the thermometers are only graduated in tenths of a degree, and are estimated to perhaps fiftieths of a degree. It would be easy to provide electrical thermometers reading

* Prof. Ernest Wilson, "The Induction Motor," *loc. cit.*; Behrend, "The Induction Motor," p. 27.

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to one five-hundredth of a degree, but where can they be calibrated? Differences of potential of one fifty-thousandth of a volt can be detected, but working to such accuracy is at present a waste of time owing to thermometry. As for the ampere, no demands have been made for hign precision, but the instruments at Whitehall can detect differences of one twenty-thousandth of an ampere; meanwhile the chemical constant is known only to about one part in a thousand.

ON THE PREDERMINATION OF PLUNGER ELECTROMAGNETS.*

BY SILVANUS P. THOMPSON, F.R.S.

An impression seems to be abroad that the known laws of electromagnetism do not suffice to enable the pull of the solenoid upon an iron plunger within it to be calculated, or at least that there is some obscure difficulty that prevents the design of such plunger electromagnets from being readily predetermined, so that when constructed they shall fulfil any prescribed specification as to the required pull and range of travel. The author has, however, not found much trouble in working out a set of rules for design which yield results of an accuracy quite comparable with that attained by the customary rules for the designing of electromagnets for dynamos and motors. It is believed that these will be welcomed by engineers interested in this branch of construction. Hence a brief account of them and of the principles on which they are established is here given.

To concentrate attention on the essentials of the problem consider a magnetic circuit constituted as shown diagrammatically in Fig. 1, where a cylindrical rod of soft iron is supposed to be bent so that its ends enter a tubular bobbin carrying a magnetising coil. Let the length of the gap between the ends of the rod be called z inches, and let the excitation be such that the flux-density along the gap, which will be practically uniform, be **B** lines per square inch. Let each of the end faces of the iron have an area of A square inches. Then it is known that the pull along the gap z, tending to bring the two end faces of the iron together, is expressed by the formula

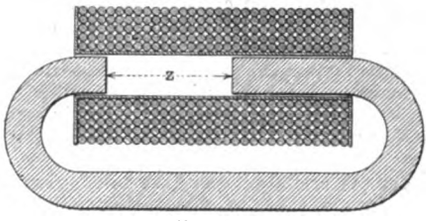

FIG. 1.

$$P = B^2A/72{,}134{,}000; \quad . \quad . \quad . \quad . \quad . \quad (I.)$$

where P is the pull in pounds weight. It is also known that the flux-density **B** in the gap is related to the excitation according to the formula

$$B \times z \times 0{\cdot}3133 = CS; \quad . \quad . \quad . \quad . \quad . \quad (II.)$$

where CS stands for the number of ampere turns of excitation that are actually expended in driving the magnetism across the gap, and 0·3133 is the gap coefficient. If the iron is of good quality, and its magnetic state is far removed from saturation, the number of ampere-turns required to send the flux along the iron part of the magnetic circuit will be negligibly small compared with the number of those thus needed for the magnetism in the gap; and therefore the total number of ampere-turns of excitation to be provided by the exciting bobbin will not be sensibly greater than that expressed by the above formula. The symbol C stands for the current in amperes, the symbol S for the number of spirals or turns of wire on the bobbin. Hence we may take it that, under the above assumption that the iron is far from saturation, the actual ampere-turns needed will be C × S. If the iron were so far saturated as to require a sensible additional number of ampere-turns for its magnetisation, then the necessary total current would need to be slightly increased, or what comes to the same thing, the reluctance of the iron must be taken into account by adding a small equivalent length to x. In all the practical cases that arise, this increase to provide for the reluctance of the iron does not amount to more than about 2 per cent. of the whole; and may, therefore, be left out of account for most purposes. The gap coefficient 0·3133 is only another expression for the reluctivity of air expressed in inch units.† In other words, to drive magnetism, with a flux-density of one line per square inch, along a gap 1in. long, requires 0·3133 of 1 ampere-turn.

Let us pass from the consideration of Fig. 1, in which nothing was movable, to the case presented by Fig. 2, of an iron-clad coil provided with a movable plunger, capable of being attracted in from the right, the iron jacket being extended at the ends so as to form on the right a sort of stuffing box (lined in practice with a thin tube of copper or brass) through which the plunger enters, and on the left a face-plate, from which a short cylindrical piece enters the other end of the bobbin. The reluctance of the joints may be taken as zero, provided they have surface enough, So then, again, if the iron is far from saturation the only reluctance that need be taken into account is that of the gap between the end of the plunger and that of the opposing iron piece. Now, let it be assumed, for reasons that will presently appear, that the plunger will not be permitted to travel so far down as actually to come in contact with this opposing iron piece, but that its movement will be stopped at some point a little further to the right, such as that marked E. Then its range of motion will be from E to some point to the right. As in the figure, let its *range* of motion (or *stroke*, to use an engine term) be called x. Then it is clear that if any particular excitation by a given number of ampere-turns were provided, the pull would differ at different parts of the stroke, being a maximum when the plunger was at the end of its stroke, E, and being a minimum when the plunger was at the beginning of its stroke. For, when at the beginning of its stroke, the length of the internal gap is a maximum, and the flux-density will be a minimum, since from formula (II.) we have: $B = CS/0{\cdot}3133z$.

Now write $P_{max.}$ for the pull at the end of the stroke, where **B** is a maximum, and $P_{min.}$ for the minimum pull when **B** is at its minimum The designer will generally be required to work between a given maximum and a given minimum pull. Thus, for example,

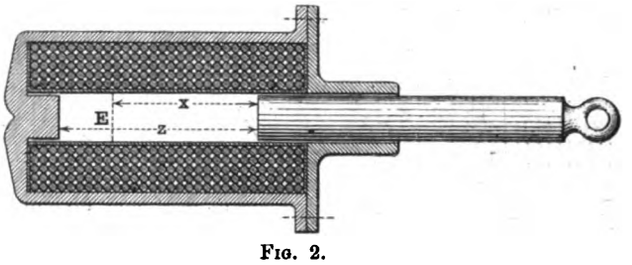

FIG. 2.

he may be required to design an apparatus to give a maximum pull of 100lb. and a minimum pull of 40lb., with a stroke of 2in. Let the ratio of the maximum pull to the minimum pull be called y. Then, since, by formula (I.), P varies as the square of **B**, we have:

$$y = P_{max}/P_{min.} = B^2_{max}/B^2_{min.}; \text{ whence, } \sqrt{y} = B_{max.}/B_{min.}; \text{ and}$$

$$B_{min.} = B_{max.} \div \sqrt{y}. \quad . \quad . \quad . \quad . \quad . \quad (III.)$$

Going back to formula (II.), and writing it out for the two extreme cases, we have, at the beginning of the stroke, where the distance along the gap from iron to iron is at its maximum value, which we will call z, $B_{min.} \times z \times 0{\cdot}3133 = CS$; and at the end of the stroke, when the gap is reduced to $z - x$, $B_{max.} \times (z - x) \times 0{\cdot}3133 = CS$. From this it follows that, $z/(z - x) = B_{max.}/B_{min.} = \sqrt{y}$. Hence, z *must necessarily* have the value

$$z = \frac{\sqrt{y}}{\sqrt{y} - 1} \times x; \quad . \quad . \quad . \quad . \quad . \quad (IV.)$$

and as y is the ratio of the specified maximum and minimum pulls, it is at once seen that, in order to calculate z from x this function of y becomes important. For convenience some values of it are here tabulated for reference. The ratio $\sqrt{y}/(\sqrt{y} - 1)$ is called u for brevity.

Table I. *of Functions for Pull-Ratio y.*

$y = P_{max.}/P_{min.}$	1·0	1·5	2·0	2·5	3·0	3·5	4·0	5·0
$u = \sqrt{y}/(\sqrt{y} - 1)$ ..	∞	5·4	3·44	2·7	2 37	2·15	2·0	1·83
$1/u = 1 - 1/1\sqrt{y}$ ..	..	0·185	0·29	0 37	0·42	0·465	0·5	0·55
$1/(\sqrt{y} - 1)$	∞	4·4	2·44	1·7	1·37	1·15	1·0	0·83
$y = P_{max.}/P_{min.}$	6·0	7·0	8·0	9·0	10·0	16·0	25·0	100·0
$u = \sqrt{y}/(\sqrt{y} - 1)$ ..	1·69	1·60	1·55	1·5	1·47	1·33	1·2	1·11
$1/u = 1 - 1/1\sqrt{y}$ ..	0·59	0·625	0·645	0·666	0·68	0·75	0·8	0·9
$1/(\sqrt{y} - 1)$	0·69	0 6	0·55	0·5	0·47	0·33	0·2	0·11

So for as the first two lines of the table are concerned, their use is exemplified as follows:—Taking the instance of a design to have a pull varying from 40lb. to 100lb. with a stroke of 2in., we have here $y = 100 \div 40 = 2{\cdot}5$, and looking in the table we see the corresponding value of u is 2·7. This means that we must multiply the stroke by 2·7 to find z, which will therefore be 5·4. In fact, unless we design the apparatus so that at the beginning of the stroke the

* Paper read before the International Electrical Congress at St. Louis.

† For those who prefer to work with metric units the formulæ will stand as follows:—

$$P \text{ in kilogrammes} = B^2A/24{,}700{,}000. \quad . \quad . \quad . \quad . \quad (I.a)$$

and $$B \times z \times 0{\cdot}795 = CS. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (II\,a)$$

where A is the area in square centimetres, **B** the flux-density in lines per square centimetre, and z the gap-length in centimetres. The numeric 24,700,000 is made up of 8π and 981,000, the latter being the number of dynes in the weight of 1kg. The gap-coefficient 0·795 is the reciprocal of $0{\cdot}4\pi$.

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reluctance of the magnetic circuit is 2·7 times as great as the reluctance is at the end of the stroke, we shall find that the minimum pull will drop to a less value than $\frac{1}{2\cdot5}$ of the maximum pull. It is obvious that, if the minimum pull is specified to come to a higher fraction of the maximum, the greater will be u.

Next, returning to formula (I.), let us remember that if d be the diameter of the core, the area A of its end face will equal $d^2 \times 0{\cdot}7854$. Hence we may immediately deduce the new rule that :—

$$d = 9{,}580 \times \sqrt{P_{min.}}/B_{min.} \quad . \quad . \quad . \quad . \quad . \quad . \quad (V.)$$

This determines the diameter of the core if $B_{min.}$ has been fixed. Conversely, if d is given we can fix $B_{min.}$ as follows :—

$$B_{min.} = 9{,}580 \times \sqrt{P_{min.}}/d. \quad . \quad . \quad . \quad . \quad . \quad . \quad (V.a)$$

To get a new relation we may go back to formula (II.), and inserting in it the value of $B_{min.}$ just obtained, and z is the total gap-length, we find :—

$$3{,}000 \times z \times \sqrt{P_{min}}/d = CS. \quad . \quad . \quad . \quad . \quad (VI.)$$

This enables us to calculate the required number of ampere-turns if the diameter of the core has been fixed. The rule is in itself of some practical interest, for it shows us that in any given case where the maximum and minimum pulls, and the stroke, are given, the necessary ampere-turns will vary inversely as the diameter chosen for the core. If we double, for example, the diameter of the core, making the plunger four times as heavy as before, the excitation may be reduced to one-half.

We are now ready to consider a number of trial values or alternative designs to fulfil any prescribed case. Using the same illustration as before, we will put down as being specified $P_{max.} = 100$lb.; $P_{min.} = 40$lb.; $x = 2$in. We have already found $y = 2{\cdot}5$, $u = 2{\cdot}7$ and $z = 5{\cdot}4$. We also know that $\sqrt{y} = 1{\cdot}58$. Hence, by rule (III.), $B_{min.} = B_{max.} \div 1{\cdot}58$. Also $\sqrt{P_{min.}} = 6{\cdot}32$

Schedule of Trial Values.

$B_{max.}$	100,000	80,000	60,000	50,000	40,000	30,000	20,000
$B_{min.}$	63,290	50,640	37,980	31,645	25,320	18,990	12,660
d	0·96	1·2	1·6	1·91	2·39	3·19	4·78
CS	107,000	85,600	63,600	53,500	42,800	31,800	21,400

We first put down some trial values of $B_{max.}$ and, dividing each by $\sqrt{y}$, we get corresponding values of $B_{min.}$ By formula (V.) we then find the resulting values of d: and then CS follows either from (VI.) or from the rule

$$CS = B_{min.} \times z \times 0{\cdot}3133 \quad . \quad . \quad . \quad . \quad . \quad (II.b)$$

On comparing together the values so set down, we see at once that if we attempt to work up to a maximum density of magnetic field in the gap as high as 100,000 lines per square inch, the plunger may have a diameter of only 0·96in.; but then we should have to provide no fewer than 107,000 ampere-turns of excitation. And when we consider that on large multipolar dynamos the amount of excitation on one pole is generally of the order of 6,000 to 10,000 ampere-turns, or exceptionally rises to 20,000 in large alternators, we see that this design is impossible by reason of the copper required. On the other hand, if we reduce the maximum density to 20,000, the core diameter comes up to 4·78in., and the ampere-turns fall to 21,400.

The considerations which will settle our choice between the various alternatives have yet to be laid down. It may be remarked that a different order of procedure might have been followed. Thus we might have taken as trial-values for d, 1, 1½, 2, 3, 4in., and calculated the corresponding values of $B_{min.}$, and thence $B_{max.}$ from formula (V.a).

It is found in practice that the maximum pulls are given with great accuracy by the above rules, but that, owing to secondary causes, the minimum pulls are rather higher (in some cases several per cent.) than the calculated values.

We next enter on the thorny question of the length and depth of the magnetising bobbin. Let us call the winding length between the bobbin checks L, and the available winding depth T. Also call the mean length of one turn M, then the sectional area of the whole winding is LT, and the winding volume is MLT. Also, if the actual permissible current density through the cross-section (not the current density in the copper only) in amperes per square inch be called β, we obviously have the relation $LT \times \beta = CS$. So if β is known from experience we get the rule

$$LT = CS/\beta. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (VII.)$$

Now experience shows that if proper pains are taken to give cooling surface, by radiating ribs or otherwise, β may be as great as 2,000 or 3,000 for coils that are used for momentary work—that is to say, for which the current is never kept on for more than 20 or 30 seconds at a time. For apparatus in which the current is kept on for as much as 10 minutes or more much lower current-densities must be used. The extreme case of prolonged user for several hours continuously involves either special cooling arrangements with internal ducts, or else the use of a very low density, such as $\beta = 300$ to 400. This is at best a rough way of reckoning: the more exact way is indicated later. If in cases for momentary user we assume $\beta = 2{,}000$, we can fix a provisional value for the winding area LT. Now we have seen that the requirement that the minimum pull shall not fall below a definite fraction of the maximum pull involves the provision of a total length, z, of "equivalent gap" which is u times greater than the actual stroke. The greater u is the greater must the excitation be for a given maximum pull. Thus, for example, to give a maximum pull of 12lb., using a core 1in. in diameter, and with a stroke of 3in., will require an excitation of 133,000 ampere turns if the minimum pull is not to drop below 8lb.; whereas it will only require 46,600 ampere-turns if the minimum is permitted to drop to 4lb., and only 4,080 if the minimum is permitted to drop to 1lb. at the beginning of the stroke. We have to pay a very heavy price in ampere-turns (that is, in copper, or in current, or both) for the attempt to keep up the minimum pull.

Suppose that the total winding area LT has been provisionally found, it remains to ascertain the separate values of L and T. This is again a matter where experience must to some extent guide. The total weight of copper (for a given number of ampere-turns) will be reduced if we make L very long and the depth T small, since then the mean length per turn is kept small. But L should obviously have *some* relation to the length of stroke, since it would be absurd to use a very long bobbin if only a short stroke is required, and a long stroke cannot be got if the bobbin is short. Here it must be remembered that in order to keep up the minimum pull at the beginning of the stroke we were forced to provide an addition to the gap, or, rather, to calculate the ampere turns as if the gap-length were z not x. A glance at Fig. 2 will make it clear that if for this reason the gap has had to be increased from x to z, the length L of the exciting bobbin cannot be less than z. For, if there is a good stuffing-box or cylindrical collar at the right, we may reckon the beginning of the stroke as the point when the plunger actually begins to enter the windings, and at the other end there is no need to make the projecting iron piece enter further than the thickness of the bobbin cheek. Hence, unless in some special case this would lead to an undue heaping up of the coils, it is a useful guide to take for L provisionally the same value as was found for z. All this is under the assumption still that the solenoid is going to be jacketed with iron, so that the only sensible reluctance in the magnetic circuit is that of the internal gap. If now we take equation (VII.) and insert in it the value of CS given in equation (VI.) we get

$$T = \frac{3{,}000}{\beta} \times \frac{\sqrt{P_{min.}}}{d} \times \frac{z}{L}. \quad . \quad . \quad . \quad . \quad (VIII.)$$

And if we assume as above that β may be as great as 2,000 (for cases of apparatus used only for a few seconds at a time), and that $L = z$, the rule becomes

$$T = 1{\cdot}5 \times \sqrt{P_{min.}}/d. \quad . \quad . \quad . \quad . \quad . \quad (IX.)$$

Let us see how this works out in the example previously used. The minimum pull was 40lb., so $\sqrt{P_{min.}} = 6{\cdot}32$ and z was 5·4in. If we had used a plunger 2in. in diameter, the exciting bobbin would have the following dimensions :—L = at least 5·4in., T = at least 4·74in. This, allowing ¼in. for the tubular part of the bobbin, would imply an exciting coil the inner diameter of which was 2·25 and the outer diameter 11·73in. If, instead, a plunger 4in. in diameter had been used, formula (IX.) shows that T would be reduced to 2·37in., and the inner and outer diameters of the coil would become 4·25in. and 8·99in. respectively.

Another approximate way of estimating the length L of the exciting bobbin is to draw upon experience, which shows that if T is not more than, say, 3in., and due care is taken as to cooling, each inch length of tubular coil can carry from 3,000 to 10,000 ampere-turns, the lower number being appropriate for cases of continuous service, the higher for cases of momentary service only. Now, this gives us a means of judging which of the trial values previously set out should be selected, for, since on $B_{min.}$ depends the number of ampere-turns needed, it must not be taken too high. If we apply these considerations to formula (II.) we find at once that, in apparatus for prolonged work, $B_{min.}$ must not exceed 9,580; while in that for momentary use $B_{min.}$ may be taken at 16,000 or 20,000, or even up to 38,000 in those cases where there is no danger of $B_{max.}$ rising over 100,000. To find the mean length of one turn M, on the supposition that the thickness of the tubular walls of the bobbin and the internal clearance add 0·25in. to the diameter, the formula is

$$M = \pi(0{\cdot}25 + d + T). \quad . \quad . \quad . \quad . \quad . \quad (X.)$$

So far we have considered the excitation simply as so many ampere-turns, regardless of the separate values to be assigned to the amperes and the turns, and regardless of the resistance of the coil or of the watts wasted in it as heat. Now, as the rules pertaining to these matters are in no way different from those of ordinary electromagnets they may be here treated as briefly as

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possible by merely quoting those that will be found most useful. The symbols used are as follows:—

a = ampere-density in the copper section.
β = ampere-density in the gross winding space.
δ = diameter (bare) of wire in inches.
δ_1 = diameter (covered) of wire in inches.
R = resistance of coil in ohms.
r_1 = resistance of wire per inch in ohms.
ρ_1 = resistance per cubic inch of coil space.
s = sectional area of wire in square inches.
σ = space-factor = copper area ÷ gross area.
V = voltage applied to terminals of coil.
w = watts consumed = CV = C^2R.

If C is prescribed, CS ÷ C = S; β = CS ÷ LT; $\rho_1 = a\beta \times 0{\cdot}8/C^2 \times 10^6$, which fixes the gauge of the wire; s = C ÷ a; V = w ÷ C.

If V is prescribed, C = w ÷ V; r_1 = V/M × CS, which fixes the gauge of the wire, or 12,000V/M × CS = resistance per 1,000ft.;

$$\delta = \frac{1}{1{,}000}\sqrt{\frac{M \times CS}{V}};$$

$$s = \frac{CS \times M}{V} \times \frac{0{\cdot}8}{10^6}$$

The following are also useful: $\sigma = 0{\cdot}785 \times \delta^2 \div \delta_1^2$; LT = S × s ÷ σ; $M = 420 \times d \times w/a \times z \times \sqrt{P_{min.}}$.

Example.—An example will make the process clearer. The case taken is an iron-clad coil to give a pull of 10lb., increasing to 30lb., over a range of 1in. Voltage of supply 100 volts for intermittent work. Here $P_{max.} = 30$; $P_{min.} = 10$; $x = 1$; $y = 3$; $\sqrt{y} = 1{\cdot}732$; u (see Table I.) = 2·37; $z = 2{\cdot}37$; $\sqrt{P_{min.}} = 3{\cdot}16$.

CS × d = 3,000 × 2·37 × 3·16 = 22,500, by formula (VI.).
$B_{min.} \times d$ = 9,580 × 3·16 = 30,300, by formula (V.).
$B_{max.} = B_{min.} \times \sqrt{y}$, by formula (III.).

Trial Values.

d	0·5	1·0	1·5	2·0
CS	45,000	22,500	15,000	11,250
B_{min}	60,600	30,300	20,200	15,150
$B_{max.}$	104,800	52,400	34,930	26,200

The first of these requires too many ampere-turns for so small an apparatus. To judge of the merits of the designs we calculate them out, assuming that β may be taken as high as 2,000, so that LT = CS ÷ 2,000. If the space-factor is taken at 0·5, this implies that the current density in the copper will be a = 4,000 amperes per square inch.

Trial Values.

LT	22·5	11·25	7·5	5·625
L	7·5	3·75	3·0	2·82
T	3·0	3·0	2·5	2·0
M	11·8	13·4	13·4	13·4
LTM	266·0	151·0	101·0	75·5
δ	0·0730	0·0550	0·0450	0·0389
s	0·00434	0·00242	0·00161	0·00121
C	17·36	8·68	6·44	4·84
S	2,600	2,325	2,325	2,327
w	1,736	868	644	484
Lbs. of copper	42·3	24·0	16·0	12·0
Wt. of plunger	0·6	1·53	3·05	5·2

The last of these designs is the cheapest, and wastes less power than the others; but if the weight of the iron jacket is included it will be rather heavier than the third design.

In calculating the length L in the above example, it was assumed that T must, for reasons of heating, not exceed 3in., and this assumption caused L to be greater than z, as it must in many cases be. For if the whole coil is taken as short as z, then the coils may pile up to too great a thickness, and with the increase in the mean length of one turn will come a great weight of copper, and, what is also bad, the cooling surface will be insufficient. The relation between watts expended and necessary cooling surface cannot be stated with any precision, because of the intermittent nature of the user of the apparatus. But, taking the watt-consumption during the periods of use, and averaging it out over an hour, if the average consumption came to more than 3 watts per square inch of cooling surface the design ought to be reconsidered to give more cooling surface. Even so, the temperature rise will exceed that permitted in dynamos and motors. Lengthening the coil always is advantageous from this point of view, for it not only increases the surface but reduces the mean length of the turn and, for a given permissible watt-consumption, reduces the weight of copper; or for a given weight of copper it reduces the watt-consumption.

Incompletely Enclosed Coils.—So far we have assumed an iron-clad type of coil, and we have found that, in order to fulfil the specified conditions of the minimum pull at the beginning of the stroke not falling below a certain fraction of the final pull, it was necessary to make z, the length of the equivalent gap at the beginning of the stroke, longer than the length x of the stroke itself. In other words, there was left in Fig. 2 a space between the bottom of the plunger, when it reached the end of its stroke at E, and the end of the iron piece which closed the tube. In engineers' language, a clearance was left at the end of the cylinder below the piston. This clearance space might be filled up with brass or any other non-magnetic material so far as the reasoning was concerned. It might be thought that this space simply wasted power by requiring more ampere-turns to drive the magnetism through it. But the part it plays is best seen by considering what would occur if it were not there. Suppose it to be filled up with iron. Then when the plunger is right up to E there would clearly be required very few ampere-turns to give the maximum pull. If the excitation were reduced accordingly, then, when the plunger was again pulled out to the top of its stroke, there would be so little excitation that the pull would fall far below the required minimum. So, then, it is absolutely necessary that when the plunger is at the bottom of its stroke, and the pull is a maximum, there should be this additional gap or its equivalent. Now that equivalent may be attained in another way—viz., if an equal amount of reluctance is introduced into the circuit at some other part. Let the point E, the bottom of the stroke, be shifted right to the end of the coil (on the left). Then a gap in the magnetic circuit can be obtained by removing the iron face-plate at the end, or as much of it as may be needed to produce an equivalent reluctance. Suppose we were dealing with the case where $P_{max.}$ is four times $P_{min.}$, or where the pull-ratio $y = 4$. Reference to Table I. shows that in this case $u = 2$ or $z = 2x$. If we removed the end shield this would possibly not sufficiently increase the reluctance—it might be necessary to cut off some of the external jacket also. The amount would depend on the shape of the whole coil. If the whole cylindrical space down the tube were long compared with its diameter, the reluctance from end to end through the interior would be great compared with the reluctance of all the possible paths through the external air if the jacket had been entirely removed. Hence removing the jacket in such a case would not double, but would only slightly increase, the total reluctance existing when the plunger is in the position of beginning the stroke.

The principle of magnetic images will help toward an understanding of the matters involved. In a Paper read by the author before the Electrical Congress at Como in 1900, it was shown, and experimental proofs were adduced confirming the theory, that if a sheet of iron of indefinitely great permeability compared with air, and of indefinitely large size, were placed beyond the end of a solenoid, the effect of its presence is precisely that of a magnetic mirror. At all points of the space in front of it the effect of its presence is the same as would be produced by the presence of a second solenoid of equal power situated behind the mirror at the place where, optically speaking, the virtual image of the first solenoid would be situated. If placed hard up against the end of the solenoid the effect is to double the length of the solenoid. If two such "mirrors" are placed against the two ends of a solenoid of finite length, they have the same effect as making the solenoid of infinite length.

Now it is known that the strength of the field (in C.G.S. units) at any point inside an indefinitely long uniform solenoid is given by the expression $\mathfrak{H} = 4\pi CS/10l$, l being in centimetres. The corresponding expression in inch units is H = CS/l × 0·3133. These values are true to within 1 per cent. for the field at the mid-length of a solenoid, provided its length be not less than six times its internal diameter. The value of the field at the mouth of the solenoid is exactly half this value, as is at once seen by considering that the effect at the middle must be equally due to that part of the solenoid which lies to the right and to that which lies to the left. The effect of putting an iron sheet or end plate across the end of an unjacketed solenoid is then (assuming the iron to be of indefinitely great permeability and extent) to bring up the value of the field within the mouth to the same amount as it would have if the solenoid were indefinitely extended and had the same number of ampere-turns per unit of length.

Consider by the light of this fact what is the effect of putting on an iron face-plate with a well-fitting iron stuffing box on the anterior end of the solenoid. Saving that it will have a permeability and an extent less than infinite, the effect of its presence is that, when the plunger is in the initial position just beginning to enter the coil, the field at that end of the tube is brought up to the same strength that it has at the middle. Now, even without such an end plate, the extended long plunger performs partially the same function. If it were a perfect performer it would be pulled in this position with an initial pull corresponding to the magnetic tension along that field, and this, even with a long solenoid and as many as 2,000 ampere-turns per inch, would scarcely be as much as ½lb. per square inch of end surface of the plunger. Once entered, however, into the mouth of the coil the plunger experiences a pull which steadily increases—supposing the plunger to be at least a little longer than the coil—until its advancing end reaches the bottom of the coil, where the pull is a maximum. And this maximum is seen, by reasoning analogous to that used above, to be equal to one-quarter of the pull there would be between this plunger and its image if an

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iron mirror were placed against the bottom of the coil. What that pull would be will depend on the permeability of the iron as well as on the ampere-turns per unit of length that magnetise it and on its area of section. If the permeability is known, or its curve has been ascertained, **B** can be found from the curve; and the pull will be one-quarter of that calculated by equation (I.). Hence it is the permeability of the iron as well as its section which determines the maximum pull of an unjacketed coil upon the plunger. In the iron-clad coil it is the permeability of air in the gap (or in the equivalent gap) which determines the maximum pull; since, as experience shows, and as can be foreseen from the equations, those designs in which the plunger is of so small a diameter that saturation approaches a point where the reluctance of the iron need be taken into account, are more costly than those where the iron saturation is kept low.

Adaptation of the calculations to cases of coned plungers is reserved for a future publication, the present communication being confined to cylindrical plungers.

A 16-MILE 80,000-VOLT EXPERIMENTAL ELECTRIC TRANSMISSION LINE.*

BY A. C. BALCH.

Early in 1903 a discussion arose regarding the proper insulators to be used on the then proposed Kern River transmission line, which was to be 125 miles in length, and to deliver at its terminal 10,000 H.P. The copper had been determined for a working voltage of 45,000 at the power house and 40,000 at Los Angeles with both lines working. The country about Kern River, however, having great water powers available, it was quickly seen that a higher voltage would be desirable in order to carry more power to Los Angeles over the same line. Accordingly, Mr. W. G. Kerckhoff, president of the Pacific Light and Power Co., instructed that a test should be made of the various types of line insulators then on the market. Nine types of insulators were available for testing, and each type was installed part with wooden pins and part with metal pins; the cross-arms were painted with metallic paint. For convenience the insulators here are referred to as "porcelain 3-14-29½"; the first figure being the number of pieces, the second figure the diameter of the largest petticoat, and the third figure the creepage surface—*i.e.*, the actual surface distance between the wire and the pin. Stated in this way the insulators were as follows:—Locke porcelain 3-14-29½, Locke porcelain 3-11-28, Locke porcelain 3-11-27, Locke porcelain 2-11-25, Locke porcelain 4-14-35, Locke glass 2-11-28, Provo glass 1-9-16, Muncie glass 1-9-16¾, Knowles imperial porcelain 1-10-21, Allen special, composed of two-storey Provo 1-9-16, a single insulator being mounted on top of two others with a cross-piece supporting the upper insulator.

On April 1st a line 16 miles in length, having three wires mounted in triangular shape with a distance of 40in. between wires, was started up. The test continued until June 1st. During this time all sorts of weather was experienced, including heavy fogs and light and heavy rainfalls. In one night 4in. of rain fell on the country through which the line was built. The line ran east and west through the San Gabriel Valley, about 1 mile from the foot of the Sierra Madre range, and parallel to the same. During this test the usual experience of having no difficulty whatever with new insulators was most prominently noted. There was an average voltage of 80,000 between two of the wires and the third wire. Only single-phase transformers were available, and these were two 40,000-volt transformers, which were connected in series with the centre between the two grounded. Each transformer had a capacity of 250kw. Two of the wires were connected to one of the outside terminals of these transformers and one to the other. The current transmitted to the line was measured with a standard ammeter, which was placed in the line wires and set on top of the line insulator. This ammeter showed no apparent tendency to become inoperative on account of static charge. The current to the line was approximately 3 amperes, and this did not vary more than 5 per cent. at any time during the test. The size of the wire was No. 4 B. & S. gauge.

A sharp rattling sound was in evidence, which seemed to be localised at points along the wire, varying from one pole length to a half pole length apart, but could never be placed. It is difficult to determine whether the noise actually shifted or whether it was an error due to the listener. At times it seemed as though objects extending up from the ground, like neighbouring trees and poles standing in the line, made greater noise apparent in their locality, but this was not definitely found to be the case. No danger could possibly have come to a lineman by his thinking the current was off when it was on, as the sound could easily have been heard 100yds. from the line at any time. A native of the locality said that the line sounded like bees and a great many of them. A reduction of 20 per cent. in the voltage practically stopped all the noise. The line was luminous on a dark night or when looking toward a dark mountain on any night, and presented the appearance of a stream of bluish light about 3in. in diameter for each line. This line did not show any nodes or extra brilliant points, but seemed to have exactly the same luminosity throughout its entire length. There was no extra intensity of brilliancy at the insulators or any other place, except at the tie wire on the top of glass insulators it seemed to somewhat enlarge the luminous volume which appeared as a somewhat brighter point than the other portions of the wire. The single wire, however, was considerably brighter than the other two, and could be seen at times and conditions of darkness when the other two wires were not in evidence, although the glass insulators on the other two wires were in evidence. In extra dry times the luminosity was somewhat greater and was frequently reported to be visible half a mile from the line, and was seen on many occasions as far as a mile from the line. The luminosity was of such a nature as to actually illuminate the surrounding objects, which made very perceptible shadows. A camera set at the power house clearly showed 10 spans of the single wire and showed three insulators on each of the poles in question. The telephone insulators on the first two or three poles were also evident in the photograph.

A telephone line ran about 6ft. below the lower cross-arm, and this line was charged so that it would flow ½ ampere through 100 ohms—*i.e.*, it would light a 32 c.p. lamp to half its full brilliancy when connected directly between the combined telephone wires and ground. On open circuit, however, either of the telephone wires would discharge a spark 4in. long to ground terminal. In spite of this, however, the telephone was easily used, provided the operators were willing to chance the conditions of static charge. This was only tested by standing on insulated stools and not used for regular work. No difficulty was experienced in throwing the current on the line during a fog or in any other weather.

One day, after a Locke 2-11-28 was put on the line, the outer piece was found to be split vertically through the top groove, but the inner piece held the voltage successfully except for a small amount of arcing, which caused the patrolman to shut the line down the next day and replace the insulator. On April 18th a Knowles Imperial porcelain 1-10-21 broke down and burned the top off the pole, making a short-circuit and shutting down the line. This porcelain insulator was split down from the top a little to one side of the centre in a manner similar to that shown by the Locke which had previously broken. On April 29th a Muncie glass 1-9-16¾ broke down, shutting off the test. This insulator also had a vertical crack as though it were split down from the top and parted through the threads letting it drop free from the pin. On May 21st a Knowles Imperial Porcelain 1-10-21 was broken off and carried away the top of the pole down as far as the second cross-arm, the wires remaining clear until the arms fells, thus bringing the wires into direct contact.

During the entire test three wires on the other side of the poles, spaced with the same 40in. distance, carried a three-wire 15,000-volt line which was doing regular business, and no difficulty whatever was experienced with it. The conclusions arrived at by this test were that all is well while the insulators are new, or during any period when the insulators have no dust which can become mixed with fog or moisture by weather conditions. No difference was experienced between wood and iron pins, and in no case did the current short-circuit from the wire to the pins over the insulators. The results pointed out to the Pacific Light and Power Co. were that it would be well enough to use a large insulator. Their general knowledge of porcelain led them to adopt for the Kern River line a brown porcelain, and the insulators were made of four pieces. The insulator was not unlike the usual 15in. Locke insulator known as No. 329. The only difference between the Kern River insulator and the Locke No. 329 is that the inner petticoats are spread somewhat in order to allow the company to apply what they consider to be the cure for all evils. This cure, which was to keep the insulators in as good condition as new for an indefinite length of time, was to have the lineman climb the pole once or twice a year, varying with the local conditions, and wipe out the inside of the insulator thoroughly with a cloth in order to remove the dust which might be collected there, at the same time inspecting the pole carefully. This, it is believed, will keep the insulators as good as new, and if they are so kept the company feels safe in assuming that 66,000 volts will cause them no difficulty whatever.

* Paper read before the Pacific Coast Electric Transmission Association.

Telephone Equipment of a Liner.—The ss. "Minnesota" contains, it is said, the largest telephone installation ever placed on a vessel. According to the *Western Electrician* of Chicago, a regular exchange and a separate intercommunicating system are installed. The instruments are worked from a central battery and every state room is provided with a telephone. There are 11 stations for the use of officers and engine room staff.

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CORRESPONDENCE.

ELECTRICITY SUPPLY IN WOOD GREEN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The leading article in your issue of September 16th deals with the Local Government Board's treatment of the Wood Green Urban District Council's application for authority to carry into effect their electric lighting order. We do not propose dealing with the principle of the "Middleman" position suggested by you as the correct one for municipalities to assume in electricity supply, but there are certain erroneous statements in your article which you will no doubt be glad to correct.

No comparisons were made by us between Wood Green and Liverpool, Glasgow or any other similar town as is suggested in your article. The estimates referred to in the article were based on a lamp connection and not on any stated number of consumers.

It is misleading to state that "Wood Green alone" attempted to convince the Local Government Board. Wood Green happens to be the first of the five councils to make application, one Council having made arrangements with the company and the remainder having not yet taken any definite step. Wood Green has not attempted to show that it can generate electricity at the same price as the Power Supply Company. It does estimate that it can generate at less than the sale price offered by the company for bulk supply.

Mr. Hawtayne did not state that he had "refused to entertain any negotiations with the North Metropolitan Electrical Power Supply Co. unless he could get a supply for 1d. or ¾d. per unit," for the simple reason that he was never asked to entertain any such negotiations, and that the figure put down in the engineers' report handed in to the inspector as the top price for bulk supply is 1·341d. per unit.

A comparison with other London electricity supply works scarcely proves the reasonableness of the company's offer as you suggest. The total costs at Hackney, according to the *Electrical Times* tables, including all interest and sinking fund charges, both on plant, machinery and distribution, including all works costs of distribution, amount to only 2·7d. per unit sold, the total cost at Stepney being 1·82d. If Stoke Newington, at a considerable distance from the company's power station, can be supplied by the company at 1·62d. per unit, as stated in your article, there would seem to be reason for objecting to the company's proposed charge of 2½d. per unit at Wood Green, and to expect a supply at about the figure of 1·341d. above mentioned. It was stated on behalf of the company in the House of Commons in 1900, and again in 1902, that "current could be generated and supplied in bulk at a price not exceeding 1½d."

It is not correct to say that the order for cables (conditionally accepted) will have to be "reduced considerably" if the Council now elect to take supply in bulk instead of generating current themselves. Mr. Hawtayne's proposed generating station site is not "at the boundary of the area at a considerable distance from the centre of the district," but is, on the other hand, centrally situated less than half a mile from the company's sub-station.

The population of Wood Green is approximately 40,000; the rateable value of Wood Green is approximately £227,133, so that the rateable value per head is approximately £5. 15s., as compared, say, with a rateable value per head of £4. 4s. at Walthamstow, the Urban District Council of which has possessed its own electricity supply undertaking for some years. To describe Wood Green as "a residential district of by no means a high class, peopled almost entirely by working men earning only average wages," is to furnish additional proof that the information you have received, both as to the character of the district and the nature of the scheme propounded, is far from accurate.—Yours, &c., HAWTAYNE AND ZEDEN.

London, Sept. 21.

[We did not suggest that the consulting engineers made comparisons between Wood Green and Liverpool, Glasgow, &c., but these comparisons were certainly made by members of the Urban District Council to obtain the ratepayers' support to the scheme. As to the estimates of the number of consumers and lamp connections, we must refer Messrs. Hawtayne and Zeden to the letter from the Local Government Board, in which the estimates we quoted are given; such estimates are usually made by the consulting engineers. On the question of price, according to published reports, Mr. Hawtayne distinctly said at the enquiry that he would not recommend the Wood Green or any other council to tie themselves down to any outside company to pay anything more than ¾d. per unit. The figures of costs at Hackney and Stepney, which he quotes, cannot be compared with the probable results at Wood Green, Hackney having had lamp connections equivalent to 90,000 8 c.p. lamps, including 600 H.P. of motors, on January 1st last, and Stepney 76,000 8 c.p. lamps, including 600 H.P. of motors. The total costs just published for Erith, a station of Mr. Hawtayne's own design, amount to 3·75d. per unit, including capital charges, and the nett financial result is a loss. Erith is, moreover, a far more favourable district for electricity supply than Wood Green. That the company has not come down to the price quoted in the Parliamentary Committee room is beside the question, and we have certainly no desire to defend the practice of making such estimates too rosy. In conclusion, we would only draw Messrs. Hawtayne and Zeden's attention to the fact that the Local Government Board has evidently adopted the view that we have always taken, that the council of a small district should not erect its own electricity supply works when it can obtain a supply in bulk from a company at reasonable rates.—ED. *E.*]

MOISTURE AND EXTRA HIGH-PRESSURE LINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In Mr. Campbell Swinton's Paper on "Electricity from Water Power," published in your issue of 2nd inst., it is stated that a pressure of 40,000 volts is to be used with an overhead line of bare wire laid along the hill sides of Loch Lomond. The abnormal climatic conditions of that district appear to me to be likely to cause trouble from which other similar installations are free.

I do not know if the engineers of this line are personally acquainted with that condition of the atmosphere known as a Scotch mist, but it is well known that it is a fairly frequent phenomenon in the West Highlands, and also that it is the most wetting condition possible. Minute particles of water, so small that their rate of fall is almost inappreciable, drift along with the air, and the horizontal flow of water is quite comparable with the vertical flow of a rain storm. Suspended in the air they will eddy into every nook and cranny, past which the wind blows, and, accordingly, I fear that the insulators, however many sheds they may have, will be continuously coated with moisture on every part of their surface. It is true that live insulators have a great power of drying themselves, but only at considerable risk of starting an arc, and in this case the moisture will be continuously and quietly renewed, without sufficient delivery of water to effect any appreciable cooling action.

When it is remembered that these conditions may continue for hours, or even for days, and are certain to occur many times in the year, the importance of the question is obvious. The experience of other lines of similar or higher pressure in parts of the world which enjoy for the most part a dry climate, and where it never rains but it pours, is not applicable. A violent rain storm, as every telegraphist knows, is fairly harmless, since the sheds give adequate protection; although those other installations appear to suffer occasional earths. But a condition which seems likely to produce a continuous earth is too serious to be risked without definite experiment under the actual conditions, or at least a very careful copy of them. The rainfall of the valley in which Loch Lomond lies may not be very exceptional, but for general dampness its reputation is undoubted.

There is, moreover, another side to the question in which the general public may claim an interest. On the occurrence of an earth at an insulator, there may be an area of many yards round about it, in which a man's stride will include a dangerously large fall of potential, and though the wayleaves are stated to be private, it may be questioned whether the

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owners and the public in general are prepared to see so long a strip of country marked as "dangerous during wet weather."

If, to avoid this action, the insulator pins are metallically connected, I believe the leakage losses will rise to a prohibitive value.

It may be that I am needlessly raising an alarm, and that the intense electrostatic field will cause coagulation of the droplets, with their consequent fall to earth. Such a consummation is devoutly to be wished; but in the absence of actual evidence on this point, or some other convenient property, some speculative doubt may be allowed. I should like to add that, if I am writing in ignorance of already completed trials, I owe an apology to Mr. Campbell Swinton for suggesting doubt on a matter which may have been his first care to determine.—Yours, &c.,

FRANCIS G. BAILY.

Heriot-Watt College, Edinburgh, Sept. 15.

A NEW SINGLE-PHASE MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Prof. Elihu Thomson in his remarks, contained in your issue of August 19th, on the above subject refers to his American patents of the repulsion motor. I find these do not differ much from the British ones. Even in the original form of the motor an ordinary commutator is used. Fig. 1 in my letter of July 15th, which Prof. Thomson states to be similar to a sketch contained in one of his patents, is only a diagram showing two poles and three armature coils. There is nothing to indicate that it represents a repulsion motor at all, it is only intended to show the slot in the middle of the pole, which is the point where it differs from the sketch in U.S. patent No. 516,849. I think this discussion is due to the inexact form of my first patent published in *The Electrician*. Certainly every repulsion motor will be based on the repulsion principle originated by Prof. Thomson, but the difference "in minor details" may make all the difference between satisfactory working and the contrary.—Yours, &c.,

Chelmsford, Sept. 20. RUDOLF GOLDSCHMIDT.

SYNTONY IN WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In an editorial note on p. 545 of your journal for July 22nd, concerning the working of the Marconi wireless telegraph system on the "Nantucket" lightship, the Marconi Company is reported as seeing "insuperable difficulties" in the interchange of signals between its system and others. With regard to modifying the system, the company appears to have no reason "to overturn its system and undo the work of many years for sentimental reasons." We beg to state that the attainment of a good intercourse between the Marconi apparatus and the apparatus of our system is not a question of sentiment but of erecting a more practical installation, in which it is possible to resyntonise the exciting circuit of the transmitter and the resonance circuit of the receiver, as well as the aerial conductor, to any desired wave-length within certain limits.

Apart from the will to do this, all that is requisite is suitably-worked apparatus for varying the self-induction and capacity. As we ourselves have possessed such devices for about two years, we must absolutely take for granted that the Marconi Company likewise have similar apparatus at their disposal. We have, therefore, in delivering our apparatus, again and again undertaken to guarantee to be able to resyntonise our transmitter and receiver to every wave-length of the Marconi Company, and we have likewise proved our ability practically.

As methods exist of measuring wave-lengths even at the longest telegraphic distance, it is easy to syntonise one's receiver to any previously unknown wave-length one pleases, and at the same to be able to arrange one's own transmitter with the help of an ordinary ondameter in such a way that it sends out the same wave to serve the distant receiver.

We intend shortly to publish further details concerning this method and to dispose, once for all, of such assertions regarding the existence of "insuperable" difficulties in the mutual working of different systems.—Yours, &c.,

GESELLSCHAFT FÜR DRAHTLOSE TELEGRAPHIE, M.B.H.

Berlin, Sept. 17. Arco.

LEGAL INTELLIGENCE.

Maund v. Loughlin.

At Manchester County Court on Monday, before Judge Parry, plaintiff sought to recover £41. 11s. expended on labour and material in carrying out certain experimental work for defendant. It appeared that defendant had invented apparatus for deadening tramway trolley wires in the event of an accident, and about two years ago obtained permission from Oldham Corporation to experiment with this invention on a section of their tramways. He employed plaintiff (Mr. Albert Maund, electrical engineer, Southport) to fix the apparatus on half a mile of trolley wire. When, however, the device was tested, it did not achieve its object, the failure being due to the fact that the guard wires had not been insulated from the iron standards supporting them. The defect was remedied by another contractor called in by defendant, and the device was then found to work to the complete satisfaction of the Corporation.

Defendant pleaded that plaintiff had done the work negligently, with the result that the equipment had to be re-erected, and the cost of the re-erection was counterclaimed. For the defence it was alleged that it ought to have been obvious to plaintiff, as an electrical engineer, even if he had received no express instructions on the point, that the insulation of the guard wires from the standards was essential to the successful working of the device.

Plaintiff replied that he worked according to instructions received from defendant from day to day during the progress of the work.

Judge PARRY decided that, as plaintiff had no written specification to work from, and as the work was of an experimental nature, it was absurd to charge him with serious negligence because he had not foreseen the necessity for insulators. He gave judgment for plaintiff on both claim and counterclaim.

Workmen's Compensation.

At Lancaster County Court on Friday last Judge Coventry decided, in an application under the Workmen's Compensation Act, 1897, that a workman injured while removing goods for his employer from a railway waggon was not entitled to compensation.

A labourer, named Norman, was engaged by Messrs. Robert Blackwell & Co. in connection with an extension of the Lancaster Corporation Tramways. On July 21 he was engaged with another labourer unloading trolley wire bracket arms from trucks in the L.&N.W. Railway goods yard at Lancaster. In some way he strained the muscles of his back and shortly afterwards left work. Compensation under the act was claimed, but Messrs. Blackwell were advised that no claim would lie in law, hence the present proceedings.

After hearing the evidence, Judge Coventry decided that a workman injured while removing goods for his employer from a railway waggon away from his employer's works was not entitled to compensation, as the accident must happen in, on or about the works of the employer, and a railway goods station could not be shown to be in the joint occupation of the firm in question and the railway company. Judgment must be for defendants.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

"Central Electrical Stations: their Design, Organisation and Management." By C. H. Wordingham. 2nd edition. (London: Griffin & Co.). 24s.

"Report of Preliminary Wireless Telegraph Conference, 1903." (London: "The Electrician" Printing & Publishing Co.) 8s. 6d. net.

"The International Telegraph Convention and Service Regulations," 1903 Revision (London). (London: "The Electrician" Printing & Publishing Co.). 6s. net.

"Elementary Manual on Applied Mechanics." By Andrew Jamieson. 6th edition. (London: Griffin & Co.). 3s. 6d.

"Laboratory Handbook of Electrotechnology." By W. Brown and R. G. Allen. (Dublin: Sealy, Bryers & Walker.) 5s.

"Machine Drawing, for Evening School and Technical Institute Students." By Alfred P. Hill. (London: P. S. King & Son.) 2s. 6d.

"Electrical Engineering for Students." By S. S. Bottone. Part. I.—Magnetism and Magnetic Apparatus. Part II.—Static Electrical Instruments. (London: G. Pitman.) 2s.

"Die Wechselstromtechnik." Edited by E. Arnold. Vol. I. —Theorie der Wechselströme und Transformatoren. By J. L. La Cour. Vol. II.—Die Transformatoren. By E. Arnold and J. L. La Cour. Vol. IV.—Die synchronen Wechselstrommaschinen. By E. Arnold and J. L. La Cour. (Berlin: Julius Springer.) 12m., 12m. and 20m. repectively.

"The Story of Wireless Telegraphy." By Alfred T. Story. (London: G. Newnes.) 1s.

"The Diseases of Electric Machinery." By C. Kinzbrunner. (London: Harper Bros.) 1s. 6d.

"Technological and Scientific Dictionary." Part V. Edited by G. F. Goodchild and C. F. Tweney. (London: George Newnes.) 1s

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MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Southwark (London) Borough Council invite applications for the position of chief engineer and manager of their electric light undertaking. Salary £300, rising by annual increments of £20 to £400 per annum. Applications to the town clerk (Mr. J. A. Johnson), Town Hall, Walworth-road, S E., by noon Oct. 5. See also an advertisement.

Dartford District Council require a resident electrical engineer to take charge of their electricity supply undertaking. Commencing salary £250 per annum. Applications to the clerk (Mr. W. Kay), Council offices, Dartford, Kent, by Oct. 6. See also advertisement.

A wiring inspector is wanted by the Durban (Natal) Municipality chiefly for testing, inspecting and reporting upon house wiring. Salary £300 per annum. Applications to the agents of the Corporation (Messrs. Webster, Steel & Co.), 5, East India-avenue, Leadenhall-street, London, E.C., by Sept. 26. See also advertisement.

Two junior assistants are required by Dundee City Council to take charge of switchboard in combined lighting and traction station. Applications to the city electrical engineer and tramways engineer (Mr. H. Richardson) by Sept. 28. See advertisement.

Applications are invited for the position of lecturer and demonstrator in electrical engineering at the school of engineering, electricity and technical science, Canterbury College, University of New Zealand. Salary £300 per annum, with saloon passage to New Zealand. Particulars of qualifications and forms of application from the Agent-General for New Zealand, 13, Victoria-street, London, S.W., to whom applications by Oct. 29. See also advertisement.

The Agent-General for the Cape of Good Hope is prepared to receive applications for the appointment of a mechanical and electrical engineer to his department Salary £800 per annum. Preference to one with practical experience in the testing and inspection of material. Applications to the Agent-General, 100, Victoria-street, London, S.W., by Sept. 28. See also advertisement.

A shift engineer is wanted at Blackburn electricity works. Applications by 28th inst. to the engineer and manager.

An assistantship in the Metrological Division of the Physics Department of the National Physical Laboratory is vacant. Salary £200 per annum. Applications to the director (Dr. R. T. Glazebrook, M.A., F.R.S.), Teddington, Middlesex, by Oct. 1.

The Council of Durham College of Science invite applications for the Principalship. Salary £1,000 per annum. Applications to Secretary by Sept. 30.

Huddersfield Corporation confirmed on Wednesday the appointment of Mr. R. H. Wilkinson, of Oldham, as tramways manager at £350 per annum.

Mr. T. Macdougald, of Dundee, has been appointed assistant electrical engineer at Falkirk.

Radcliffe (Lancs.) Council have appointed Mr. Geo. Nuttall charge engineer at the electricity works.

Mr. J. S. Paterson, of the National Telephone Co., is recommended, out of 40 applicants, for appointment as chief electrician of the Glasgow Corporation telephone department at a commencing salary of £190 per annum.

West Ham Education committee have selected Mr. P. R. Friedlander, late of Messrs. Crompton & Co., Chelmsford, as assistant lecturer in electrical engineering at the Technical Institute at £200 a year.

Mr. J. Coxon, A.I.E.E., chief assistant in the lighting and power department of the G.P.O., has been provisionally appointed instructor in electric wiring at West Ham Technical Institute.

EDUCATIONAL NOTICES.

University of Liverpool.—The session 1904-5 commences on Oct. 3. The courses of study in the faculty of engineering leading to the ordinary B.E. degree or the certificate in engineering are so arranged as to afford a general scientific training for those intending to become engineers or to enter any allied profession. There is an honours course for students who desire to specialise in some branch of the profession and opportunities are afforded for post graduate work and research. Prospectuses from the Registrar. Included in the staff of professors and lecturers are Mr. A. Bromley Holmes (who is associate professor in municipal electrical engineering) and Mr. J. A. Brodie (associate professor in municipal engineering).

Durham College of Science (Newcastle-on-Tyne).—Courses are provided at this college for students proceeding to the degrees in Science, and special facilities are offered for the study of agriculture, chemistry, mining, engineering and naval architecture. Matriculation and exhibition examinations begin Sept. 26, and lectures Oct. 4. Prospectuses from the Secretary.

Merchant Venturers' Technical College, Bristol.—Courses of instruction are given at this college in civil, mechanical and electrical engineering, chemistry, architecture and building; also for matriculation, intermediate and final B.Sc. (including engineering degree) of the University of London. In addition to the professors, the college staff includes 79 assistant lecturers, demonstrators and skilled artisans. There are 11 laboratories, eight workshops, a dynamo room, engine house and an electric light installation. The calendar (price 6d.) or short prospectus (free) may be obtained from the registrar. The former is a volume containing much interesting information concerning Merchant Venturers' College, which was established as far back as 1856.

King's College (London).—The session 1904-5 commences on Wednesday, Oct. 5. Evening classes are also held for civil, mechanical and electrical engineering workshop practice, metallurgy, physics and all science subjects. Prospectuses from the secretary.

Glasgow and West of Scotland Technical College.—The annual meeting of the governors of this college was held on Tuesday.

In moving the adoption of the financial statement, Mr. Goodwin said that through the generosity of the subscribers to the Building Fund they were shortly to enter into possession of the first section of their new buildings. They would then have at their disposal class rooms and laboratories to accommodate their 5,000 students in a more adequate manner. The class-rooms and laboratories would require to be lighted, heated and ventilated, and also suitably furnished and equipped. They proposed to devote the balance that they somewhat unexpectedly found at their disposal (£6,500) to that purpose. The governors regretted that it did not seem possible to proceed immediately with the erection of the second section. The subscriptions to the building fund amounted to £186,525. The cost of the first section would be £140,000 plus £44,654 expended on the site, &c. The second section would cost not less than £60,000. The numbers of students during the past session was 5,333. The number of class enrolments was 7,848, and the total number of "student-hours" was 368,282.

Mr. J. G. Longbottom, A.R.C.S., has been promoted to the chair of Mechanics, and Mr. J. H. A. M'Intyre, M.I.Mech.E., appointed lecturer in engineering drawing.

The chairman (Mr. Copland) awarded the diplomas and medals won last session—viz., chemistry, James W. Agnew; civil engineering, Robert Neilson and George S. Young; mechanical engineering, William Foulis and John M. Young (with Montgomerie Neilson medal and prize, value £15); electrical engineering, Andrew N. Aikman, George B. Clerk, Frederick H. Downie (with Sir John Pender Scholarship, value £40, and gold medal, value £5. 5s.), Douglas Money and Carment Urquhart.

Birkbeck College, London.—The new session begins on Monday, Oct. 3. There are day and evening classes and systematic courses of instruction (lectures and laboratory) for the degrees of Science and Engineering of the University of London Further information can be obtained from the Principal. Birkbeck College has just completed 81 years of educational work in the metropolis. During last session 71 students passed some university examination, while a large number gained successes at various public examinations. The modern language classes at this institution are a distinctive feature.

Sir John Cass Technical Institute (London).—The new session begins on Sept. 26. There are advanced classes in chemistry, metallurgy, physics and mathematics. Facilities are afforded for special and advanced practical work in well-equipped laboratories, both in the afternoon and evening. Courses of instruction will be given in glass blowing during the session by Mr. A. C. Cossor. The Institute is readily accessible, being adjacent to Fenchurch-street, Liverpool-street, Broad-street, and Metropolitan Railway stations. Particulars from the Institute or by letter to the Principal (Mr. Charles A. Kohn, M.Sc., Ph.D., F.I.C.)

Borough Polytechnic Institute, London, S.E.—The 1904-5 session commences on Oct. 3. There are evening classes (lectures and laboratory work) in inorganic and organic chemistry, electrochemistry, electricity and magnetism and electrical and magnetic measurements. Prospectuses from the Principal (Mr. C. T. Millis). The course in electrical and magnetic measurements is intended for electrical engineers, instrument makers and others engaged in electrical work. See also an advertisement.

Hackney Technical Institute.—The session commenced on Monday last. There are special courses and laboratory work in electrical engineering, including electrical measurements, dynamo and motor design and telephony. Prospectus from the secretary, Dalston-lane, London, N.E.

South-Western Polytechnic (Chelsea).—Complete three years' courses of instruction in electrical engineering are given at this Polytechnic during both the day and evening. Lectures and instruction in practical work are given in electrical engineering (elementary, intermediate and advanced), electrical design, instruments and lamps, alternating and polyphase currents, electrical wiring and fitting, and calculus for engineers. Particulars can be obtained from the secretary.

Battersea Polytechnic (London, S.W.).—The new term commenced on Monday. Technical day college courses in mechanical and electrical engineering and day and evening courses in prepara-

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tion for London University engineering degree are provided at this polytechnic. Prospectus from the secretary.

Calendars, &c.—We have received a copy of the "Announcements" of the Northampton Institute, Clerkenwell, London, E.C., for the session 1904-5, which, as regards evening courses and classes in engineering (mechanical, electrical and horological), artistic crafts and other technological subjects, will begin on Monday, 26th inst., and as regards day courses in engineering, technical optics, &c., on Monday, Oct. 3. The publication gives complete particulars of the course of instruction, staff, fees, hours of classes, &c. Among the new developments are the day courses in technical optics, which is claimed to be the first complete course in this subject in this or any other country. The evening classes are separated from the applied physics department, and have been re-modelled under Mr. S. D. Chalmers, who now devotes his whole time to the work as head of the department. Days courses for artistic crafts also appear for the first time. The subjects taken, besides drawing and design, are goldsmiths' and jewellers' work, silversmiths' work, engraving and decorative metal work. The complete day courses in electrical and mechanical engineering extend over four years. There are full evening courses for the design, construction and working of automobiles. The evening courses in electrical engineering have been remodelled—the complete course now covers five years—while the courses in structural engineering have also been re-arranged.

Technical Lectures for Employes at Electricity Works.—The Central Trades' Association of Königsberg, Prussia, a few months ago established a free course of instruction for employés at the various electricity works in the city (minors excepted). Lectures are given two evenings a week after work hours (from 7:30 to 9:30) by engineering experts of long practical experience. At the end of each course of about 12 weeks' duration examinations are held and certificates awarded to those who pass satisfactorily. It is considered that the experiment has proved a success.

Alaska.—In the Seattle "Sunday Times" for Aug. 28 there is an interesting and patriotic description of the laying of a submarine telegraph cable between Seattle and Sitka by the cs. "Burnside" for the American Government. This telegraph service runs between Seattle, Sitka, Skagway and Juneau, and is to be extended shortly to Dutch Harbour, and possibly to Kiska Island, where a United States naval station has been established. The final splicing was celebrated with full honours on Aug. 28.

Alcohol Motors.—It is stated that German supply houses are selling large numbers of alcohol motors for driving electric lighting and small water-pumping plants in Cuba.

Argentina.—The "Review of the River Plate" states that a company has been formed at Coronel Suarez for the working of an electricity supply scheme.

Mr. A. C. Morris is to submit proposals to San Juan Municipality for the electric lighting of the city.

Armagh.—The Council will be invited at their next meeting to authorise steps being taken to erect electricity works.

Ayr.—The Council require, as a condition of their consent to the National Telephone Co.'s lines being placed underground, that the company shall allow Ayr the full benefit of any reduction in their charges in any town with a population of less than 35,000. The company have, however, declined to agree, and the Council are advised by their General Purposes committee to "drop the negotiations."

Belfast.—A joint specification for the proposed electric tramway scheme is being prepared by Messrs. H. A. Cutler (city surveyor), Victor A. H. M'Cowen (city electrical engineer) and Andrew Nance (manager of the tramways), in which Mr. Cutler is paying special attention to the permanent way, Mr. Nance to cars and depots and Mr. M'Cowen to the generating station and the overhead works.

The reconstruction of car sheds is to be deferred for the present. Considerable extensions are included in the scheme. Rosettes are not to be attached to buildings, and side posts are to be generally adopted, with centre poles in the principal thoroughfares. On completion of the specification, advertisements will be issued for tenders for the work. The Tramways committee have decided that, in the construction of the permanent way, each contractor tendering shall be required as a condition of his contract to carry out the general work by giving a preference to local labour. A consulting engineer is not to be employed, but Mr. M'Cowen has been instructed to report to the committee on special points likely to call for expert advice.

Belgian Trade.—An interesting consular report on the trade of Belgium for 1903 has just been published. Mr. Consul J. Hertslet, besides reviewing the trade and commerce of Belgium deals with many subjects of interest to traders in this country, and particularly points to the opportunity which the exhibition to be held next year in Liège will afford British manufacturers of making themselves acquainted with the requirements of the mining districts of Belgium.

Birmingham District Tramways.—The British Electric Traction Co.'s cars commenced running on Monday between Steelhouse-lane and Aston Church. This system is worked by the company on behalf of Aston Corporation.

The new electric tramway route between Old Hill and Blackheath which is being constructed by Rowley Council is nearing completion.

Rowley, Quarry Bank and Brierley Hill Councils are constructing a joint line between Cradley Heath and Brierley Hill.

Bradford.—The general manager of the Corporation tramways (Mr. C. J. Spencer) has issued his report for the year ended March 31.

Mr. Spencer considers the income must be regarded as most satisfactory. Traffic receipts were £193,206. 12s. 7d., an increase of £23,091. 3s. 5d. on the previous year; the carriage of Post Office mails showed a satisfactory and lucrative addition to the income, and parcel traffic an increase of £218. 19s. 4d. The total income was £197,437. 13s. 5d. (10·421d. per car-mile), an increase in the aggregate of £23,903. 7s 11d. or 0·044d. per car-mile) since March 31, 1903. The earnings in the previous year amounted to £4,409 per route-mile of tramway in operation on a total route-mileage of 39·36 miles, and last year to £4,183 per route-mile of tramway on a route-mileage of 47·2 miles, a decrease in income per route-mile of £226 and an increase in length of 7·84 miles. The receipts per 1,000 of population served were well above the average, and the receipts per route-mile of tramway in operation were several thousand pounds below systems of like size and importance. The total cost of operation, excluding interest, sinking fund and depreciation, was £137,932. 0s. 7d., leaving a gross profit of £59,505. 12s.10d. The net increase in operation expenses was 0·255d. per car-mile. The cost of electricity showed a considerable increase over the previous year, both in the aggregate and per car-mile, due to several causes. The majority of the sections recently opened have been either of a very hilly character, or are a long distance from the power station. The adoption of car-tops has increased the power consumption per car from 15 to 20 per cent. Some of the power cables, both positive and negative, are overloaded, causing high transmission losses. The Electricity committee are taking steps to increase the capacity of the cables. A large proportion of the expenditure on rolling stock repairs was in wheels and axles. Mr. Spencer thinks that it may be accepted as a general rule that repairs (taken over a period of years) will vary pro rata with the current consumption per car-mile. Of the amount expended in repairs to overhead equipment, £2,978 had been spent in the tramway department. There was a constant deterioration of overhead fittings, altogether apart from ordinary wear and tear, and as that was quite apart from car-mileage run, its ratio to total expenses per car-mile in Bradford was of necessity much higher than in some towns. Rents, rates, taxes and insurance amounted to £7,820, a heavy proportion to total expenditure. Compensation and professional charges as to accidents came to £3,762, which exhibited a serious increase. The total capital expenditure to March 31 was £817,000, on which the department has been charged with £46,105 as interest and sinking fund, or 5·63 per cent. In the previous year the capital expenditure amounted to £679,618, on which the department paid £36,188, or 5·32 per cent. The increase in capital expenditure for the year was £138,000.

The Corporation have powers to construct a tramway on Canal-road, and the Tramways committee have under consideration proposals to exercise these powers and also to construct a tramway between Wakefield-road and Laisterdyke, subject to Parliamentary consent being obtained.

Brantford (Ontario).—The municipality of this town has received an offer from the Chicago Telephone Supply Co. to instal a municipal service for $37,500, the present customers of the Bell Telephone Co. being supplied with instruments free of charge pending the expiry of existing contracts.

Brentford.—The Council were recommended by their General Purposes committee to refuse the request of Mr. H. B. Renwick (on behalf of the Brentford Electric Supply Co.) for an interview to discuss the proposed application for a provisional order, but an amendment to refer the report back in order to ascertain the company's terms was carried at the last meeting.

Bristol.—On Friday an inquiry was held into the application of the Corporation to borrow £126,500 for electric lighting extensions.

It was stated that £89,000 was required for extensions to the Avonbank electricity works, £16,000 for Temple Back works and £21,500 for the extension of mains. The undertaking commenced in 1893, and the amount borrowed had reached £574,080.

Mr. H. Faraday Proctor supplied technical details and produced plans of the extensions at Avonbank and Temple Back, and said that, owing to the fire at Temple Back last Christmas it was proposed to replace the destroyed switchboards by fireproof switch rooms.

There was no opposition.

Burslem.—The Council are recommended to pay the borough electrical engineer (Mr. Ashton Bremner) £200 per annum for three years from his appointment (in addition to his salary of £200 per annum) for services rendered in connection with the preparation of plans and specifications, &c., for the Council's electricity undertaking.

Cable Ship "Monarch" Explosion.—We are officially informed that the "explosion" on board the "Monarch" last Saturday was of a trivial nature and that the vessel, which was out of commission at the time, is going to sea on Monday next. The facts of the case are that a supply of coal was received on the ship (which lay at her moorings off Woolwich) two days before the accident and was put in the bunkers while heavy rain was falling. The coal being very new and the damp getting to it a small quantity of gas was given off and an explosion occurred when coal was being got out to fire up an auxiliary boiler. Very slight damage was done.

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Caerphilly.—The Council have appointed Mr. A. H. Preece (Messrs. Preece & Cardew) their consulting electrical engineer.

Cambridge.—The Council will support the bill of the Cambridge Electric Tramways Synd. (Ltd.) for powers to extend the present tramways, and to convert the whole to electric traction, 9 miles of route in all.

Canton (China).—Electric light fittings and gearing to the value of £1,794 was imported into Canton in 1903. This is the first time this class of apparatus has been separately indicated in the imports.

Cardiff.—Out of the estimated surplus profit for the current year the Electricity committee propose to apply £3,000 to relief of rates and to increase the reserve fund by £2,282, bringing it up to £4,413. The borough electrical engineer and tramways manager (Mr. Ellis) urges that there is no practical need for a separate depreciation fund.

Cleethorpes.—On Wednesday the District Council decided to purchase the Cleethorpes power station of the Grimsby Street Tramways Co. at £17,000.

Coal Conveyance on Tramways.—The Potteries Electric Traction Co. are making experiments in the conveyance and delivery of coal within in the company's district.

Recently the Tunstall Council were requested by the Chatterley-Whitfield Collieries (Ltd.) and the Potteries Company to permit the laying of rails to connect the present tramway with the Chatterley Company's private sidings to enable that company to supply not only the Traction Company with fuel for their works but also the manufacturers in the town. The Council have agreed to the coal being taken to the generating stations only, as an experiment, no expense to be incurred by the town, and the connecting rails being subject to removal on three month's notice.

Companies to be Struck off Register.—The "London Gazette" of 16th inst. announces that the following will be removed from the register of Joint Stock Companies in three months, unless cause be shown to the contrary :—

Clayton Engineering & Electrical Co.	Farrell Incand. Elec. Light Synd.
Electrical Automatic Loom Synd.	L. & N.W. Electric Tramways.
Electrical Instruments Synd,	Metropolitan Electric Tubes Synd.
Electric Traction Insurance Assoc.	Nottinghamshire Elec. Tramways.
European Elec. Railways & Public Works Construction Co.	South-West Wireless Telegraph Ship Co.
	Tramways Construction Co.

Croydon.—The Corporation adopted the recommendation of the Lighting and Electricity committee on Monday to reduce the price of electricity, on the maximum demand system, from 7d. per unit for the first hour and 2d. after to 7d. and 1½d.

The Board of Trade have sanctioned a loan of £10,000 for tramways—viz., £2,623 for 30 years and £7,377 for 15 years.

Customs Decisions.—A modification of the import duties on telegraph instruments imported into France has recently come into effect, and the duty is now 125fr. against the former 75fr.

Galvanised copper or vulcanised steel wire imported into Japan to be used for underground telegraph lines is dutiable at the rate of 10 per cent. ad val., and not at the conventional rate of 5 per cent. ad val., as provided for "telegraph wire."

Durham.—The Rural Council is in favour of the proposed application of the County of Durham Electrical Power Distribution Co. for a provisional electric lighting order.

Edinburgh.—The accounts of the electricity department for 1903-4 show total income £116,178. 18s. 10½d., including £92,782. 1s. 6d. for current supplied for private lighting, £13,006. 14s. 1d. for motor power and £10,101. 3s. 7d. for public lighting.

Expenses were £42,999. 11s. 8½d., leaving a surplus of £73,179. 7s. 2d. to meet interest and contribution towards liquidation of debt, income tax, &c. The net profit was £23,997. 7s. 4d. 11,704,182 units were generated. 7,001,715 were supplied for private lighting, 2,291,976 for motors and 1,311,174 for arc lighting. The total capital expended to date was £845,336. 17s. 6d., an increase of £44,626. 9s. 6d. for the year.

Egypt.—Imports of electrical apparatus into Alexandria in 1903 amounted in value to £69,386. About £31,794 came from the United Kingdom, Germany coming next with £14,359.

Finchley.—An inquiry will shortly be held into the application of the Council to borrow £17,000 for electric lighting extensions.

Fulham (London).—The district auditor, in his report, takes exception to the electricity and dust destructor undertakings being treated as a single enterprise in regard to profit and loss.

The auditor thinks that the cost of the destructor should be charged directly upon the general rate fund and the value of the heat supplied by it be refunded out of electricity revenue. The report continues :

"The cost of providing and maintaining the electric lamps and pillars for public lighting is also treated in the accounts as a charge upon the electricity revenue, and presumably taken into account in arriving at the annual charge upon the general fund for lighting each lamp. In this case also there does not appear to be authority in law for the charge upon the electricity revenue. The cost of providing the lamps should be transferred to the general fund and the charge for the supply of current be based upon that fact."

The report was adopted without discussion at the Council meeting on Wednesday.

Gourock.—The Corporation are negotiating for a supply of electricity in bulk, and a formal offer will be submitted by Greenock Corporation.

Gowerton.—A committee of three, including the chairman (Col. Wright) has been formed to consider and report upon certain offers made for supplying electricity in this district.

Greenock.—The borough electrical engineer (Mr. Robertson) has reported to the Corporation upon the extension of the electricity supply mains to Gourock, and the subject is still under consideration. The cost of extending the mains is put at £1,150, and of the erection and equipment of a sub-station at £2,850.

Hammersmith (London).—The Council have been notified by the Local Government Board

That on this occasion, in order to avoid a disallowance, they would sanction payments amounting to £309. 1s. 3d. made by the Council in connection with the purchase of electric motors for letting on hire or on hire-purchase. The Board of Trade consider (continues the communication) that local authorities are authorised by the orders relating to electricity undertakings to lay down such electric lines as may extend from the mains to consumers' terminals, and, if required, to supply meters, but that there is nothing in the orders or in the Electric Lighting Acts which empowers undertakers to execute any works on consumers' premises beyond these terminals.

The Electricity committee reported that application had been made by the Society of Motor Manufacturers and Traders for a supply of current to Olympia in connectiou with a motor exhibition to be held in February.

It was estimated that the lighting would involve the use of between 10,000 and 20,000 8 c.p. lamps, and the Society offered to pay 4d. per unit for current and guarantee a minimum payment of £500 for the first exhibition. The Society were endeavouring to arrange for a series of exhibitions extending over a number of years, and as Olympia will be fitted up for the purpose, it is probable that other exhibitions will be held there. It would be necessary to lay a special main at a cost of £1,898 to give the required supply, and in consideration of this the Society would deposit with the Council £750 as security for payment for current to be consumed, &c. The Society were also prepared to enter into an agreement to take whatever electric energy they required for extra lighting and power at their three next exhibitions in the building.

It was decided that supply be given on the terms named, and that the necessary mains be laid.

Handsworth.—The Tramways committee have appointed a deputation to discuss with the South Staffordshire Tramways (Lessee) Co. the matters in dispute between the Council and the company.

Honduras.—A concession has been granted to Capt. J. W. Grace, an American, to "improve the town" of Puerto Cortes. The works include a system of tramways and of electricity supply.

Inquest.—At Ferryhill, on Tuesday, an inquest was held on the body of Thos. Lee, who was killed at the colliery on Saturday.

J. T. Hubbard said that on Saturday evening he came to the shaft with deceased and another man. Deceased took hold of the rapper to signal that they wanted to ride and immediately shouted "Pull me off." Witness got hold of deceased and pulled him free, but in doing so he got a severe electric shock and they both fell to the ground. Deceased breathed for about 10 minutes and then died. The rapper wire would be about 6in. from the electric cable, but he could not say whether deceased had got hold of it.

Stanley G. Smith, electrician at the pit, said he had superintended the putting in of all the wires, which were temporary ones. The Brockwell seam was lighted, the cables passing the Harvey seam, about 6in. apart from the rapper rope. The insulation of the cable as it passed the Harvey seam and down the shaft was perfect so far as he knew. The rapper wire was a naked one, but there should have been no danger of it coming in contact with the electric cable as long as the insulation of the cable was complete. On Saturday night, after the accident, he made a thorough examination of the Brockwell cable, as it was the only one that could have proved dangerous, as the Harvey cable was not alive. He could see nothing wrong with the cable in the shaft, but on testing he found there was a slight leak in the cable, which he had not yet been able to locate, as he was ordered to leave things as they were until after the official inspection. The voltage of the current would be 220, which would give a severe shock to anyone standing in a damp place.

The jury returned a verdict that deceased was accidentally killed by coming in contact with an electric cable whilst using the rapper rope, and added a rider that cable, rapper and other ropes should be kept sufficiently apart from danger, or some other means of complete insulation should be adopted.

Inverness.—The work of erecting the electricity station will be commenced on 29th inst.

Keighley.—It is expected that the new electric tramways will be opened in about a month. The Council have decided to construct a single-track tramway, with crossing places, from Victoria Park gates to the borough boundary at Stockbridge, at an estimated cost of £3,000 to £4,000.

Sanction to a loan of £11,500 has been received by the Council for electric lighting extensions. The Council have resolved to extend the electric tramways to Stockbridge.

Launceston (Tasmania).—The loans sanctioned for municipal electricity supply amounted to £130,000 at the end of 1903, while

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£110,000 has been borrowed and £115,580 expended. The sinking fund, &c, absorbed £8,066 and £1,000 has been applied to depreciation.

The receipts for 1903 were £10,692, the total costs £5,116 and the gross profit £5,576, or 4·91 per cent. on average capital expended. The equivalent of 38,675 8 c.p. lamps is connected. 442,015 units were sold for private lighting, 16,752 for power and heating, and 248,550 for street lighting. The maximum load reached was 575kw., and the load-factor was 14 per cent., compared with 14·6 in 1902. The works costs per unit were 1·35d., against 1·972d. in 1902, the total costs being 1·736d., against 1·577d. The net surplus for 1903 was £652. 6s. 11d., compared with £1,873 in 1902, the decrease being mainly due to reductions in the price of current and meter rentals and increased lamp renewals and maintenance charges. The electrical engineer (Mr. W. Corin) anticipates that as soon as the new plant is running there will be a large increase in the motor load. The anticipated surplus for 1904 is put at £660, with an increase to £1,180 in 1905. During the past year £2,030 was expended on mains extensions, new connections, &c., compared with £5,480 in 1902. £10,792 has been expended on the new plant to date, and it is estimated that £8,500 more will be required to complete the extensions. The total value of fittings, motors and meters on rental at end of 1903 was £8,069, and the rentals received (£772) represent over 10½ per cent. on capital expended. There was a marked increase in the number of heating apparatus put into service, the total power being doubled during the year, the apparatus chiefly in favour being electric flat irons and luminous radiators. The new generating plant consists of four three-phase generators, which displace four of the old alternators, and are each of three times the power of the set they displace. Current will be carried by six cables (two circuits of three cables each) to the new sub-station, and will be distributed thence, partly at high and partly at low pressure, all over the city.

Leeds.—A scheme for the equalisation of the lengths of the 1d. stages on the tramways, making all such stages 2 miles, was submitted by the tramway manager (Mr. J. B. Hamilton) to the Tramways committee on Monday.

Liverpool.—Meetings of the City Council are to be held on Oct. 20 to consider proposals to apply to the Board of Trade for a tramway provisional order and to the Light Railway Commissioners for a light railway order authorising extensions of the Corporation's electric tramways in Liverpool, Fazakerley, Gateacre, Woolton, Wavertree, Garston, Speke, Hale, Halewood, Ditton and Widnes.

The Electric Power, Lighting and Health committees are to report upon the practicability of placing electric capstans at the top of Park-street, Toxteth Park, to cheapen cost of haulage and develop the trade of the south end of the city.

London County Council Tramways—A full service of electric cars between Clapham Common and Southwark Bridge commenced running on Monday.

March.—Messrs. Foote & Milne have submitted to the Council terms for establishing and working an electricity station.

The Council are to raise the capital by loan, the company to subscribe 20 per cent. and to pay interest and sinking fund charges and deposit security for same. The Council to have the right to terminate the arrangement at 14 years on payment of loss incurred and interest thereon at 5 per cent. per annum. The company to provide capital for wiring premises free of initial expense.

Mexborough.—The accounts of the electric lighting department for the past year were submitted to the Council on Wednesday:—

Revenue from the sale of current increased from £565. 5s. in 1903 to £995. 5s. 11d., and for public lighting from £903 to £645. 19s. The deficit was about £340, against £179 the previous year. Sinking fund came to £569. 14s. and interest to £566. 2s. 11d. A ratepayers' petition asking for a reduction in the charge for electricity has been referred to the committee.

Municipal Telephony.—In moving the adoption of the minutes of Swansea Telephone committee on Wednesday, the chairman (Mr. D. Davies) stated

That as the National Telephone Co. would not meet the Corporation in a reasonable manner on the subject of intercommunication, there was no alternative but to take legal proceedings, and action would be instituted at the end of the long vacation.

New Barnet.—At the Council meeting last week Mr. Stutters opposed the proposal to enter into an agreement with the National Electric Construction Co. for the erection and maintenance of electricity works as it might entail loss on the ratepayers. He moved that a poll of ratepayers be taken, but after discussion the motion was rejected by six votes to five. It was subsequently decided to have the draft agreement with the company prepared.

New York Shallow Tramways.—The Rapid Transit Commission will open their new shallow tramway system, which has cost about $35,000,000, this week. The uniform fare on the line between Brooklyn Bridge and the extreme end of Manhattan Island (10 miles) is 5c. There are four tracks, and on the two centres, which are reserved for express traffic, the trains travel the 10 miles in 15 minutes. The roofs of tunnels are 3ft. below the main street.

Norwich.—The City Council has authorised the erection of 12 additional arc lamps, at an annual charge of £16 each for eight lamps lighted all night and £12 per annum each for four lamps lighted up to midnight. The arc lamps will supersede 42 gas lamps.

Obituary.—We regret to record the death, on Wednesday, of Mr. H. A. Willey, head of the well-known firm of Willey & Co., electric lighting and gas engineers, Exeter. Mr. Willey was a very prominent citizen of the famous cathedral city, and was only 41 years of age.

Provisional Order Revocation.—The Board of Trade have decided to revoke the Skipton District Council's electric lighting order, 1901.

St. Pancras (London).—The Council on Wednesday passed estimates, amounting to £3,080, for the requirements of the electricity department for the six months ending March 31 next, including engine-room supplies (£550), materials for repair of buildings and machinery (£1,000), meters and indicators (£300), house service switches (£160), joint boxes (£100), cables for service lines (£100), general stores tools (£100), repairs of meters, switches, public lamps, &c. (£100), and repairs of mains (£600). The estimates do not include coal, nor cables, nor materials required for extensions of supply mains, arc lighting, &c.

Shildon.—The Northern Counties Electricity Supply Co. have acquired a site for electricity works in this district.

Shoreditch (London).—The Finance committee report that the estimated expenditure of £47,073 for the year ending March 31 next in respect of the Hoxton and Haggerston electricity stations, can be reduced by £6,505 for the maintenance of the refuse destructor, and that the estimated income of £49,525. 16s. required to be reduced by £3,373. 16s. in respect of the revenue from sales of steam, charges for destroying refuse, &c. The effect of the alterations will be to increase the estimated surplus from £2,452. 15s. 11d. to £3,538 An estimate of £640 for cables was approved by the Council. The electrical engineer (Mr. C. Newton Russell) states that the expenditure was necessary to avoid risk of overloading the mains, and for the extension of the three-wire system.

Southampton.—Sanction to a loan of £2,000 for the extension of the electric lighting mains and services has been received by the Corporation.

State of Trade.—It is generally considered that there is no better index to the condition of trade than is shown by the demand for large and small industrial properties and for land for building large or small manufacturing premises. Messrs. Leopold Farmer & Sons, auctioneers and surveyors, of Gresham-street, London, and High-road, Kilburn, N.W., report that they have found no perceptible diminution in the demand for this class of property. We fear, however, this index to the state of trade is not an infallible one.

Stockport.—The Council resolved on Wednesday to acquire the undertaking of the Stockport and Hazelgrove Tramways Co. at £24,000.

Stoke Newington (London.)—Consideration of the Electric Lighting committee's report submitting an agreement with the North Metropolitan Electric Power Supply Co. has been again adjourned.

Tewkesbury.—The town clerk is collecting information as to the advisability of establishing municipal electricity supply.

Theft of Electricity.—At Durham County Police Court on Wednesday, George Savage, Tudhoe Grange, was charged with stealing electric current belonging to the Northern Counties Electricity Supply Co., at Tudhoe, on Sept. 5. It appears that defendant had a penny-in-the-slot meter fixed on his premises, and by inserting a hairpin he was able to obtain electricity without being metered. Defendant's wife admitted that she had done this, but defendant said he knew nothing about it. The Bench convicted and imposed a fine of 40s.

Tramway Roof Covers.—Mr. A. L. C. Fell, manager of the London County Council tramways, states that the experimental covered-top car which has been running on the South London tramways has earned more money than the other cars, even in fine weather, having been specially well patronised on very hot days. 50 covered-top cars are on order, and the Council's tramway department are themselves fitting 10 covers on the existing cars. The windows of the covers are to be controlled by the conductor.

Mr. A. Baker, manager of Birmingham Corporation tramways, has invented an improved tramcar roof cover. In this invention the sides can be raised or lowered by the conductor in one operation.

Trans-Pyrenean Railway.—An electric railway is projected from Ax les Thermes (Ariège) to Ripoll, across the Cerdana mountains at Perigcerda, to connect Barcelona with Toulouse. The construction of this railway has been authorised by the French and Spanish Governments, the convention between the parties stipulating that this electric and some steam lines are to be constructed "within 10 years."

Tunnel Working.—The Canadian Grand Trunk Railway are about to substitute electric for steam working in the Sarnia tunnel, the plant and track for this purpose costing $500,000. The third-rail system will be put down.

Wallasey.—The net capital expended on the electricity undertaking to the end of March, 1904, was £66,715. 1s. 1d. The income for 1903-4 was £20,529. 7s. 1d. Expenses were £9,547. 16s. 8d.

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leaving £11,031. 11s. 2d. to meet interest on loans (£2,450. 7s. 9d.), and repayment of loans £2,406. 9s. 2d.; £6,174. 4s. 3d. has been carried to credit of district fund account and £1,000 to depreciation and renewals.

Waipori Falls.—The "Australian Mining Standard" says the Waipori Falls Electrical Power Co.'s bill has passed the New Zealand House of Representatives and all the local authorities approached by the company, except Dunedin City Council, favour the supply of electrical energy to their districts by the company.

Walton-on-Thames.—Recently, Weybridge Council obtained an injunction restraining the Urban Electric Supply Co. from supplying current from their works in Weybridge to Walton. Walton Council have now authorised the erection by the company of a temporary generating station at Walton.

Whitby.—On Thursday an inquiry was held into the application of the Council for permission to borrow £3,100 for extensions to the electricity works. Mr. W. S. Gray (clerk) and Mr. L. H. King (electrical engineer) gave evidence.

A profit of £442 is anticipated on the current year's working of the electricity undertaking, the loss having decreased each year since the opening of the works in 1900. There was no opposition to the application.

Workhouse Lighting.—Ormskirk Guardians are considering the question of installing independent electric lighting plant, and as the District Council contemplate establishing electricity supply, the Guardians have been asked to consider the question of taking current from the Council.

Wedding.—Mr. A. P. Patey, resident electrical engineer of the Houses of Parliament, was married at St. Margaret's, Westminster, on Tuesday, to Miss Jessie Brown, daughter of the late Mr. Peter Brown.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Directors of the *Lancashire and Yorkshire Railway* invite tenders for the supply of the company's ordinary requirements of stores during the 12 months ending Oct. 31, 1905. The articles required include ironmongery, reflectors, oil, sponge cloths, steel and files, sundry tools, twist drills, indiarubber, iron chain, hinges, sheets, &c., also spikes and steel fish bolts for way materials. Tender forms, &c., from Mr. Duffin, stores department, Osborne-street, Manchester. The sample room will be open until Oct. 1. Tenders (addressed to the directors) to the secretary (Mr. R. C. Irwin), Hunt's Bank, Manchester, by 10 a.m. Oct. 3. Additional information in advertisement.

The directors of the *Metropolitan Railway Co.* are prepared to receive tenders for the supply of general stores (electric lamps, wires and cables, carbon brushes, &c., telegraph battery jars, zincs, insulators, &c.) during the 12 months ending October, 1905. Tender forms, &c., from the secretary (Mr. R. H. Selbie), 32, Westbourne-terrace, London, W., after 27th inst. Samples and patterns may be seen at the offices of the company's storekeeper, adjoining Neasden station, N.W. Tenders to the secretary by 10 a.m. Oct. 8. See also an advertisement.

Brighton Corporation invite tenders from persons willing to enter into an agreement for the right to place painted or tablet advertisements on the tramcars belonging to the Corporation. Specifications, &c., from the town clerk (Mr. Hugo Talbot), Town Hall, Brighton, where sealed tenders must be left by 10 a.m. Oct. 10. See also advertisement.

Manchester Electricity committee invite tenders for supply of ampere-hour and watt-hour meters. Specifications from the secretary of the electricity department (Mr. F. E. Hughes), Town Hall, Manchester. Tenders (addressed chairman of the Electricity committee) to the Town Hall before the 4th prox. See also advertisement.

The Municipality of *Philippopoli*, Bulgaria, announce in an advertisement in another column that the electric lighting and electric tramway concession was not adjudicated upon on Aug. 3 (16) last, and that a new adjudication will take place on Oct. 2 (15), at 10:30 a.m. in the Town Hall, Philippopoli. Offers should be submitted in the Bulgarian language and in sealed envelopes. Tenderers should supply references (under separate cover) showing that the tenderer has already successfully executed a similar foreign enterprise, and has deposited at the Banque Nationale Bulgare 150,000fr. (£6,000) as security. Conditions, &c., in Bulgarian and French may be obtained on payment of 20fr. (16s.) The sur-adjudication will take place on the following day (Oct. 3/16) if by 10:30 a.m. of that day a reduction of 5 per cent. on the price per kilowatt hour on the prior offer is made.

Edmonton District Council are desirous of entering into an arrangement with a company for the exercise of powers under their provisional order. Particulars and forms of tender of the clerk (Mr. W. F. Payne), Town Hall, Edmonton, to whom tenders by noon Sept. 27.

Edinburgh District Lunacy Board require tenders by 28th inst. for wiring their existing and projected buildings at Bangour for lighting, telephones and bells. Particulars from the architect (Mr. H. J. Blanc), 25, Rutland-square, Edinburgh.

London County Council want tenders by Oct. 11 for steam exhaust pipes, valves, &c., at their Greenwich electricity generating station.

Ilford District Council invite tenders for supply and erection of balancer and switchboard panel, reversible traction booster and switchboard panel. Tenders to chairman of Council by noon Oct. 4.

Tynemouth Corporation invite tenders for a 600kw. steam dynamo. Tenders to the town clerk (Mr. Horatio A. Adamson) by first post Sept. 30.

Aberdeen Tramways committee invite tenders for 20 top-deck car covers. Tenders to city electrical engineer (Mr. J. Alex. Bell), electricity works, Millburn-street, Aberdeen, by Sept. 27.

Exeter City Council require tenders by Oct. 8 for the erection of the superstructure of an electric car depot in Heavitree-road.

Manchester Tramways committee invite tenders by 1 p.m. Oct. 1 for a turntable for the Hyde-road car works.

It is announced that the Deputy Postmaster-General of the Australian Commonwealth will receive until noon of Nov. 15 tenders for the supply and delivery at *Melbourne* of 6,000yds. of two-core unarmoured telephone cable. Specifications from the General Post Offices of Melbourne, Sydney, Brisbane and Adelaide. Tenders to the Deputy Postmaster-General, Melbourne.

Tenders will be received up to noon of Nov. 23 at the office of the Deputy Postmaster-General, *Hobart*, Tasmania, for the supply of telegraph and telephone material. A schedule and other particulars can be seen at the General Post Offices at Hobart, Sydney, Melbourne, Brisbane, Adelaide and Perth.

The adjudication of tenders for a concession for the construction and working of a line of tramways by mechanical traction in the town of *Craïova*, Roumania, is to be made on Oct. 25 (Nov. 7) at the municipal offices of Craïova. The concession is for 50 years. Particulars can be obtained at the municipal offices.

The Municipality of *Almendralejo* (Spain) invites tenders for the public lighting of the town by arc and incandescent lamps. The concession will be for 10 years, rescindable by the Municipality after five years, "if a better offer can be then obtained." The Madrid Gazette" for Sept. 13 contains additional particulars.

TENDERS RECEIVED AND ACCEPTED.

Correction.—In reference to the statement made in our issue of the 9th inst. that Lincoln City Council had accepted the tender of Messrs. E. Nuttall & Co. for the reconstruction of the permanent way of the High-street tramway, Mr. Stanley Clegg, M.I E.E., city electrical and tramways engineer, writes to inform us that the statement is inaccurate, and that no such tender has been let. We may say that we find the statement that Messrs. Nuttall & Co. have obtained this tender to be in general circulation. The facts of the case are, we understand, that contracts for the construction and equipment for electric traction of the local tramways, recently acquired by the Corporation, have been awarded to Messrs. Wm. Griffiths & Co., in association with the "G. B." Surface Contact Co.

Chelsea (London) Guardians have received the following tenders for wiring the infirmary :—

C. Mickleborough (*accepted*)	£366	17	6	T. Potter & Sons	£525	0	0
P. Turner.....	995	0	0	E. Probert & Co.....	511	0	0
Bolton, Fane & Co....	652	0	0	W. J. Fryer & Co.....	508	0	0
Warren Smith	642	0	0	T. Clarke & Co.	481	4	6
Donnison, Sillem & Co.	618	0	0	G. E. Taylor & Co.....	480	0	0
Coleby & Co.....	585	10	0	P. McCarthy	475	0	0
Smeeton & Page.....	552	3	0	E. P. Allam & Co.	430	0	0
W. Seymour	547	0	0	J. Boulting & Sons ..	403	10	0
Buckley & Beach	545	0	0	Wm. Wing	399	4	0
Engineering Co.....	537	9	0	Wells, Raynor & Co...	399	0	0
Farringdon Electric Wiring Co.	530	3	0	District Electric Co. ..	380	0	0
				Lea & Warren.....	375	0	0
				M. Wiedhofft	366	0	0

Shoreditch (London) Council received the following tenders for 2,430yds. of cable :—

British Insulated & Helsby Cables (Ltd.) (*accepted*)....	£590 0
W. T. Glover & Co.	598 0
W. T. Henley's Telegraph Works Co.....	597 10
Siemens Brothers & Co.....	592 15

Bermondsey (London) Council have accepted the tender of Leo Sunderland & Co. at £138 for installing the electric light in the staircases and courtyards at the Fulford-street dwellings. There were 15 tenders, ranging from £550 to £138.

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The Hart Accumulator Co. (Ltd.), Marshgate-lane, Stratford, London, have secured the contract for the storage battery (consisting of 256 of the company's standard lighting type cells) at the Carnarvon electricity works.

We are informed by Monté Callow & Co. that orders have recently been placed with them for three 40 H.P., four 75 H.P., two 100 H.P. and three 250 H.P. "Perfecta" polyphase controllers for haulage gear in South Wales collieries.

The contract for three electric power generators of 250 H.P. each for Messrs. James Ross & Co., Philipstoun Oil Works, N.B., has been awarded to the British Electric Plant Co., Alloa.

Brighton Corporation have placed an order with the International Electric Co. for a new switchboard and batteries for their telephone department.

The Underground Electric Railways Co. of London have placed an order with the American Car Co., New York, for 100 cars of a total value of £100,000 for the Baker Street and Waterloo Railway Co.

Colne Council have accepted the tender of Körting Bros. for piping and valves at £145.

Brierfield Council have accepted the tender of S. Rawlinson & Sons for a tramway tower ladder at £13.

Montrose Council have accepted the tender of Mr. J. L. Warden for wiring the free library.

The contract for wiring and fitting the Working Men's Club, Batley, has been secured by Spivey & Jubb at £120.

Croydon Corporation have accepted the tender of Masson, Scott & Co. for water purification plant at £515.

BUSINESS NOTICES.

Messrs. F. A. Glover & Co. (Ltd.), of 10 and 12, Garrick-street, London, W.C., are moving on Sept. 24 to larger premises at Vine-street, London, E.C. (off Rosebery-avenue).

Messrs. Cecil Hodges & Co. have appointed W. G. Morrison & Co., 59, St. Vincent-street, Glasgow, sole agents for Scotland, Mr. J. Gray, of Glasgow, ceasing to represent the company for that district.

Mr. David Alexander, A.M.I.E.E., 43, Mains-street, Waterloo-street, Glasgow, has been appointed representative for Scotland of the London Electric Wire Co., Anchor Works, Playhouse-yard, Golden-lane, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

Ferranti Limited.—A meeting is to be held on Thursday next at Winchester House, Old Broad-street, London, E.C., when a "scheme of arrangement" will be submitted for the approval of the creditors of the company.

Under this scheme it is proposed that a new limited company shall be incorporated, bearing the same title as at present, or such other name as may be decided upon by the liquidator of the present company. It is proposed that the new company shall start with a nominal capital of £130,000 in shares of £1 each, 60,000 6 per cent. cumulative preferred, 60,000 ordinary and 10,000 deferred. The ordinary shares are to be entitled to a division of 7 per cent. per annum, the balance, if any, going to the deferred. The new company is to take over all or any of the assets and liabilities of the present company, of which the first directors are to be Mr. A. W. Tait, Mr. A. Whittaker, Mr. J. M. Henderson, and Mr. S. Z. de Ferranti. The debenture-holders of the new company are to have the right to nominate two directors. It is further proposed that the new company shall constitute a 5 per cent. first mortgage debenture stock of £100,000 and a 5 per cent. second mortgage debenture of £30,000. The unsecured creditors of the present company are to accept in satisfaction of their debts fully paid-up preference shares of the new company, and every preference shareholder is to be entitled to subscribe fully paid-up ordinary shares in the new company to half the nominal amount of his preference shares. In consideration of the allotment to Mr. Ferranti of the 10,000 deferred shares in the new company as fully paid, he will covenant to serve the new company for a term of years at a salary of £500 per annum, giving the company the full benefit of all his inventions in switch and meter work hereafter to be made and all improvements of such inventions and of existing patents and inventions the property of the present company. If the sanction of the Court is obtained to this proposed scheme of reconstruction, then the litigation in the actions brought by Messrs. Estler Bros. and others are to be withdrawn and the present receivers and liquidators are to be discharged, except so far as is necessary for carrying out the scheme in its relation to the old company. Subject to the provisions of this scheme, the new company is to take over and discharge all the debts and liabilities and contracts of the liquidator and receivers in carrying on the business of the present company since the commencement of the winding-up, and is also to discharge all debts and liabilities of the present company. Unless the scheme is adopted by the proposed new company within six weeks after it is sanctioned by the Court, the liquidator retains power (with the sanction of the Court) to declare that the proposal has fallen through.

In the liquidation of the Electric Timber Seasoning & Preservation Co. (Ltd.), the official receiver (Mr. H. Brougham) reports that The company was promoted by the Founders' Synd. (Ltd.), and was incorporated on April 10, 1899, nominal capital £150,000. It was formed for acquiring the British patent rights in the Nodon-Bretonneau process of seasoning and preserving timber by electricity. The purchase price was £100,000—viz., fully-paid ordinary shares, £88,693; cash, £11,307. Cash advances for working capital had been made by the directors amounting to £4,948, and debentures were issued for these advances charging all the assets of the company. Failure was attributed to want of working capital. The patents were valued by the directors at £10,000, but it was doubtful whether that amount would be realised. The books had in recent years been imperfectly kept, and it was impossible to ascertain the result of the company's trading. The accounts showed unsecured debts £3,896. 12s. 1d., loans on debenture bonds £4,948. 5s. 7d., estimated surplus assets £1,405. 7s. 1d. As regards shareholders, a deficiency of £105,780. 12s. 2d. is shown. The liquidation is in the hands of the official receiver and a committee of inspection.

The trustee (Mr. E. T. Peirson, 17, Hertford-street, Coventry) in the failure of W. H. Hooley and J. W. Talbot, electrical engineers and contractors, Regent-street, Rugby, has been released.

The trustee (Mr. J. Bowling, 92, Park-row, Leeds) in the bankruptcy of E. E. Clarke, lately electrical engineer, 11, Claypit-street, Camp-road, Leeds, has been released.

Plant for Sale.—St. Pancras (London) Borough Council invite offers for two 200 I.H.P. Belliss engines, one Belliss engine coupled to two 60kw. Crompton dynamos, and two Willans engines coupled to Johnson & Phillips dynamos. Particulars from the electricity department offices, 57, Pratt-street, Camden Town, N.W. See also advertisement.

Messrs. Wheatley Kirk, Price & Co. have for sale some electric generating sets for power and lighting, in first-rate running order, which have been displaced by larger units. For further particulars see advertisement.

Mr. M. M. Henderson, 4, Stirling-street, Airdrie, N.B., has electric lighting plant for sale. See advertisement.

Provisional Order Development.—An advertiser is open to negotiate for the transfer of electric lighting and electric tramway provisional orders.

Catalogues, &c.—The London Electric Wire Co., Playhouse-yard, Golden-lane, London, E.C., have ready a new revised price list and circular of flexibles. Copies can be obtained by the trade on application.

The new (11th) edition of the catalogue of the General Electric Co., dealing with main switches, cut-outs, house service fuses, &c., is issued, and contains particulars of a number of improved examples of apparatus designed to meet the increasing demand for high voltage fittings complying with Board of Trade requirements. "Peel" switches are listed from 30 up to 1,000 amperes for single, double or triple pole, and with or without cut-out terminals. The change-over type of these switches ranges from 30 to 800 amperes, and are not provided with fuse terminals. A new type of "Adelphi" switch has been specially designed to meet motor work requirements, and consists of a double-pole switch mounted in strong cast-iron case with removable iron cover. We illustrate two types of multiple switches, radial and rectangular, described in the list. These switches are designed for regulating accumulator circuits and main resistances. The radial type is provided with a handwheel. The rectangular type is constructed with travelling contact brushes, which allow of uniform and smooth regulation from one contact to another. Shunt resistance regulating switches are also shown, and several types of house service fuses and main cutouts. "Bobbin" and "Arch" types of main switchboard fuses are listed. Either type can be arranged to take a "Mordey" fuse in parallel. They are intended for circuits up to 500 volts, and are made to carry from 50 to 400 amperes.

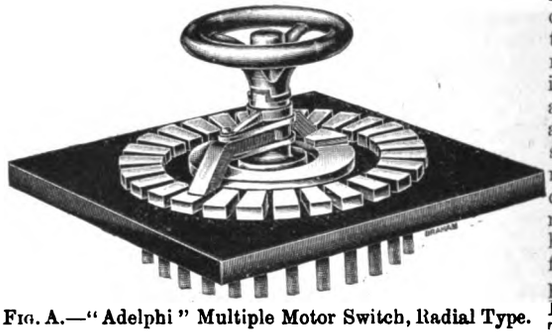

FIG. A.—"Adelphi" Multiple Motor Switch, Radial Type.

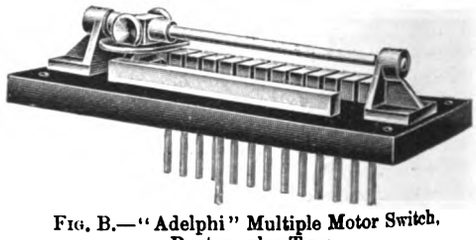

FIG. B.—"Adelphi" Multiple Motor Switch, Rectangular Type

There is ready a descriptive catalogue of the "Hunterlite" patent electric candle lamps. Copies can be obtained from the company at 77, Newman-street, London, S.W.

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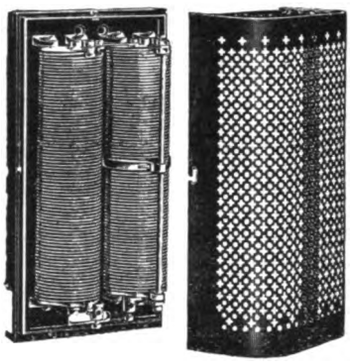
The National Boiler & General Insurance Co., 22, St. Ann's-square, Manchester, have prepared a pamphlet dealing with recent accidents to insured gas engines. An instructive list of recent claims and the causes of accidents is included, proving the advantages of insurance and the necessity for inspection.

Mr. R. S. Blackburn, of Hebden Bridge, forwards an illustration showing outer and inner views of improved apparatus for his system of telephonic fire alarms. This apparatus takes up a space 9in. by 9in., is watertight and is made to finish neat up to surface of wall.

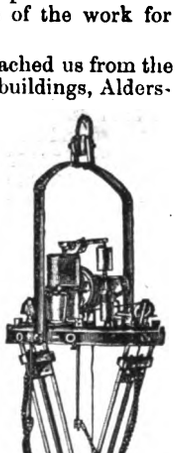
Messrs. Ernest F. Moy, Camden Town, London, N.W., have ready a sheet list of closed resistances, double-coil type. The wire is a high resistance alloy wound on highly vitrified porcelain cylinders. As shown in the illustration, both terminals, which are substantial mechanical connections, are at the bottom of the coils, so that the rising heat from the resistance does not injure the insulation on the cables. Openings are provided on each side and at the lower end of the base, so as to admit the cables instead of bringing them through slots in the cover.



Moy's Enclosed Resistance Double Coil Type.

A well-prepared and nicely-illustrated catalogue of electric generating engines has been prepared for publication by Messrs. J. & H. McLaren, Midland Engine Works, Leeds. The installation of these machines at the Corporation electricity works, South Shields, is illustrated, as well as examples of a compound type triple-expansion surface-condensing engine, and of a 3,000 I.H.P. slow-speed enclosed triple-expansion engine supplied to Leeds Corporation. An independent surface-condensing plant of this firm's standard type is also shown. Accompanying this catalogue is a copy of Mr. John McLaren's pamphlet on "Traction Engines and Their Use," which, in its first chapter, shows interior views of the firm's Leeds works, and in the subsequent chapters deals with the question of traction engines for various purposes, including military operations. This pamphlet is very fully illustrated with examples of the work for which traction engines are nowadays employed.

A new catalogue of "Weinert" arc lamps has reached us from the agents, Messrs. Wilhelm & Co., 3, Westmoreland-buildings, Aldersgate-street, London, E.C. Various types of this lamp are listed and illustrated, including a flame lamp, of which the mechanism is shown in the accompanying illustration. These lamps are made for continuous or alternating current, and for burning 6 to 7 hours and 10 to 12 hours, the former with 12in. carbons and the latter with 17½in. carbons.



Mechanism of the "Weinert" Flame Arc Lamp.

An illustrated circular relating to "Tetrad" trolley ears, for which certain advantages are claimed, is issued by William C. Yuille & Co., Tradeston, Glasgow. In the use of these cars solder is dispensed with. It is further claimed that for emergency work these ears are especially adapted.

Messrs. Geipel & Lange, Vulcan Works, St. Thomas'-street, London, S.E., are issuing two leaflets describing and illustrating "Solenoid Controlled Motor Starters" and "Electric Lift Controllers." In the starter list, apparatus suitable for operating motors, working well pumps, air compressors, hydraulic accumulators, &c., are listed, and also a pressure regulator, by means of which a motor can be started and stopped automatically, according to the pressure in an enclosed tank. This operation is performed by means of a diaphragm contact maker and breaker, which excites or de-energises the operating solenoid of the standard starter supplied by this firm. The controllers are of the Schureman make, and in America a large number of installations have been fitted with this apparatus.

"Cryselco" lamps are illustrated, described and priced in a new list issued by Cryselco Limited, Kempston Works, Bedford.

Robertson Lamp Works.—Last Saturday, at the Crystal Palace, a competition for the championship of private fire brigades of the United Kingdom took place. The Robertson Electric Lamp brigade tied for first place in this competition, in which 18 brigades took part.

There is a flourishing football club connected with the Robertson Works, and a concert will be given in the works' dining hall at Brook Green, Hammersmith, to-morrow (Saturday), under the presidency of Mr. C. Wilson, president of the club.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Sept. 14 to 20, with the ports of destination:—

Africa—Cape Town, £41; Durban, £980 (including £512 telegraph material); Port Elizabeth, £20. *Argentina*—Buenos Ayres, £302. *Australasia*—Auckland, £3,000; Fremantle, £1,276; Lyttelton, £29; Melbourne, £50 and 152 cwt. telegraph wire; Otago, £28; Sydney, £4,519; Wanganui, £54; Wellington, £28. *British Guiana*—Demerara, £168 (telegraph material); *Ceylon*—Colombo, £41; *China*—Shanghai, £120. *Cochin China*—Saigon, £44. *Denmark*—Copenhagen, £18. *France*—Boulogne, £25. *Germany*—Hamburg, £28. *Gibraltar*, £544. *Holland*—Amsterdam, £85; Rotterdam, £213 (including £13 telegraph wire). *Hong Kong*, £214. *India*—Bombay, £2,908 (including £179 telegraph material); Calcutta, £1,544; Karachi, £53; Madras, £157. *Japan*—Nagasaki, £131. *Malta*, 26. *Mexico*—Vera Cruz, £10. *Straits Settlements*—Penang, £120; Singapore, £55. *Sweden*—Gothenburg, £30; Stockholm, £1,515 (telegraph material). *West Indies*—St. Lucia, £35; Trinidad, £26. Total, £18,437 against £17,712 in the corresponding week last year (Sept. 16 to 22).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

August 4, 1904.

17,046 A. MARSHALL. System of electric traction for railways and tramways.*
17,051 G. SPERRYN and W. H. Wood. Birmingham. Tumbler switches.
17,058 W. R. EVANS. Manchester. Operating points of electric tramways.
17,059 H. M. DARRAH and L. A. HACKETT. Manchester. Electro-magnetic controlling devices.
17,092 F. WALKER. Prepayment wattmeters.
17,101 B.T.-H. Co. (G.E. Co., U.S.). Emergency brake control systems.
17,121 S. O. COWPER-COLES. The electrolytic deposition of metals.

August 5, 1904.

17,130 H. F. ROGERS and F. E. BROWN. Birmingham. Contact breaker for electric ignition for gas and oil engines.
17,133 G. A. E. ROBERTS. Winchester. Electric governor for internal combustion engines.
17,140 R. PARKIN. Lemington-on-Tyne. Covering a live electric rail.
17,147 G. H. WOODS. Blackburn. Sparking plug-tester.*
17,160 C. I. CLEMENTS. Birmingham. Chain for suspending electroliers and the like.
17,162 E. G. CRAVEN. Telephone transmitters and receivers and apparatus.
17,166 S. E. FLICHTNER. Gas or vapour electric apparatus. (Date applied for, Aug. 10, 1903, date of application in U.S.)*
17,167 A. P. L. BOULANGER and G. H. SMITH. Tremblers or contact breakers.*
17,176 G. PERITZ. Liverpool. Arc lamps.
17,181 J. F. TESTOR. Contact devices for apparatus for electrically lighting and extinguishing gas.*
17,190 E. A. GIMINGHAM. Electric glow lamps to represent candles.*
17,191 O. IMRAY (Albert de Madaillan, France.) Filaments for electric lamps.
17,196 G. SCHAULI and G. PETRIDES. Plates and electrodes for accumulators.

August 6, 1904.

17,201 A. E. HARDAKER. Lancashire. Third-rail systems for electric railways.
17,207 A. WELSH. Glasgow. Trolley pulleys for electric tramways, &c.
17,220 UNION ELECTRICITÄTS GESELLSCHAFT (in liquidation). Connecting monophase motors having armatures furnished with collectors employed with electric rails and working together in pairs. (Date applied for, Aug. 8, 1903, date of application in Germany.)*
17,236 J. L. WELLER. Electric transmission poles.*

August 8, 1904.

17,243 F. R. KEITH. Boston. Tenders for electric cars and other vehicles.*
17,248 J. BYROM. Liverpool. Accumulators.
17,268 T. KIRKLAND and D. L. CAPPER. Electrical indicating apparatus for a range-finder or the like.
17,285 F. G. KLEINSTEUBER. High-tension current insulator.*

August 9, 1904.

17,332 T. COWBURN. Gloucester. Automatic trolley-wheel adjuster.
17,339 W. G. HEYS. Manchester (The Meyrowitz Mfg. Co., U.S.). Switch.*

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17,358 L. Nelken. Electric hygienic heel pad.
17,359 F. L. Bronaugh and the British Compressed Air Cleaning Co. Apparatus for cleaning telephone and like switchboards.
17,364 E. G. P. Bousfield and the Ozonised Oxygen Co. Preventing the breaking of an electric circuit.*
17,365 A. J. Boult. Alarm-operating mechanisms. (Eastern Fire Protection Co., U.S.)*
17,374 R. A. Fessenden. Wave telegraphy.*
17,375 J. L. Sardy. Terminal for cables.
17,377 G. Englisch and the "Deutsche Erfinder Genossenschaft," Germany. Wave indicator for wireless telegraphy.
17,378 G. Englisch and the "Deutsche Erfinder Genossenschaft," Germany. Induction apparatus.*

August 10, 1904.

17,393 F. Butterworth. Manchester. Life-guards.
17,399 F. S. Hollister. Dorset. Mechanical contrivance to control the tram line point and trolley-wire point.
17,423 H. Rosenberg and E. Rosenberg. Self-regulating dynamos.
17,430 The Metals Corpn. and Sherard Cowper-Coles. Electrolytic refining of copper.
17,434 A. Lloyd. Liverpool. Electric lamps for medical purposes.
17,442 W. H. Scott. Electric controllers.

August 11, 1904.

21,939A Sir O. J. Lodge and A. Muirhead. Signalling through submarine and like cables. (Date applied for, Oct. 12, 1903.)
17,469 S. P. Thompson. Alternate-current motors.
17,478 J. Marsden. Electric light fittings.
17,483 W. Harbison. A receiving system for wireless communications. (Date applied for, Aug. 27, 1903, date of application in U.S.)*
17,484 W. Harbison. A receiving system for wireless communications. (Date applied for, Feb. 8, 1904, date of application in U.S.)*
17,493 M. G. Potiewski. Transmitter for electric telegraphs.*
17,501 W. T. Eastwood. "Cow catchers" for electric and other cars.
17,523 F. M. Lewis. Liquid-starting resistances for continuous-current motors.
17,527 Siemens Brothers & Co. and H. Berry. Commutators.*
17,532 F. B. Hinkson and S. H. Hey. Electric filters.*
17,534 T. E. R. Phillips. Mechanical car for trolley wires.

August 12, 1904.

17,553 E. E. Kelsey. Lingfield. Dynamos, motors and the like.
17,562 J. D. White. Printing telegraphs.
17,595 Conduits & Fittings (Ltd.), D. G. Edwards and E. A. Brown. Bends, elbows and other angle pieces for conduits.*
17,600 M. Baumer. Relays.*
17,601 A. P. Zani and Dick, Kerr & Co. Rotors of alternating-current machines.
17,605 G. E. Heyl-Dia. Liverpool. Insulating cables on the conduit system.
17,611 Drake & Gorham, B. M. Drake and J. M. Gorham. Electric imitation candles.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

10,468 Parsons. Sound intensifiers for telephones, &c.
17,082 Munro, Brecknell and Rogers. Trolley poles and connecting same to standards.
17,272 Grainger. Electrically firing blasting cartridges.
17,601 Leitner and Lucas. Systems of electric lighting.
17,602 Hill. Electric lighting of trains.
17,632 Harrison. Electricity meters.
17,643 Cerebotani and Silbermann. Steel magnetic armatures for electro-magnet pairs.
17,871 Oliver. Flame arc lamps.
18,010 Fiedler and Gerard. Galvanic batteries.
18,076 Sayer. Electric traction.
18,186 Siemens Brothers & Co. and Clift. Telphers.
18,250 Carolan (G.E. Co., U.S.). Thermal cutouts.
18,256 Carolan (G.E. Co., U.S.). Time-limit controllers for circuit breakers.
18,536 Imray (Bullock Electric Mfg. Co.). Controlling electric motors.
18,648 Hill. Grapnels for raising submarine cables.
18,853 Armstrong and Orling. Electric relays.
19,053 Cooley. Guiding trolley heads along frogs and crossings.
20,027 Smith. Switches.
20,101 Maclean. Construction of armatures for dynamos and motors.
20,137 Ewart. Arc lamps.
20,219 Boult and Boult. Surface contact and like systems of electric traction.
20,434 Hill and Young. Direct reproduction of drawings by photography.
20,517 McCallum and McGruther. Fixing electric wires, &c., to ceilings.
20,528 Eckstein and Krause. Switches.
20,606 Holmes. Multipolar dynamo-electric machines.
20,820 Chitty. Dynamo-electric machines.
21,005 B.T.-H. Co. and Meyer. Alternating-current motors.
21,054 Hobart and Punga. Rheostats.
21,093 Porter. Switches.
21,078 Heide (Lowry). Party-line telephone system.
21,140 Isdale. Engine telegraphs or signals on board ship.
21,320 Brodin and Schepeler. Electric signalling.
21,596 Short. Rheostat.
21,609 Creswick and Shaw. Electro-deposition of metals upon aluminium.
21,650 Jackson. Terminals for battery plates of lead or lead alloys.
21,972 Mawdsley. Dynamo-electric machinery.
22,097 Upham. Current collectors for electric traction.
22,190 Hunt and Sandycroft Foundry Co. Alternate-current induction motors.
22,269 Gibson. Brushes for electrical machines.
22,507 Steven. Electric hoists.
22,906 Carolan (G.E. Co., U.S.). Machines for covering conductors with insulation.
24,025 White. Printing telegraph receivers.
25,114 Allan. Coin-freed electric meters.
25,305 Perkins and Massey. "Frog" for making connection between line wires at junctions or cross-overs where line is not continuous in conductors for electric vehicles.
25,657 Zapf. Lightning arresters or devices for preventing over-charging in conductors.
26,165 Smith. Electrical elevators.
26,211 Fairweather (Miner). Multiplex telephony.
27,133 Harnack. Protective device applied to X-ray tubes.
28,623 Martin. Joint box for electrical conductors.
28,793 Ludorf. Electrically-operated trains.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANY.

ELECTRICAL CONTRACTORS' ASSOCIATION (INC.)—Reg. Sept. 16, with an unlimited number of members, each liable for £1 in the event of winding-up, to promote and protect the trade of electrical engineering in Great Britain, and to take over (so far as the same may be legally vested in the Association) the property of the unincorporated association known as the National Electrical Contractors' Association. The word "Limited" is omitted from the title by licence of the Board of Trade. The subscribers are W. R. Rawlings, A.M.I.E.E., 82, Gloucester-road, London, S.W. (president of National Electrical Contractors' Association); J. McDermott, J.P., A.M.I.E.E., Spain House, Ashton-under-Lyne; E. C. Wallis, M.I.E.E., 27, Ash Grove, Hyde Park, Leeds; E. L. Berry, A.M.I.E.E., Lyric-chambers, Whitcomb-street, W.C. (chairman London Electrical Contractors' Association); A. Rashleigh Phipps, 147, Oxford-street, W. (past president London Electrical Contractors' Association); A. E. Porte, M.I.E.E., 61, Dawson-street, Dublin; and T. Wright, 136, Bothwell-street, Glasgow. The management is vested in a central board consisting of not more than 40 members.

STATUTORY RETURNS.

ELECTRICAL OIL REFINING CO. (LTD.)—The return to July 23 gives capital as £5,000 in £1 shares, of which 4,375 have been taken up. £882 has been received, and £3,492 is considered as paid. Mortgages and charges, nil.

SOUTH AMERICAN CABLE CO. (LTD.)—The return to Aug. 4 gives capital as £500,000 in 50,000 shares of £10 each, of which 24,707 have been taken up. £10 per share has been called up on 14,707 and £147,070 has been received. £100,000 is considered as paid on 10,000 shares. Mortgages and charges nil.

SUNBEAM LAMP CO. (LTD.)—The capital in the return to Aug. 11 is given as £25,000 in 2,500 shares of £10 each, of which 1,765 have been taken up. £10 per share has been called up on 908 and £9,080 has been received. £8,570 is considered as paid on 857 shares. Mortgages and charges, £8,400.

MORTGAGES AND CHARGES.

BURNAND TRANSFORMER CO. (LTD.)—A memorandum of satisfaction in full of 10 debentures, dated Dec. 3, 1903, securing £1,275, has been filed.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—Issue on Aug. 25 of £100 debentures, part of series created June 3, 1896, securing not more than two-thirds of subscribed share capital for time being, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £32,100.

SUNBEAM LAMP CO. (LTD.)—Issue on Sept. 1 of £100 debentures, part of series created Jan. 28, 1904, to secure £10,000, charged on company's undertaking and property, present and future, except uncalled and unpaid capital. No trustees. Previously issued of same series, £8,400.

TELEPHONE CO. OF EGYPT (LTD.)—A memorandum of satisfaction in full of debentures dated April 29 and May 20, 1903, securing £5,000, has been filed.

CITY NOTES.

MEMORANDA (Sept. 22).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26 7/8d. per oz. Consols 88 1/8—88 1/4 for money, 88 3/16—88 5/16 for account; 2½ per cent. annuities 87—87½. Consols Pay Day, Oct. 5; Stocks and Shares Continuation Days, Sept. 27 and Oct. 11; Ticket Days, Sept. 28 and Oct. 12; Pay Days, Sept. 29 and Oct. 13; Mining Share Carry-over Days, Sept. 26 and Oct. 10.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—The directors have declared an interim ordinary dividend at the rate of 6 per cent. per annum.

BABCOCK & WILCOX (LTD.)—The following interim dividends have been declared:—On ordinary shares, 1s. 7½d. per share, tax free (compared with 1s. 4½d. last year), and on preference shares 7½d. per share, less tax.

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BUENOS AYRES ELECTRIC TRAMWAYS CO. (1901), LTD.—The directors' report states that the gross receipts for 1903 amounted to £18,282, and the working expenses (inclusive of London charges) to £15,913, showing a net profit of £2,506.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The directors have declared an interim dividend on the paid-up share capital at the rate of 6 per cent. per annum for the half-year ended June 30, payable Nov. 15.

CAMBRIDGE STREET TRAMWAY CO.—The chairman (Mr. C. Armstrong) said at the meeting last week that the proposition at their meeting in April last to adopt a system of electric traction met with the general approval of the Corporation, and the agreement to be discussed by the Town Council was drawn up in a very reasonable spirit. The Corporation have since decided to support the company's bill.

CITY OF BUENOS AYRES TRAMWAY CO. (LTD.)—At a meeting of shareholders yesterday the scheme of arrangement between the holders of the 6 per cent. debenture stock and the shareholders was approved. The undertaking has been acquired by the Anglo-Argentine Tramways Co. The debenture stockholders receive £150 4 per cent. stock in the new company for each £100 6 per cent. stock they now held.

COMPANIA CO-OPERATIVA DE TELEFONOS (BUENOS AYRES)—For year ended June 30 the profits were $115,274.83 m/n, and working expenses $279,595.70. The total receipts were $394,103.98. There are 3,573 subscribers, an increase of 745 on the year. An 8 per cent. dividend was paid. The capital was increased to $2,500,000 in January last.

DICK, KERR & CO. (LTD.)—The report for the year ended June 30 states that the profits amount to £84,170. Interest, trustee fees and premium payable on redemption of debenture stock absorb £14,441, leaving £69,729, added to £35,544 from last year, making £105,274. The 6 per cent. preference dividend required £18,300, one-fifth of the remaining profits was placed to reserve (£10,285) and £10,765 was placed to reserve. A dividend of 10 per cent. on the ordinary share capital (tax free) required £26,000, leaving £39,922 to be carried forward. During the past year the company has completed, amongst other important contracts, the electrification of the L. & Y. Railway between Liverpool and Southport and the Hong Kong and Mandalay electric tramway systems, and are at present engaged in Tokio, Singapore, Bangkok and other places both at home and abroad. The reserve to be set aside under clause 31 of the debenture trust deed has now reached the prescribed limit of £150,000 stock.

DIRECT WEST INDIA CABLE CO. (LTD.)—The directors recommend a further dividend of 3 per cent., making 6 per cent. for the year ended June 30. £1,817 is carried forward.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The directors have decided to pay, in addition to the preference dividend at the rate of 10 per cent. per annum, an interim ordinary dividend at the rate of 4 per cent. (tax free) for the half-year ended June 30, payable Oct. 1.

DUNDERLAND IRON ORE CO. (LTD.)—The chairman (Sir David Dale) gave a sketch of the progress of the works at the meeting yesterday (Thursday). All the buildings (he said) were erected. A concentrate stock house with a capacity of 10,000 tons of concentrates had been built, and a power plant sufficient to provide all electrical energy required by the company was in process of completion.

EASTERN TELEGRAPH CO. (LTD.)—This company announce the payment on Oct. 15 of a dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ending Sept. 30, and the usual interim dividend of 1½ per cent. on the ordinary stock (tax free) in respect of profits for the quarter ended June 30 last. The transfer books of the ordinary stock will be closed from Oct. 7 to 14 inclusive.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended June 30 last of 2s. 6d. per share (tax free), payable 15th prox. The share register will be closed from 7th to 14th prox. inclusive.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—A further dividend of 2½ per cent. (making 5 per cent. for the year) has been declared. £192 is carried forward.

MERSEY RAILWAY CO.—For the half-year ended June 30 the train mileage run was 411,683, compared with 218,308 (steam 103,687, electric 114,621) for the corresponding half of 1903. The number of passengers conveyed was 4,499,147, against 3,201,644, exclusive of season ticket holders. Total receipts were £40,918. 1s. 7d., compared with £32,277. 15s. 7d. Working expenses (exclusive of exceptional charges for pumping, ventilation and lifts) £29,751. 13s. 10d. (equal to 72·71 per cent.), against £27,375. 10s. 4d. (equal to 84·41 per cent.) The exceptional charges for pumping, ventilation and hydraulic lifts for the past six months amounted to £3,839. 9s. (9·38 per cent.), compared with £4,686. 2s. (14·52 per cent.) for the corresponding period of 1903. The questions between the company and the British Westinghouse Co. have been satisfactorily settled since the close of the half-year.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—For the year ended June 30, the profit, after deducting depreciation and adding £81,576 from last year, was £583,263. It is proposed to declare a dividend of 3s. per share on the ordinary shares, of which an interim 6d. per share has been already paid. £86,369 is carried forward.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed Sept. 28 a special settling day in a further issue of 12,000 £5 fully and partly-paid ordinary shares of the *United River Plate Telephone Co. (Ltd.)*, and in a further issue of 10,000 £5 fully-paid 6 per cent. preference shares of the *London Electric Supply Corpn. (Ltd.)*, and have ordered the latter to be quoted in the official list.

WESTERN UNION TELEGRAPH CO. (LTD.)—A quarterly dividend of 1¼ per cent. has been declared.

WILLANS & ROBINSON (LTD.)—The transfer registers are closed from Sept. 21 to Oct. 5 inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept. 17	1,396	+ 231	15	26,067	+ 4,691
Airdrie	,, 9	202	...	31	6,177	...
Ayr Corporation*	,, 17	776	+ 179	18	7,791	+ 448
Barnsley	,, 9	172	- 12	36	6,145	- 434
Barrow	,, 9	244	...	31	6,055	...
Bath Electric Trams, Ltd.	,, 14	762	...	37	28,838	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 19	1,078	- 35	...	...	...
Birmingham Corporation	,, 17	371	...	37	1,310	...
Birmingham Tramways Co.	,, 17	5,329	+ 284	11	19,601	+ 2,922
Blackburn Corporation	,, 16	1,084	+ 94	25	24,556	+ 2,339
Blackpool Corporation	,, 15	2,087	+ 455	24	34,941	+ 4,859
Blackpool and Fleetwood	,, 17	1,170	+ 88	11	16,405	+ 96
Blackp'l, St. Anne's & Lytham	,, 15	761	+ 35	46	18,289	+ 7,081
Bolton Corporation	,, 18	1,956	+ 102	25	47,520	+ 464
Bournemouth Corporation	,, 14	1,294	+ 126	‡24	29,322	+ 1,670
Bradford Corporation	,, 17	4,964	+ 1,068	24	116,208	+ 20,917
Brighton Corporation	,, 18	1,166	+ 181	24	27,567	+ 2,867
Brisbane Tramways	Aug. 8	2,240	+ 28	5	11,036	- 102
Bristol Trams & Carriage	Sept. 16	5,225	+ 331	6	32,285	+ 1,119
Buenos Ayres & Belgrano	Aug. 21	3,421	+ 348	18	58,549	+ 2,884
Burnley Corporation	Sept. 17	1,063	+ 212	25	26,816	+ 6,029
Burton Corporation	,, 18	339	- 42	¶24	9,095	+ 2,004
Calcutta Tramways Co.	,, 17	R38,782	+ R3,068	12	R398,728	+ R45,497
Camborne-Redruth	,, 19	114	+ 2	20	2,372	- 115
Cardiff Corporation	,, 17	2,211	+ 213	24	52,068	+ 1,811
Carlisle Tramways Co.	,, 17	228	+ 23	37	7,506	+ 293
Central London Railway	,, 17	6,088	+ 188	11	64,150	- 1,427
Chatham & Dist. Lt. Rys.	,, 15	623	+ 32	37	22,679	+ 2,124
City & South London Rly.	,, 18	2,493	+ 11	12	28,253	- 1,184
Colchester Corporation	,, 15	329	...	7	2,634	...
Cork Electric Trams Co.	,, 15	529	- 59	37	17,491	- 2,325
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 9	601	+ 80	36	19,542	+ 3,257
Dover Corporation	,, 17	250	- 8	25	6,185	- 160
Dublin & Lucan Railway	,, 16	130	+ 1	11	1,615	- 14
Dublin Southern District	,, 16	1,008	+ 41	} 11	62,162	- 3,115
Dublin United	,, 16	4,035	+ 190			
Dudley—Stourbridge	,, 9	988	+ 54	36	31,760	+ 1,284
Dundee Corporation	,, 14	864	+ 21	...	...	...
East Ham Council	,, 17	739	+ 21	24	18,912	+ 1,430
Gateshead & Dist. Trams	,, 9	940	+ 14	36	32,757	+ 1,429
Glasgow Corporation	,, 17	15,511	+ 943	†16	226,152	+ 14,198
Glossop	,, 17	127	+ 10	39	4,015	...
Gravesend—Northfleet	,, 9	289	- 7	36	9,473	+ 746
Gt. Northern & City Rly.	,, 17	1,080	...	31	29,517	...
Greenock & Port Glasgow	,, 9	668	+ 103	36	20,988	+ 1,114
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 9	322	+ 12	36	10,874	+ 1,007
Huddersfield	,, 17	1,337	+ 126	24	33,927	+ 2,760
Hull Corporation	,, 17	2,182	+ 573	24	58,109	+ 7,311
Ilford District Council	,, 17	481	- 12	¶24	12,419	+ 645
Ilkeston Corporation	,, 14	142	- 20	...	...	...
Ipswich Corporation	,, 17	552	...	24	13,310	...
Isle of Thanet Co.	,, 17	1,216	+ 166	¶51	21,914	+ 1,092
Kidderminster & District	,, 9	149	+ 9	36	4,829	+ 25
Kirkcaldy Corporation	,, 14	284	- 33	37	8,571	...
Lanarkshire Trams Co.	,, 15	759	+ 78	37	23,785	...
Leeds Corporation	,, 17	6,078	+ 581	25	149,957	+ 9,953
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	,, 10	10,655	+ 89	37	383,473	+ 12,396
Liverpool Overhead Rly.	,, 18	1,561	- 129	†12	20,045	- 551
*London County Council	,, 10	13,778	+ 3,108	§24	297,959	+ 61,534
Lowestoft	,, 17	310	+ 48	...	...	...
Maidstone Corporation	...	...	...	...	...	...
Manchester Corporation	,, 17	12,619	+ 888	24	302,992	+ 12,812
Mersey Railway	,, 17	1,540	+ 203	11	16,858	+ 1,172
Merthyr	,, 9	210	- 10	36	7,321	+ 119
Metropolitan Elec. Trams	,, 16	2,010	+ 679	11	21,674	+ 5,027
Middleton	,, 9	328	- 15	36	12,117	+ 184
Nelson Corporation	...	...	...	...	...	...
Newcastle-on-Tyne Corp.	,, 17	3,619	+ 217	11	40,671	+ 2,639
Newport (Mon.)	,, 17	525	+ 68	24	12,966	+ 2,289
Oldham, Ashton & Hyde	,, 9	549	- 41	36	19,973	- 886
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams	,, 16	1,258	+ 140	37	48,406	+ 5,928
Peterborough	,, 9	170	+ 4	36	5,600	- 103
Poole and District	,, 9	398	...	36	11,212	- 50
Portsmouth Corporation	,, 18	2,249	+ 325	...	...	...
Potteries	,, 9	1,728	+ 22	36	61,370	+ 5,063
Reading Corporation	,, 15	677	+ 91	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 9	162	+ 7	36	5,898	- 77
Salford Corporation	,, 19	4,286	+ 198	24	102,562	+ 7,226
Sheerness	,, 7	82	- 4	36	2,846	- 475
Sheffield Corporation	,, 18	4,744	+ 171	§25	119,438	+ 3,122
Southampton Corp'ation	...	...	...	...	...	...
Southend Corporation	,, 14	476	+ 67	24	10,486	+ 1,167
Southport Tramways	,, 9	365	- 15	36	12,235	+ 688
S. Staffordshire Trams.	,, 9	764	- 829	36	27,830	- 4,564
Stockport Corporation	,, 16	562	+ 190	24	14,989	+ 6,274
Sunderland Corporation	,, 18	1,274	- 160	24	3,948	+ 306
Swansea Trams	,, 9	557	- 17	36	20,027	+ 1,008
Taunton Trams	,, 9	60	- 2	36	2,060	- 192
Tynemouth and District	,, 9	349	- 109	36	11,669	- 907
Tyneside Trams Co.	,, 14	459	+ 123	37	14,170	+ 2,307
Wallasey District Council	,, 17	791	+ 43	§24	19,693	+ 1,235
Walsall	,, 17	481	...	36	18,040	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 15	1,122	...	29	26,126	...
Weston-super-Mare	,, 7	270	+ 42	36	5,193	+ 390
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 9	408	+ 13	36	14,238	- 43
Worcester	,, 9	369	+ 210	31	10,100	+ 4,795
Wrexham	,, 9	133	- 3	36	4,080	- 579
Yorkshire Woollen District	,, 9	580	+ 94	36	21,749	+ 8,417

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 8 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Sept. 21	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to Sept. 21. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c					
5	..	Anglo-Argentine Ordinary Shares	6⅜—6⅝	..	April, Oct	6⅞	6½
5	2/6	Do. 5% Cum. Pref.	5⅝—5⅞	4 8 10	..	5⅞	5⅝
St.	6%	Do. Permanent 6% Deb. Stock	139 —142	4 4 10	..	141	139
St.	6%	Auckland Elec. Trams 5% Deb. (red.)	100 —102	4 19 3	..	101½	..
10	6%	Barcelona Tramways Ord.	9 —10	3 0 0	..	9⅛	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 0	..	..	..
100	5%	Do. 5 per Cent. Debs.	98 —101	4 19 6	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	⅛—¼	..	..	..	..
1	..	Do. 5% Cum. Pref.	¼—½	..	..	⅜	..
5	..	Brisbane Electric Trams. Invest. Ord.	1—2½	..	..	2	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4½	5 17 8	..	4½	4⅛
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96 —101	4 9 3	..	98½	..
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107 —109	3 13 4	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	97 —100	6 2 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	100 —103	4 18 0	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	104⅝—106⅞	4 6 7	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 —100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	8½—10	6 0 0	..	9⅛	9⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—11	5 9 1	Feb, Aug	11	10⅞
St.	5/0	Do. 5 per Cent. Perpetual Debs	117 —120	4 4 9	..	119	118
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	94 —97	..	..	96	95½
5	1/8	†Buenos Ayres and Belgrano Ord.	8½—8⅝	6 8 6	..	8⅞	8⅝
5	2/0	† Do. 6 per Cent. "A" Cum. Pref.	5⅜—5⅝	5 4 4	..	..	..
5	2/0	† Do. "B"	4⅜—5⅛	5 14 4	..	..	..
St.	5%	Do. 5 per Cent. Debs.	105 —108	4 12 8	..	106½	101½
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102 —105	4 16 3	..	..	..
5	3/6	Calcutta Tramways	7½—8	3 15 0	..	7⅞	7⅞
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 4 0	..	107	..
1	1/0	Cape Electric Tram Shares	1⅜—1⅞	5 6 3	..	..	..
St.	4%	Central London Ordinary Stock	85 —87	4 12 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. Pref. Stock	100 —102	3 18 3	..	..	..
St.	4%	Do. Deferred Stock	79 —81	4 18 9	..	..	..
100	4%	Do. 4 per Cent. Debs.	106 —109	3 13 5	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—5	5 0 0	..	5	4⅞
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 2	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	46 —48	4 13 9	Feb, Aug	47⅛	46
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 3	Feb, Aug	124	122⅜
St.	5%	Do. (1896)	117 —120	4 3 6	..	..	..
St.	5%	Do. (1901)	115 —118	4 5 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	105 —108	3 14 9	May, Nov	106	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	101 —104	4 18 0	..	103½	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13 —14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	15⅜	..
10	3 0½	Gt. Northern & City Rly. Prf. Ord. (4%)	5 —5½	.. ..	..	5⅜	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	† Imperial Tramways Ord	19 —20	4 10 0	Mar, Sept	..	..
10	6%	† Do. 6 per Cent. Pref.	14½—14⅞	4 1 4½	Mar, Sept	..	..
St.	4½%	† Do. 4½ per Cent. Debs.	109 —111	4 1 0	Jan, July	..	..
5	2/6	†Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 —91	4 7 11	..	..	..
10	1½%	Liverpool Overhead Railway Ord	8⅜—8⅝	3 15 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10⅛—11	4 10 11	..	10⅛	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —105	3 16 4	..	104¼	103½
St.	..	Madras Elec. Trams 5% Deb. Stk.	102 —105	.. ..	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6 —9	.. ..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	.. ..	..	..	..
1	..	Metropolitan Electric Trams Def	⅞—1⅛	.. ..	..	1⅛	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	..	1	..
St.	18/7	Do. 4½% Deb. Stock	98 —100	.. ..	..	99½	99½
100	5%	Montreal St. Ry. St'g 5% Mrt. Dbs. (1908)	100 —103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 —105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 —2	.. ..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	101 —104	4 7 3	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	9⅛	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	.. ..	.. ..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	.. ..	.. ..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	.. ..	.. ..	Jan, July	..	..
St.	8%	Waterloo and City Ord.	86 —89	3 7 5	June, Dec	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	⅜—½	5 14 2	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	⅜—½	.. ..	..	..	..
5	4/0	†British Insulated & Helsby Cables Ord.	5½—6	6 13 4	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5½—6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 7	..	..	..
St.	4½%	British Thom's'n-Houst'n 4½% 1st Mt. Db.	99 —101	4 9 1	..	..	..
5	3/0	British Westinghouse 6% Pref.	2⅝—3⅛	9 4 6	..	3⅛	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	86 —89	4 10 9	..	87⅛	..
2	..	Brush Electrical Engineering	½—¾	.. ..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1 —1½	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	94 —97	4 12 10	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	70 —75	6 0 9	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½—10½	5 14 3	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 10 11	Jan, July	5⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	101 —105	4 5 8	Nov, May	103½	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 16 10	..	..	..
1	1/2½	Chadburn's (Ship) Telegraph Ord.	⅞—1⅛	8 0 0	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—2	3 15 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	90 —95	5 6 5	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7½—8	.. ..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5¼—5⅜	5 4 4	..	5⅜	..
St.	4½%	Do. 4½% Deb. Stock	103—106	4 5 9	..	104	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	.. ..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —2	.. ..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 —82	4 18 1	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 —83	6 3 8	..	..	..
5	4/8	Edmundson's Elec. Corp. Ord.	6 —6½	5 12 0	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 16 0	..	6⅜	6⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105 —108	4 3 10	..	106½	..
2	1/7½	Electric Construction Co.	1 —1½	6 8 0	July	1⅝	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2 —2½	5 12 0	July	2⅜	..
St.	4%	Do 4 per Cent. 1st Mort. Deb. (red.)	96 —99	4 0 9	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 —9½	5 5 8	..	9⅜	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	5/0	† Henley's Telegraph Works Ord.	10½—11½	6 1 9	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.	107 —111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 6	Feb, Aug	..	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.	100 —103	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	84 —87	6 9 11	Mar, July	86	85½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 6	Jan, July	..	..
5	..	Willans and Robinson Ord.	2 —3	.. ..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3 —4	.. ..	Apr, Oct	..	..

Share.	Last Dividend	Name.	Price Wed., Sept. 21	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to Sept. 21. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	11⅜	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 —106	4 5 9	..	104½	104
5	..	Bromley (Kent) El. Lt. & Power Shares	5½—6	.. ..	..	..	..
St.	4½%	Do. Do. 1st Debs	101 —104	4 8 3	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11½	4 8 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10½—10⅝	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7½—8	4 7 6	..	7⅝	7½
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	107 —110	3 13 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8 —8½	4 14 3	Feb, Aug	8⅜	8⅛
5	2/8	Do. 4½ per Cent. Pref.	5½—5⅝	4 1 10	Feb, Aug	5⅝	5⅝
5	2/8	Do. City Undertaking 4½% Cm. Pref.	4⅝—5	4 10 0	..	4⅝	4⅝
5	2/8	Do. Do. (1903)	4⅝—5	.. ..	..	4⅝	4⅝
St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 0	..	103½	102½
5	2/8	†Chelsea Electric Supply Ord.	6½—7	4 2 2	March ..	6⅞	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 2 6	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10½—10⅝	4 13 0	Feb, Aug	10⅝	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅛	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	120 —125	4 0 0	Jn, Dec ..	123½	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 5 9	..	..	..
10	4/0	County of London Elec. Supply Ord.	8 —9	4 8 11	..	8⅞	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—12	5 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	105 —108	4 3 6	..	107	10
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —104	4 7 10	..	..	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 —93	5 7 6	..	..	..
5	3.6	Folkestone Electricity Supply Co. Ord.	5⅜—6⅛	4 8 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 —102	4 8 9	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	.. ..	..	..	..
5	5.0	Hove Electric Lighting Ord.	7⅜—8⅛	5 0 0	..	..	..
St.	4½%	I. of W. Elec Lt. & Power 4½% Db. St (red.)	101 —103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅛—⅜	.. ..	..	..	..
5	5/0	Kensingtn & Knghtsbdge Ord.	12 —13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Knghtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 6	..	..	..
3	..	London Electric Supply Ord.	1⅛—2⅛	.. ..	..	..	..
5	3/0	Do. 6 per Cent. Pref.	5 —5½	5 9 1	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 —99	4 1 6	Mr, Jn, S, D	96½	..
10	9/0	Metropolitan Electric Sup. Ord.	16 —16½	5 0 0	April, Oct	16⅝	16⅛
5	2/8	Do. 4½ per Cent. Cum. Pref.	5⅛—5⅜	4 0 0	Jan, July	5⅛	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —115	3 18 11	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 —99	3 10 6	..	..	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	93 —96	4 13 9	..	..	..
10	6/0	Notting Hill Electric Ord.	14½—15½	3 17 6	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	100 —103	3 18 3	..	..	..
5	2/6	†Oxford Electric Ord.	5⅜—6⅛	4 1 0	March ..	5⅛	..
St.	4%	Do. 4% Deb. Stock	97 —100	4 0 0	..	..	..
1	..	Rand Electric	1⅛—1⅜	.. ..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 —103	4 7 9	April, Oct	..	..
5	5.0	St. James' & Pall Mall Elec. Ord.	14½—15½	4 13 7	Feb, Aug	14⅞	14⅛
5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 2	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2⅝—3⅛	6 8 1	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 —88	4 10 11	..	..	..
5	3/0	South London Electric Supply Ord.	4½—4⅝	3 8 1	..	4⅝	4⅜
1	..	South Metrop'n Elec. Ltg. & Power Ord.	¾—1	.. ..	..	¾	..
1	0/8½	Do. 7% Cum. Pref.	1⅛—1½	4 13 4	..	..	..
St.	..	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	105 —109	4 3 0	..	..	..
5	2/6	Urban Electric Supply Ord.	4⅜—5⅛	4 15 3	..	4⅝	..
5	2/6	Do. 5% Cum. Pref.	4⅝—5⅛	4 15 3	..	4⅝	4⅝
5	6/6	Westminster Electric Supply Ord.	12 —13	5 8 9	Mar, Sept	12⅞	12⅝
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	6⅞	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 19 0	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	.. ..	Jn, Dec	..	..
St.	12/6	Anglo-American	50 —53	5 5 9	F, My, Ag, N	51⅛	..
St.	25/0	Do. Preferred	95 —98	5 12 8	F, My, Ag, N	98	96½
St.	2/0	Do. Deferred	8½—8⅝	1 2 10	F, My, Ag, N	8⅞	8⅛
100	$2	Commercial Cable Capital Stock	170 —190	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 —96	4 3 6	Jn Ap, Jy, O	96	93½
10	5/0	Cuba Submarine Ord.	7 —8	7 10 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2⅜—3⅛	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅝—101⅞	4 9 2	Jan, July	..	..
20	3/0	Direct United States Cable	10½—10⅝	5 11 3	Ja, Ap, Jy, O	10⅝	10½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 —101	4 9 2	Jn, Dec ..	..	..
St.	65/0	Eastern Ordinary	128 —133	5 5 2	Ja, Ap, Jy, O	132½	130½
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —90	3 18 6	Ja Ap, Jy, O	89⅛	88½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106 —109	3 14 3	May, Nov	107½	..
10	2/6	Eastern Extension	12½—12⅝	5 12 9	Ja, Ap, Jy, O	12⅝	12½
St.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 14 3	Feb, Aug	105½	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	99 —102	3 18 9	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—103%	3 18 6	May, Nov	..	..
10	5/0	Gt. Nrthn. (of Copenhagen)	28½—29½	5 8 5	Jan, July	29	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 —101	4 9 2	June, Dec	..	..
25	37/6	Indo-European	43 —46	5 8 9	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..
10	6/0	West African Telegraph Shares	6 —7	5 14 3	..	..	..
2½	..	West Coast of America	⅛—¼	.. ..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 6	Jan, July	..	..
10	..	West India and Panama	⅞—1	.. ..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½—7	8 11 5	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	5 —6	.. ..	May, Nov	5⅛	5
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 17 10	Jan, July	..	..
10	3/0	Western Telegraph	12½—12⅝	5 9 9	Mr, Jn, O, D	12⅝	12½
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 16 3	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 —104	3 17 6	..	102⅝	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5 —5½	6 7 3	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	⅛—¼	.. ..	..	..	..
St.	6%	National Co. Pref. Stock	104 —106	5 13 9	..	105½	104½
St.	5%	Do. Def. Stock	92 —94	5 6 4	..	93⅝	92½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 8	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	11⅞	11½
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅛—5⅜	4 13 0	Feb, Aug	5⅜	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 —99	3 10 8	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104 —106	3 15 9	..	104½	..
..	5/9	Do. Do. Prov. Certs, 35% to be pd.	67 —69	.. ..	..	..	..
1	0/8½	Oriental	⅞—1⅛	6 6 8	April, Oct	1⅛	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1⅜	5 0 10	..	..	..
5	5/0	United River Plate	6 —6½	6 3 3	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅜—5⅛	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 —106	4 14 4	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4⅜—4⅝	5 14 4	..	..	..
10	2/0	Globe Telegraph and Trust	9½—9⅝	5 12 8	Ja Ap, Jy O	9⅝	9½
10	3/0	Do. 6 per Cent. Pref.	12⅞—14½	4 3 3	Ja Ap, Jy, O	13⅛	13⅛
100	6%	Submarine Cables Trust (Cert.)	118 —123	4 17 9	April, Oct	..	..
	56/7	Underground Elec. Rys. Co. of London					

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THE ELECTRICIAN:

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NOTES.

WE would call the attention of electric traction engineers and financiers to the latter part of Mr. BELLAMY'S Presidential Address to the Municipal Tramways Association of Great Britain given on another page. Mr. BELLAMY makes an earnest appeal on behalf of the extension of light railways—not merely tramways built under the Light Railways Act, but real light railways intended primarily for the transport of agricultural produce. When first the Light Railways Act came into force, promoters realised, with a fair degree of promptitude, that, while it gave increased facilities for the carriage of produce, the transport of human freight was more profitable. Hence Light Railways and Tramways have become practically synonymous terms in the majority of cases. Now, however, that the most profitable passenger routes are gradually being filled, attention may well be directed to the construction of light railways which will still remain light railways after the promoters have obtained their Light Railway Order.

A METHODICAL system of collecting agricultural produce, especially that of a more perishable nature, is needed, and there is little doubt that such a system, if combined with light railway working, would possess the elements of success in a high degree. Farmers, orchardists and market gardeners will not themselves take the initiative—whether the reason be a disinclination to act in combination, or a lack of enterprise, we are unable to say—and it would appear, therefore, that there is room for a middleman to step into the breach and act as a medium for the collection and despatch of the produce to the markets of the country. Subsidies from the Government would not, we think, be difficult to obtain under the Light Railways Act, if the enterprise were shown to be a legitimate one. Mr. BELLAMY urges that municipal authorities should turn their attention to the matter, but we think that schemes of this nature would be developed with greater rapidity and certainty by private enterprise. Herein lies an opportunity for the railway companies.

OUR special correspondent with the Institution party in America has sent us some interesting information regarding the electric supply undertaking of the City of Montreal. He emphasises the disfiguring appearance of the network of overhead wires, and calls special attention to the extraordinary load-factor of 75 per cent. The overhead wires will, however, soon disappear, giving place to underground mains. So high a load-factor as 75 per cent. is certainly phenomenal, and is due to the fact that a very low tariff is in force for power. A specially low price is offered to power consumers who agree not to avail themselves of the supply during certain hours of the day except for lighting. This plan has been tried with success on a small scale at Brighton, but has not, we believe, been successfully practised elsewhere in this country.

WE publish in this issue the latest revised form of the Board of Trade regulations for the use of electrical power on tramways and light railways on public roads. It will be noticed that one of the old regulations has been deleted and a new one added. The addition bears the number 8, and runs, "The current density in the rails shall not exceed 9 amperes per square inch." Evidently the object is to prevent excessive current density and fall of potential which may occur at a convergence of routes or in the immediate neighbourhood of a generating or sub-station, and may, conceivably, produce a local "danger area" for pipes, although the potential differences over the whole system are not in excess of the prescribed 7 volts. Clearly, the rate of potential difference per unit length may have an important influence upon the current picked up by closely

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adjacent pipes. There is a reasonable suspicion that electrolytic damage has been done in a few cases under such conditions, although the published evidence falls far short of legal proof. It is significant that this additional safeguard is not due, so far as we can learn, to any suggestion of those experts who have so persistently endeavoured to hamper tramway enterprise with "electrolysis clauses," but is the result of careful and spontaneous examination of available evidence by the officers of the Board, thus affording a proof of their commendable desire to modify their regulations, with due regard to all the interests affected, as experience suggests.

THE new regulation will have a material effect upon the distribution lay-out of tramway systems. With 100lb. rails, the maximum current to be carried per track will be 180 amperes, corresponding to, say, 12 four-wheel cars on an average road, so that if the number of cars per track at any station or feeding point exceeds 12 (or such other number as may be indicated by the weight of the cars and the hardness or ease of the road), return feeders will have to be laid down to carry the surplus. Return feeders usually have to be boosted, and the capital and working cost involved may suffice in conceivable cases to determine the choice of high-tension transmission with converter sub-stations as against direct feeding.

THE disappearance of No. 17 of the old regulations can only excite the regret of the antiquarian. It called for the gradual variation of the current on the car "by means of a rheostat containing at least 20 sections or by some other equally efficient method," &c. Non-disturbance of telephone or local telegraph lines with earthed returns was the object of this rule, an object not achieved, at least as regards telephones. Such lines in the neighbourhood of electric tramways are probably more completely obsolete than the 20-section rheostats intended to protect them; a certain number of the latter were in use a few months ago. The small alteration suffered by the original regulations during 10 years of undreamt-of extension of electric tramways is striking evidence of the care, moderation and foresight with which they were drawn up originally.

SINCE extra high speeds have been introduced into central-station practice by the advent of the steam turbine, the design of electric generators coupled to these prime movers has come in for a considerable amount of discussion. A contribution to this subject by Mr. B. A. BEHREND appears elsewhere in this issue. The author's curve, showing the variation of the weight of a 1,000kw. 25~ alternator with the speed is most interesting, but we fail to see how Mr. BEHREND computed the points of the curve between the speeds corresponding to a whole number of pole pairs. At a speed of 750 revs., for instance, the number of pole pairs required for the given frequency of 25~ per second is two. If we halve the number of poles—and that is our only choice—the speed necessary to obtain the same frequency is 1,500 revs. Yet his curve reaches a minimum between these points. In any case it seems remarkable that the 2-pole alternator should weigh so much as 50 per cent. more than the 4-pole machine. Some more information as to the calculation and design of turbine-driven generators is urgently needed.

THE 60,000-volt Mexican power transmission, of which a description appears in this week's issue, is remarkable in various ways. Perhaps the most striking feature is not the mere adoption of the high voltage, but rather the unmistakable indication which it affords of the fact that extra-high tension is becoming more and more general, particularly for transmission lines of comparatively small length. Even 101 miles, the distance over which the power is transmitted, is by no means the longest distance over which power is conveyed electrically, and not so very long ago a much lower transmission voltage would have been deemed quite sufficient to cope with the problem to be solved. If further proof of this tendency were required, we might point to the Italian 40,000-volt transmission, some particulars of which are contained in a note in this issue. In this case the distance of transmission is but 20 miles, practically the same distance as the 40,000-volt scheme which Mr. CAMPBELL SWINTON is developing in Scotland.

IN many sporting events, the time-honoured method of timing by means of a stop-watch is not altogether satisfactory. This is notably the case in motor-car racing, where the distance covered in one-fifth second—the shortest interval of time usually recorded by stop-watches—may be considerable. Occasional use has been made of electrical and mechanical means for recording time intervals more accurately, but they have never come into general use, no doubt on account of their costliness and complexity. The electro-chronograph, described by Mr. DAVID OWEN on another page of this issue, is a praiseworthy attempt to produce a simple time-recording apparatus. We cannot help pitying the poor operator, however, who will occasionally have to handle some dozens of sooted cylinders during a busy race meeting, and we would suggest that Mr. OWEN should endeavour to adapt for his purpose a less troublesome and more permanent method of marking the record on the time-cylinder.

Erratum.—In an editorial note on p. 894 of last week's issue of *The Electrician*, we referred to Mr. Addenbrooke, instead of to Mr. A. A. Campbell Swinton, as the consulting engineer to the Loch Lomond power transmission scheme.

Rugby Engineering Society.—The annual general meeting of the Rugby Engineering Society will be held on Thursday next in the Benn Buildings, High-street, Rugby, at 8 p.m. Among the preliminary business will be the election of officers and members of Council for the ensuing session, and the reception of the president's report for session 1903-4. A discussion will then take place on the metric system, which will be opened by Messrs. E. R. Briggs and R. C. Jackson.

Tramways and Light Railways Association.—In the official circular for September, it is notified that the following lectures will be given at the Society of Arts, John-street, Adelphi, viz.:—"Automatic Regenerative Control for Electric Traction," by Mr. J. I. Hall, on October 20th; "Notes on Permanent Way," by Mr. A. N. Connett, on November 3rd; and "Running Powers," by Mr. Stephen Sellon, in December. Also that members of the Association have been invited to visit the various works of the London County Council tramways on November 11.

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Iceland Cable.—Reuter announces that the negotiations between the Danish Government and the Great Northern Telegraph Co. regarding a submarine telegraph cable to Iceland were brought to a successful conclusion on Monday. The company undertakes the laying and working of the cable between the Shetland and Faroe Islands and Iceland in return for a yearly subsidy of 54,000 kronen (£3,000) from Denmark and 35,000 kronen (£1,944) from Iceland, the cable to be opened for traffic at latest by October 1, 1906.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 18, 1902
Beissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Cayenne—Paramaribo	July 13, 1904
Cap Haitien—Mole St. Nicholas	Aug. 20, 1904
Bundaberg—Gomen (New Caledonia)	Aug. 30, 1904
Marseilles—Barcelona	Sept. 16, 1904
Cap Haitien—Puerto Plata	Sept. 26, 1904

A Curtis Turbine Set for Japan.—Considerable interest was created recently by the news that a large contract for Curtis steam turbines for supplying power to a Japanese street railway had been placed with the General Electric Co. of America. Information has just come to hand that the Nagoya Electric Light Co.'s plant is to be extended, and the British Thomson-Houston Co., the holders of the patent rights of the Curtis turbine for Great Britain and Ireland, inform us that a contract has been placed with them, through the Japanese house of Mitsui & Co., for a 500kw. Curtis turbine set.

Italian Submarine Telephone Cable.—According to the *Journal Télégraphique* Messrs. Pirelli & Co., of Milan, are constructing at the present time a submarine telephone cable, the first of its kind to be made in Italy, for connecting the mainland of Italy with Sicily. Its length is to be 9km. (5·6 miles) and the points connected will be a place near Gallico de Reggio and a place south of Messina. The conductors consist of seven copper wires of a diameter of 0·8mm. insulated by alternate layers of gutta-percha and Chatterton compound, the diameter being thereby brought up to 7mm. (0·275in.). Upon this is a covering of Indian hemp, followed by an armouring of galvanised steel wire. The principal electric data of the cable are:—Copper resistance per mile at 15°C., 7·9 ohm; insulation resistance per mile at 24°C., 372 megohms; capacity per mile, 0·296mfd.

The Late Major-Gen. C. E. Webber.—The funeral service of the late Major-Gen. Webber, C.B., R.E., was held at Brompton parish church on Wednesday, and the interment subsequently took place at St. Margaret's, Lee, Kent. Among those representing the Institution of Electrical Engineers at Brompton parish church were Mr. Alexander Siemens, Prof. W. E. Ayrton, F.R.S., Prof. Carey Foster, F.R.S., Dr. J. W. Swan, F.R.S., Prof. S. P. Thompson, F.R.S., Dr. J. A. Fleming, F.R.S., Mr. J. E. Kingsbury, Mr. W. M. Mordey, Mr. W. H. Patchell, Mr. F. Gill, Mr. S. Morse and Mr. P. F. Rowell (Assistant-secretary). The following were also present at the interment:—Mr. A. Siemens, Dr. J. W. Swan, F.R.S., Mr. W. M. Mordey and Mr. P. F. Rowell. Death was due to angina pectoris, and took place very suddenly. An obituary notice will be found in another column.

German Submarine Cable Enterprise.—A Reuter telegram from Constantinople states that, after protracted negotiations extending over two years, the German Telegraph Co. for Eastern Europe has succeeded in obtaining a concession for the laying and working of a cable between Kustenji and Constantinople. The city of Berlin and the Turkish capital will thereby be connected by a special wire, which it is proposed to extend ultimately to the Persian Gulf and the Far East. The Iradé authorising the laying of the cable has already been issued, but certain formalities still remain to be carried out. This concession interferes with the preferential rights of the Eastern Telegraph Co., which some time ago lodged a protest with the Porte, and it is now presumed that the company will demand from the Ottoman Government an indemnity, which, it is understood, the German company has undertaken to pay.

Opening of the Weymouth Electricity Works.—The electricity works which have been erected by the Weymouth Corporation were opened on Monday. An electric lighting provisional order was obtained in 1898, but it was not until a few years afterwards that Messrs. Kennedy and Jenkin were engaged to prepare a scheme. The system adopted is a three-wire continuous-current one, supply being given at 230 volts. In the generating station are three Lancashire boilers, which have a total evaporative capacity of 19,500lb. per hour; two Reavell high-speed vertical compound and three three crank engines, having an aggregate capacity of 650 I.H.P.; and six dynamos by the International Electrical Engineering Co., aggregating 400kw. There is also a battery of 240 Tudor cells, having a capacity of 360 ampere-hours, and a maximum discharge rate of 280 amperes. The cables are Johnson and Phillips paper lead-sheathed, laid solid in wood troughs.

Fire at a Sub-station of the Metropolitan Electric Supply Co.—A fire occurred at 10:15 a.m. on Saturday morning at the Metropolitan Electric Supply Co.'s Tower-street sub-station through the short-circuiting of copper strip laid in compound, the strip leading up to the continuous-current switchboard. Large quantities of gas were given off by the compound owing to the heat, and becoming ignited, destroyed the whole of the Ferranti continuous-current switchboard and some E.C.C. boards, putting them entirely out of service. The copper strip, of course, bent in all directions, causing short-circuits on the low-tension 'bus bars. This accident laid off a large part of the supply on one side of the network, the other side fortunately remaining sound. The fire was extinguished at 10:45 a.m., and some part of the supply was already restored by that time, the whole being put in order by 12:50 (noon). Smoke poured upstairs into the high-tension room (which is approached by means of an iron staircase) and was so dense that the man in charge could not get down the steps; he was compelled to make his exit through the window, and, very fortunately, was not seriously injured. The station itself is practically fireproof throughout, and had it not been for the presence of compound, but little damage would have been caused.

Pacific Cable Conference.—A conference on the subject of the Pacific cable has been fixed to take place in London early in November. The parties to the Pacific cable scheme will be represented as follows:—Great Britain, the Colonial Secretary; Commonwealth of Australia, Lord Jersey; Canada, Sir William Mulock; and New Zealand, Sir Sandford Fleming. The members of the Pacific Cable Board and some of the Agents-General will attend the sittings. The conference has, it is stated, become necessary owing to friction between the partners over the working of the cable. The principal question to be discussed is whether a contract entered into by New South Wales with the Eastern Extension Telegraph Co. is in accordance with its undertaking with its partner States. Another point is the amount charged for terminal fees in Australia. Both Great Britain and Canada contend that the terminal charge—5d. per word—is far too high. The following statement has been published concerning the terminal rate question:—"Considering that Australia pays 50 per cent. less for cable charges than she did when she had to give a private company the subsidy, it is thought both in Britain and in Canada that the Pacific cable should be at least placed on the same footing as the private enterprise." This is a mis-statement of facts, the message rates having been reduced before the Pacific cable was laid.

Wireless Telegraph Notes.—We learn that applications for wireless telegraph licences have been received by the Postmaster-General from various sources, including certain of the submarine cable companies. Although, according to the act, all applications have to be made by to-morrow (Saturday), we believe that further applications may be made after that day, but there will be no necessity to grant them. No licences drafted in general terms will be granted, but each will be on specific data as set forth by individual applications. The following information must be given by every intending licensee:

1. Full name and address of company or person by whom the licence is desired. 2. Particulars of the situation of the station or stations to which the licence would apply. 3. Particulars of any other station or stations with which it is desired to carry on communication. 4. Par-

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ticulars as to ownership or occupation of each station mentioned in 2 and 3. 5. Particulars of the purpose or purposes of the installation to which the licence would apply, as, for example, whether it is intended solely for experiments. 6. General description of apparatus to be used at each station, including statement of its maximum range. [Note.—If the apparatus is of some well-known kind, it will suffice here to give its name with a statement of its maximum range.] 7. Any other particulars indicating the nature of the installation, and the circumstances in which it is to be used.

It is stated that experiments are being conducted by Royal Engineers at Llanrwst on behalf of the Government with a view to establishing wireless telegraphic communication over the Snowdon range.

Rotterdam Electricity Supply.—A noteworthy feature of the supply of electricity in Rotterdam is the adoption of a five-wire distribution. There is, according to *L'Eclairage Electrique*, one central station, which supplies continuous current to two sub-stations. One of the latter, known as the A station, is about 1·2 miles distant and deals principally with lighting loads. Its principal equipment consists of a battery and two double dynamos. As a rule, these dynamos serve for regulating the current to the battery, but in case the latter breaks down, the dynamos may be suitably coupled up for supplying current on the five-wire system. The second station, the B station, is on the left side of the River Meuse, nearly 2 miles from the central station. Its equipment is similar to that at the other station. The B station has to deal chiefly with a power-load, arising from the 25 electric cranes (46 motors) in the docks and harbours. The total number of lamps to be supplied is equivalent to 14,400 16 c.p. lamps, while the total number of motors is at present 141, representing a combined capacity of 1,543 H.P. In the central station itself the power plant consists of the following items:—Three Willmann boilers, supplying steam at 186lb. per square inch to five high-speed steam engines. Two of these are 170 H.P. Willans engines running at 350 revs. per min. and directly coupled to two 112kw. 500 to 700-volt continuous-current generators. A third set consists of a 260 H.P. steam engine driving a 175kw. generator. The remaining two sets, only recently installed, consist of two Willans engines of 260 H.P. and 500 H.P. capacity respectively, which drive two continuous-current generators designed for the same voltage as the other sets.

Tests of a 46,000-volt, 2,750 kilo-volt-ampere Transformer.—The Maschinenfabrik Oerlikon, who built the Caffaro water-power station, send us the following interesting particulars with regard to the electrical plant with which the station is equipped. At present there are three three-phase dynamos, designed for generating 150 amperes at a voltage of from 9,000 to 10,500 volts and at 42~ per second when driven at a speed of 315 revs. per min. The voltage is then stepped-up by three transformers to 46,000 volts at which pressure electric energy is transmitted to Brescia. In construction, the generators present no new features; they are of the revolving field type, with the pole-pieces shaped in such a manner as to obtain a current wave as sinusoidal as possible. The total weight of a generator is about 82,000lb. of which the revolving field system accounts for 30,000lb. Tests were made with one of these generators in the latter part of March of this year, at the makers' works, with the following results:—Efficiency at full load and a power-factor of 0·75, 95·2 per cent.; efficiencey at half load and the same power-factor, 92 per cent.; rise in voltage from full load to no load, the power-factor being 0·75, 13 per cent.; maximum rise in temperature 50·4°F. The transformers are remarkable, not only for their size, but also for the way in which they are cooled. The cast-iron case consists of three parts, placed one above the other, and the top piece has cooling ribs extending inwards and double sides, between which the cooling water is caused to circulate. Cores of rectangular section are used, three being placed side by side to form one three-phase set. The winding is composed of bare copper strip insulated with presspahn. As is now usual practice, the low-tension coils are inside, the high-tension winding, which is divided into 36 elements, being placed on the outside. In order to test thoroughly the insulating qualities of the transformers, the latter were subjected for half an hour to 60,000 volts alternating between the high-tension winding and the iron core. The resistance of each phase of the high-tension winding is given as 2·01 ohms, that of a phase of the low-tension winding as 0·074 ohm. From these figures the copper losses corresponding to a load of 1,760kw. are calculated to be 6·6kw., and as the hysteresis losses were experimentally determined to be 20·5kw., it follows that the efficiency at the output stated and a power-factor equal to unity is 98·5 per cent. At the same load, but a power-factor = 0·75, the efficiency is 98·2 per cent. Various tests were also made with regard to the cooling, and it was found that with 2·9 gallons of cooling water per minute at a temperature of 64·4°F., the temperature rise of the fully-loaded transformer did not exceed 81°F. The temperature of the water on leaving the transformer was 95°F. Of the total weight of 26,600lb. nearly 4,500lb. is represented by the oil and the transformer case.

Italian 40,000-volt Power Transmission.—An interesting power transmission, claimed by Herr L. J. Sidler, in an article recently contributed to the *Schweizerische Elektrotechnische Zeitschrift*, to be worked at the highest pressure in Europe, was inaugurated on July 11th between Gromo and Nembro, a distance of 20 miles. At the present time only 2,000 H.P. is transmitted, although this amount will be doubled later on, when the water power available at Gromo is utilised to the greatest extent. This station is now equipped with the following plant:—Three 12-pole 750kw. 4,000-volt three-phase alternators, directly driven by water turbines through a coupling of the Zodel type at a speed of 500 revs. per min. They are star connected, and their full-load efficiency was guaranteed by Messrs. Brown, Boveri & Co., who carried out the entire scheme, to be not less than 93 per cent. With a power-factor of 0·8, the drop in voltage is said not to exceed 20 per cent. The alternators are of the revolving field type, and weigh 13 tons each. Two 25kw. 115-volt exciters furnish current for the alternator fields and for actuating the high-tension oil switches. Each alternator is connected to the primary of a 850kw. water-cooled oil transformer, which raises the pressure to 40,000 volts. No switches or 'bus bars are interposed between the alternators and their transformers. The latter are of the core type, fully immersed in oil and requiring about 4 gallons of water per minute. Efficiency and drop (power-factor = 0·7) at full load are stated to be 97·8 and 2·6 per cent. respectively. After passing through high-tension oil switches, the trip mechanism of which may be operated electrically or mechanically, the leads from the transformers are led to 'bus bars fixed in brick compartments. The electrical trip mechanism is based on the Ferraris principle, its chief points of design being briefly these: Eddy currents are induced in an aluminium disc by a single-phase current derived from the high-tension circuit. As soon as this current exceeds a predetermined value the torque exerted on the aluminium disc suffices to wind up a weight, which, in its turn, causes the oil switch to open. Current is broken in these oil switches at six points, each break being somewhat over 2in. long. The transmission line consists of three copper wires, 6·5mm. (0·256in.) in diameter, supported by porcelain insulators, with three petticoats, fixed to wooden poles. In order to test the insulation these insulators were exposed to an artificial rain equivalent to a rainfall of about 1½in. per minute, and it was observed that the insulation broke down at 54,000 volts. When conveying 4,000 H.P. the transmission losses are not to exceed 5 per cent. At crossings the poles are 9 metres high, but in all other places they are 8 metres in height. On an average the distance between poles is 130ft. Telephone wires are strung about 5ft. below the high-tension wires. At Nembro, where power is used for driving works, the voltage is reduced to 500 volts by two 500kw. transformers, similar to those in the power station. Before entering the sub-station, however, the line wires have to pass a long-break three-pole air switch, which, when opened, automatically short-circuits the three wires leading into the station. The incoming wires are connected up to the high-tension 'bus bars, and then branch off to the high-tension side of the transformers by way of disconnecting links and oil switches; in the secondary three-pole switches are inserted.

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THE AMERICAN TOUR OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

BY OUR SPECIAL CORRESPONDENT.

(*Continued from p. 900.*)

Tuesday, September 6th.

On our arrival at Schenectady, the special train was shunted into the General Electric Co.'s works, and the whole party was received in the new steam turbine building by the president, Mr. C. A. Coffin, and the chief engineer, Mr. Steinmetz. After lunch had been served, a tour of inspection through some of the principal departments was made; but owing to the vast size of the works only a series of mere impressions was gained. The progress which is being made in the manufacture of Curtis turbines was most noticeable, and attracted the greatest attention on the part of the visitors. Already the orders in hand, amounting to nearly 300,000 H.P., have necessitated the construction of a new building especially devoted to their production, and covering nearly 6 acres. The standard size of Curtis turbine for the larger power houses is 5,000kw., and for the present, at least, it may be said that this type of machine has become the standard of the Association of Edison Companies at Chicago, Boston, New York, &c. Most of the turbines are of the four-stage type, in some of which the valves are operated by electromagnets controlled by a governor, but in others the control of the valves is direct without the use of magnets. In the larger sizes, the buckets are of cast gun-metal finished to the proper surface and form by specially designed machinery. In the smaller sizes the buckets are cut from steel discs or rings as, on account of the high speed, steel is more desirable for mechanical strength. Although the speed of the Curtis turbine is low compared with that of other types, great care has to be exercised in the design of the generator, so that a perfect balance is always obtained.

One of the most interesting features in the development of the General Electric Co.'s products is the increasing output of electric generators of very large capacity and high voltages. There is now on order a 10,000 H.P. 10,000-volt generator for the Canadian Niagara Falls Power Co., which is the largest electrical machine ever constructed, notwithstanding which, its speed of 250 revs. per min. is also unusually high for a water-driven machine of so large an output.

The departments open for inspection were the wire and cable building, the power station for driving the whole of the factory, the transformer building shop, the armature winding and general machine shops. Those interested in switches, circuit-breakers and similar articles could have easily spent the whole day in the three large buildings especially allotted to that class of work.

The General Electric Co. have such a large and uniform output that they can, with economy, make almost everything required in their factory from the raw material. This applies even to such special articles as porcelain insulators, fuse-plugs, &c., and last year more than 1,000 tons of porcelain parts were thus produced. The floor-space available in the Schenectady works is 58 acres, and the men employed number 17,000.

The next stage on our tour, as planned, was the journey in electric cars from Schenectady to Ballston, N.Y., and in this connection several novel features were introduced. The first was the running of one of the cars conveying the party with a motor equipment capable of being used on a continuous or alternating-current supply; for this purpose, of course, the motors employed were of the series type with commutator, and, as far as one could see, the starting torque and the smoothness of running were quite as good on the alternating as on the continuous trolley wire.* After leaving the central district of Schenectady, the tramway became practically an enclosed railroad, and high speeds, approximating to 60 miles an hour, were reached on several sections. On arriving at Ballston we again took our places in the special train, and moved on to Saratoga, where dinner was served at the United States Hotel. We then had an all-night journey in the sleeping-cars, and reached Montreal about 7 o'clock next morning.

* A description of this system appeared in our issue of Sept. 9th.—ED. *E.*

Wednesday, September 7th.

The weather was clear and bright, and the first entertainment arranged by our Canadian hosts—shooting the Lachine Rapids—was most enjoyable. We were first taken by train 9 miles up the St. Lawrence, and there embarked on the steamer, which passed through the Rapids and finally landed us at one of the quays, not far from the chief sub-station of the Montreal Light, Heat and Power Co. This company received us at lunch in their sub-station building, and gave us many interesting particulars regarding the operation of their various power plants. The chief feature of the equipment was the 25,000-volt transformers, through which the power developed at the Chambly power house was distributed to the city circuits.

In the afternoon a formal reception of the visitors had been arranged at the McGill University, in the McDonald engineering building. The visitors were welcomed by Prof. Owens, of the electrical department, and most of them spent a considerable time in the examination of the laboratory apparatus, both in the electrical and mechanical divisions. The University has every reason to be proud of the very fine collection of machine tools and measuring instruments which are available for the use of students.

In the evening an entertainment was given at the Forest and Stream Club by the local Reception committee. Indians from the reservation on the other side of the river had been invited to come across by Mr. Walbank, of the Montreal Company, who had acquired the distinction of being their White Chief, and they gave a remarkable display of war dances and canoe racing on the river.

Thursday, September 8th.

Next day those of the party who were not too tired after our late return to the city paid a visit to the Shawinigan Falls, at which is to be found, in the midst of magnificent natural scenery, one of the large generating plants supplying power to Montreal and district. The various power houses and sub-stations in Montreal and its vicinity were available for inspection during the afternoon and were visited by numbers of the party. The first thing that strikes the European engineer on visiting this city is the extensive network of overhead electric wires. Owing to the number of the wires and the heavy weight of snow to be sustained in the winter, the posts have to be spaced very close together, and give the streets rather an unsightly appearance. The reason for this type of construction was due in the first instance to cheapness, and also because competition between the various companies was so keen as to prevent any one of them adopting underground mains. This state of matters has now become more financially satisfactory by the consolidation of the different interests, and the centre of the city will soon be without overhead wires. The magnitude of the supply business in Montreal is astonishing in a comparatively young city of its size. The consumers number 10,600, and the annual output is approximately 85,000,000 kilowatt-hours, while the load-factor averaged over the whole year is about 75 per cent. This high load-factor is no doubt partly due to the institution of an attractive rate for power, on the condition that it is not used between the hours of 4 p.m. and 7 p.m. of any day during the winter months.

The three power houses are very different in character. The Lachine station is located about 5 miles distant on the St. Lawrence river, where it passes through the Rapids. A fall of 16ft. to 17ft. is utilised, and eight units of 1,000 H.P. each are at work. On account of the low fall, each unit is made up of six vertical turbines, connected to a jack shaft by means of crown gears and pinions. The working pressure is 5,000 volts three-phase, so that no special precautions are needed in its transmission. Chambly is the second station, 17 miles distant, where, naturally, a higher voltage is employed. The generators consist of four 3,200kw. sets at 2,200 volts, feeding transformers which raise the potential to 20,000 volts. The high tension current is taken to a selector knife switchboard, but no disconnecting switches are employed at this high pressure, all the necessary operations being done on the low-tension side. The line is carried on wooden poles 90ft. apart and 40ft. high, and crosses the St. Lawrence at the Victoria Bridge, to which it is attached by special fixtures.

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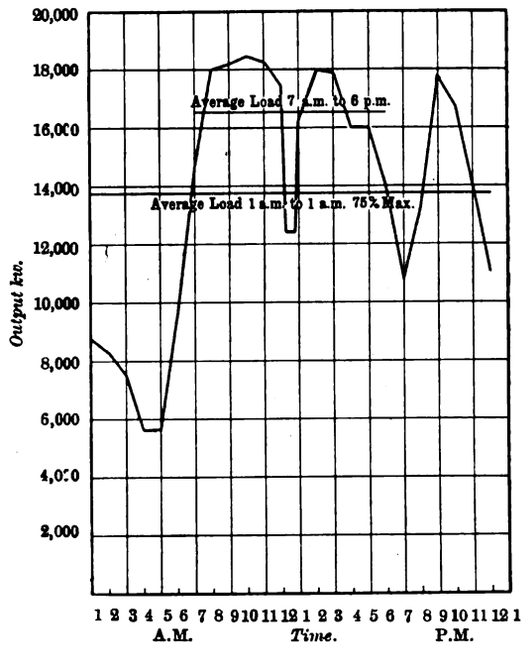
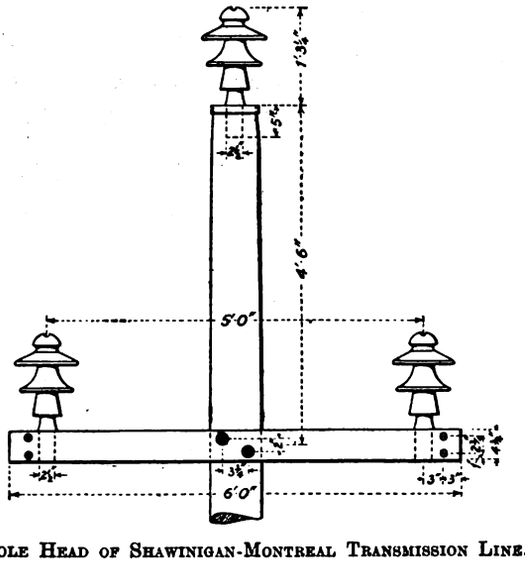
The development of power at the third station of Shawinigan, with its 85 miles of intervening space, necessitated the use of one of the highest working pressures hitherto adopted for the transmission of power—viz., 50,000 volts. Three line cables, each composed of No. 7 aluminium wires, are arranged on the poles in the form of an equilateral triangle, with 60in. distance from centre to centre of the cables, as shown in the adjoining figure. The insulators were specially designed for this high voltage,



Load Curve. Montreal Light, Heat and Power Co. (June 3, 1904.)

and consist of three separate porcelain parts held together by Portland cement. When 8,000 H.P. is being delivered in Montreal, with a power-factor of unity, the total drop in the line is about 18 per cent. The plant consists of three sets of 3,750kw. capacity, the turbines being built by Escher, Wyss & Co., of Zurich, while two of the generators were supplied by the Westinghouse Company and one by Messrs.



Pole Head of Shawinigan-Montreal Transmission Line.

Dick, Kerr & Co. Current produced at 2,200 volts passes through a special oil-insulated transformer, which raises the pressure to 50,000 volts. In this case, as at Chambly, the high-tension working circuit is never broken, but the line and transformers at each end are considered an indivisible element. The high-tension wires are led out of the building through large drain tiles set in the wall and closed by glass plates with a hole in the centre for the conductor. The lightning arrester is of the Wurts type with non-arcing metal cylinders. Of course, only a certain proportion of the power produced at Shawinigan is sold in Montreal, the surplus power being employed in various industries in the town of Shawinigan, which has rapidly increased in size on account of the cheapness of the power at its disposal.

On the whole, the time spent in Montreal was most pleasant and instructive and the English visitors were much impressed by the warm hospitality of their Canadian cousins and by the progress which they have made in the employment of electricity. Late on Thursday evening we returned to our special train en route for Niagara Falls, which were reached on Friday morning.

(To be continued.)

A MEXICAN WATER-POWER SCHEME.

A remarkable water-power scheme has been installed for the purpose of utilising the water of the River Duero, in Mexico, to the extent of about 283 cubic ft. per second. The pipe line is 3,300ft. long, with no lateral bends, and it varies in diameter from 57in. at the discharge end to 69in. at the beginning. When it was tested there was not a single leak, although no fewer than 70,000 rivets were used in its construction. The nozzles of the Pelton wheels are curved in form, making a 45deg. bend, so as to bring the axis of the jet at right angles to the water-wheel shaft. They are of the needle regulating type, having core pieces movable axially within them, by means of which the annular area of the orifice is changed. Each nozzle is equipped with a deflecting hood, operated through a system of levers by a governor, for regulating the speed of the generating unit, as is shown in Fig. 1, which represents a view taken from below. The water emerging from the nozzle tips in solid jets more than half a foot in diameter, at a velocity exceeding a mile and a-half per minute, with a pressure of 138lb. per square inch, is projected into the buckets of the water wheels. Each water wheel has 15 huge buckets, more than 2ft. in width and weighing 254lb. each, made of close-grained cold-blast charcoal iron. Solid carbon-steel is employed for the shafts, which are 12in. in diameter from the water wheels through the bearings, being enlarged to 16in. diameter in the middle portion. The bearings are 36in. in length by 12in. in diameter, of ring-oiling water-cooled type of special design. The generators are of the revolving-field engine-type 2,300-volt three-phase 60~ 200 revs. per min. machines, rated at 1,250kw. and designed for a 25 per cent. continuous overload. They have a full load commercial efficiency of 95·77 per cent., and 94·92 per cent. at three-quarter load. The total weight of the revolving element, consisting of the field, the shaft, and the two water wheels, is about 50,000lb., carried on two bearings. The units are conspicuous by reason of their compactness and simplicity. The 1,250kw. unit occupies a floor space of only about 17ft. by 25ft. Continuous current for exciting the alternators is supplied by two 120kw. 500-revolution self-contained hydro-electric units each of sufficient capacity to excite the four generators, so that one exciter is a spare.

From the switchboard the 2,300-volt current is conducted to the 1,800kw. transformers, where the potential is raised to 60,000 volts for transmission. The transformers are delta-connected on the low-potential side and Y-connected on the high-potential side, the neutral being grounded. The 101-mile 60,000-volt transmission line differs materially in design from any line heretofore constructed, notably in the use of a hard-drawn copper cable instead of the usual solid conductor, metal pins, cross-arms and towers for supporting the insulators, and unusually long spans. The conductors are 19-strand hard-drawn copper cables approximately $\frac{3}{8}$in. in diameter, equivalent in carrying capacity to a No. 1 B. & S. G. wire, weighing 1,348lb. per mile, and having a tensile strength of over 55,000lb. per square inch. Joints were made with special copper-tube connectors, 12in. long and elliptical in cross-section. The two ends to be joined were passed through

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the connector in opposite directions, and three complete twists were given by means of special wrenches. No soldering was done. The cables are placed in grooves on top of the insulators, 78in. apart, at the points of an equilateral triangle, as shown in Fig. 2. The insulators were required to stand a test potential of 120,000 volts for five minutes. They are over 12in. in height and 14in. in diameter, weigh 15lb., and are made of porcelain with a brown glaze and consist of four parts. The top and the first petticoat were glazed together in the kiln, and the other two joints were made with Portland cement. The pins, likewise secured into the completed insulator, are of cast iron, conical in shape and cored hollow. The pin which carries the top insulator has an enlarged base, threaded on the inside, and is screwed on to the end of the 3½in. extra heavy pipe, which projects from the top of the tower. The pins which carry the lower insulators have rectangular bases, which are securely clamped between the ends of the 4in. channels, which constitute the cross-arm.

The towers are special 40ft. four-post galvanised steel structures, weighing about 1,500lb., made of 3in. by 3in. by $\frac{3}{16}$in. angles, braced and stayed with smaller angles and rods. They are spaced 440ft. apart, 12 per mile, except near Guanajuato,

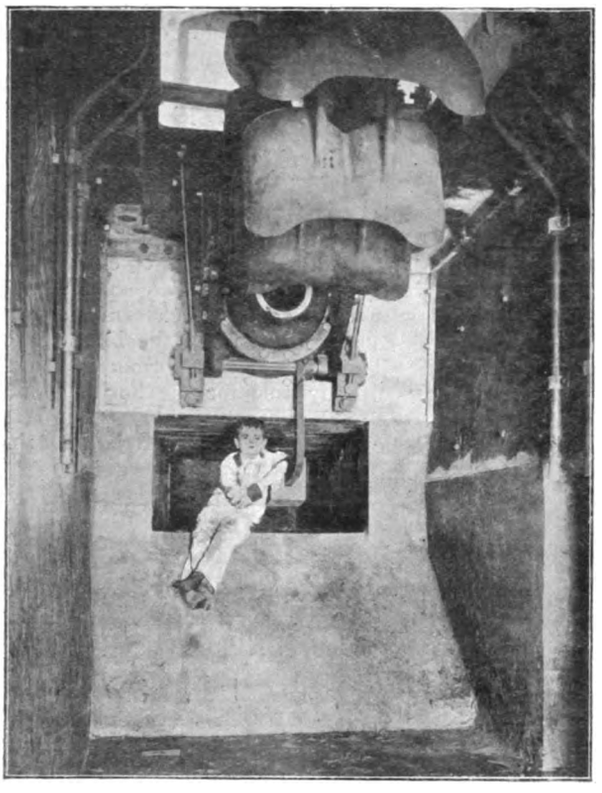

Fig. 1.—A Water Wheel from Below.

where the nature of the ground necessitated the use of a few 60ft. towers and spans up to 1,320ft. in length. The No. 9 B. B. double galvanised-iron wires for a telephone circuit are fastened on the transmission towers 10ft. below the copper power cables. The telephone wires are transposed one complete revolution every four towers; the power cables are not transposed. High-resistance instruments are used, and the telephone service is quite satisfactory. The line is divided into four sections of about 25 miles and is in charge of a superintendent whose headquarters are at the middle storehouse. At each of the three division points there is a first-class storehouse, a set of 60,000-volt disconnecting switches in the main line, a line foreman and patrolman, both mounted. In the middle of each section there is a second-class storehouse in the care of a mounted patrolman.

At Guanajuato the transmission line cables enter the sub-station through a set of 60,000-volt disconnecting switches, passes a set of lightning arresters with disconnecting switches, and goes to a bank of oil-insulated water-cooled transformers, where the line potential is reduced to 15,000 volts. These transformers are rated at 970kw. each. Their efficiencies, as determined by factory test, are as follows:—Full load, 98·193 per cent.; three-fourths load, 97·93 per cent. From the step-down transformers the cables pass through ducts under the floor to the switchboard, thence to the six 15,000-volt three-phase distributing circuits, each of which is equipped with lightning arresters and air-break switches with tube fuses.

The solid copper wires of the distributing circuits are carried on 5½in. brown porcelain insulators, supported on wooden pins in wooden cross-arms on square yellow pine poles 30ft. to 35ft. in height, 9in. by 9in. at the butt and 7in. by 7in. at the top. The iron telephone wires are carried on the same poles, but are frequently transposed. The power wires are not transposed.

At the mines and mills, where the electric power is used, the potential is reduced in three-phase transformers from 15,000 volts to 460 volts for motor service. The Guanajuato city two-phase 2,100 volt lighting system is supplied through a bank of 150kw. three-phase to two-phase transformers, with a feeder regulator in each phase.

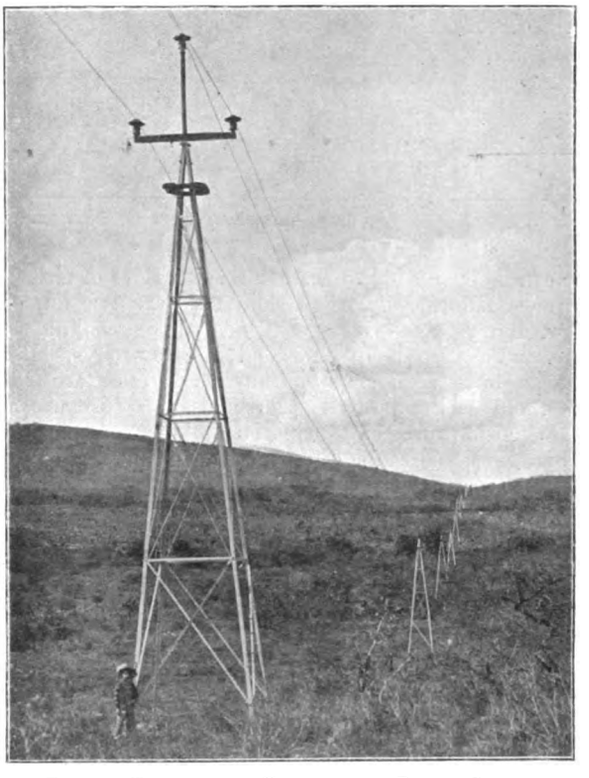

Fig. 2.—Transmission Towers with Power Cables.

A branch line extends to Irapuato, the "Strawberry Station" on the Mexican Central Railway. The Irapuato sub-station is a brick building equipped with 60,000-volt disconnecting switches and lightning arresters, and the following oil-insulated air-cooled transformers:—Four 200kw. line potential to 15,000 volts; four 75kw., 15,000 to 460 volts, for motor service; two 40kw., 15,000 to 2,200 volts, for the city lighting system. Power is supplied to various small industries throughout the city, including three grist mills, a foundry, a waggon works, a paint factory and various pumps used in irrigating the strawberry fields. The short time in which this project was executed is most remarkable. The preliminary examination was made in March and April, 1902, construction was begun in the fall of the same year, and in October, 1903, the plant was put into regular operation. This undoubtedly establishes a record in Mexico for rapid and efficient execution of construction work of a technical character and of considerable magnitude, especially in view of the fact that the work was completed within the estimates of cost.

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THE WILLESDEN POWER HOUSE OF THE NORTH METROPOLITAN ELECTRIC POWER SUPPLY CO.

(Concluded from p. 905.)

The mains from the slip-rings of the generators lead the low-tension alternating current to a "selector" board placed by the step-up transformers beneath the switchboard gallery and seen to the left in Fig. 6, published in our last issue. This board consists simply of a number of bare copper bars which can be connected together by switch fuses, so that any generator can be connected to the low-tension sides of either group of three transformers. At present there are two sets of three 100kw. Berry transformers, with no artificial cooling arrangements, and a third is to be added in a few days. Both the primaries and secondaries of the transformers are mesh-connected, and each winding is protected by a fuse at each end, the low-tension fuses only being on the selector board. From the high-tension terminals of the transformers, cables are led directly to the high-tension switchboard on the gallery, passing through a roomy cable subway which runs parallel to the gallery. These cables are insulated with vulcanised rubber and braided, and are carried on brown earthenware shackle insulators.

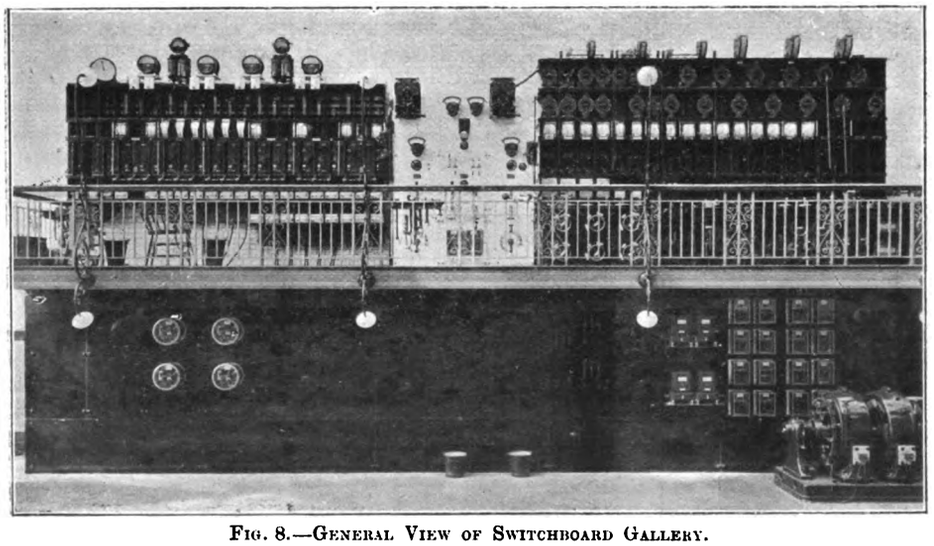

FIG. 8.—GENERAL VIEW OF SWITCHBOARD GALLERY.

The subway is 6ft. wide and 9ft. high, so that there is plenty of room to pass through The main feeders are also carried through the subway, being suspended on rounded cast-iron brackets fastened to the walls, and a tunnel extends right beneath the yard to a few feet beyond the main entrance to the works, so that it will be unnecessary to dig up the yard when laying additional feeders. The continuous-current leads from the brushes of the generators are also insulated with vulcanised rubber. They are led through ducts to the cable subway and thence are taken vertically to the low-tension panels of the switchboard.

Following out the 3,000-volt cables from the transformers, the six leads from the high-tension secondaries of each group of three transformers are taken to three panels of the switchboard where they are connected in mesh on three Ferranti panels to the three high-tension 'bus bars. This board, which is seen to the left on the gallery in Fig. 8, is of the ordinary Ferranti pattern, the only exception being that there are two fuses on each pole, both ends of each transformer winding being connected through a fuse. These fuses are of the oil-trough pattern; it is proposed to replace their porcelain covers with glass. The switches are of the oil-pot pattern, the final break (which is a shunt to the main contacts) taking place under oil. The usual synchronising contact is provided, and in addition to the ordinary synchronising arrangements an Everett-Edgcumbe rotary synchroniser is provided. The handles of each set of three switches are linked together in the usual way. The ammeter is in the main circuit on one phase only, the corresponding cell of the switchboard on the other two panels being taken up by a wattmeter and its star resistance and fuses. At present there are six panels on this part of the board, corresponding to two groups of three transformers, but there is space for considerable extension. It will be noticed that there are no regulating panels on the high-tension board. As the generators supply both the alternating and continuous current from the same armature, it is evident that voltage regulation by varying the field excitation will have the same effect on the continuous-current and alternating-current sides. Hence the regulation is done on the continuous-current board, in order that the 2 × 240 volt network supplied directly from the works shall always have a constant pressure. No regulation of the alternating current is necessary at the works, as variable ratio transformers are used in the sub-station.

To the right of these panels are three sets of high-tension feeder panels similar to those already described except as regards the instruments. There is a single ammeter as before, but this is not in the main circuit, but connected to an instrument transformer (placed below the gallery), and on the two panels corresponding to the other two phases there is a wattmeter and a "wattless wattmeter," both by Messrs. Elliott Bros. and both connected to transformers below. The diagram of connections for these instruments is given in Fig. 9, from which it is seen that the ammeter and the current circuits of the wattmeter and "wattless wattmeter" are connected in series and operate off the secondary of a current transformer, the primary of which is connected in one of the line wires of the three-phase circuit. This current transformer is made to fit into the contact jaws usually used for the Ferranti ammeter, and is mounted in one of the pockets behind the instrument. The volt circuits of the wattmeter and "wattless wattmeter"

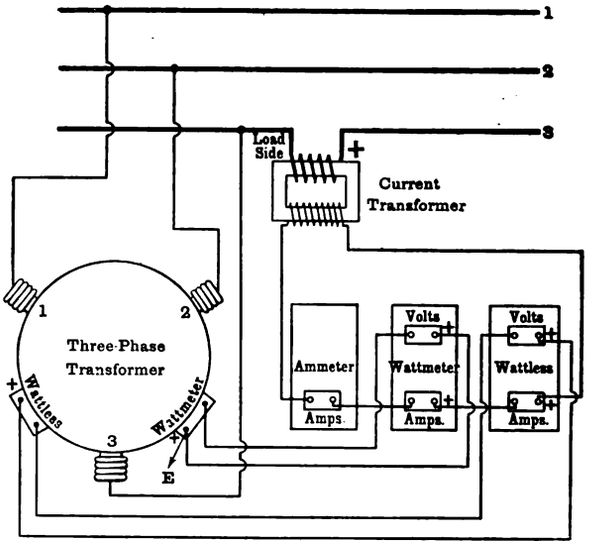

FIG. 9.—CONNECTIONS OF INSTRUMENTS ON H.T. FEEDER PANELS.

are operated off the secondaries of a three-phase potential transformer having a ratio of 30:1. This transformer is of the three-limb type with common circular yoke and is complete with fuses. Placed in the base of this transformer is the neutral point resistance of the wattmeter. The wattmeter is scaled 0–700kw., and reads the total load in the feeder, assuming that it is equal in each phase. The "wattless wattmeter" is scaled 700–0–700, and reads the total out-of-phase watts, assuming that the phases are equally loaded. The

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ratio of the readings of the two instruments gives tan ϕ, and, therefore, by reference to a curve the power-factor of the circuit. With a leading current the "wattless" instrument reads on one side of the zero, and with a lagging current on the other. This instrument is therefore used in connection with the rotary converters, the excitation of which can be altered until the reading of the instrument is zero. All the instruments are of the dynamometer type, spring controlled and magnetically damped, and are not affected by wave-form or frequency. They are interchangeable mechanically and electrically—that is to say, any of the instruments can be connected in series to form a set and put to operate off either of the current and potential transformers and will still read accurately.

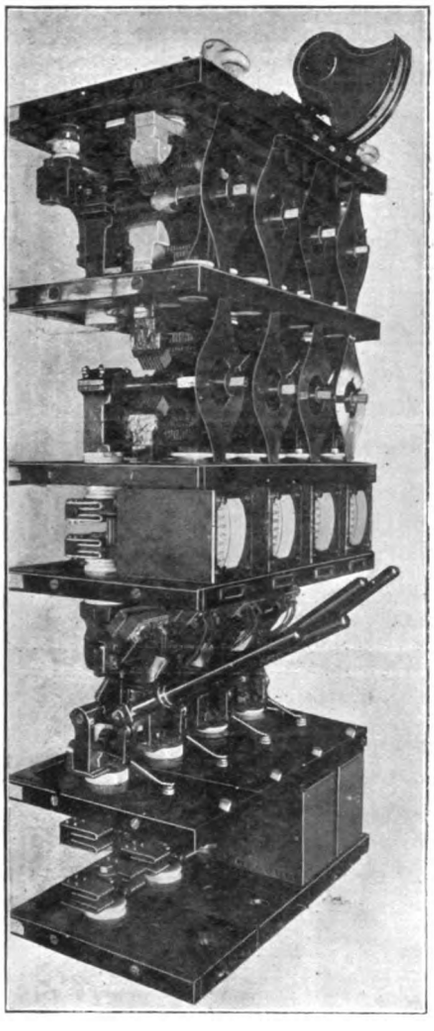

FIG. 10.—THE FOUR GENERATOR PANELS BEFORE BEING BUILT IN.

company. The "inverted rotaries" are, therefore, ordinary rotary converters, used, however, to convert continuous into alternating current instead of alternating to continuous. Two of these machines have been erected, taking continuous current at 500 volts from the continuous current 'bus bars and delivering alternating current at 50 ~ directly to step-up transformers. The extra high-tension feeders to Hendon are connected directly to the secondary terminals of these transformers, there being no switches, fuses or excess-pressure dischargers on the alternating-current side. The omission of mains dischargers, which, we understand, was at the desire of the cable makers and with the consent of the transformer makers, is surprising, as the machines are run up on the mains, a process which, as is now known, conduces to surgings of excessive pressure due to resonance effects. The rotary converters (which are of the B.T.-H. make) are each rated at 250kw., and each is provided with an independent exciter, so that the frequency does not vary with every change of the 'bus bar pressure.

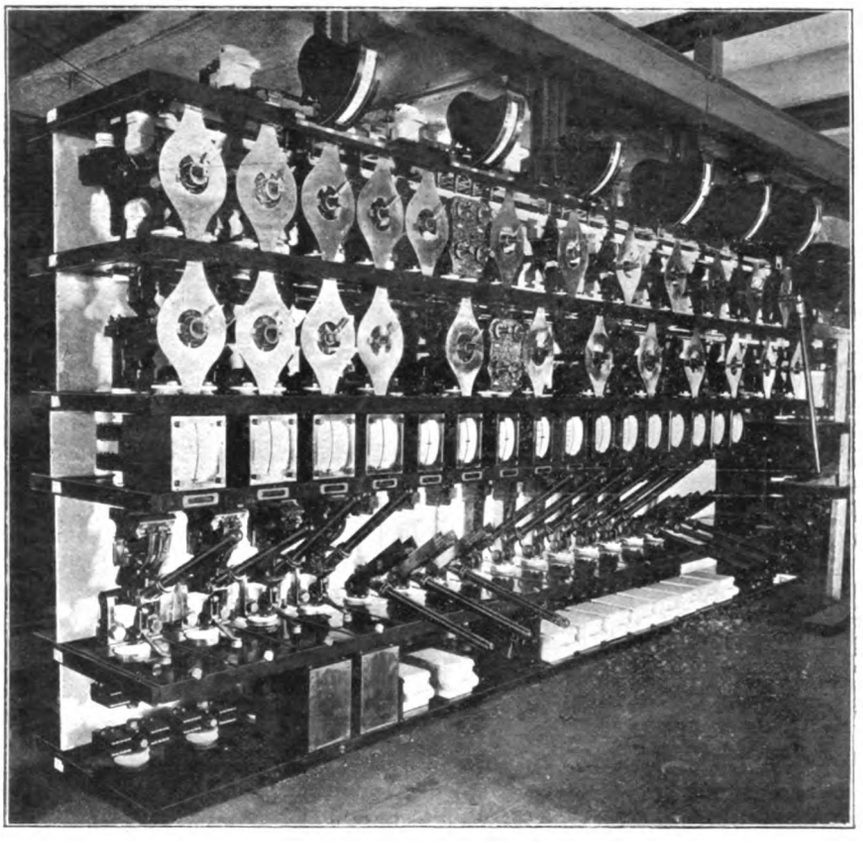

FIG. 11.—L.T. SWITCHBOARD ASSEMBLED IN SHOP.

From the 'bus bars, connection is made through two three-phase meters in series to the feeder cables in the subway. The meters are for measuring the "bulk" supply, the two in series being merely in order that the readings may be checked. They are placed on a meter board immediately below the switchboard on the floor of the engine room (see Fig. 8).

Between the high-tension board and the low-tension board there is a space which is temporarily occupied by a panel for the "inverted rotaries." It will be remembered that the Willesden station, in addition to lighting Willesden, has now to supplement the supply derived from the Brimsdown station for the North Metropolitan tramways. The tramway sub station which the Willesden station feeds is at Hendon, and an extra high-tension supply (10,000 volts) has been chosen, with a frequency of 50 ~ per second instead of 25 ~, which is the frequency at the Taylor's-lane works, the higher frequency being in order that the tramway rotary converters on the system should all be similar. The frequency of 25 ~ was adopted for Willesden long before there was any question of the works being acquired by the

Each converting set is considered as a complete unit in itself, feeding an exact duplicate set located in the Hendon sub-station. Each set feeds through a separate feeder, but at the Hendon end provision is made by means of sectionalising switches so that either rotary can be fed through either feeder, which arrangement ensures a continuation of the supply in the event of an accident occurring on any one feeder. When the scheme is completed, and additional three-phase generating sets at 50 ~ have been installed in the Willesden generating station, it will only be necessary to connect these to the existing Hendon sub-station feeders in place of the temporary inverted rotaries, which will then be released for work in some other sub-station.

Each rotary runs at a speed of 750 revs. per min., and is flat compound-wound for 550 volts. The exciters are belted to the rotaries, and operate at a low point on the saturation curve, thus making the sets sensitive to any speed variation. The exciters themselves are so designed that they may be converted into series wound track boosters at a later date. The

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stationary transformers are of the single-phase oil-cooled type, and call for no special mention. They are connected in mesh.

For starting, the shunt coils of the rotaries are first excited from the continuous-current 'bus bars in the ordinary way, and when all the starting resistance has been cut out and the rotaries are up to speed, the field resistance of the exciter is varied until the exciter voltmeter shows a voltage equal to the 'bus bar pressure. The exciter is then switched in, and the connection between the field of the rotary and the 'bus bars is broken. In order to prevent excessive speeds in the rotaries at the two ends in the case of the exciter fields being diminished, an excess speed contact-maker (actuated by centrifugal force) is placed on the shaft of the rotary and actuates a tripping coil on the circuit-breaker between the 'bus bars and the rotary armature. This circuit-breaker has also a useful "tell-tale" contact, which closes a bell circuit when the cut-out drops. As the circuit-breaker serves also as the main switch on one pole, it is necessary to provide means to switch off the bell circuit when the circuit-breaker has dropped, this has to be done by turning the contact piece which it carries, but on replacing the circuit-breaker to switch in again this contact is automatically set to its original position.

For the general arrangement, and for the design of many of the special details of the low-tension continuous-current switchboard, Mr. Ruthven-Murray was responsible. His object was to arrange a switchboard embodying the distinctive and valuable features of the Ferranti high-pressure cellular type of switch-gear for low-pressure working. The principal feature of novelty in the low-tension switchboard is that four separate 'bus bars are provided, and there are "selector switches" which enable any machine or feeder to be connected to any 'bus bar. This makes it possible to have four different feeder pressures, and the arrangements are so simple that no complication is introduced on the switchboard at all, the only effect being a slight increase in height. This is unimportant, for the selector switches are only moved occasionally and can, therefore, be placed high up. This addition to the Ferranti board was patented by Mr. Ruthven-Murray. Figs. 10 and 11 show the selector switches clearly in position; they are turned by a long handle fitting over the square end of the spindle. Fig. 12 is a drawing showing the details of the switch.

The selector switches are, of course, placed on each pole, but the main switch and edgewise ammeter are on the positive pole only. The main switches have each an excess current tripping coil, placed in the cubicle beneath the switch itself. In front of the generator panels is the field regulating switch, externally of the Ferranti desk pattern, and internally of the Westinghouse manufacture. In addition to this a field switch is provided which switches the field coils of the machines on to the brushes for self-exciting or to exciter bars in case separate exciting is subsequently found necessary. Two plug holes are provided on the field board for plugging in a voltmeter in front of the field ammeters when paralleling, a portable differential zero voltmeter with plugs being provided for the purpose.

The four-plug switches taking the place of the selector switches on the sixth and seventh panels are for connecting the four 'bus bars in parallel if desired. One is for the positive bars and the other for the negative. Three voltmeters are seen at the top of the board, each so arranged that it can be pulled by cords to any one of four positions. These voltmeters show the voltage across the outers and on each side of the network respectively, and they can be placed across any of the four sets of 'bus bars, as the rails they run on make the necessary contacts. The four panels on the extreme right are for the feeders, and they are similar to the generator panels, with selector switches on both poles and a main switch on one pole. The tripping coil is replaced by a fuse, however. One of the voltmeters above them is connected to any pair of pilot wires from the feeding points by means of an eight-point switch. There is space for a considerable number of additional feeders.

The fifth and sixth panels from the left are the panels for the positive and negative balancers, only one selector switch being needed for each of these. The ammeters on these panels are central zero instruments. These panels have fuses in place of the excess current tripping coils. Next come two battery panels similar to the balancer panels, but with the addition of a change-over switch enabling the position of the two halves of the battery on each side of the neutral bar to be changed, or else to be connected in series across the outers and disconnected from the neutral bar. Two plug holes similar to those on the exciting panel for paralleling the generators are provided, so that a voltmeter can be placed in them to parallel the batteries with the 'bus bars.

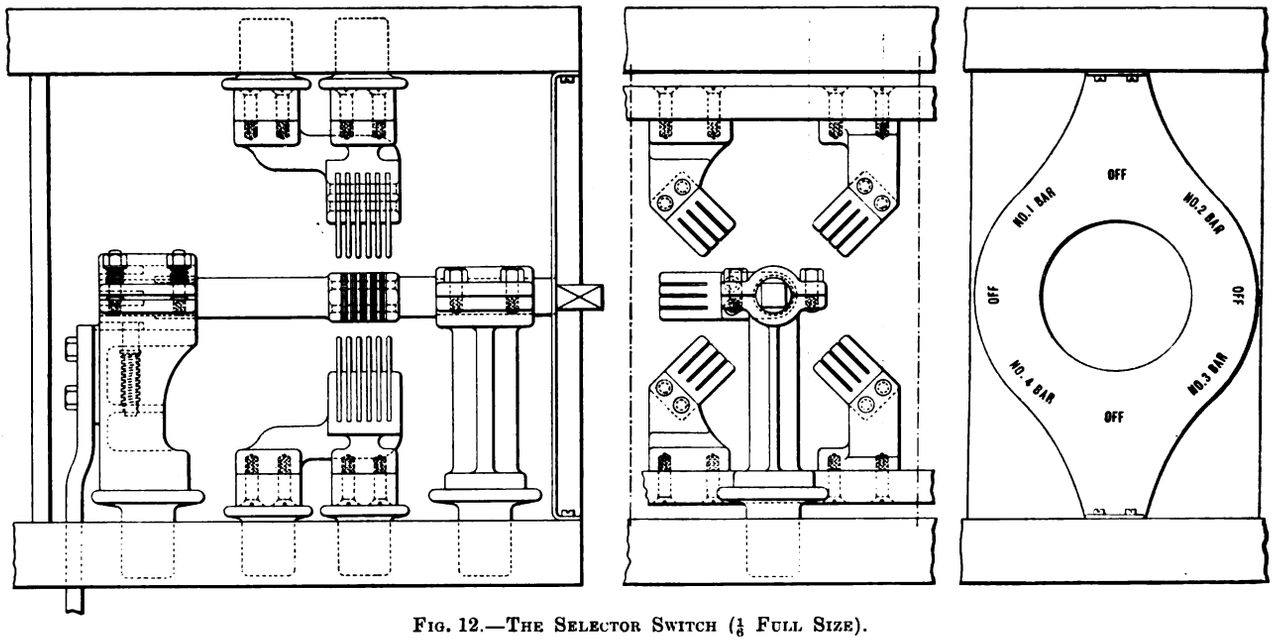

FIG. 12.—THE SELECTOR SWITCH ($\frac{1}{8}$ FULL SIZE).

The boosters and balancers are combined on the same shaft. This has three bearings, and the balancer commutators are to the inside facing the central bearing, the booster commutators being outside. Each booster can raise or lower the pressure by 167 volts, and the balancers can deal with 84 amperes of out-of-balance current. The balancer fields are cross-connected as usual, but the booster fields are also cross-connected, so that, although not "automatic" boosters, there is a certain amount of automatic pressure regulation. A switch enables the field of either of the boosters to be reversed, so that the machines can be discharged through and boost the voltage from the batteries up or down; or they may be used to boost up from one pair of 'bus bars to another, so as to supply any particular feeder at higher or lower pressure than the others. No regulating cells are provided, the regulation being effected entirely by the boosters both on charge and discharge. The

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switches for this are in front of the main board in a line with the generator field regulating board. There are two central zero voltmeters for the boosters above the board. The starting switch for the booster-balancer set is at the end of the switchboard, and independent. All the instruments on the low-tension board were supplied by Messrs. Nalder Bros. and Thompson, as sub-contractors to Messrs. Ferranti.

The battery room contains 250 Tudor cells with a capacity of 840 ampere-hours at a 10 hour discharge rate. The cells are placed in pairs on racks of the usual pattern. As has already been mentioned, there are no regulating cells, but a few extra cells are provided as spare and for "milking" purposes.

The works are well lighted with arc and incandescent lamps (the wiring being in "Simplex" tubing) and present a clean and bright appearance both by day and night. This is assisted by the white glazed bricks, with a neat brown dado in the

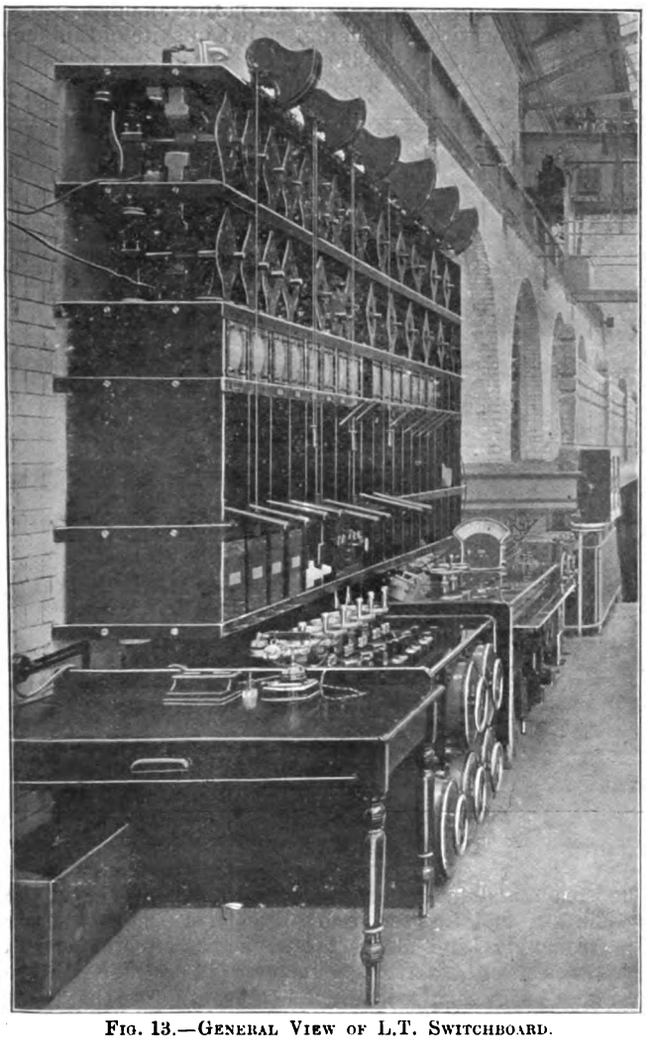

FIG. 13.—GENERAL VIEW OF L.T. SWITCHBOARD.

boiler house and a similar green dado in the engine room. The floor of the engine room is covered with dark red adamantine tiles.

A single-motor 12-ton travelling crane (by Messrs. T. Broadbent & Sons) was found very useful during erection. It was employed for the erection of all the plant, being worked by a small dynamo and oil engine put down for the purpose temporarily by the contractors. It is now supplied off the 480-volt continuous current mains, the other motors being run off the 240-volt mains. The latter can be switched over to either side of the network to aid balancing the three-wire system at light loads.

Our thanks are due to Mr. Ruthven-Murray for considerable personal assistance in the preparation of this article, and also to Mr. F. D. Napier, the station superintendent at Taylor's-lane. Our next article will deal with the Willesden sub-station, the distributing network and the public lighting.

A NEW ELECTRO-CHRONOGRAPH.

BY DAVID OWEN.*

The aim of this instrument in the first instance was to realise the suggestion that an apparatus should be devised capable of automatically recording the time of a 100yds. flat race with an accuracy well exceeding that of the stop-watch—say, to the hundredth part of a second. The stop-watch has two well-understood sources of error. First, the personal error of the operator; and, secondly, that due to the jerky movement inherent in the watch mechanism, whereby an error of a fifth of a second either way may result. It was necessary that the chronograph should be accurate and at the same time reliable.

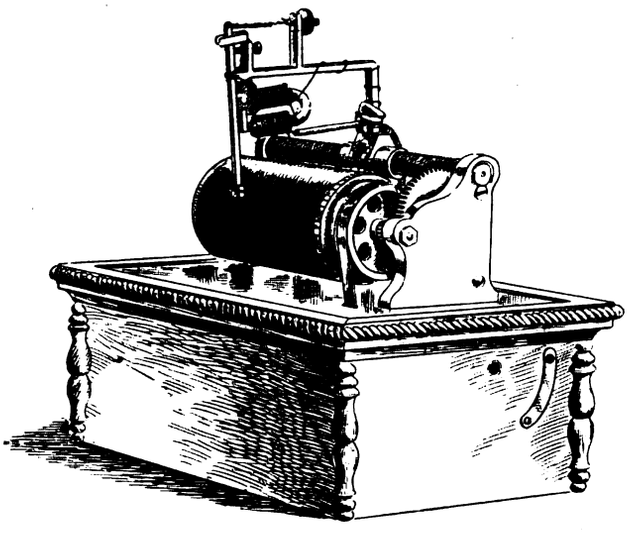

FIG. 1.—GENERAL VIEW OF CHRONOGRAPH.

In its present form it consists of a cylindrical drum made to revolve uniformly by means of a flat spiral spring. The speed of the drum can be made to vary between any desired limits—say, one to four revolutions per second. Uniformity of running is secured by use of a centrifugal governor. Supported parallel to the axis of the drum is a guide rod, consisting of a tube, within which is a leading screw driven through gear wheels from the drum. Geared to this leading screw is a traverser, which carries a brass frame on which is mounted an electromagnet. The pivoted armature of the magnet is provided with a steel needle acting as a style which, when the magnet is excited, presses on the surface of the drum, leaving it when the circuit is broken. The drum consists of an inner cylinder over which fits just tightly an outer hollow cylinder,

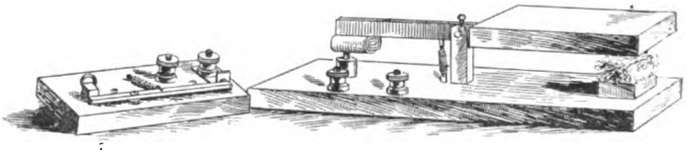

FIG. 2.—THE STOPPING AND STARTING SWITCHES.

which is, therefore, readily detachable. The outer cylinder has a smooth surface which is thinly coated with soot. It will thus be seen that when the apparatus is in motion the style if pressing on the drum, will trace a fine spiral line.

For timing a 100yds. race two switches (Fig. 2) were used. Normally each of these is closed by a spring. The first, which may be called the target switch, is opened momentarily when the starting pistol is aimed at it from a distance of 2ft., and so the circuit, which consists of electromagnet, switches, 100yds. of wire (lead and return) and battery in series, is rapidly broken. The second, or tape switch, at the finishing end of the course, grips one end of the tape or worsted, the other end of which is fixed. When a runner breasts the tape

* Lecturer in Physics at the Birmingham Technical School.

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the tape-switch is opened and again the circuit is broken. The chronograph drum has been running uniformly the whole time, and on the smoked surface a spiral trace, therefore, appears which is broken at two places. The interval between the *beginnings* of these breaks measures the time of the race. For facilitating the measurement, the drum is adjusted to revolve once in a second, or once in a half or quarter second. The perimeter of the drum is divided into 100, or some sub-multiple of 100, equal parts, so that each division means the hundredth part of a second. The size of these divisions is of the order of $\frac{1}{2}$cm. This scale is wound round one end of the drum. The marks on the drum can readily and with accuracy be referred to this scale by setting the style exactly on to a mark, the traverser on which it is mounted being put out of gear with the leading screw. The traverser may then be moved along the guide rod until the style reaches the scale. Further, the scale being rotatable, one of the marks can be set at zero.

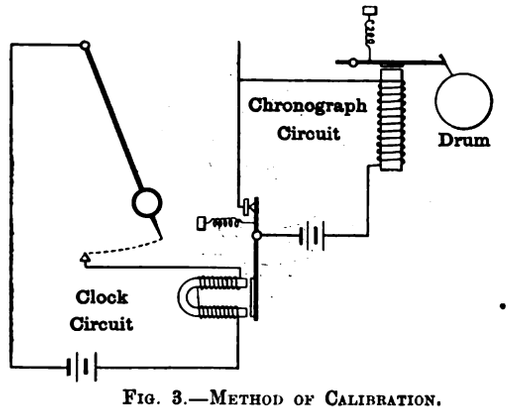


FIG. 3.—METHOD OF CALIBRATION.

The reading of the second mark then gives direct in hundredths of seconds the fractional part of a second in the whole time interval under measurement.

The two important points to secure are: Firstly, uniformity of running of the drum; secondly, a means of accurately determining the time of one revolution. To obtain the latter, the electromagnet was put in connection with a clock pendulum and a sounder, as shown in Fig. 3. The chronograph style pressed on the revolving drum precisely as in an actual time measurement. Breaks appeared in the spiral trace every second. The time of revolution of the drum could then be quickly adjusted to be exactly one second, or half, or quarter second. If the adjustment was not quite correct, the trace on the drum, when developed, would appear as in Fig. 4, *provided*, further, that the drum was revolving uniformly. The style leaves at the left hand side of the breaks in Fig. 4, and comes on with the closing of the switch after a few oscillations, as shown by the dots. The points *a*, where the style *leaves*, are those used in the measurements. This method of timing, at the same time, affords a very accurate test of uniformity of running. The results show that such uniformity is amply secured. The error occurring from non-uniformity of running is below one five-hundredth part of a second in the whole interval measured.

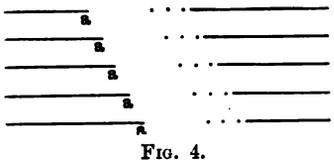


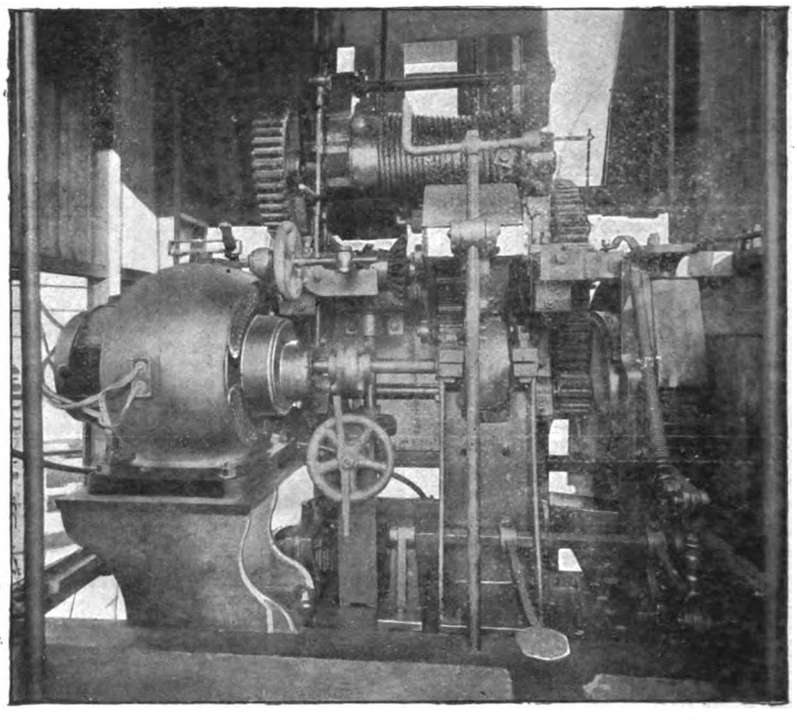
FIG. 4.

The instrument was used in the measurement of three races at the Birmingham Athletic Sports of July last, in each case with complete success. The time of the final in the 100yds. Open event was recorded as 10·05 seconds. (The stop-watches agreed to call it 10 seconds.)

This chronograph is well adapted for measurement of the time of fall of a body, and so to determination of the law connecting velocity and time when a body falls through any given medium. It is hoped by the author shortly to apply it to this purpose.

THE USE OF ELECTRICITY IN THE ERECTION OF THE NEW HOME OFFICE.

At the new Home Office buildings there are three electrically-driven and one steam-driven mortar pans. The motors for these are situated in small sheds, into which are also brought services from the Westminster Electric Supply Co.'s mains. There are four of these services altogether, each provided with the usual fuses, switches, meters, &c. A counter-shaft is driven from each motor shaft by means of a belt and another belt drives the mortar pan from the counter-shaft. The motors themselves work at 400 volts continuous current, are shunt wound, and were manufactured and supplied by Electromotors Limited, of Openshaw, Manchester. Messrs. Spencer, Santo & Co., the contractors for the building, express great satisfaction at their performance, and remark particularly upon the immunity from breakdown which they have enjoyed. As a rule, the vicinity of a mortar pan is by no means an ideal atmosphere for a motor with a commutator, but in spite of this fact very little trouble indeed has been experienced from dust.



13 B.H.P. MOTOR, COUPLED THROUGH FRICTION GEAR TO 4-TON DERRICK CRANE.

One steam and four electric cranes are employed on the new building, and these also are fitted with motors made by Electromotors Limited. All these motors are identical in every respect, with the sole exception that those on the cranes are compound wound, and the result is that only one spare armature is kept, this armature being interchangeable with any of the motors. The total height from the ground to the top of the highest jib is 140ft., and one of the 13 H.P. motors raises a load of 2 to 3 tons, single purchase, through this distance in very little over a minute. The cranes were manufactured by Messrs. Rushworth Bros. Up to the legs of the cranes the 7/16 conductors are carried in screwed iron barrel, but after this point lead-covered cables are used. For carrying energy into the crane itself a cable, surrounded by an armoured flexible tube, is employed, and this enters through the centre of the crane hut, so as to allow of slewing. The construction of the cranes is similar to the older forms of jib cranes which were driven by steam The modification consists of substituting hard cast-iron friction wheels for transmitting the power instead of the spur and bevel gearing. On the motor shaft a friction wheel is mounted running free from the crane gearing, and two friction wheels mounted on a rocking bracket transmit the power. One drives the crane gearing in a certain direction,

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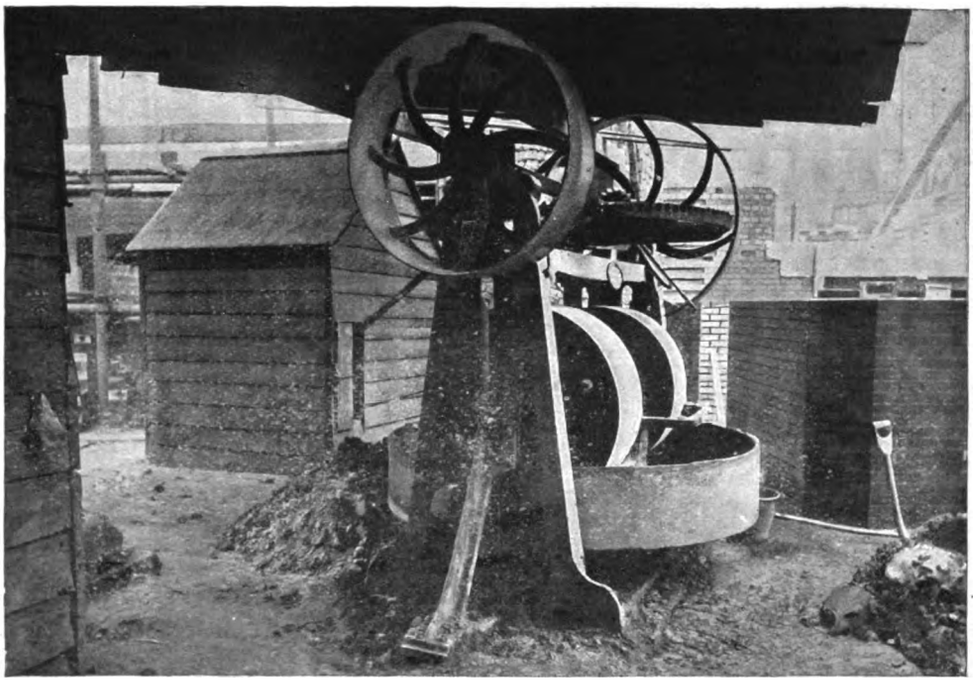
and the other in the reverse direction. These friction wheels on the bracket are brought into contact with the driver by the operation of a vertical spindle, which is directly under the control of the crane man, and is threaded through the loose end of the rocking bracket. By giving the spindle a couple of turns the rocking bracket is moved, bringing, say, the lifting friction wheel in operation, or by revolving the spindle in the opposite direction the lowering friction wheel is brought into contact.

constant speed. The jib can be slewed round through an arc of 270deg., giving a very wide range of operations. Cumulative compound-wound 13 H.P. motors at 400 volts and 750 revs. per min. are employed. These cranes are constantly working at 100 per cent. above their rated loads—*i.e.*, with 50 cwt. in the fast gear—with splendid results. Owing to the cranemen not having to attend to any valves or levers, other than those operating the crane gears, he is able to work much faster and with greater ease and safety. When placed on



ELECTRICALLY-DRIVEN MORTAR PAN.

The length of the jibs varies from 50ft. to 75ft., and the rated loads are: 4 tons with the slow gear, lifting at 20ft. per minute, and 25 cwt. with the single gear, lifting at 120ft. per minute. There is no variation of speed with load, as the motor works without any controlling gear and maintains a

scaffolds, the shear legs of the crane are secured by heavy chains run to the ground and weighted.

Electromotors Limited inform us that a very large number of their motors are now employed in similar building operations throughout the country.

ELECTRIC TRAMWAY IN MANDALAY.

A few weeks ago we published an announcement relating to the opening of an electric tramway system in Mandalay by the Lieutenant-Governor of Burma, Sir Hugh Barnes, K.C.S.I., K.C.V.O. Now that the system has been in successful operation for the last two months, and in view of the fact that Mandalay is the first city in Burma to adopt electric traction in place of horses, a description of the enterprise is of interest.

The Mandalay Electric Co. was floated in London in October, 1902, with a capital of £200,000. Actual work was commenced in December of the same year by the contractors, Messrs. Dick, Kerr & Co. (Ltd.), and within the short space of a year and a half the first car was propelled by electrical power on June 17, 1904. The centre of the tramway system has been wisely placed at the new Zegyo Bazaar, on which the municipality is spending a large sum of money; this promises to be, when finished, the largest bazaar of its kind in the East, and will become a centre of attraction to the Burmese from all parts of the city. From the Zegyo Bazaar the tramway radiates in three branches. One leads to the shore, where the Irawaddy Flotilla Co.'s steamers embark their passengers, and so will cater for the travelling public. The second runs to the Arakan Pagoda, and will serve the suburbs which cluster round that famous shrine. The third leads to the Court House, where the daily legal business of the city and district is transacted, and to which a certain number of citizens always desire to resort.

The tramways have a route length of 7 miles, double track throughout, the rails being in accordance with standard tramway practice, 6in. deep, with a 1¼in. groove, laid to a gauge of 3ft. 6in., in 45ft. lengths, with a proportion of shorter lengths to allow for piecing in and closures. Double spikes hold the rails to hard wood sleepers, which are laid at 2ft. 9in. centres, the whole resting on a ballasted bed, the road surface being made up with macadam in the ordinary way. Joints are of the plain type, secured with six-holed fishplates and double-bonded with two 4/0 B. & S. Neptune pin bonds, the usual cross and intertrack bonds being provided.

The overhead equipment is on the span-wire system, a double line of trolley wire being used throughout. Standards are made up of solid-drawn weldless steel tubes, and have an overall length of 28ft.; they are set 6ft. deep below the upper surface of the rails, the excavation being entirely filled with concrete. The trolley wires consist of hard-drawn copper 0·364in. diameter, with a breaking strain of 23 tons per square inch. Section insulators are provided so that each half-mile of trolley can be controlled separately if required, and lightning arresters of the Garton Daniel type have been provided at every half-mile.

The feeder system, which is a somewhat elaborate one for an Eastern tramway, consists of solid soft-drawn copper wire, carried on special high-resistance toggle clamp insulators, which are in turn bolted to substantial malleable iron brackets attached to the poles. At several points along the route of the tramways these feeders are tapped by insulated cables, which are connected to the main feeder switches in switch pillars fixed on the side walk in a manner similar to that used with underground feeders. The rolling stock consists of 24 electric motor cars of the single deck open cross-bench type; they have all the very latest improvements, and were built for Dick, Kerr & Co. by the Electric Railway & Tramway Carriage Works (Ltd.), Preston. Special care has been taken in designing the cars to ensure the interchangeability of all the important parts entering into the construction of the rolling stock. The car bodies are 35ft. 4½in. in length, about 6ft. wide and are designed to provide seating accommodation for 48 passengers. The floor frames are built of well-seasoned teak in combination with steel sections of such members and sizes as to ensure maximum strength and minimum weight. Openings are arranged in the frame over the motors to afford convenient access to the armature brushes and to all bearings requiring frequent inspection and oiling. The platform floor frames are formed of teak timbers extending under the main floor frame as far as possible without interfering with the clearance of the trucks, and

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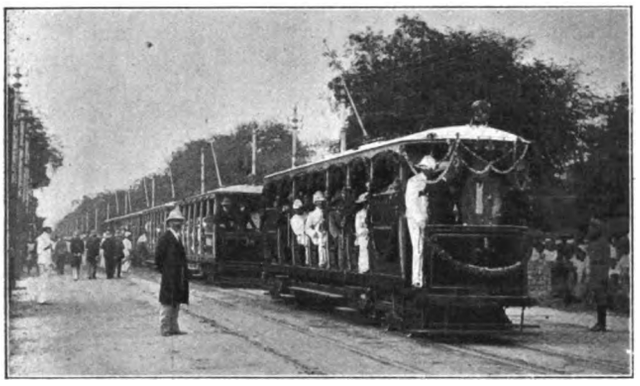
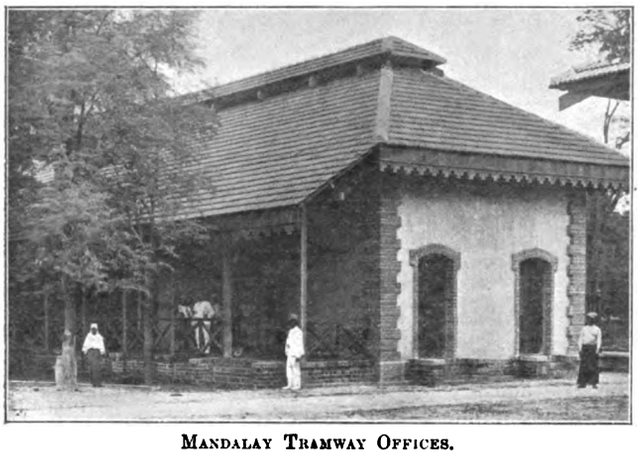
project out from each end sill 3ft. to provide room for the brake shaft and controllers. Teak end bars are secured to the outside ends of these timbers, forming sills to which the platform dashes and the



OPENING CEREMONY. DEPARTURE OF LIEUT.-GOVERNOR.

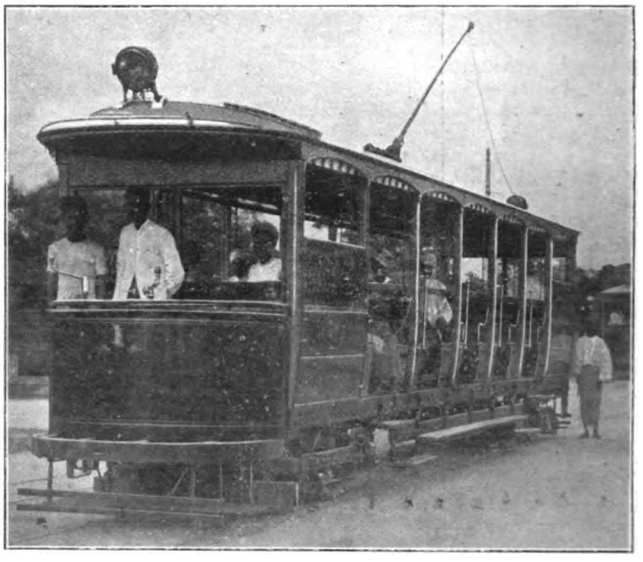
entrance steps are secured. The main floor is laid with $\frac{7}{8}$in. matched teak boards and secured at all bearing with barbed wire nails. To prevent the car from sagging, a substantial truss is provided, sup-



MANDALAY TRAMWAY OFFICES.

ported in the centre by two wrought-iron standards. The roof frames are composed entirely of teak, the covering being of cotton duck laid wet in a coat of white lead paint. Storm curtains sliding in grooves between the posts are provided for each side entrance of the cars. The dashes are made up of No. 16 B.W.G. steel plates furnished with substantial iron rails and wrought-iron posts. The collision buffers consist of 3ft. by 5in. steel angles, and are secured to the ends of the platform to protect them from injury in case of accidents; they are slotted, and pins are provided to enable cars to be hauled in case of emergency. Each car is provided with two circuits of 100-volt incandescent lamps, with change-over switches for putting one or the other headlight in circuit.

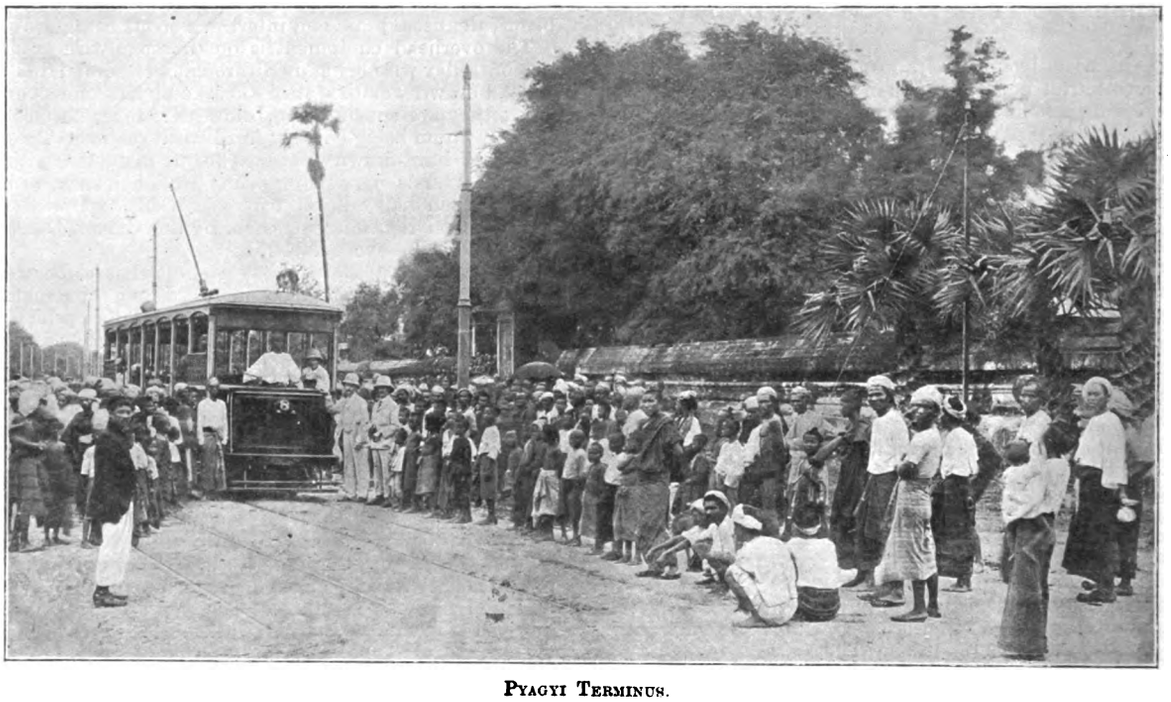
The trucks upon which the cars are mounted are of the Brush Company's single type, suitably built to support the car bodies and to receive the motors and gearing. Each car is fitted with a complete electrical equipment, consisting of two Dick-Kerr standard 25 B traction motors, each capable of delivering approximately



VIEW OF ELECTRIC CAR.

28 H.P., the temperature of the various parts not exceeding 75° C. after running at full load for one hour. The controllers are of the same firm's standard D.B.I. form "C" type, specially arranged with resistances for emergency braking, operated by the driving handle, which may be utilised either when the car is proceeding forwards or backwards. On the company's site in Seventy-eighth-street a power house has been erected, together with the necessary offices, car shed and repair shops. The steam plant consists of three B. & W. water-tube boilers, working at a pressure of 160lb. per square inch, each boiler being provided with a superheater fitted with all the usual accessories. There is also a water storage tank with a capacity of 20,000 gallons of water, a fuel economiser and two double-acting single-cylinder feed pumps, each capable of delivering 2,000 gallons of water per hour.

The engines, of which there are three, are of the Belliss com-



PYAGYI TERMINUS.

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pound two-crank type, mounted on bedplates extended to take the directly-coupled generators; each engine is fitted with a heavy fly-wheel and steam separator and is capable of delivering a normal output of 300 B.H.P, when running at 400 revs. per min. non-condensing and at a steam pressure of 155lb. per square inch at the stop valve. Coupled to each engine is a continuous-current compound-wound generator, having an output of 200kw. at 500 to 550 volts when running at 400 revs. per min., and designed to give an overload of 20 per cent. for 2½ hours with a moderate rise of temperature. The generators are in every respect in accordance with the standard practice of Messrs. Dick, Kerr & Co., the magnet frames being of cast-iron and the pole pieces of laminated steel, cast into the magnet frame. Commutation is said to be sparkless at all loads and the field windings are so arranged to give a 10 per cent. rise in the E.M.F. from no load to full load.

The switchboard was built by Messrs. Dick, Kerr & Co., and consists of nine black enamelled slate panels 1½in. thick, each supported independently on an iron frame. There are three generator panels, four feeder panels, one station lighting and one B,O.T. panel. Each generator panel is provided with two single-pole switches, one equalising switch to connect the shunt of the compound-wound dynamo on to the equalising 'bus bar, one shunt-field rheostat to enable the E.M.F. of the generator to be raised and lowered 50 volts, one field switch with resistance and pilot lamp, one main ammeter and an automatic circuit-breaker with magnetic blow-out. Each feeder panel is provided with one main single-pole switch, one automatic circuit-breaker and one ammeter. On the testing panel are all the necessary instruments and switches for recording or measuring leakage; also a recording voltmeter for recording the difference in potential between the terminus ends of the rails and the negative 'bus bar. The station circuit panel is mounted with all the necessary switches and fuses, together with the ammeters required for station lighting and motor circuits.

One of Messrs. Higginbottom & Mannock's 10-ton engine room travelling cranes for a span of 38½ft. with a lift of 20ft. has been installed in the power house, the lifting, longitudinal and transverse motions being worked by chains from the engine room floor.

Messrs. Dick, Kerr & Co. were represented in Mandalay by Mr. T. Williamson, the sub-contractors being Messrs. Nahapiet & Martin, of Rangoon. Messrs. Kincaid, Waller, Manville & Dawson acted as consulting engineers and prepared the detailed plans and specifications. They were represented in Mandalay by Mr. E. Sellon. The local work was carried out under the able superintendence of Mr. Griffin and Mr. A. C. Morgan.

STANDARD FORM OF MUNICIPAL TRAMWAY ACCOUNTS.

The following suggested standard form of tramway accounts, prepared by a joint committee of the Institute of Municipal Treasurers and Accountants (Incorporated) and the Municipal Tramways Association of Great Britain, has received the approval of the Institute of Municipal Treasurers and Accountants, and was adopted *nem. con.* by the Municipal Tramways Association on Tuesday :—

Dr. REVENUE ACCOUNT for Year from ..... to ..... *Cr.*

EXPENDITURE.	Average per car-mile.	£ s. d.	£ s. d.	INCOME.	Average per car-mile.	£ s. d.
To traffic expenses :—	d.				d.	
1. Superintendence				By traffic revenue...		
2. Wages of motormen and conductors ...				By sundry revenue :—		
3. Wages of other traffic employés				Advertising on cars		
4. Cleaning and oiling cars						
5. Cleaning, salting, and sanding track ...						
6. Fuel, light, and water for depots						
7. Ticket check, including wages of inspectors and clerks						
8. Uniforms and badges						
9. Miscellaneous						
To general expenses :—						
10. Salaries of general officers and staff ...						
11. Store expenses						
12. Rents						
13. Rates and taxes						
14. Printing and stationery						
15. Fuel, light, and water for offices						
16. Law charges						
17. Accident insurances and compensations						
18. Fire and other insurances.....						
19. Miscellaneous						
To general repairs and maintenance :—						
20. Permanent way						
21. Electrical equipment of line.....						
22. Buildings and fixtures						
23. Workshop tools and sundry plant						
24. Cars						
25. Other rolling stock						
26. Miscellaneous equipment						
To power expenses :—						
27. Cost of current at .....d. per B.T.U....						
Total amount of working expenses						
Balance carried to Net Revenue Account.....						
* An abstract of the total expenses should be shown in the form provided for Abstract of Power Expenses on p. 949.						

Dr. NET REVENUE ACCOUNT, for Year from ..... to ..... *Cr.*

	Average per car-mile.	£ s. d.		Average per car-mile.	£ s. d.
	d.			d.	
To interest on capital (including tax).....			By balance from revenue account		
To income tax on profits			By bank interest (less interest charged)		
To bank interest (less interest received).....					
To rent of leased lines					
To balance carried to appropriation account					

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Dr. APPROPRIATION ACCOUNT, for Year from ..... to ..... *Cr.*

	Average per car-mile.	£ s. d.	£ s. d.		Average per car-mile.	£ s. d.
	d.				d.	
To amounts appropriated for :—				By net revenue for the year brought down.....		
Repayment of mortgage loans.....						
Contributions to sinking fund.....						
Reserve or renewals fund.....						
.....						
To amounts otherwise appropriated, viz. :—						
Transferred to.....fund in aid of rates ...						
.....						

Dr. RESERVE OR RENEWALS FUND ACCOUNT, for Year from ..... to ..... *Cr.*

	£ s. d.	£ s. d		£ s. d.
To appropriation for renewal of :—			By balance brought forward	
.....			By dividends on investments	
.....			By appropriation account :—	
To balance carried to balance-sheet.....			Amount set aside for renewals	

Dr. SINKING FUND ACCOUNT, for Year from ..... to ..... *Cr.*

	£ s. d.		£ s. d.
To balance carried to balance-sheet		By balance brought forward	
		By dividends on investments.....	
		By appropriation account :—	
		Contributions during the year	

Dr. CAPITAL ACCOUNT, Year ended ..... *Cr.*

EXPENDITURE.	To March 31, 190...	April 1, 190...to Mar. 31, 190...	Total.	INCOME.	To March 31, 190...	April 1, 190...to Mar. 31, 190...	Total.
To permanent way				By loans raised (*less* loans redeemed), viz. :—			
To electrical equipment of line				.....			
To land				.....			
To buildings and fixtures				.....			
*To power stations and sub-stations plant ...				By loans redeemed			
To workshop tools and sundry plant				By revenue contribution to capital outlay ...			
To cars (including electrical equipment of cars)..							
To other rolling stock							
To miscellaneous equipment							
To office furniture							
To Parliamentary expenses							
To preliminary expenses							
* This item applies only to systems having a separate tramway power station.							

BALANCE SHEET, as at .....

LIABILITIES.	£ s. d.	£ s. d.	PROPERTY, ASSETS AND OUTLAY.	Expenditure. To..... 190—	Expenditure. During year.	Total.
				£ s. d.	£ s. d.	£ s. d.
Loans :—			Cost of existing works, &c. :—			
Stock			Permanent way			
Mortgages			Electrical equipment of line			
			Land			
Redemption of debt :—			Buildings and fixtures			
Amount of mortgage loans repaid			*Power station and sub-stations plant			
Sinking fund.....			Workshop tools and sundry plant.....			
Reserve or renewals fund			Cars (including electrical equipment of cars)			
Sundry creditors			Other rolling stock			
			Miscellaneous equipment			
			Office furniture			
			Parliamentary expenses			
			Preliminary expenses			
			Investments :—			
			.....			
			.....			
			Stores :—			
			.....			
			.....			
			Sundry debtors.....			
			Unexpired licences ..... , ...			
			Cash			
			*This item applies only to systems having a separate tramway power station.			

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ABSTRACT OF POWER EXPENSES.

EXPENSES.	Average per kw.-hour	Average per car-mile.	£ s. d.
27. Salaries and wages			
28. Fuel			
29. Water			
30. Oil and waste			
31. Miscellaneous supplies			
32. Repairs to steam plant			
33. Repairs to electrical plant			
34. Repairs to ducts, feeder cables, &c.			
35. Repairs to power and sub-station buildings			
Proportion of rents, rates and taxes			
Proportion of insurance premiums			
Proportion of general management			
Amount laid aside to meet depreciation and renewal			
Interest on capital, £.....at £..... per cent.			
Sinking fund			

STATISTICAL INFORMATION.

Total borrowing powers ..... £
Borrowing powers exercised ..... £
Unexhausted borrowing powers ..... £
Gross capital expenditure ..... £
Mileage of track :—

	SINGLE.		DOUBLE.		TOTAL.		
	Miles.	Fur. Yds.	Miles.	Fur. Yds.	Miles.	Fur.	Yds.
Owned							
Leased							
Totals							

Population served by tramways .....
Traffic revenue ..... £
Total revenue ..... £
Working expenses ..... £
Interest on capital ..... £
Sinking fund ..... £
Net balance ..... £
Disposal of net balance,

Car-miles .....
Passengers carried .....
Total number of units used .....
Number of units used per car-mile .....
Average number of cars in use for hour day .....
Percentage of working expenses to receipts .....
Average traffic revenue per car-mile .....
Average traffic revenue per mile of single track .....
Average total revenue per car-mile .....
Average car-miles per day per car .....
Average speed per hour .....
Average car-hours per day .....
Average working expenses per car-mile, excluding power cost...
Average working expenses per car-mile, including total power cost, as detailed on p. 950 .....

Scale of fares :—

	½d.	1d.	1½d.	2d.	2½d.	3d.	3½d.	Average fare charged per mile.
Average distance (miles)								

Average fare paid per passenger .....
Average number of passengers per car-mile .....
Average journeys per head of population per annum .....
Number of cars in stock .....
Total amount of sinking fund ..... £
Amount of sinking fund applied in reduction of debt ..... £
Amount of reserve or renewals fund ..... £

REVENUE ACCOUNT.

CLASSIFICATION OF WORKING EXPENSE ACCOUNTS.

Traffic Expenses.

ACCOUNT No. 1. *Superintendence.*—Charge to this account salary of traffic superintendent and assistants.

2. *Wages of Motormen and Conductors.*—Wages of motormen and conductors engaged in operation of cars.

3. *Wages of other Traffic Employés.*—Wages of depot clerks, traffic regulators, trolley turners, points boys, &c.

4. *Cleaning and Oiling Cars.*—Wages paid to car cleaners and oilers, and cost of all cleaning material, brooms, brushes, buckets, chamois skins, dusters, mops, polish, soap, sponges, waste, disinfectants, water, oil, grease, &c.

5. *Cleaning, Salting and Sanding Track.*—Wages of men employed in cleaning, salting and sanding track, cost of tools for cleaning track, salt and sand.

6. *Fuel, Power, Light and Water for Depots.*—Cost of fuel for depot offices, cost of lighting depots and water, other than water for cleaning cars.

7. *Ticket Check.*—Cost of tickets, conductors' punches, wages of ticket inspectors, clerks in punch and ticket office, and deduct the receipts from advertisements on back of tickets.

8. *Uniforms and Badges.*—Cost of uniforms and badges supplied to traffic staff.

9. *Miscellaneous.*—Cost of Inland Revenue and police licences for cars.

General Expenses.

ACCOUNT No. 10. *Salaries of General Officers and Staff.*—Charge to this account salaries of general manager, accountant, auditors and all officers and clerks not engaged exclusively in any one department.

11. *Store Expenses.*—All salaries and expenses in connection with store room, including wages of vanmen conveying supplies from general store to depots and collecting scrap.

12. *Rents.*—Rental of head offices, sub-offices and wayleaves.

13. *Rates and Taxes.*—All local rates and taxes, including municipal rates, police rates, poor and school rates, &c., on the annual value of the tramways undertaking.

14. *Printing and Stationery.*—All expenditure for printing and stationery supplies. The cost of tickets should be charged to Account No. 7.

15. *Fuel, Light and Water for Offices.*—Cost of coal and other fuel for head office and sub-offices, also cost of electric light, gas and water for same.

16. *Law Charges.*—All legal expenses except those incurred in connection with damage claims.

17. *Accident Insurances and Compensations.*—Annual premium on third party and employers' liability policies, or if claims are settled by the department the amount of claims paid and the legal expenses connected therewith.

18. *Fire and other Insurances.*—Annual fire, boiler and other insurance premiums.

19. *Miscellaneous.*—Any other sundry expenses not included in any of the foregoing accounts, including repairs to office furniture.

General Repairs and Maintenance.

ACCOUNT No. 20. *Permanent Way.*—Charge to this account all expenditure for repair and maintenance of track and roadway, of tracks in yards, depots and other buildings, including wages, material, tools, fuel, light, water, freight, cartage and other expenses in connection with this work. The cost of preparing rails for repair of bonding and of removing and re-laying paving, &c., for repair of electrical equipment of line should be charged to Account No. 21. The expenses of the permanent way yard, including wages of yardmen, would be distributed over the accounts benefited.

21. *Electrical Equipment of Line.*—All expenditure for repair of overhead, conduit, or surface contact electric line, including wages, material and tools employed or used in taking up, re-setting and re-painting poles, taking down trolley, feed, guard and supplementary wires and substituting new, repairing rail bonding, removing and re-laying paving for repairs of the electric line, repairs to ducts and cables, section boxes, &c. The cost of repairs of electric line in yards and depots should be charged to this account.

22. *Buildings and Fixtures.*—All expenditure for repair of buildings and fixtures used in connection with the operation of the tramways, including wages, material, tools, freight, cartage of materials and all other expenses connected with this work. The term "Buildings and Fixtures" includes workshops, office buildings, waiting rooms, car sheds, stables, stores, &c., and all fixtures, including gas pipes, water pipes, drains, heating apparatus, lighting fittings. The cost of repair of power station and sub-station buildings should be charged to Account No. 35. The cost of repair of tracks in yards, car sheds and other buildings should be charged to Account No. 20. The cost of repairs of electric lines in yards, car sheds and other buildings should be charged to Account No. 21.

23. *Workshop Tools and Sundry Plant.*—Charge to this account all expenditure for repair of workshop tools, machinery and appliances, such as engines, boilers, shafting, motors, &c. Hand tools of tradesmen should be charged to the account benefited by their use.

24. *Cars (including Electrical Equipment of Cars).*—Charge to this account all expenditure for repair of cars, and electrical equipment of same, including wages, material, tools, freight, cartage of material and all other expenses connected with this work. The term "cars" includes car bodies, trucks, motors and controllers, and all fixtures or appliances inside of or attached to these parts. The cost of incandescent lamps, bell cord, trolley rope, commutator brushes, tools for motormen, &c., should be charged to this account.

25. *Other Rolling Stock.*—Chare to this account all expenditure for repair of sundry vehicles, including water cars or carts, sand and salt cars or carts, store carts, snow ploughs, sweepers, lorries, vans, broughams, &c., including wages, material, tools, freight, cartage of material and all other expenses connected with this work. All vehicles used exclusively for work included under any of the foregoing accounts should be charged directly to the accounts benefited.

* These items only apply to systems having a separate tramway power station.

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26. *Miscellaneous Equipment.*—Charge to this account all expenditure for repair of harness and cost of replacing horses, not otherwise directly charged.

Power Expenses.

ACCOUNT No. 27.—Charge to this account cost of power at a price per unit, or

*27. *Salaries and Wages.*—Charge to this account proportion of chief engineer's salary, and all wages in the power station and sub-stations, except wages of men engaged in repairing plant. This account should include wages to the following employés:—Superintendent of station, engineers, greasers, feed-pump attendants, stokers, coal and ash attendants, electrical engineers, switchboard attendants, motor attendants, basement attendants, cranemen, cleaners, boiler fitters, clerks and storemen, watchmen, sub-station attendants, sub-station improvers, sub-station cleaners.

*28. *Fuel.*—All expenditure for coal or other fuel used at the power station, including freight, cartage and removal of ashes.

*29. *Water.*—Cost of water for boilers and condensers.

*30. *Oil and Waste.*—All expenditure for lubrication of power plant and sub-station plant, including oil, grease, waste, rags, &c.

*31. *Miscellaneous Supplies.*—All sundry expenditure in the operation of the power station and sub-stations not detailed under the foregoing accounts. Material used in repairs should not be charged to this account. The following is a list of some of the items chargeable to this account:—Globe metal polish, emery and glass paper, brushes and mops, oil cans and spouts, soaps and sodas, tallow, turpentine, graphite, sternoline grease, pumice stone, ground black lead, bath bricks, chalk, squeegees, toilet rolls, twines.

*32. *Repairs to Steam Plant.*—All expenditure for wages, material, tools, freight, cartage of material, and all other expenses in connection with repair of steam plant, including engines and engine parts, appliances, and fixtures, belts, belt tighteners and fixtures, receivers, lubricators and oiling devices, boilers, furnaces, economisers, pumps, feed-water heaters, tanks, condensers, coal and ash conveyers, mechanical stokers, and other boiler room appliances, piping and steam fitting, including valves, separators, water connections and water meters.

*33. *Repairs to Electrical Plant.*—All expenditure for wages, material, tools, freight, cartage of material, and other expenses in connection with repair of electrical plant, including generators, switchboards, cable and feeder terminals, storage batteries, transformers, rotaries, boosters, rheostats, circuit breakers, ammeters and other electrical equipment. Commutator brushes for generators should be charged to Account No. 31.

*34. *Repairs to Ducts, Cables, &c.*—All expenditure for wages, material, tools, freight, cartage of material, and other expenses in connection with repair of ducts for cables, manholes, cables and other electrical plant, which expense, when the power is purchased, is included in the price of the current.

*35. All expenditure for repair of power station and sub-stations buildings, including wages, material, tools, freight, cartage of materials and all other expenses connected with this work.

CAPITAL ACCOUNT.

CLASSIFICATION OF CAPITAL ACCOUNTS.

Expenditure.

Permanent Way.—Charge to this account all expenditure for track and roadway construction, including labour, materials, tools, freight, cartage, cost of grading, excavating, track laying, ties, yokes, slot rails, sewer manhole frames and covers, rails, rail fastenings, welded joints, special work (including crossings, crossovers, curves, frogs, guard rails, switches), concrete, paving, oils, pitch, gravel, chips, asphalte, bitumen, drain boxes, sewer boxes, F.C. traps, gratings, cast-iron pipes, F.C. pipes, iron paving blocks, bricks, bolts and nuts, coal, cement, dog spikes, road metal, sand, pelter, F.C. syphons, lifting wood, fences, bridges, culverts, trestles, subways, tunnels, &c., engineering and superintendence, wages of clerks, timekeepers, watchmen, light and water, street improvements, and other expenses not detailed above. The cost of tracks in car depots and other buildings should be charged to this account. The cost of preparing rails for bonding should be charged to Electrical Equipment of Line Account.

Electrical Equipment of Line.—All expenditure for electrical equipment of line, including labour, materials, tools, freight, cartage, cost of preparing rails for bonding, rail bonds, *ducts, *manholes, poles, rosettes, *cables, guard wire, span wire, strain wire, supplementary wire, trolley wire, *ground feeders, *underground feeders, pole fixtures, overhead appliances, conduit appliances, surface contact appliances, engineering and superintendence, wages of clerks and timekeepers, and other expenses not detailed above.

Land.—Cost of ground purchased for workshops, car sheds, offices and other buildings used in operation of line. Ground purchased to form tramway track should be charged to Permanent Way Account.

Buildings and Fixtures.—All expenditure for buildings and fixtures including labour, materials, tools, freight, cartage and all other expenses incidental to the work. "Buildings and Fixtures" includes car sheds, *power station, *sub-stations, workshops, stores, stables, offices, waiting rooms, &c.

* *Power Station and Sub-station Plant.*—All expenditure for steam and electrical equipment of power station and sub-stations, including foundations for equipment. The cost of buildings used for power station and sub-stations should be charged to buildings and fixtures account.

* These items only apply to systems having a separate tramway power station.

Workshop Tools and Sundry Plant.—All expenditure for shop tools and workshop machinery, car-shed tools, granary machinery, permanent-way plant, sand-drying plant and other appliances, including foundations for same.

Cars (including Electrical Equipment of Cars).—All expenditure in the construction of cars from the operation of which revenue is derived. The term "car" includes the car body, truck, motors and controllers, and all fixtures or appliances inside of or attached to these parts.

Other Rolling Stock.—Cost of sundry vehicles, including water cars or carts, sand and salt cars or carts, store cars, snow ploughs, sweepers, lorries, vans, broughams, &c.

Miscellaneous Equipment.—Cost of horses, harness, uniforms, cash boxes, ticket boxes, bell punches, &c.

Office Furniture.—Cost of furniture for head office, sub-offices, &c.

Parliamentary Expenses.—Costs of Acts of Parliament promoted by the Corporation for tramway purposes.

Preliminary Expenses.—All preliminary organising expenses not chargeable under any of the foregoing accounts.

Income.

Credit all loans raised or repaid, also amount provided for redemption of loans, as well as any contribution by revenue to capital expenditure.

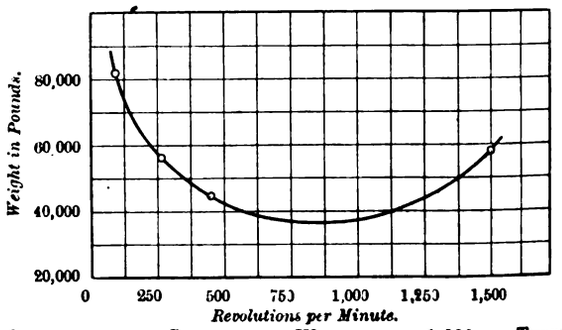
STEAM TURBINE GENERATORS.*

BY B. A. BEHREND.

Electric generators for direct connection to steam turbines are characterised by a number of revolutions per minute, several times as great as the speed of reciprocating engines.

The mechanical requirements impress their stamp upon the electrical design of steam turbine generators, and it is to them that attention will have to be given in the future. We have assumed that the generators are alternating-current generators, although many of the principles here discussed apply also to direct-current machines. The peripheral speed of the rotating element must be made high for a satisfactory electrical design. It is limited by the strength of the materials used and by the mechanical construction adopted.

The principles which determine the design of alternating-current generators of the slow-speed type are essentially the same in *kind*, though not in *degree*, as those underlying the design of turbine generators. We distinguish between the *main* characteristics—viz., the regulation and the thermal conditions, as produced by the losses in the machine, and finally the ventilation and windage. The high peripheral speed leads to pole-pitches of 50in. and 60in. on large 25-cycle generators, and to 20in. and 30in. on 60-cycle generators. To take care of the great armature reaction thus produced, the air-gap of the turbine generators must be made considerably larger than on slow-speed machines. The 3,500kw. generator at the



CURVE SHOWING COMPARATIVE WEIGHTS OF 1,000KW. THREE-PHASE 25-CYCLE GENERATORS AT DIFFERENT SPEEDS.

World's Fair, running at 75 revs. per min., has an air-gap of 0·5in., whereas a 3,500kw. generator running at 750 revs. per min. for the same regulation has an air-gap of nearly 2in. As in the case of slow-speed generators, the regulation curves for zero power-factor should be carefully calculated, and from them the regulation curves for higher power-factors should be deduced.

While the core and copper losses of turbine generators are slightly smaller than those of the slow-speed type, yet it is far more difficult to get rid of the heat produced by them on account of the considerably smaller radiating surfaces of the turbine generators. Low densities in the iron and copper are necessary, and the most careful ventilation of the core and of the field winding becomes essential. To this point a great deal of care must be devoted.

To reduce the loss produced by windage or air friction at the high speeds, the rotating element should preferably be in shape of a perfect cylinder. In one of the most modern high-speed alternators of the revolving-field type the plane of the field coils is placed radial, so that the centrifugal force acts normal to the surface of the flat copper strip. The field coils, being embedded in slots, are thus

* Abstracted from the *Electrical Review* of New York.

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secured against shifting sideways. They are retained in the slots by bronze wedges. The ordinary construction of field magnets is not well adapted to high-speed work as, on account of the plane of the coils and the direction of the centrifugal force not falling together, the centrifugal force has an unbalanced component normal to the plane of the coils which is liable to break the coil or make its turns slide over the poles.

It is interesting to compare the weights of alternating-current generators for the same output at different speeds. At first sight it would seem as though the weight of the machine decreased in proportion with the increase in speed. All engineering problems, however, are problems of maximum and minimum, and hence it may be expected, *a priori*, that there must be a speed at which the weight of the generator is a minimum—*i.e.*, above and below this speed the weight increases. The curve on page 950 shows the weights of a 1,000kw. 25-cycle generator at different speeds, indicating that the weight of a machine of this capacity is a minimum at 750 revs. per min. and that a 1,000kw. generator at 1,500 revs. per min. weighs as much as a 1,000kw. generator at 250 revs. per min., a fact which is certainly most interesting. Increased speed, then, may mean increased weight, and, as increased speed also involves greater care and better material, increased speed may often mean greatly increased cost.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Ionic Mobilities.—F. Kohlrausch and E. Grüneisen have examined the conductivities of aqueous solutions of electrolytes with a number of divalent ions, such as Ba, Sr, Ca, Mg, Zn, Cd, Cu, Pb, in the form of sulphates, nitrates and chlorides. They find considerable difficulty in deriving the conductivity from the ionic mobilities. To obtain the conductivity at infinite dilution by extrapolation is more difficult than it is in the case of monovalent ions, since the rise is from two to five times as great. The difficulty, which can be more or less surmounted when at least one of the ions is monovalent, becomes insuperable when they are divalent. The supposition that an ion has always the same mobility at a very high dilution is conditioned by the water taking no part in the conduction. This is no doubt true at infinite dilution, but there is no knowing up to what dilution the influence of the water continues to be felt. Hydrolysis is more likely in the case of divalent ions than in the case of monovalent ions. A fraction of 1 per cent. in the way of hydrolysis would account for the discrepancies found in magnesium sulphide.

[KOHLRAUSCH and GRÜNEISEN, *Sitzungsberichte der Preussischen Akademie der Wissenschaften*, July 28, 1904.]

Magnetic Change of Length in Heusler's Alloy.—L. Austin has investigated the behaviour of Heusler's alloy of manganese, copper and aluminium in a magnetic field, in order to shed further light upon the magnetic properties of that curious alloy of non-magnetic metals. He found an extension on magnetisation in two different specimens, the extension being nearly proportional to the magnetisation. The curve of extension is similar in shape to the curve of magnetisation, but it rises more slowly. The greatest extension observed was 11×10^{-7} of the length in a field of 400 units, or about one-third the maximum extension of soft iron. A novel observation made was that in strong fields there is a contraction, which, however, takes time to develop. An accurate determination of the contraction could not be made as it was partly compensated by thermal expansion. But it appears to be proportional to the square of the field intensity. The contraction is so large that if it went on for several days it would produce a shortening of the rod. This would correspond to the immediate shortening of iron rods in strong fields, but the author has not yet succeeded in obtaining a final value.

[L. AUSTIN, *Verhandlungen der Deutchen Physikalischen Gesellschaft*, VI., No. 14, 1904.]

Ionisation of Röntgen Rays.—R. K. McClung draws attention to the fact that the ionisation of hydrogen by Röntgen rays shows very different values as determined by different authors. He undertook some experiments to test whether these discrepancies are due, as Thomson suggested, to the different hardnesses of the rays employed by various experimenters, and found that this is so. The method employed was a differential one, the ionisation of hydrogen, which showed the greatest discrepancies, being compared with that of air, which showed the least. Several experiments were made with Cox's automatic regulating bulb, and extremely constant results were obtained. The pressure of the hydrogen giving the same ionisation was 0·116 times that of air. But though the results agreed very well among themselves, the ratio differed very considerably from any of the numbers obtained by the previous observers. Substituting other bulbs gave quite different results. In some instances the results obtained at different times from the same bulb varied among themselves, and the above ratio varied from 0·084 down to 0·052. The author next endeavoured to measure the hardness of the rays. In parallel with the Röntgen-ray bulb was placed an alternate spark-gap. When a balance was being obtained, the length of this spark-gap was adjusted at the same time so that the discharge would pass across this air space just about as easily as through the bulb. The sparking distance was the distance between two brass spheres. The length of this alternative spark-gap depends upon the pressure in the bulb, and the hardness of the rays also depends upon this pressure. Although the relation between this alternative sparking distance and the hardness of the rays is not a very definite one, yet the greater this sparking distance the harder are the rays, and the length of the spark-gap therefore gives some indication of the hardness of the rays. The experiments showed that the relative ionisation in air and hydrogen depended in a very definite manner upon the hardness of the rays. The ratio of the total ionisation in oxygen and sulphur dioxide to that in air tended to become more nearly equal to the ratio of the densities of the gases as the rays became harder; while in the comparison of hydrogen and carbon dioxide with air, the variation of the ratio for the relative ionisation was in the opposite direction. In all cases, the general tendency appeared to be for the ionisation in the denser gas to become more nearly equal to that in the less dense gas as the rays became more penetrating.

[R. K. MCCLUNG, *Philosophical Magazine*, September, 1904.]

Momentum in the Electric Field.—J. J. Thomson discusses some applications of the principle that momentum as well as energy is distributed throughout the electromagnetic field, and that changes in the momenta of magnets, of circuits conveying electrical currents, and other material systems in that field are accompanied by equal and opposite changes in the momentum of the field itself. Thus the system, consisting of the field and the material systems in it, form a self-contained system the momentum of which remains constant in magnitude and direction. If we take the view that the effects in the electromagnetic field are to be explained on dynamical principles by the agency of a medium filling the field, the conception of momentum in this medium is as essential and fundamental as that of energy. The method is based upon the principle that in the electromagnetic field there is at any point an amount of momentum per unit volume equal to $\mu HD \sin\theta$, where H is the magnetic force at the point, D the electric polarisation or "displacement," μ the magnetic permeability of the medium, and θ the angle between the directions of H and D. The momentum is at right angles to both H and D. The author gives, by an application of the principle, an elegant calculation of the force acting on a charged point moving in a magnetic field. He also deals with the pressure of radiation on the same plan, and extends it to cover the case of refraction. Radiation will give rise to pressure when it is refracted, for the momentum in the medium being in the direction of propagation, when the latter is changed the momentum in the medium is changed also, and, therefore, by the principle of the conservation of momentum the refracting substance must suffer a change in momentum. Thus, suppose a beam of light is travelling along a covered path in a refracting medium; then, if ds is an element of the path, $d\theta$ the angle between the direction of the beam at the beginning and end of the element, the direction of momentum is changed by $\delta\theta$ in passing along ds. Thus, if M is the momentum per unit volume in the beam, an amount of momentum $VM\delta\theta$ at right angles to the path of the light must be communicated to the medium per unit time; thus the force per unit volume at right angles to the light will be $VM\delta\theta/\delta s$ or E/ρ, where ρ is the radius of curvature of the beam.

[J. J. THOMSON, *Philosophical Magazine*, September, 1904.]

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ELECTRICITY IN BUILDING OPERATIONS.

It is, perhaps, no exaggeration to say that wherever a building of any magnitude is being erected within a convenient distance of electricity supply mains, the use of steam as a source of power is nothing less than a waste of money and time. The days of steam engines in such circumstances are assuredly numbered, and it only remains for builders to be convinced that enormous economies are to be effected by the adoption of electric driving. A remarkably fine object lesson is that presented by the new Home Office buildings now in course of erection at the corner of Parliament-street and Bridge-street, Westminster. No fewer than 17 million bricks have already been used, and it is estimated that another eight millions will still be necessary before the work is completed. In addition, there will be 2,000 tons of steel work and 250,000 cubic ft. of Portland stone. All this material has to be brought to the site, lifted from vehicles, and deposited on the spot where it is required. The greater part of it has, however, already been delivered and fixed in position, as may be seen from a casual inspection of the edifice in its existing condition. When electrical driving for cranes and mortar pans was first suggested to them, the contractors were reluctant to abandon steam, but, once having become converted, they are now as enthusiastic in favour of electricity as they were previously doubtful of its suitability. Their change of attitude is due, to a certain extent, to the reduction which has taken place in the quarterly returns of working expenses. This reduction is undoubtedly very substantial, as we shall show presently, but there are also other advantages which cannot be stated in quite so bald and convincing a manner. Superior convenience, cleanliness and many other points are obvious advantages which tend toward economy and efficiency, but the saving which they effect cannot be expressed exactly in pounds, shillings and pence. A single instance may be taken as a illustration. In the case of a crane raising a large block of stone weighing, say, a couple of tons, and placing it in position before the mason for laying, much depends on the speed with which it can be delivered on precisely the right spot without subsequent movement. As far as actual speed of lifting is concerned there is

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little to choose between steam and electricity, but when it comes to delicate adjustments of the order of half an inch, then the electric crane is greatly superior to one driven by steam. No matter how expert the driver may be, he is almost sure to admit too much steam to the cylinder, which will raise the stone with a jerk and probably carry it through much too great a distance. With the electric crane, on the other hand, it is a comparatively simple matter to effect adjustments of this kind with the greatest nicety, and thus time and money are economised. Similar arguments apply equally to slewing and raising the jib, the latter often causing considerable trouble in windy weather.

As may be seen from the illustrated article which appears in another column of this issue, the motors driving the mortar pans are situated in small houses adjacent to the pans themselves; it is probably due to this fact that so little trouble is experienced from dust. In the case of the cranes there is little to fear from this cause since they are fixed far above their work, and, as with the mortar pans, the motors are protected by the crane shelters.

By a fortunate coincidence there happen to be steam and electric mortar pans doing identically the same work at the Home Office buildings in Westminster, so that an unusually accurate comparison of working costs can be made. On the basis of a week, consisting of 50 working hours, it is found that the steam-driven pan costs £2 for coal and £2 for labour, whereas the total costs in connection with the electrically-driven pan does not exceed 25s. under the worst conditions. This is accounted for partly by the fact that the motor requires absolutely no attention whatever, while there must be at least one man in constant attendance at the steam engine, and partly by the difference in cost between coal and electrical energy. There is no fear of fuel or water giving out; there is no getting steam up in the morning, no banking of fires during the dinner hour, and no cleaning down after work is finished at night. With cranes, the main advantage is the possibility of delicate adjustment, already referred to, and the consequent saving of time and labour; but there is still a great saving in the actual driving costs, although this is not quite so marked as in the case of the mortar pans, owing to the fact that every crane, whether steam or electric, must have the entire attention of a driver. However, with electric cranes there is no steam to raise and no blowing-off to do, the saving of time thus effecting an economy of about 10s. per week, while energy costs only 14s. per week, as compared with £1 for coal. On the whole, it is computed that the adoption of electricity in the erection of this building has resulted in a saving of from £10 to £12 per week in working expenses, without taking account of the effect it has had in accelerating the completion of the work.

OBITUARY.

CHARLES EDMUND WEBBER.

It is with deep regret that we announce the death of Major-Gen. C. E. Webber, C.B., in his 66th year. He was active and energetic to the last, for he attended the meeting of the British Association at Cambridge last month, and took a prominent part in the discussion in Section G (Engineering). He was born in Dublin, and was a true Irishman, possessing in a high degree the attributes of the Kelt—brave to a fault, combative in everything, a splendid supporter, and a very dangerous opponent. He loved to be on the opposition side. When he saw a head exposed, he, like a true Kelt, loved to hit it, and he was always "agin the Government" of every kind. He was educated at the Woolwich Academy; distinguished himself there very well, and gained his commission in the Royal Engineers in 1855. In India, Major-Gen. Webber served actively throughout the Mutiny, and subsequently was attached to the headquarters of the Prussian army throughout the Austro-Prussian war of 1866. He was present at the siege of Chandaree, the siege and storming of Jhansi, the battle of Betwa and the action at Koonch. He also took part in the operations before and the capture of Calpee and Gwalior, as well as the operations in Central India against Man Singh, Roop Singh and Feroge Shah. During the campaign he was mentioned in despatches, and afterwards received the medal and clasp. In 1879 he accompanied Lord Wolseley (then Sir Garnet Wolseley) to South Africa as assistant adjutant and quartermaster-general, and took part in the Zulu campaign and also in the operations against Sekukuni in the Transvaal, being again mentioned in despatches and receiving the medal with clasp. In the Egyptian expedition of 1882 Major-Gen. Webber held a similar position—namely, that of assistant adjutant and quartermaster-general at headquarters, and was in charge of the telegraph lines. He was present at the battle of Tel-el-Kebir, and was again mentioned in despatches, receiving the medal with clasp and the bronze star. At the same time he was made a C.B., and was decorated with the Third Class of the Medjidieh. He was up the Nile again in 1884-5 with the Soudan expedition, and added a clasp to his Egyptian medal. This brought his active military career to an end. He retired in July, 1885, with the honorary rank of major-general. Between 1861 and 1866 he was an assistant professor in surveying and topography at the R.M.A., Woolwich, and in 1867 (as a captain) he was attached to the British Commission at the International Universal Exhibition at Paris, superintended the erection of all the buildings undertaken by the Commission, and was in charge of the experiments in heating and lighting carried on in the English test house. In 1870 he was placed upon the Engineering Staff of the Post Office in command of the 22nd and 34th companies of Royal Engineers for service in the Postal Telegraph Department; appointed a divisional engineer, first of the Eastern and afterwards of the Southern Division of the Postal Telegraphs. During the early years of the development of this great service he was connected with the extension of the system in various parts of Great Britain, and during that time, up till 1879, while carrying on the duties of construction and maintenance of telegraphs, as an officer of the Postal Telegraph Department, was instrumental in training in all branches of telegraphy over 300 officers, non-commissioned officers and soldiers of the Royal Engineers, whose services have since been of value in several military operations. In 1870 and 1871 he and Col. Bolton originated and founded the Society of Electrical Engineers, of which he has since been either the treasurer or a member of Council, and in 1882 he was elected the president of the year.

In 1878 (when a major) Major-Gen. Webber was appointed a member of the British jury for telegraph apparatus at the International Exhibition at Paris. In 1881 he was appointed by Her Majesty's Government one of the British Commissioners for the Electrical Exhibition at Paris, and was also one of the members of the International Electric Congress held the same year in Paris. In reward for these services the 3rd Class of the Legion of Honour was conferred on him by the French Government in common with the other Commissioners, but as a military officer he was not allowed to receive it. He was also a member of the General Council and of the jury for the electrical exhibition at the Crystal Palace in 1882, and was a member of the electrical jury at the Health Exhibition in 1884. Major-Gen. Webber was charged with experiments in connection with prizes offered by the Society of Arts in 1873 for inventions in apparatus for heating and the utilisation of fuel, and has thrice sat as a member of council of that society.

He was the author of several Papers in the *Journal* of the Society of Telegraph Engineers and Electricians and on many military subjects. He was the first of our military engineers, after completing his army service to be elected a corporate member of the Institution of Civil Engineers. He took a very active part in developing the telephone system in this country, but he was unfortunately on the wrong side. He

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was first managing engineer and director, and afterwards consulting electrical adviser, of the Anglo-American Brush Electric Light Corpn. from November, 1885, to July, 1889; was deputy chairman and consulting engineer of the Chelsea Electricity Supply Co. (Ltd.); was chief engineer of the City of London Electric Lighting Co.; and was an original member of the Société Internationale des Electriciens.

He will be remembered principally for the part he took in originating and managing the Institution of Electrical Engineers. He was a very constant attendant, especially at the Council meetings, and took an extraordinary personal interest in the policy and action of that body. His restlessness in the internal changes of the administration of the Institution was the marvel of all his friends. No discussion could deter him from interfering when he thought things were going wrong, nor could he himself be prevented from doing that which appeared clearly wrong to others. He made his own line, fought persistently along it, and never said "die."

His presence will be very much missed at many social as well as professional gatherings. It is, indeed, in the social world that he shone, for his manner was charming, his conversation entertaining, and his expressed views refreshing and instructive.—W.H.P.

NIELS RYBERG FINSEN.

Owing to the inestimable benefits which his brilliant discoveries have conferred upon mankind, Prof. Finsen is to-day mourned by every civilised country. Born in 1860 in the Faroë Islands, he was attacked by a complication of incurable diseases in early youth, and his life has since been one long period of suffering. He gained his doctor's degree in 1890 at Copenhagen University, and subsequently became a lecturer in anatomy there. In 1893 he put forward the red light treatment for smallpox, in which only red rays are permitted to fall on the skin of the patient. This prevents scarring and the occurrence of the secondary fever. Many royal personages were counted among his friends, and it will be remembered that the first Finsen lamp for lupus used in this country was presented by Queen Alexandra to the London Hospital. Finsen spent most of his time in the laboratory, leaving assistants to carry his ideas into practice; he was an incessant worker and retained his faculties to the last. The actual cause of his death, as revealed by the post-mortem examination, was calcination of the pericardium, probably caused by arthritic fever. King Edward has sent an autograph letter to Mrs. Finsen through Sir William Goschen, the British Minister in Copenhagen, expressing his sincere condolence with her in her bereavement.

THE DUPLEX BALANCING OF TELEGRAPH CABLES.

BY W. GAYE.

(Continued from page 907.)

Meanwhile, it would seem not improbable that a careful study of the conditions under which a working balance is at present obtained on various cables might be of some guidance with respect to the values of L.

When in Fig. 1 r is short-circuited and therefore $=0$, but the capacity of the condenser is of the finite value s, the case is one, perhaps, of theoretical rather than practical interest, owing to a difficulty of conception as regards an entire absence of all ohmic resistance. Its investigation is, however, equally instructive. Putting $St/Rs^2 = b$, expansion and development of the fundamental formula (2) lead to

$$V=100\left\{\epsilon^b-\left(\frac{4b}{\pi}\right)^{\frac{1}{2}}\left[1+\frac{2b}{3}+\frac{(2b)^2}{3\,.\,5}+\frac{(2b)^3}{3\,.\,5\,.\,7}+\text{ \&c.}\right]\right\} \quad (2A)$$

$$\text{or } V=100\left\{\left(\frac{1}{b\pi}\right)^{\frac{1}{2}}\left[1-\frac{1}{2b}+\frac{3}{(2b)^2}-\frac{3\,.\,5}{(2b)^3}+\frac{3\,.\,5\,.\,7}{(2b)^4}-\text{ \&c.}\right]\right\} \quad (2B)$$

according to the mode of expansion adopted. In calculation, (2A) may be used when $2b$ is small and (2B) when its values are large. If, however, comparison is made with (1A) and (1B), it is at once evident that the potential in this instance *falls* from the value e—which, since no ohmic resistance is present, is instantaneously acquired at $t=0$—in the same manner as it *rose* towards it when r was finite and s infinite, at a speed, that is to say, which varies as S/Rs^2. It follows, consequently, that the table of values given in that connection may be applied equally well in this. The potential value in percentages of e for any particular value of $Rs^2/2St$ (*i.e.*, $1/2b$) being ascertained by subtracting that opposite the same value for $1/2a$ in the table from 100. For example, if $1/2b = 3{\cdot}5$, the potential value is $100-31{\cdot}596$, or $68{\cdot}404$. Curve 1 (Fig. 5) illustrates the fall in cases where $Rs^2/S = 0{\cdot}00031846$, as, for instance, with the three cables, A, B and C, when s has the values respectively of $3{\cdot}1846\phi$, $7{\cdot}7414\phi$ and $0{\cdot}26538\phi$.

Curve 2 shows the fall when $Rs^2/S = 0{\cdot}001274$—*i.e.*, in the cases quoted, when s is doubled. Curve 3 shows the effect of increasing s to $10s$, and represents, of course, also the fall in

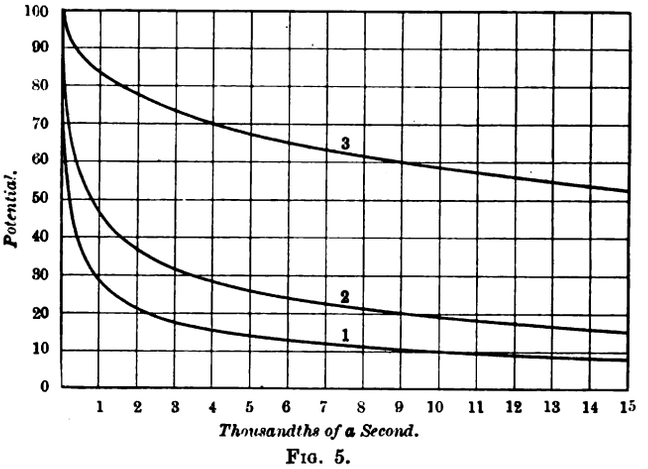

FIG. 5.

all other cases where $Rs^2/S = 0{\cdot}031846$. Attention should be given to the fact that if s bears the same proportion to S as r when of finite value does to R, the fall of *potential* from the commencing value e is identical with that of the *current* from the commencing value e/r on that occasion: thus curve 1 in the last figure is the same as curve 2 in Fig. 3.

At $t=\infty$ the condenser has become fully charged, and the total quantity of electricity or charge that has been displaced from it into the cable is es units. Since we are dealing with a cable of infinite length, and as this amount becomes, therefore, distributed over an infinite area, the final potential at the beginning and elsewhere $=0$.

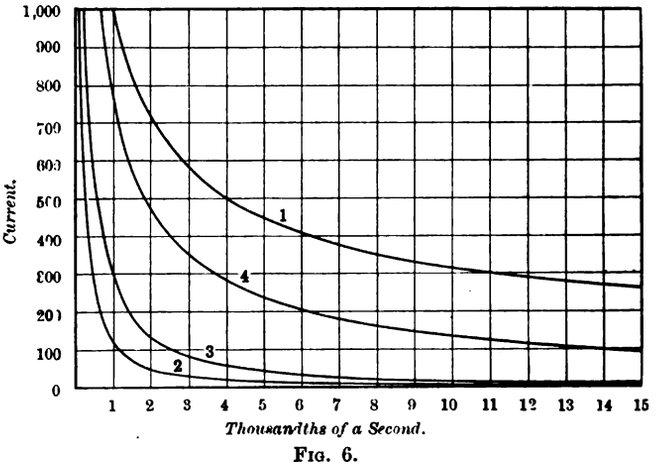

FIG. 6.

When the key is depressed at $t=0$, and the displacing agency e thereby applied, there is no resistance present, since that of the condenser $1/sp$ and that of the cable $(R/Sp)^{\frac{1}{2}}$ are both then alike of zero value. The speed with which the charge starts entering the cable—*i.e.*, the current—is consequently infinite.

For the current we have fundamentally the expression

$$C=\frac{e}{\frac{1}{sp}+\left(\frac{R}{Sp}\right)^{\frac{1}{2}}},$$

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but, the potential V having been already ascertained, there exists no necessity for the further development of this, since the current may be derived from the expression

$$C = e\left(\frac{S}{R\pi t}\right)^{\frac{1}{2}} - V\frac{S}{Rs}.$$

This, it is to be noted, is the current that would exist were the condenser short-circuited *less* an amount that depends upon its capacity. The use of this affords the curves in Fig. 6, which represent the current with respect to the time, the ordinates being percentages of *es*.

Curve 2 illustrates cases where $Rs^2/S = 0{\cdot}00031846$ as—quoting the three examples employed before—when with cable A $s = 3{\cdot}1846\phi$, with B $7{\cdot}7414\phi$, and with C $0{\cdot}26538\phi$. Curves 3 and 4 show the result of increasing s to respectively $2s$ and $10s$, and the current in all other instances in which $Rs^2/S = 0{\cdot}001274$ and $0{\cdot}031846$. Curve 1 is given for purpose of comparison, it is representative of the current when the condenser is short-circuited and its capacity therefore infinite. On comparing the areas enclosed by the different curves and the limiting ordinates it becomes apparent, as distinguished from the effect of the resistance r, how materially affected is the quantity of charge that has entered the cable in a given time, by the magnitude of the condenser's capacity. As the time increases the quantity begins rapidly to vary more and more closely with the capacity, ultimately—at $t = \infty$—doing so exactly.

Passing on now to the more complicated problem of when, in Fig. 1, the capacity of the condenser s and the resistance r are *both* of finite value, putting, as before, $Rt/r^2S = a$, and $St/s^2R = b$, and also $sR/rS = z$, expansion and development of the fundamental formula (3) lead to

beyond it. An exceptionally simple case is when $z = 4$. Then, besides a considerable simplification of the first series, the second is replaced by the exponential formula and the expression becomes

$$V = 100\left\{\left(\frac{4a}{\pi}\right)^{\frac{1}{2}}\left[1 + \frac{a}{2} + \frac{1}{3}\left(\frac{a}{2}\right)^2 + \frac{1}{3.5}\left(\frac{a}{2}\right)^3 + \&c.\right] - ae^{4}\right.$$

With this the limit in calculation may be very greatly extended.

(3B) is of service when $2a$ is large. Its range of utility begins at the end of the curve when $2a = \infty$ and extends backwards to a limit increasing as z is reduced.

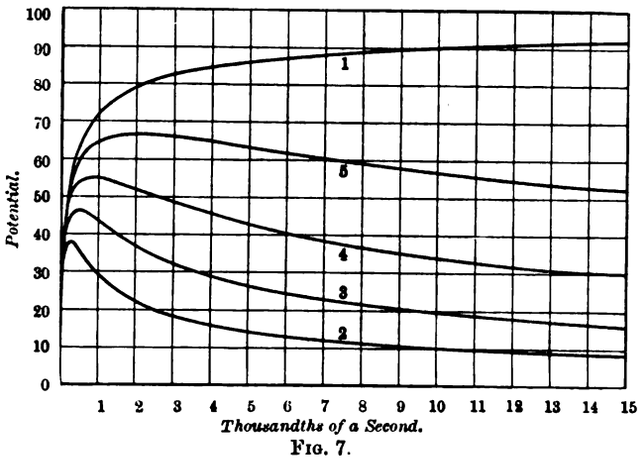

FIG. 7.

(3C) operates only when z is over 9 or 10, and then, owing to its composition of two of rising and one of falling, powers of t, we cannot obviously employ it at either the beginning or end

$$V = 100\left[\left(\frac{4a}{\pi}\right)^{\frac{1}{2}}\left\{1 + \frac{1}{3}\cdot\frac{2a}{z}(z-1) + \frac{1}{3.5}\cdot\left(\frac{2a}{z}\right)^2\left(z^2 - \frac{3z}{\lfloor 1} + 1\right) + \frac{1}{3.5.7}\cdot\left(\frac{2a}{z}\right)^3\left(z^3 - \frac{5z^2}{\lfloor 1} + \frac{3.4z}{\lfloor 2} - 1\right) + \frac{1}{3.5.7.9}\cdot\left(\frac{2a}{z}\right)^4\left(z^4 - \frac{7z^3}{\lfloor 1} + \frac{5.6z^2}{\lfloor 2} - \frac{3.4.5z}{\lfloor 3} + 1\right) + \frac{1}{3.5.7.9.11}\left(\frac{2a}{z}\right)^5\left(z^5 - \frac{9z^4}{\lfloor 1} + \frac{7.8z^3}{\lfloor 2} - \frac{5.6.7z^2}{\lfloor 3} + \frac{3.4.5.6z}{4} - 1\right) + \&c.\right\} - z\left\{\frac{a}{z} + \frac{1}{\lfloor 2}\left(\frac{a}{z}\right)^2(z-2) + \frac{1}{\lfloor 3}\left(\frac{a}{z}\right)^3\left(z^2 - \frac{4z}{\lfloor 1} + 3\right) + \frac{1}{\lfloor 4}\cdot\left(\frac{a}{z}\right)^4\left(z^3 - \frac{6z^2}{\lfloor 1} + \frac{4.5z}{\lfloor 2} - 4\right) + \frac{1}{\lfloor 5}\cdot\left(\frac{a}{z}\right)^5\left(z^4 - \frac{8z^3}{\lfloor 1} + \frac{6.7z^2}{2} - \frac{4.5.6z}{\lfloor 3} + 5\right) + \&c.\right\}\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3A)$$

$$V = 100\left(\frac{z^2}{a\pi}\right)^{\frac{1}{2}}\left\{1 - \frac{z}{2a}(z-1) + 3.\left(\frac{z}{2a}\right)^2\left(z^2 - \frac{3z}{\lfloor 1} + 1\right) - 3.5.\left(\frac{z}{2a}\right)^3\left(z^3 - \frac{5z^2}{\lfloor 1} + \frac{3.4z}{\lfloor 2} - 1\right) + 3.5.7.\left(\frac{z}{2a}\right)^4\left(z^4 - \frac{7z^3}{\lfloor 1} + \frac{5.6z^2}{\lfloor 2} - \frac{3.4.5z}{\lfloor 3} + 1\right)\right. \quad . \quad . \quad . \quad (3B)$$

or

$$V = 100\left[1 - \left(\frac{1}{a\pi}\right)^{\frac{1}{2}}\left\{\left(1 + \frac{3}{\lfloor 1}\cdot\frac{1}{z} + \frac{4.5}{\lfloor 2}\cdot\frac{1}{z^2} + \frac{5.6.7}{\lfloor 3}\cdot\frac{1}{z^3} + \frac{6.7.8.9}{\lfloor 4}\cdot\frac{1}{z^4} + \frac{7.8.9.10.11}{\lfloor 5}\cdot\frac{1}{z^5} + \&c.\right) - \frac{1}{2a}\left(1 + \frac{5}{\lfloor 1}\cdot\frac{1}{z} + \frac{6.7}{\lfloor 2}\cdot\frac{1}{z^2} + \frac{7.8.9}{\lfloor 3}\cdot\frac{1}{z^3} + \&c.\right) + 3.\left(\frac{1}{2a}\right)^2\left(1 + \frac{7}{\lfloor 1}\cdot\frac{1}{z} + \frac{8.9}{\lfloor 2}\cdot\frac{1}{z^2} + \&c.\right) - 3.5\left(\frac{1}{2a}\right)^3\left(1 + \frac{9}{\lfloor 1}\cdot\frac{1}{z} + \frac{10.11}{\lfloor 2}\cdot\frac{1}{z^2} + \&c.\right) + 3.5.7.\left(\frac{1}{2a}\right)^4\left(1 + \frac{11}{\lfloor 1}\cdot\frac{1}{z} + \&c.\right) + \&c.\right\} - \left(\frac{4b}{\pi}\right)^{\frac{1}{2}}\left\{\left(1 + \frac{3}{\lfloor 1}\cdot\frac{1}{z} + \frac{4.5}{\lfloor 2}\cdot\frac{1}{z^2} + \&c.\right) + \frac{1}{3}.2b\left(1 + \frac{5}{\lfloor 1}\cdot\frac{1}{z} + \&c.\right) + \frac{1}{3.5}(2b)^2\left(1 + \frac{7}{\lfloor 1}\cdot\frac{1}{z} + \&c.\right) + \frac{1}{3.5.7}(2b)^3\left(1 + \frac{9}{\lfloor 1}\cdot\frac{1}{z} + \&c.\right) + \&c.\right\} + \left\{\frac{2}{z}\left(1 + \frac{3}{\lfloor 1}\cdot\frac{1}{z} + \frac{4.5}{\lfloor 2}\cdot\frac{1}{z^2} + \&c.\right) + b\left(1 + \frac{4}{\lfloor 1}\cdot\frac{1}{z} + \frac{5.6}{\lfloor 2}\cdot\frac{1}{z^2} + \&c.\right) + \frac{b^2}{\lfloor 2}\left(1 + \frac{6}{\lfloor 1}\cdot\frac{1}{z} + \&c.\right) + \frac{b^3}{\lfloor 3}\left(1 + \frac{8}{\lfloor 1}\cdot\frac{1}{z} + \&c.\right) + \&c.\right\}\right] \quad . \quad . \quad . \quad (3C)$$

The cumbrous appearance of these expressions calls for some apology. (3A) and (3B) (probably, also (3C), although the method has not made itself exactly apparent to the writer), admit of expression in a more simple form, since the coefficients of the $2a/z$ and a/z terms $(z-1)$, $\{z^2 - (3z/\lfloor 1) + 1\}$, and $(z-2)$, $\{z^2 - (4z/\lfloor 1) + 3\}$, &c., are ascertained without much labour by the observance of a simple rule. Thus, call $(z-1)$ or $(z-2) = q$, $\{z^2 - (3z/\lfloor 1) + 1\}$ or $\{z^2 - (4z/\lfloor 1) + 3\} = q_1$, $\{z^3 - (5z^2/\lfloor 1) + (3.4z/\lfloor 2) - 1\}$ or $\{z^3 - (6z^2/\lfloor 1) + (4.5z/\lfloor 2) - 4\} = q_2$, &c., then as the case may be $z-1$ or $z-2 = q$; $(z-2)q - 1 = q_1$; $(z-2)q_1 - q = q_2$; $(z-2)q_2 - q_1 = q_3$, and so on.

(3A) will be noticed to be the difference between two series. Its range of application extends from the beginning of a curve when $2a = 0$, to some limiting value determined by one's endurance as regards calculation. The labour this entails is disagreeable; indeed, when z is less than 0·5 in value it is prohibitively so. Beyond this, progress is more easy and though calculation up to this point becomes increasingly tedious as z rises we may, when it does not exceed 5 or 6, calculate the curve up to the maximum potential value reached; at the smaller intermediate values we may even go some little distance of the curve. It, however, has a big range over the intermediate part, which, moreover, increases as z rises, and is that of principal interest since it contains the maximum potential value reached.

It is evident from these expressions (as also the fundamental 3 itself) that, whatever the individual values of R, S, r and s, so long as those of Sr^2/R and sR/rS remain the same, the course followed by the potential with respect to the time is unchanged. Thus, in the same manner as curve 1, Fig. 7, represents it in all cases where—the condenser being short-circuited and s infinite—$Sr^2/R = 0{\cdot}00031846$, so the others indicate it under the same circumstances, but with various finite values given to the condenser's capacity.

Curve 2 illustrates instances in which z or $sR/rS = 1$, as, to quote three only, when employing cable A $r = 100\omega$, $s = 3{\cdot}1846\phi$, or with B $r = 41{\cdot}137\omega$, $s = 7{\cdot}7414\phi$, or, again, with C $r = 618{\cdot}18\omega$ and $s = 0{\cdot}26538\phi$.

The effects of using condensers of respectively double, four and ten times the capacity, and, consequently, raising z to the values 2, 4 and 10 are shown by curves 3, 4 and 5. On comparison of curve 1 with the others it is to be noticed that the potential starts in all cases to rise precisely as if the

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condenser were short-circuited. Later on, however, and the earlier as its capacity is reduced, the condenser's limiting effect becomes more and more manifest until, a maximum having been reached, the values begin to fall. In the end—at $t = \infty$—a finite quantity of charge (es units) having become distributed over an infinite length of cable, $V = 0$ in all cases, with the exception, of course, of curve 1. It will be remarked also that, while the maximum value is dependent upon the capacity of the condenser, the time at which this occurs is similarly controlled, being directly proportional to it.

Some results produced by a variation of the resistance r while s is constant are shown in Fig. 8. Curve 1 is illustrative of cases where $Rs^2/S = 0{\cdot}0050954$, but r is short-circuited and therefore $= 0$. Curve 2 shows the effect when z has a value of 20, as, for example, with cable A, if $s = 12\,7384\phi$ and $r = 20\omega$,

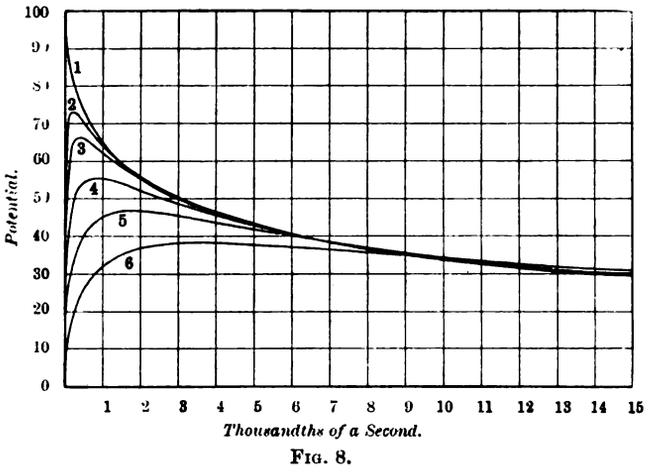

FIG. 8.

with B $s = 30{\cdot}9656\phi$, $r = 8{\cdot}227\omega$, or with C $s = 1{\cdot}0615\phi$ and $r = 123{\cdot}63\omega$. Curves 3, 4, 5 and 6 illustrate matters when r is increased to $2r$, $5r$, $10r$ and $20r$, z becoming, consequently, 10, 4, 2 and 1. The maxima and the times at which they occur are now observed to be determined by the value of the resistance, the latter varying directly with it.

(To be continued.)

MUNICIPAL TRAMWAYS ASSOCIATION OF GREAT BRITAIN.

The third annual conference of this Association was held at Liverpool on Tuesday and Wednesday, under the presidency of Mr. C. R. Bellamy, the General Manager of the Liverpool Corporation Tramways. About 100 members assembled in the St. George's Hall, Liverpool, on Tuesday morning, and were welcomed by Sir Charles Petrie, chairman of the Liverpool Corporation Tramways committee. Mr. Bellamy's presidential address was then read by the honorary secretary, Mr. J. M. McElroy (General Manager of the Manchester Corporation Tramways). Mr. Bellamy stated that the membership of the Association now included 56 corporations and 71 tramway managers or their assistants—in fact, nearly all the municipal tramway undertakings of the United Kingdom were now represented. The greater part of the address was taken up with an earnest appeal for the better recognition of the necessity of real light railways for carrying agricultural merchandise. An abstract of the address appears elsewhere in this issue.

A vote of thanks to the president for his address was enthusiastically accorded on the motion of Mr. John Young (General Manager of the Glasgow Corporation Tramways).

A discussion was then opened on the standard form for municipal tramway accounts, prepared by a joint committee of the Institute of Municipal Treasurers and Accountants (Incorporated) and the Municipal Tramways Association of Great Britain. It was explained that the report of the committee had been approved by the former institute, and that it was now before the Municipal Tramways Association for approval. The form will be found on p. 947 of this issue.

Mr. James Dalrymple (accountant and cashier of the Glasgow Corporation tramways department) explained that he had been in a minority of one in the committee with regard to some of the forms of account. Chief among these were the net revenue and appropriation account. He contended that the contributions to sinking fund and also contributions to renewal fund should be included on the debit side of the net revenue account; in fact, if he had his way, renewals should be a charge against gross revenue. There was, he said, too much anxiety to make out an account that would compare with the balance-sheet of a tramway company which had no interest or sinking fund to pay. He also objected to reserve and renewal funds being united in one item, as reserve and renewal were quite distinct matters. He hoped, however, that every committee would adopt the general form for their accounts, although he would not have the audacity to place the renewal fund in the appropriation account at Glasgow.

The president (Mr. Bellamy) pointed out that, if Mr. Dalrymple's suggestion were carried out, unfavourable comparisons of the net revenue account would be made with company undertakings, and losses would be attributed to municipal tramways when no real losses existed. This view was adopted by other speakers, one of whom expressed the opinion that the committee which had drafted the form of accounts could not presume to dictate what the various tramways committees should do with their balances. The old question as to whether the provision of a sinking fund did not exempt the undertaking from providing a renewal fund as well was also touched upon. A question how the item for advertising should be entered if an intermediate contractor was employed (as at Southport) raised some amusement, as Mr. Bellamy on the one hand and Mr. McElroy and Mr. Dalrymple on the other expressed opposite views with equal decisiveness. Finally, the form of accounts was adopted by the Association on the motion of Mr. McElroy, seconded by Mr. J. B. Hamilton (Leeds), the chairman stating, in answer to Mr. Mozley (Burnley) that the Association could not bind its members to employ this precise form, although it was hoped that they would. It was further decided that a copy of the form of accounts and of the resolution adopting them should be sent to the town clerk of every municipality having a tramway.

Mr. Peter Fisher (General Manager of the Dundee city tramways) then presented a Paper on "Economy in Consumption of Current," which was read by the hon. secretary. He had circulated a number of enquiries under this heading among other tramway managers, and his Paper was based on the replies received. It is suggested that when current is purchased from another department three meters should be used in series, and the average of the readings taken; if one meter varies 3 to 5 per cent. from the others it is taken out and recalibrated. Considerable difference of opinion existed as to cross-bonding the overhead work as an assistance to the maintenance of constant pressure. The answers received to the circular and the opinions expressed in the discussion may be summarised by saying that cross-bonding is desirable on hilly routes, at all events at the grades themselves, while the disadvantage is that both the up and down lines are put out of service over a half-mile section between feeder pillars if there is a short-circuit on either line. Glasgow is an instance where the overhead work is cross-bonded at one or more points in each section. After touching on the question of more rapid acceleration, the real point involved being apparently not quite appreciated by the author, the question of the training of motormen was dealt with. At Blackburn a bonus sytem has been introduced. An average of 1·87 B.T. units per car-mile has been taken as the basis of what should be the consumption, and, for every tenth of a B.T. unit below this figure, 1s. per week is added to the wages of each motorman. This keeps the question of economy before the men. Car watt-meters have so far been used with little success in most places, the prevalent opinion being that they are unreliable. Some discussion took place on the question of watering the rails to keep a clean surface; while several managers were of opinion that this should be done so as to save power by having the best possible contact between the wheels and the rails, others were not in favour of the practice on account of the depreciation of the

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permanent way which it occasioned. Bogie-cars came in for some criticism. Mr. Fisher cited tests made with the two types on a line rising 225ft. in 1½ miles, and found that the bogie-car required 40 per cent. more energy, while the respective seating capacities were 51 and 59. It was pointed out in the discussion, however, that owing to the small extra seating capacity of the bogie-car in this case, the test could hardly be considered a fair one; but, on the whole, double-truck cars are falling into disfavour, and in some places they are being converted into single-truck cars.

On the question of the use of wattmeters and the paying of bonuses to the motormen, Mr. A. E. Le Rossignol (Newcastle-on-Tyne) pointed out that wattmeters on cars did not record correctly on account of the rapid variations of current at starting, and, moreover, it would not be feasible to pay bonuses to each man according to results, as the condition of the rails and the regularity of the voltage made considerable difference. Replacing a small generator by a larger one would even make more difference than 0·1 B.T.U. in the consumption of current per car-mile, owing to the greater constancy of the voltage. Other speakers doubted if the amount paid away in bonuses would not be greater than the value of the energy saved. Mr. C. J. Spencer (Bradford) was in favour of cross-bonding the overhead lines throughout, as there was a loss in running the motors at too low a pressure. Apart from the question of accuracy of car meters, it would be impossible to base a bonus system upon their readings, as the motormen were changed. Mr. A. S. Giles (Blackburn) explained that his bonus was paid to all drivers, the total units consumed being divided by the total car-mileage. He found that the curve fluctuated considerably with the weather. The variations of pressure which had been spoken of, were often due to the extension of traffic after the lines had been built, and it was, in his opinion, a badly-managed generating station in which the voltage variation exceeded 4 or 5 per cent. On hilly routes, he fed both his trolley wires at each end of the half-mile sections. Councillor Spencer (Halifax) said that experiments had been made with regenerative control in his town, but it was too early to give any results. Councillor Travis (Southport) said that on his tramways it had been found that the power of the motors was too high for such flat country, and that they had lately tried with success disconnecting one of the motors on the parallel notches of the controller. Mr. W. H. Tittensor (Preston) thought that a reduction in the length of sections to less than half a mile was worthy of consideration, and that the section of copper in the feeders was too small in most systems. He said that the largest amount of energy was wasted in the brake blocks, and recommended the employment of a greater number of inspectors to keep watch on the motormen. Mr. Fisher having briefly replied, this closed the morning's proceedings.

The afternoon sitting was opened with a Paper by Mr. J. B. Hamilton, General Manager of the Leeds city tramways, which dealt with the arrangement of motormen's and conductor's duties. Although not an engineering subject, as the questions discussed related chiefly to the hours of work and the arrangement of the shifts, some interesting points were raised. Twelve years ago (with horse traction) the wages of drivers and conductors in Leeds averaged 3¾d. and 3⅛d. per hour respectively for 82 hours per week; now the motormen get from 6d. to 7d. per hour and the conductors 5d. to 6d. per hour with a week of 60 hours, and, in addition, have uniform and waterproofs provided, and are granted a week's holiday every year with pay. The result is that a higher class of men are attracted. At Leeds all the routes converge to a central part of the city, and the difficulty of making the shifts of reasonable length and of allowing intervals for meals has been overcome in the following manner:—Mess-rooms, and smoking and reading rooms have been established at the central termini of the principal lines, and the men are relieved at these points, and join another car on the same route after an interval of 20 minutes or more. The standard of six 10-hour days a week for each man is aimed at, and the average time over which the 10-hour working day extends is only slightly over 11 hours.

One or two speakers, including Mr. A. R. Fearnley (Sheffied) said that they could give the motormen continuous duties, and would not introduce split turns, but the majority recognised that this was unavoidable owing to the increase necessary in the number of cars twice a day. In most cases, however, a longer interval than that adopted by Mr. Hamilton was allowed in the middle of the day. Mr. A. L. C. Fell (London County Council tramways) had to split the duties over 15 hours, the actual work on the car occupying 9½ hours, and six days being worked a week. Mr. J. M. McElroy (Manchester) explained the system he employed. This works successfully, and has been held up by the men's union as a pattern. In Manchester there are a certain number of all-day cars, running 18 hours. These are served in two nine-hour shifts, the afternoon man relieving the morning man for one journey (which occupies an hour or more). These men always work on the same routes. There is then a second class of "part-day" men, who have to come on in the morning and evening for the "rush" hours. The duties of these men rotate, and when vacancies occur on the all-day cars the part-day men are promoted to them.

The greater part of Mr. A. L. C. Fell's Paper on "Methods of Dealing with Mixed Systems of Traction" dealt with the problem which faces the tramway engineer and manager during the reconstruction of the line for electric traction. On the London County Council system (of which Mr. Fell is chief officer) the roads have been kept open for vehicular traffic in the majority of cases, and the tramways have, with two exceptions, been kept running on a temporary track at the side of the road. During the reconstruction period, horse, cable and electric traction were used simultaneously, although while the Brixton cable section itself was being converted this portion of the line had to be closed. It was not found feasible to haul the electric cars by cable over this section owing to their weight. After reconstruction, the receipts on the Brixton part of the route were doubled and the completion of the through route increased by 25 per cent. the receipts on the other portions of the electrically-equipped line from Westminster and Blackfriars to Brixton. The cost of combined horse and cable traction on this whole route had been 9·99d. per car-mile, "mixed" electric, horse and cable traction 7·92d. and electric traction alone 7d. per car-mile. Mr. Fell anticipates that this will be reduced to 6d. when the permanent generating station at Greenwich is opened. Some of the new L.C.C. electric lines will be on the trolley system, and no difficulty will be experienced in working these in conjunction with the present conduit system. Mr. Fell considers the latter system the ideal one for London, however. A shallow tunnel is being constructed between Southampton-street and the Victoria Embankment, and as it is only 13ft. high, single-decked cars with vestibules that can be opened or closed will be used, and will run through from one end of the system to the other. Those that do not run through the subway will be double-decked. Incidentally, Mr. Fell deplores the lack of uniformity in the so-called standard gauge. Those who desire to see to what extent traction can be "mixed" are advised to visit Paris where no less than 12 systems are in use. Answers by a number of Corporations to a circular containing queries with regard to mixed traction are summarised in a table appended to the Paper.

Mr. J. F. C. Snell (Sunderland), who was present together with Mr. V. McCowan (Belfast) as representatives of the Municipal Electrical Association, was called upon to open the discussion. He thought that, on the whole, closing the road for vehicular traffic during reconstruction was the best plan, and the work would then be finished quicker. He asked why a depth of only 13ft. had been adopted for the shallow tunnel, instead of 16ft. 6in. which would have enabled a double-deck car to pass through. Finally, he deplored the fact that a standard section of rail was only now introduced by the Engineering Standards Committee, when practically all the tramways had been built. Mr. E. Benedict (Secretary of the Tramways and Light Railways Association) wondered why the conduit system had been extended so far out of the centre of London where the trolley system would have done equally well at a less cost. Mr. W. H. Tittensor (Preston) referred to recent experience of closing up a route altogether during reconstruction, and thus compelling the regular customers to walk to and from their

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work instead of driving; he would never do this again. Mr. Pitcairn (Manager of the Edinburgh cable tramways) confirmed Mr. Fell in the statement that it was impossible to keep a cable tramway going with a double line of track under construction beside it. He strongly objected to Mr. Fell's estimate of 9·99d. per car-mile for the cost of "mixed" horse and cable traction, and asked what the cost of the cable traction alone had been. 9·99d. was, he said, preposterous. Mr. Fell, replying to the discussion, said that it was only advisable to close a route entirely if other accommodation could be found by passengers. The cost of a shallow tunnel for double-decked cars would have been prohibitive. Conduit lines had been adopted on all routes which would be sufficiently remunerative to permit it. In answer to Mr. Pitcairn, he regretted that he had not more detailed figures.

The meeting then adjourned for the day. In the evening a splendid dinner was given to the Association by the Corporation of Liverpool. Bailie Paton (Glasgow) proposed the toast of the Corporation of Liverpool, and Ald. F. Smith (to whom the Lord Mayoralty of Liverpool has been offered for the coming year) responded.

On Wednesday a business meeting of the Association was first held. Mr. A. Baker (general manager of the Birmingham tramways) was elected President for the coming year, and it was decided to hold the meeting in London early in July to give the members an opportunity of visiting the tramways exhibition at the same time. Mr. Baker then presented his revised report on the hours of labour and rates of pay of employés of various municipal tramway undertakings in the United Kingdom.

A Paper by Mr. John Aldworth (general manager of the Nottingham Corporation tramways) was next read. This Paper dealt with the equipment and maintenance of cars, and covers a number of practical points: it will be found on another page of this issue. In the discussion Mr. F. Coutts (Ayr) pointed out that the glass window in the riser of one of the steps of a reversed stairway was often covered up if the car were crowded, and Mr. J. Gottschalk (Northampton) and one or two other members said that they had had trouble with folding steps. Some discussion took place with regard to wheels, Mr. A. E. Le Rossignol contending that the wear on steel tyres was due to bad adjustment of brakes, a point of view which was contested by Mr. Aldworth in his reply. The general opinion was apparently in favour of steel tyres as compared with chilled iron wheels. Mr. J. C. Spencer (Bradford) had found that the former lasted 70,000 to 80,000 miles, as compared with 15,000 to 20,000 in the latter case. Another speaker stated that he had required a guarantee with car wheels, and agreed to pay 1s. per 1,000 miles over the guaranteed run, and deduct 1s. per 1,000 car-miles under. Several speakers alluded to trouble due to broken axles, and suggested that the axles should be made ¼in. larger than present practice and the keyways be cut shallower. Others preferred solid wheels pressed on to the axles. Mr. J. F. C. Snell thought it would be advisable to make the commutator and armature spiders in one, as the wires between the commutator and the armature windings often broke off. Mr. Spencer and Mr. Snell both agreed that the motors were frequently too small for the work, and Mr. T. B. Holliday (Brighton) thought that the motors ought to be designed for each particular system. There was a general agreement that to grind up the commutators with an emery wheel was preferable to turning them up in a lathe; only one speaker disagreed with this and he had not tried the emery wheel. Cut-outs on cars were condemned, fuses being considered preferable. Mr. Spencer had had trouble with the insulation of the trolley after wet weather, and now tested his trolleys at 2,000 or 3,000 volts. He had given up the use of graphite bushes for the trolley and adopted a type with a hollow spindle filled with grease.

Several other matters were discussed, and so much time was occupied that it was necessary to defer the consideration of Mr. J. M. McElroy's Paper on "Overhead Equipment: its Construction and Maintenance" until the next meeting of the Managers' Section, which is to take place in Birmingham. We hope to publish Mr. McElroy's Paper in full, however, in an early issue. In the afternoon visits were paid to the Lister Drive electricity works and to the car-repairing shops of the Liverpool Corporation. The supply at Liverpool is on the continuous-current system, but three three-phase sets have recently been added at the Lister Drive electricity works. These generate current at 6,000 volts for some of the outlying districts, where it is transformed to continuous current by motor generators. The car-repairing shops are very large, and in addition to the actual repair of the Corporation's own cars, the Corporation is able to turn out six or seven new cars a year. In the evening the Association dinner was held and proved a most successful function. Yesterday was devoted to pleasure, a trip by tramcar over the Liverpool and South Lancashire systems to Prescot, and a visit to Knowsley Hall having been arranged for the morning, and in the afternoon a cruise round Liverpool Bay on the Mersey Dock and Harbour Board's tender "Galatea." Much credit is due to the honorary secretary, Mr. J. M. McElroy, to whose unremitting labours the success of the conference was largely due.

BOARD OF TRADE TRAMWAY REGULATIONS.

The following is the text of regulations made by the Board of Trade under the provisions of special Tramways Acts or Light Railway Orders authorising lines on public roads; for regulating the use of electrical power; for preventing fusion or injurious electrolytic action of or on gas or water pipes, or other metallic pipes, structures, or substances; and for minimising, as far as is reasonably practicable, injurious interference with the electric wires, lines and apparatus of parties other than the company, and the currents therein, whether such lines do or do not use the earth as a return. These regulations were first made in March, 1894, revised in April, 1903, and further revised in July, 1904.

Definitions.—In the following regulations the expression "energy" means electrical energy; the expression "generator" means the dynamo or dynamos or other electrical apparatus used for the generation of energy; the expression "motor" means any electric motor carried on a car and used for the conversion of energy; the expression "pipe" means any gas or water pipe or other metallic pipe, structure or substance; the expression "wire" means any wire or apparatus used for telegraphic, telephonic, electrical signalling or other similar purposes; the expression "current" means an electric current exceeding one-thousandth part of an ampere; the expression "the company" has the same meaning as in the Tramways Act (Light Railways Order).

REGULATIONS.

1. Any dynamo used as a generator shall be of such pattern and construction as to be capable of producing a continuous current without appreciable pulsation.*

2. One of the two conductors used for transmitting energy from the generator to the motors shall be in every case insulated from earth, and is hereinafter referred to as the "line"; the other may be uninsulated throughout, or may be uninsulated in such parts and to such extent as is provided in the following regulations, and is hereinafter referred to as the "return."

3. Where any rails on which cars run, or any conductors laid between or within 3ft. of such rails form any part of a return, such part may be uninsulated. All other returns or parts of a return shall be insulated, unless of such sectional area as will reduce the difference of potential between the ends of the uninsulated portion of the return below the limit laid down in Regulation 7.

4. When any uninsulated conductor laid between or within 3ft. of the rails forms any part of a return, it shall be electrically connected to the rails at distances apart not exceeding 100ft. by means of copper strips having a sectional area of at least $\frac{1}{16}$ sq. in., or by other means of equal conductivity.

5. (*a*) When any part of a return is uninsulated it shall be connected with the negative terminal of the generator, and in such case the negative terminal of the generator shall also be directly connected, through the current indicator hereinafter mentioned, to two separate earth connections, which shall be placed not less than 20yds. apart. (*b*) The earth connections referred to in this regulation shall be constructed, laid and maintained so as to secure electrical contact with the general mass of earth, and so that an E.M.F. not exceeding 4 volts shall suffice to produce a current of at least 2 amperes from one earth connection to the other through the earth, and a test shall be made at least once in every month to ascertain whether this requirement is complied with. (*c*) Provided that in place of such two earth connections the company may make one connection to a main for water supply of not less than 3in. internal

* The Board of Trade will be prepared to consider the issue of regulations for the use of alternating currents for electrical traction on application.

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diameter, with the consent of the owner thereof and of the person supplying the water, and provided that where, from the nature of the soil or for other reasons, the company can show to the satisfaction of an inspecting officer of the Board of Trade that the earth connections herein specified cannot be constructed and maintained without undue expense, the provisions of this regulation shall not apply. (*d*) No portion of either earth connection shall be placed within 6ft. of any pipe except a main for water supply of not less than 3in. internal diameter which is metallically connected to the earth connections with the consents hereinbefore specified. (*e*) When the generator is at a considerable distance from the tramway the uninsulated return shall be connected to the negative terminal of the generator by means of one or more insulated return conductors, and the generator shall have no other connection with earth; and in such case the end of each insulated return connected with the uninsulated return shall be connected also through a current indicator to two separate earth connections, or with the necessary consents to a main for water supply, or with the like consents to both in the manner prescribed in this regulation. (*f*) If the current indicator cannot conveniently be placed at the connection of the uninsulated return with the insulated return, this instrument may consist of an indicator at the generating station connected by insulated wires to the terminals of a resistance interposed between the return and the earth connection or connections. The said resistance shall be such that the maximum current laid down in regulation 6 (i.) shall produce a difference of potential not exceeding 1 volt between the terminals. The indicator shall be so constructed as to indicate correctly the current passing through the resistance when connected to the terminals by the insulated wire before-mentioned.

6. When the return is partly or entirely uninsulated the company shall in the construction and maintenance of the tramway (*a*) so separate the uninsulated return from the general mass of earth, and from any pipe in the vicinity; (*b*) so connect together the several lengths of the rails; (*c*) adopt such means for reducing the difference produced by the current between the potential of the uninsulated return at any one point and the potential of the uninsulated return at any other point; and (*d*) so maintain the efficiency of the earth connections specified in the preceding regulations as to fulfil the following conditions, viz.:—

(i.) That the current passing from the earth connections through the indicator to the generator or through the resistance to the insulated return shall not at any time exceed either 2 amperes per mile of single tramway line or 5 per cent. of the total current output of the station.

(ii.) That if at any time and at any place a test be made by connecting a galvanometer or other current indicator to the uninsulated return and to any pipe in the vicinity, it shall always be possible to reverse the direction of any current indicated by interposing a battery of three Leclanché cells connected in series if the direction of the current is from the return to the pipe, or by interposing one Leclanché cell if the direction of the current is from the pipe to the return.

In order to provide a continuous indication that the condition (i.) is complied with, the company shall place in a conspicuous position a suitable, properly connected and correctly marked current indicator, and shall keep it connected during the whole time that the line is charged. The owner of any such pipe may require the company to permit him at reasonable times and intervals to ascertain by test that the conditions specified in (ii.) are complied with as regards his pipe.

7. When the return is partly or entirely uninsulated a continuous record shall be kept by the company of the difference of potential during the working of the tramway between points on the uninsulated return. If at any time such difference of potential between any two points exceeds the limit of 7 volts, the company shall take immediate steps to reduce it below that limit.

8. The current density in the rails shall not exceed 9 amperes per square inch.

9. Every electrical connection with any pipe shall be so arranged as to admit of easy examination, and shall be tested by the company at least once in every three months.

10. Every line and every insulated return or part of a return except any feeder shall be constructed in sections not exceeding ½ mile in length, and means shall be provided for isolating each such section for purposes of testing.

11. The insulation of the line and of the return when insulated, and of all feeders and other conductors, shall be so maintained that the leakage current shall not exceed one-hundredth of an ampere per mile of tramway. The leakage current shall be ascertained daily before or after the hours of running when the line is fully charged. If at any time it should be found that the leakage current exceeds one-half of an ampere per mile of tramway the leak shall be localised and removed as soon as practicable, and the running of the cars shall be stopped unless the leak is localised and removed within 24 hours. Provided that where both line and return are placed within a conduit this regulation shall not apply.

12. The insulation resistance of all continuously insulated cables used for lines, for insulated returns, for feeders, or for other purposes, and laid below the surface of the ground, shall not be permitted to fall below the equivalent of 10 megohms for a length of 1 mile. A test of the insulation resistance of all such cables shall be made at least once in each month.

13. Where in any case in any part of the tramway the line is erected overhead and the return is laid on or under the ground, and where any wires have been erected or laid before the construction of the tramway in the same, or nearly the same direction as such part of the tramway, the company shall, if required so to do by the owners of such wires or any of them, permit such owners to insert and maintain in the company's line one or more induction coils or other apparatus approved by the company for the purpose of preventing disturbance by electric induction. In any case in which the company withhold their approval of any such apparatus the owners may appeal to the Board of Trade, who may, if they think fit, dispense with such approval.

14. Any insulated return shall be placed parallel to, and at a distance not exceeding 3ft. from, the line when the line and return are both erected overhead, or 18in. when they are both laid underground.

15. In the disposition, connections and working of feeders, the company shall take all reasonable precautions to avoid injurious interference with any existing wires.

16. The company shall so construct and maintain their system as to secure good contact between the motors and the line and return respectively.

17. The company shall adopt the best means available to prevent the occurrence of undue sparking at the rubbing or rolling contacts in any place and in the construction and use of their generator and motors.

18. Where the line or return or both are laid in a conduit the following conditions shall be complied with in the construction and maintenance of such conduit:—(*a*) The conduit shall be so constructed as to admit of examination of and access to the conductors contained therein and their insulators and supports. (*b*) It shall be so constructed as to be readily cleared of accumulation of dust or other debris, and no such accumulation shall be permitted to remain. (*c*) It shall be laid to such falls and so connected to sumps or other means of drainage, as to automatically clear itself of water without danger of the water reaching the level of the conductors. (*d*) If the conduit is formed of metal all separate lengths shall be so jointed as to secure efficient metallic continuity for the passage of electric currents. Where the rails are used to form any part of the return they shall be electrically connected to the conduit by means of copper strips having a sectional area of at least $\frac{1}{10}$ sq. in., or other means of equal conductivity, at distances apart not exceeding 100ft. Where the return is wholly insulated and contained within the conduit the latter shall be connected to earth at the generating station or sub-station through a high-resistance galvanometer suitable for the indication of any contact or partial contact of either the line or the return with the conduit. (*e*) If the conduit is formed of any non-metallic material not being of high insulating quality and impervious to moisture throughout, the conductors shall be carried on insulators, the supports for which shall be in metallic contact with one another throughout. (*f*) The negative conductor shall be connected with earth at the station by a voltmeter, and may also be connected with earth at the generating station or sub-station by an adjustable resistance and current-indicator. Neither conductor shall otherwise be permanently connected with earth. (*g*) The conductors shall be constructed in sections not exceeding half mile in length, and in the event of a leak occurring on either conductor that conductor shall at once be connected with the negative pole of the dynamo, and shall remain so connected until the leak can be removed. (*h*) The leakage current shall be ascertained daily, before or after the hours of running, when the line is fully charged, and if at any time it shall be found to exceed 1 ampere per mile of tramway the leak shall be localised and removed as soon as practicable, and the running of the cars shall be stopped unless the leak is localised and removed within 24 hours.

19. The company shall, so far as may be applicable to their system of working, keep records as specified below. These records shall, if and when required, be forwarded for the information of the Board of Trade.

Daily Records.—Number of cars running, number of miles of single tramway line, maximum working current, maximum working pressure, maximum current from the earth-plate or water-pipe connections (vide regulation 6 (i.)), leakage current (vide regulations 11 and 18 (*h*)), fall of potential in return (vide regulation 7).

Monthly Records.—Condition of earth connections (vide regulation 5), minimum insulation resistance of insulated cables in megohms per mile (vide regulation 12).

Quarterly Records.—Conductance of joints to pipes (vide regulation 9).

Occasional Records.—Specimen of tests made under provisions of regulation 6 (ii.).

MR. C. R. BELLAMY'S PRESIDENTIAL ADDRESS TO THE MUNICIPAL TRAMWAYS ASSOCIATION OF GREAT BRITAIN.*

Gentlemen, my first duty, and a very pleasurable one, is to thank the members of this Association for the honour conferred in electing me its second president. Circumstances over which I had no control rendered it impossible for me to attend the first conference of the enlarged Association at Glasgow in July last to do honour to our first president, Mr. Young. Had I been present I should have felt inclined to suggest that our good friend should have held the office until the Liverpool meeting, an arrangement which would have imparted to my address to-day the, perhaps, more fitting and congenial flavour of the inaugural presidential address, rather than the valedictory discourse of one relinquishing a pleasurable and distinguished position.

It is, perhaps, well that I should refer to the progress and work of the Association during the year. Since the Glasgow conference 11 corporations and 13 officials have been added to the roll, the Association now numbering 56 corporations and 71 managers or their assistants. This indicates that practically all the municipal tramway undertakings of the country are allied with us, a circumstance upon which we are reasonably entitled to congratulate ourselves.

* Delivered at Liverpool on Tuesday.—Abstract.

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The standardisation of tramway accounts, which was referred at the last conference to a joint committee of the Institute of Municipal Treasurers and Accountants and this Association, has been pushed forward with the vigour and care which the importance of the subject demanded. As a result of conferences held at Nottingham and Bradford, a form of accounts has been evolved which, it is hoped, will meet the requirement of enabling a fair comparison to be made of the working results of comparable undertakings. The initial difficulty appeared to be to bring into line for the purpose those undertakings which generate their own electricity with those purchasing from another source, chiefly owing to the impossibility of dealing with capital charges in the revenue account. The trouble has been overcome by providing a supplementary statement setting forth the total energy costs in the case of self-contained undertakings, which will be comparable with the purchase price of the others.

The vexed question of differential depreciation has been left entirely open by carrying the balance from net revenne account to an appropriation account, where, after satisfying mortgage loans and sinking fund charges, any balance is allocated either to "Reserve or Renewal Fund" or to "Relief of Rates."

In May last the Managers' section of the Association had a meeting at Bradford, where we were met by the mayor, and entertained most hospitably by the Tramways committee. The conference was of the nature of a family gathering, where there was no "chiel amang us takin' notes," and we discussed our failures freely as well as our successes, and exchanged experiences on a variety of topics of everyday interest, with great advantage to all.

The municipalisation of British tramways is making steady progress, about 215 additional miles of tramways having been applied for during the present session under an estimated cost of over £5,000,000, and provisional orders have been granted for about 34 miles, the estimated expenditure amounting to £307,380. There is evidence of a better recognition of the principle underlying the early action of some of the large towns in arranging to acquire or operate the tramways of small adjacent authorities. In this connection the subject of through running becomes increasingly important, because where combination or absorption cannot be arranged between adjoining districts, it will have to be considered.

The convenience of the public must always be placed in the forefront of traffic considerations, and just as the railway companies had to arrange through running very early in their history, so it is becoming a necessity with the ever-extending systems of tramways, and it is desirable that this should be recognised and the principles controlling it settled by municipalities while their position for purposes of negotiation is strong. In many cases where adjacent local authorities have failed to amalgamate for tramway purposes or link their systems, company promoters, recognising the necessity, have stepped in to provide the required connections; thus, in the case of our own county, the South Lancashire Company has connected, or obtained authority for connecting, 28 of the principal towns, bringing into one vast network Liverpool and Manchester, which, in turn, is rapidly linking itself with an equally important combination of the principal towns of Yorkshire. It is unfortunate that the municipalities concerned do not control all these lines. Under a system of joint municipal ownership and more centralised management their usefulness would be enormously increased.

There are many important reasons why the work of tramways should be largely extended. There are considerations apart and beyond the immediate benefits to the public that would follow. The safeguarding of the financial stability of our undertakings must be considered. The returns for last year disclose the grave fact that nearly a dozen municipal undertakings ended the year with a deficit. It is probable that in most of these cases satisfactory results would have been obtained if routes, stages and fares had been arranged on a basis suitable to the particular district concerned, rather than framed in an attempt to imitate those of large towns, where continuous streams of point-to-point traffic alone render them possible.

In the large towns there are also signs of danger ahead. Great benefits have accrued under municipal control—routes, service and speed of cars have been largely increased, with a reduction in many cases to less than one-half the fares under horse traction. To-day, the tramways are within a few minutes' walk of everyone's door, with a practically continuous service at all times of the day and nearly all night throughout the year, and prudence suggests that further concessions should be sparingly accorded until systems are consolidated and their financial stability finally secured. It is, however, difficult to obtain proper recognition of these requirements, and we all experience the well-nigh impossible task of resisting at certain periods of the year proposals which are fraught with grave danger. The halfpenny stage, the penny universal fare, the all-night service, the season ticket, a multiplication of adjacent parallel routes and, lately, farthing fares for scholars, are all questions of most serious importance, which, if carelessly dealt with, may at any time lead to disastrous results, and the obvious danger underlying them should suggest the advisability of increasing the sources of tramway revenue in directions less subject to popular attack.

It will, however, be remembered that the Tramways Act of 1870 provided for a general merchandise traffic, and while this class of business under company control has been practically ignored, it is probable that with inter-urban connections and joint municipal control it would become a very useful source of additional revenue as well as a great boon to important sections of the trade of the country. It is satisfactory to note that the carriage of parcels has already been taken up on nearly one-half of our tramway systems.

For many years it has been apparent that some better method of collecting and carrying the agricultural and dairy produce of the districts surrounding large towns has been necessary beyond that provided by the railways, which cater almost exclusively for the traffic between the large centres. Considerable areas are wholly without any form of carriage other than the horse vehicle; in fact, the abandonment of the canals of the country, largely as a result of their purchase by the railway companies, has reduced the distributing network. This was made clear in the evidence tendered to the Royal Commission on Agricultural Depression in 1895-7, when the Light Railways Act was offered as a possible solution of the difficulty. Under this act the Treasury was empowered to make loans for the construction of light railways, and free grants where the construction of such railways would benefit agriculture or connect fishing harbours with a market, or for the development or maintenance of some definite industry.

During the first seven years of the operation of this act, 257 applications were sent to the Board of Trade for confirmation, the length of line being 1,638 miles, and the estimated cost £12,150,447, but these were largely for passenger tramways, which I do not think were contemplated under the act, and, therefore, towards the construction of these lines the Treasury has only assisted to the extent of £250,000 by loan or free grant. The object of the Government in passing the Light Railways Act was avowedly in the interest of the small agriculturist and traders carrying on business at distances from the railway, which excluded them from the markets of the country.

The recommendations of the Committee on which the bill was framed were mainly on two points—the cheapening of the methods of obtaining Parliamentary powers, and the relaxation of the Board of Trade requirements. The bill proposed to commit the authorisation of light railways to county councils and county boroughs. The Committee reported that they had given special attention to the case of light railways in agricultural districts, and had also considered tramways in rural as well as urban districts, and pointed out that the powers then existing had not been availed of in the case of light railways owing to the consent of the railway companies being necessary, and to want of latitude on the part of the Board of Trade, and in the case of tramways, in consequence of the local authorities requiring conditions which were considered too onerous.

The Committee considered that impediments to construction might be greatly diminished, and that on a large portion of the lines contemplated, regulations which had been previously enforced might be considerably relaxed. It was considered that the newly-formed county councils and county boroughs might be vested with powers of authorisation which it was assumed would be exercised with due regard to the existence of local control and responsibility. With these changes it was thought that the initial cost of construction and the expense of working would be so greatly reduced that many light railways and tramways would be constructed, to the general advantage of trade, and especially to agricultural districts without any satisfactory means of transport.

The Light Railways Act has failed for two principal reasons: Firstly, because the authorisation was not transferred to local authorities, and, secondly, largely consequent upon the first, local authorities have not attempted to provide the railways. Market gardening, including fruit growing and dairy work, is carried on profitably within easy cartage distance of any large town, but beyond a radius of a few miles from such centres heavy cartage and railway terminal charges, coupled with the unavoidable delay attending transhipment in transit render this industry unremunerative. Declining agriculture has led many of our legislators to consider the problem of dealing with the production in this country of fruit, vegetables and dairy produce which our climate favours, and which are at present largely imported. Their production at home would take a large amount of labour back to the land, which for present bulk crops is principally operated by machinery. The imports of food stuffs capable of being raised at home amounted in 1903 to the amazing total of £43,752,162. Competent authorities have persistently asserted that the bulk of this produce could be profitably raised in this country if it were possible to convey it cheaply and expeditiously from the producer to the consumer.

The ever-increasing network of municipal tramways, with their connecting links, might quickly provide the whole country with a system cheaper in operation than was contemplated under the Light Railways Act, which would do much under proper recognition of its capacity to largely increase the trade and revenue of the country. There can be no doubt as to this in the minds of anyone who has had an opportunity of seeing what has been effected in America in

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connection with inter-urban tramways. The manufacturer there has no difficulty in selecting a cheap and suitable site for building, as an inexpensive tramway siding to his premises connects him practically at any point with the gathering and distributing systems of the country. Agriculturists are largely benefited, cheap and rapid transit between the land and the town for more remunerative produce is secured, and where large systems, such as Detroit, Cleveland, Toledo and Buffalo, have got well under weigh, it is clear that large and general benefits ensue, and no interests are adversely affected. It was at one time thought that goods traffic on tramways would interfere very largely with the revenue of railways, but it is found that tramways make a business peculiarly their own, while aiding largely in the development of railways.

In these terms the railway and tramway companies are working with the utmost harmony, their systems are connected, and often a number of railway cars are taken from the steam roads over the tramways by electric locomotives from point to point in the city, to the great advantage of traders, who by this means secure much earlier and cheaper delivery. I believe there is great scope for such a development of tramways in this country.

Coming nearer home, the Belgium light railways may be referred to. These lines are independent of the main lines but in connection with them, and are light rural railways running alongside or on main roads. Generally, they are from 2 to 30 miles in length in the neighbourhood of most of the principal towns. About a quarter of the capital is furnished by the State, another quarter by the provinces and the remainder by the National Light Railway Society, which is nominally a private company but is practically controlled by the Belgian Government. Agricultural, dairy and general produce is carried at very low rates, milk is taken for distribution free of charge and empties are returned free. It is stated that these railways have been a great success and the maximum interest of 4½ per cent. paid.

A similar system is in operation in Italy and other parts on the Continent—indeed, every country in Europe, with the exception of England, is doing all it can to develop light railways for the benefit of the vast areas of land untouched by railways.

The municipalities, acting in concert with county councils, have an opportunity of providing a system of light railways by making the most effective use of the public highways, which would render it possible, in addition to other obvious benefits, to produce in our own country the £40,000,000 worth of food stuffs annually which are at present imported, conferring upon producer and consumer immeasursable benefits which should secure to our tramway undertakings the success which has followed the adoption of this class of haulage on the Continent, where, by the cheap concentration of produce and combined bulk-forwarding, it has been placed on the English markets under lower transit cost than can be secured by the British farmers operating within 20 or 30 miles of the same market.

After studying the evidence given before the Royal Commission on Agricultural Depression, I feel satisfied that farmers and landowners would join with the county council in affording, as far as possible, necessary facilities for the widening of roads and the provision of common collecting and distributing depots which might be found necessary.

I would suggest that this Association might effectively demonstrate its general usefulness by preparing a memorandum of a scheme for facilitating the provision of inter-urban tramways, in conference with the representatives of county councils, for consideration by the Minister of Agriculture. It is not too much to hope that the Government might be induced to accept the recommendations of the Special Committee of 1895 on Light Railways in connection with the amendment of that act, which is now under consideration, which, unfortunately, were largely omitted in the present act, and following the Continental practice of more generous assistance, preferably in the matter of road widening, enabling municipal and county councils acting in concert to provide a system of road carriage which would confer inestimable benefits on the whole community.

CARS: THEIR EQUIPMENT AND MAINTENANCE.*

BY MR. JOHN ALDWORTH
(General Manager, Nottingham Corporation Tramways).

Mr. President and Gentlemen, "Cars, their equipment and maintenance," is undoubtedly one of the most important matters with which tramway managers and their staffs have to deal, as this is the actual and visible source from which the revenue of the undertaking is derived. The average passenger does not trouble himself about such matters as the design or equipment of the power station, and provided there is always sufficient power to run the car on which he is travelling, rests satisfied that everything there is as it should be; but let the car be not quite to his liking as regards accommodation, especially when asked to close up and make room for "just one more, please," or the temperature inside does not exactly suit his particular ideas on the subject, he is often very much in evidence; whilst, for want of something else to grumble at, he occasionally enlarges upon the way in which he would build and run cars if he had anything to do with the matter beyond, as he is fond of telling the tramway employés, "having to help to pay for them."

The subject is also a very large one, and no attempt will be made in this Paper to treat it at all fully, as to do so would be to raise more points than could reasonably be dealt with in a Paper of this description, or discussed in the limited time at our disposal. The writer, therefore, proposes to touch only upon a few of what he considers to be the most important features, and wishes it to be understood that his observations are chiefly a description of the methods in operation on the Nottingham system, the result of some 11 years' experience in the working of that and other electric tramway undertakings; also, that it is not intended to lay down rules and regulations upon matters which have to be dealt with in accordance with the local or special conditions pertaining to each separate undertaking, but only to provide a basis for discussion and comparison with the methods in operation on such undertakings.

Design of Cars.—Cars should be of a design and size most suitable for the safe and expeditious handling of the particular class of traffic to be dealt with. For the traffic in the streets of large towns, single-truck cars carrying from 50 to 56 passengers are, in the writer's opinion, the mosts uitable. From the passengers' point of view, it gives a more frequent and a quicker service, whilst from an operating point the car is more easily handled, and can work its way through the ordinary traffic of the streets with much less risk of accidents. For dealing with a long distance and varying traffic over suburban lines, the large bogie car carrying from 80 to 100 passengers has its advantages.

Of the reversed and the ordinary type of staircase, both have their advocates. For ensuring the safety of passengers, protecting motormen and conductors from the vagaries of the English climate, and utilising all the space possible for seating accommodation, the reversed type is undoubtedly the best, the chief drawback being that it to some extent obstructs the motorman's view of the traffic on one side; the writer has overcome this difficulty by inserting a small sheet of ¼in. plate-glass in the riser of the staircase level with the motorman's head. This device has now been in use for a considerable time, and has proved very effective.

The efficient ventilation of the car is one of the things that until quite recently has not had sufficient attention devoted to it, and many of the earlier cars leave much to be desired in this respect. To remedy this defect as much as possible, the writer has had the four corner-side ventilating windows, which were originally hinged at the bottom, pivoted vertically at the centre, so that the end of the ventilator nearest the platform swings outward and the other end inward, thus giving two openings on each side of the car through which a supply of fresh air is admitted at the front, above the passengers' heads, the foul air being forced out through the two corresponding openings at the rear end. The size of the openings can be regulated according to the state of the weather. With cars having rheostats fixed inside under the seats the question of ventilation becomes still more important, and for this reason, if no other, the writer considers all rheostats should be fixed in some outside position.

A folding step is being given a trial in some towns. The writer, however, is unable to give particulars of this device, but hopes something will be said on this subject by the members present who have been trying it. The writer does not propose to touch upon such controversial subjects as top-deck covers, dry seats, wind shields, route indicators and life-guards, which for some time past have been so much in evidence.

Motors.—To ensure a satisfactory service, it is necessary that cars should be equipped with motors designed to meet the varying conditions of the particular system they have to operate, and be capable of developing sufficient power to enable them to climb the steepest gradient thereon without being unduly overloaded; as, although the initial cost may be lower and the average consumption of current per mile kept a fraction less with a smaller motor, the additional cost of repairs will more than counterbalance this, to say nothing of the risk of breakdowns on the road, with its consequent interruption of traffic. Given a properly-designed and sufficiently powerful motor, the important thing is to see that it is well taken care of. This can only be done by having it systematically inspected and maintained in its most efficient condition.

The writer has tried several methods of inspection and reporting upon the condition of the car motors, also of carrying out the repairs, and the following system has been adopted as the result thereof. The commutators, brushes and brush springs are examined nightly, and where any commutator shows signs of undue sparking or heating it is carefully examined by the night foreman, and if no cause for it can be discovered it is is cleaned, and the car again put into service; instructions are given to the chief motor inspector to

* Paper read before the Municipal Tramways Association of Great Britain on Wednesday.

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test the car on the road during the following day, and if then found to be working unsatisfactory in any way, it is sent into the works to be thoroughly tested and the defect put right. Armature and motor bearings, with their lubricating boxes, are also examined nightly, and any defect discovered is reported to the night foreman, who in every case uses his discretion whether such can be efficiently dealt with by himself, or whether the car shall be kept in for it to be dealt with by the day staff.

The writer has tried several kinds of white metal for lining motor and armature bearings, also solid gunmetal armature bushes of different mixtures; the latter, however, are not being renewed, but when worn down are bored out and run up with white metal instead of being scrapped. This has been found to answer well, besides effecting the following saving in the cost of renewals under this head:—Gunmetal bushes for one armature, including boring and turning, after allowing for their scrap value, 18s. 1½d. Boring out old bushes, filling with white metal and boring, 5s. 8d. Each subsequent re-lining and boring, 1s. 8d., or a difference of 16s. 5½d. in favour of white metal lining. The average life of the gunmetal bushes has been 25,086 miles, and that of the line bushes practically the same. A further advantage is found in the fact that should a bearing run hot, there is not the same danger of the shaft being scored with white metal as is the case with gunmetal. A metal is now being tried for lining, composed of three parts virgin spelter to one part block tin, which is considerably harder than any other white metal tried. This has not been in use sufficiently long to enable particulars to be given of the mileage to be obtained from bearings so lined; but so far they have given good results, the journals being in excellent condition, and the writer has no hesitation in saying they will give a considerably increased mileage.

Armatures, field coils and leads are thoroughly examined, tested and coated with insulating compound, also commutators turned up, if required, every time the car passes through the repair shops for overhauling the bearings. The writer believes that considerable advantage would result from having commutators ground true instead of being turned up in the lathe, and is now experimenting in this direction. The condition of the armature bearings of each car is determined at least once a month by the night foreman, who tests the clearance between the armature and bottom fields, for which purpose he is provided with a set of steel feelers, numbered and varying in thickness from $\frac{1}{16}$in. to $\frac{1}{32}$in. The exact clearance of each armature is recorded and sent to the works superintendent, who decides when it is necessary for the bearings of a car to be renewed.

After being repaired, each armature undergoes an insulation test; and before being put under a car it is also tested at full load by being run for a period of 15 minutes in either direction. This shows up any defects in the repairs, and ensures it being in perfect working order when again put into service.

Controllers.—Controllers are all examined at the end of each day's work; all contacts are cleaned and thinly coated with vaseline, also adjusted or renewed as found necessary. The whole of the inside is kept perfectly clean, and the parts which require it are periodically coated with insulating compound, with the result that it is a very rare thing for a controller to give trouble.

Automatic Cut-outs.—These appliances from time to time gave considerable trouble on the road, and it was found advisable to calibrate them every time a car passed through the shops for overhauling. This has effectively dealt with that particular trouble.

Trolleys.—All trolleys are examined daily, whilst the poles are also tested for tension, and adjusted, if found necessary, once a month. Experiments have been made with several kinds of trolley wheel bushes, and one composed of solid graphite has been found to give the best results. The bush, wheel and spindle, now submitted for your inspection, has run 5,762 car-miles, and although the wheel is nearly worn out, the bush and spindle are very little the worse; they can be put into, and will last the life of, a second wheel. The cost of the bush is 1s. 2d., compared with 1s. paid for the metal-cased graphite bush, of which two are required during the life of one wheel.

The protection of passengers from electric shock is an important matter, and to ensure this as far as possible by the immediate detection of a leakage, ruby lamps are being used in the leakage circuit, so that they shall not be confused with the platform lamps. All leakage lamps and circuits, also lightning arresters, are examined and tested at least once a month. Some undertakings have had their cars fitted with a patent "trolley earth indicator," which consists of a short-circuiting switch, held open by means of a fine wire fuse. This wire is connected in shunt with the switch, and as the whole apparatus is in circuit between the trolley base and earth, immediately upon the standard getting alive the fuse is melted and allows the switch to close by means of a spring. This connects the standard directly to earth, and causes an electric or mechanical bell to be set ringing.

Brakes.—The question of brakes is an important one on every undertaking, but where cars have to negotiate gradients of 1 in 11·5, and carry some of the heaviest rushes of holiday traffic over them, as is the case on the Nottingham system, it becomes a very important one indeed, and the writer considers that too much attention cannot be given to assure their being maintained in the highest possible state of efficiency. It is not proposed to discuss the merits or demerits of the various types on the market, but only to emphasise the importance of having motormen properly instructed in the best way to use the brakes at their disposal, and a systematic inspection and overhauling of such brakes by trained and competent men. Money so spent can be considered as a first-class insurance premium against accidents.

All the cars under the control of the writer are equipped with either a mechanical or magnetic track brake, in addition to the ordinary ratchet wheel brake, all of which are carefully examined nightly, and the necessary adjustments or renewals executed; in addition to this, all the brakes of every car are examined and tested once a month, under the direct supervision of the works superintendent, or his chief assistant. A number of the cars are fitted with an automatic adjusting device, for keeping the blocks set to the proper distance from the wheels. These are acting very satisfactorily, and effect a saving in labour.

During the time the Nottingham electric system has been in operation, nearly four years, there has not been a single case of a car running away, which of itself fully justifies the great care that has always been bestowed upon this part of the equipment.

Wheels and Axles.—As to the vexed question of steel versus chilled iron wheels, sufficient has been heard of this recently to excuse a comparison of their merits being entered upon in this Paper. Like many others, the writer has been experimenting with steel-tyred wheels, but considerable difficulty has been caused by the flanges. Possibly this may be attributed to the fact that they have a large number of curves to negotiate. On one route of about 3 miles there are seven curves of a radius ranging from 45ft to about 60ft. Very good results have been obtained from chilled wheels, some having run upwards of 45,000 miles, the average life being 34,124 miles, and in only one case has a pair been trued up in the grinding machine. We have a good permanent way, which doubtless accounts to a large extent for our comparative freedom from the troubles connected with broken axles and wheel flanges.

For single truck cars the tendency appears to be in favour of increasing the size of the axles. This is undoubtedly a step in the right direction, as a much larger diameter might be used with advantage, not only for the additional strength, but also to obtain a larger bearing surface. The writer is not in a position to discuss the question of broken axles, having had but one failure in 6¾ million miles run by the cars.

Inspection and Reports.—To avoid as far as possible breakdowns on the road, and for assisting motormen who might be in difficulties a motor inspector is stationed at a point on the system where all the lines converge. Defects reported to him are dealt with on the road, or the car changed if necessary, and a daily report of all such cases is made by him. He is in direct telephonic communication with each depot, which enables him to arrange for the changing of cars at the most convenient point. Definite instructions have also been given that under no circumstances shall a car be allowed to remain in service with its brake in the slightest degree defective. In addition to this, every motorman before going off duty enters in the report book at his depot particulars of any repairs requiring attention, and attaches his signature thereto. There reports are compared with that of the motor inspector, and a return of all repairs executed during the night is handed in to the works superintendent each morning.

The running condition of each car is tested periodically by the chief motor inspector, who himself operates it both up and down the heaviest gradient of the route upon which it is running, and the result thereof is also reported to the works superintendent. This has proved a very effective way of detecting faults, and having them dealt with on the "stitch in time" principle, as the inspector, being trained to look for defects, and able to compare the running of the different cars over the same route, is much better qualified to detect incipient troubles and express an opinion thereon than is the average motorman, whose reports are often misleading and require to be examined with great care. None but brake and trolley renewals and light repairs are executed at the branch depots, all cars requiring other attention being sent to the works, by which arrangement the work is carried out under the most economical, expeditious and efficient conditions.

Equipment of Repair Shops.—To deal with the repairs and upkeep in an economical and satisfactory manner, it is necessary that the shops should be equipped with up-to-date labour-saving machinery, testing machinery and instruments; and for an undertaking operating from 100 to 150 cars using chilled wheels, the following has been found adequate:—

In the fitting shop: A 5-ton electric travelling crane, two lines of shafting, each belt driven by a 10 H.P. motor, 10in. screw cutting gap lathe, 6in. screw cutting lathe with universal chucks, vertical wheel boring machine, wheel grinding machine, hydraulic press, radial drilling machine, small sensitive drilling machine, universal shaping machine,

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power hack saw, screwing machine, acme grinder, grindstone, moulding jigs for lining bearings, lifting jacks, and armature bogies, with various small tools as found necessary.

In the armature room: Armature stands, wire drums with tension brakes, furnace, formers, taping machine, drying oven, testing machine and insulation testing set.

In the smith's shop: Two forges, anvils, swage blocks, set of levelling blocks, small power hammer and "Roots" blower driven by independent motor.

In the woodworking shop: Line of shafting driven by a 5 H.P. motor, circular saw bench fitted with boring apparatus, band saw, planing machine, mortising machine and universal trimmer.

The buildings should be constructed and the machinery arranged so as to avoid undue handling of the car and different parts of the equipment whilst undergoing repairs. Pits should extend the full length of each track and communicate with each other, also be fitted with hydraulic platforms for removing wheels and axles from under the cars. To obtain the best results, all the shops should be concentrated as far as possible, have plenty of light and ventilation, and be provided with good heating and sanitary arrangements.

Cleaning and Painting.—As the amount of the painting bill undoubtedly depends largely upon the method of cleaning in operation, these two processes should be considered together. The writer is not sure that the cleaning ought not to be under the control of the foreman car painter, instead of the night foreman, being satisfied that considerable economy can be effected in the planting department by paying every attention to the methods of cleaning: besides which, a well-cleaned and smart-looking car is highly appreciated by the passengers, as well as being a credit to the undertaking. He has always had the cars cleaned with oil, and the amount paid in cleaners' wages is somewhat above the average of other undertakings; but as a number of cars have been in service nearly four years and the outsides required nothing more than touching up and revarnishing, he considers this course is justified. The insides are kept clean with soap and water, and, with the top seats, are revarnished as required; whilst the top decks are given two coats of best oil paint at least once a year, to insure their being kept watertight.

General.—To enable a check to be kept upon the repairs bill, which, by its tendency to increase, appears to be always trying to take a more prominent place in tramway matters, also to decide upon the best methods and materials to be used in connection therewith, full and accurate records should be kept of all matters connected with the running, inspection and repairs of the cars, as only by a careful study of these can the many points coming under consideration be adequately dealt with.

In conclusion, the writer wishes to say he is afraid there is very little new, or of a substantial nature, contained in the Paper, but feels that comparisons of the methods of working, and also the operating expenses of different systems, are always interesting if not conclusive. A manager whose system consists mainly of steep gradients has reason to feel envious of the low cost, to say nothing about the minimised risk of accidents, at which other systems can be operated whose routes are all practically level. Not only is the consumption of current much heavier with steep gradients, but the writer finds the cost of maintenance also increases in practically the same ratio. No conclusions, therefore, should be drawn from such comparisons, without taking into consideration the many different conditions under which the undertakings have to be operated.

CORRESPONDENCE.

HEAT RADIATION FROM STEAM PIPES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We notice in your issue of September 9th you print an article on "Heat Radiation from Steam Pipes," by a Mr. Francis Davies. The writer of the article absolutely ignored the better class asbestos which is used for non-conductive purposes. Moreover, you will see that the paragraph dealing with asbestos plainly shows that Mr. Davies used so-called "asbestos" compositions and millboard, which contain not more than 25 to 50 per cent. of asbestos, and that of the very lowest grade, and the results obtained he holds as representative of asbestos.

We cannot do better than enclose you our official catalogue full of tests and testimonials from first-rate authorities, as well as a report of the National Boiler and General Insurance Co., on tests made by them on our coverings, which latter alone proves the unfairness of this article. In the catalogue sent you will find the difference between blue and white asbestos well pointed out, and on p. 78, a letter from the Charlottenburg High School is printed, which proves that blue asbestos is 25 per cent. more efficient than the best white asbestos.

We are tendering for some of the requirements of the London County Council, and, as their specification requires very high insulating properties in the material to be employed, we enclose you an extract from the specification and also of a letter we received from the National Boiler and General Insurance Co., giving additional figures for comparison with their original test. It will be seen from these figures that the mattress covering fulfils the requirements of the L.C.C. twice over, whilst the rope pipe covering, which was very much thinner, more than meets the case.

As for handiness and durability of blue asbestos, the appended letter, dated Septtember 1st, from Mr. A. Atkins, should be noted.—Yours, &c.,

THE CAPE ASBESTOS CO. (Ltd.)

London, Sept. 26. R. Wild.

[We give below the reports and letters referred to.—ED. *E.*]

COPY OF REPORT BY MR. EDWARD G. HILLER, OF THE NATIONAL BOILER AND GENERAL INSURANCE CO.

Manchester, January 29, 1904.

GENTLEMEN: I beg to forward herewith our complete report on the heat non-conducting covering tests we have recently made for you. The tests are important, inasmuch as they have been made at high working pressures. These pressures were selected at 160lb. in order to represent the standard pressure in electric stations and the like, and at 300lb. in order to represent the standard naval practice. We have no records of tests having been previously made at so high a pressure as 300lb. I have to report that all the coverings tested show high efficiencies at these high temperatures and pressures.

The significance of the figures given in the schedule of results is more marked when they are put into their equivalent in pounds of coal saved by the efficient covering of heat radiating surfaces. Taking as an example the radiation loss per 100 sq. ft. of bare surface with a steam pressure of 160lb. per square inch, the weight of steam condensed per hour is 121·3lb. for the bare pipe and 9·8lb. with the pipe covered with mattresses. The saving effected by the mattress covers is thus 111·5lb. of steam per hour, which, with a boiler evaporating 8lb. of water per pound of coal, is equivalent to 13·9lb. of coal. The annual saving, therefore, per 100 sq. ft. for a year of 50 weeks of 60 working hours would be 18½ tons of coal. The great economy to be obtained is evident from these figures.

Object of Tests.—The object of the tests was to determine the efficiency and the actual heat loss with the following heat non-conducting coverings in use:—

(*a*) Blue asbestos mattresses with blue asbestos fibre filling.

(*b*) Blue asbestos rope.

Schedule of Results.

Test at pressure of 160lb. per sq. inch. Temperature of steam 370·5°F.

Particulars.	Mattress covers.	Rope covering.	Bare pipe.
Thickness of covering in inches	2¼	1¾	..
Weight of covering per foot run .....lbs.	5·4	4·3	..
Temperature of covering, outside layer	98°F.*	115°F*	..
Temperature of surrounding air	52°F.	54°F.	51°F.
Increase over surrounding air	46°F.	61°F.	..
B.Th.U. per sq. ft. of bare pipe surface per hour	83·7	141·5	1,034
B.Th.U. per sq. ft. per hour per deg. difference of temperature.....	0·263°F.	0·447°F.	3·236°F.
Llbs. of steam condensed per sq. ft. per hour	0·0982	0·166	1·213
Per cent. of condensation in covered pipes to bare pipe condensation.....	8·09	13 68	100

Test at pressure of 300lb. per sq. inch. Temperature of steam 422·3°F.

Thickness of covering in inches	2¼	1¾	..
Weight of covering per foot run.....lbs.	5·4	4 3	..
Temperature of covering, outside layer	109·5°F·*	125°F.*	..
Temperature of surrounding air	59°F.	49°F.	54·5°F.
Increase over surrounding air	50·5°F.	76°F.	..
B.Th.U. per sq. ft. of bare pipe surface per hour	89·7	148·4	1,204
B.Th.U. per sq. ft. per hour per deg. difference of temperature.....	0·2476	0·398	3·27
Llbs. of steam condensed per sq. ft. per hour	0·1105	0·182	1·478
Per cent. of condensation in covered pipe to bare pipe condensation.....	7·47	12·31	100

* These temperatures were taken just under the outside woven covering.

Further calculations, based on the results of above tests of your coverings, show that the probable loss of heat per hour per square foot of pipe surface per degree difference of temperature between steam at 200lb. per square inch in the pipe and the surrounding air would be about—

0·26 B.Th.U. for the mattress covering, 2¼in. thick.

0·43 ,, ,, rope covering, 1¾in. thick.

Description of Apparatus.—The coverings were tested on the plant, for the testing of heat non-conducting composition, which has been put down for this special object by the National Boiler and General Insurance Co. (Ltd.). The pipe on which the coverings were tested was 6in. bore,

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15ft. long, and was a lap-welded mild steel pipe with plates ⅜in. thick, with flanges welded on and generally similar to those in common use in electric light stations, &c. This pipe was suspended in an inclined position and was provided with suitable arrangements to ensure the collection of the steam condensed by the cylindrical part of the pipe and to exclude that due to the flanges and ends.

The radiating surface of the cylindrical part of the pipe was 24·45 sq. ft. All water condensed in this testing space ran to a drain provided to take the water through a flexible steel pipe to a water-collecting bottle. The water-collecting bottle consisted of a steel vessel resting on the platform of a delicate pair of scales. The condensation due to the collecting vessel and other measuring parts was determined separately from that due to the part of the pipe under test. This condensation was determined before the experiments commenced and also before and after each successive experiment.

Description of Tests.—Each covering was tested at 160lb. and 300lb. per square inch steam pressure. The steam pressure in the apparatus was maintained constant throughout each test. Time observations were taken at each ¼lb. weight increase of water of condensation to the collecting bottle, and by this means the uniformity of the rate of the condensation was checked, and when plotted out on square paper the results showed practically straight lines. This entire absence of any irregularity in the results is evidence of the uniformity of the conditions and accuracy of the tests.

As a basis of comparison, the condensation of steam was measured with the pipe uncovered. It will be noted that, taking the losses with the bare pipe as 100 per cent., the relative losses with the various coverings are as below:—

	160lb.	300lb.
Mattress covering 2¼in. thick..	8·09 per cent...	7·47 per cent.
Rope covering 1⅜in. thick	13·68 ,, ..	12·31 ,,
Bare pipe	100 ,, ..	100 ,,

Due note should be taken of the variations in the thickness of the coverings. Each class of covering offers special advantages according to circumstances, and both gave good test results.

COPY OF REPORT BY GEH. RAT. PROF. RIETSCHEL, OF THE CHARLOTTENBURG TECHNICAL HIGH SCHOOL.

Charlottenburg, October 20, 1903.

DEAR SIRS: The tests made on your insulating material (blue asbestos) have given the following results:—Ordinary white asbestos was applied on a pipe 17mm. thick, and 42 per cent. decrease in radiation was noted, as against the uncovered pipe. The same thickness of blue asbestos was applied to the same pipe, under the same conditions, and 52 per cent. decrease in radiation was noted, from which it would appear that blue possesses a greater insulating value than white asbestos. . . . We thank you, in the name of the Institute, for sending the material.—We are, dear Sirs, yours faithfully, (Signed) MARX, Assistant.

EXTRACT FROM SPECIFICATION OF LONDON COUNTY COUNCIL FOR ELECTRIC TRAMWAYS GENERATING STATION AT GREENWICH.

Steam, Exhaust and other Piping.

Pipe Covering.—34. . . . The quality and thickness of the covering to be such that, with steam pipes fed with saturated steam at 200lb. pressure, or with steam superheated to a total temperature of 550°F. the loss of heat per square foot of pipe surface per hour shall not exceed five-tenths British thermal unit for each degree Fahrenheit difference of temperature between the steam and the room. By "square foot of pipe surface" is meant the area of the outer surface of the pipe before the covering is put on, and not the surface of the pipe when covered.

EXTRACT FROM A LETTER OF THE NATIONAL BOILER AND GENERAL INSURANCE CO. (LTD.) MANCHESTER.

. . . We have made some calculations based on the results of our tests of your coverings and find that the probable loss of heat per hour per square foot of pipe surface per degree difference of temperature between steam at 200lb. per square inch in the pipe and the surrounding air would be about—

0·26 B.Th.U. for the mattress covering.
0·43 ,, ,, rope covering.

The figures, however, are for a 6in. pipe with coverings similar to those used in the test—viz., mattresses 2¼in. thick, rope 1⅜in. thick.

LETTER FROM MR. A. ATKINS AS TO DURABILITY OF BLUE ASBESTOS.

SS. "Leitrim," Victoria Dock, September 1, 1904.

The Cape Asbestos Co., 8, Minories, E.C.

DEAR SIRS: I have pleasure in stating that the blue asbestos removable mattresses fitted to above vessel's boilers and induced fan engine casings, as also your rope coverings for steam pipes (in September, 1896), have given every satisfaction, and in spite of wear and tear are still in sound condition. Their adaptability for removal, to get at parts for repairs, is most convenient, being removed and replaced by ordinary vessel's fireman.—Yours very truly, (Signed) A. ATKINS, Chief Engineer.

ELECTRICITY SUPPLY IN WOOD GREEN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Notwithstanding your advocacy of supply in bulk to local authorities by the large power distribution companies, there is no doubt that municipal electricity works of medium size, when properly designed and managed, can be made more remunerative than an undertaking taking current in bulk at the present high rates charged.

Wood Green at the present time is very similar in population, rateable value and class of residents to what Ilford was four years ago when the electricity undertaking was first started, and I have no hesitation in saying that similar results to those obtained in Ilford could be equally well obtained in Wood Green.

The first year's working here certainly resulted in a deficit, but this was more than wiped out by the profit on the second year, since when the success of the undertaking has been assured. Last year the total costs, including all sinking fund and interest charges on the whole of the plant and mains, amounted to only 2·4d. per unit sold, and it would certainly not have been possible to show anything like this result had we been obliged to purchase current at the prices at present generally charged by the large power distribution companies. When the defunct East London and Lower Thames Bill was before the House of Lords Committee recently, it was stated that current could be generated and supplied to factories, &c., at 1d. per unit, and, even at this figure, I do not consider it would pay an undertaking such as this to purchase current, seeing that the greater part of the capital expenditure would still have to be incurred, in our case approximately one-half of our total capital being expended on mains, which would still be required, in addition to converting plant, meters, &c.

I do not follow your argument that in the case of taking supply in bulk there is no possibility of a call upon the rates, as would exist in the case of a separate generating station. The sinking fund and interest charges would still have to be paid, and it would be quite possible not to make sufficient profit in the first few years to cover these charges.—Yours, &c.,

Sept. 27. ARTHUR H. SHAW.
(Electrical Engineer to the Ilford Urban District Council.)

LEGAL INTELLIGENCE.

Edey v. Smith.

On Wednesday in the City of London Court, before Judge Rentoul, K.C., Mr. F. G. Edey, electrical engineer, sued Mr. F. H. Smith for £76 for work done and materials supplied for the electric lighting of certain flats. Defendant, who was building flats in Chelsea, entrusted plaintiff with the contract for electric light wiring, electric bell fitting, &c. Plaintiff alleged that he had done part of the work satisfactorily, but was unable to complete it because defendant stopped the work. Defendant pleaded that plaintiff agreed to give three months' credit, which had not expired, that plaintiff had refused to complete his contract, that the work was badly done, that the electric lighting company would not approve the wiring, and that the electric bells which plaintiff had put up would not ring. No local authority would supply electricity to the flats in consequence of there being no reducers put in by plaintiff. Plaintiff, on his part, declared that the bells would ring, and that the wiring had all been carried out satisfactorily.

A number of witnesses were in court, but Judge Rentoul said if he heard the case out his decision would be a great deal at random. He adjourned the case for the parties to settle it between themselves as business men. If not, he would sit specially and hear all the experts.

An Electrical Company's Affairs.

In the City of London Court on Friday last, Judge Rentoul heard an action brought by Mr. J. W. Record, of Leyton, against Brooker & Goss (Ltd.), electrical engineers, Broad-street House, London, E.C., to recover £19. 14s. 6d. wages and commission due. There was a counterclaim for £50.

Mr. O. THOMPSON, for plaintiff, said defendants admitted some of the claim was due, but were seeking to enforce specific performance of a contract for plaintiff to take 50 shares in defendant company as qualification for directorship. That contract plaintiff had signed in February last year, and for some time he attended the directors' meetings. Plaintiff was a young electrician, and defendants were electrical instrument makers and engineers. Brooker & Goss had carried on business in their private capacity, but afterwards turned the business into a company. As a matter of fact, shares were allotted to no one, as the company proved entirely abortive. A prospectus was issued, but there was not sufficient capital applied for to enable the directors to go to allotment or to commence business as a company. The whole thing fizzled out. New directors were appointed, and plaintiff's office became vacant. Now, after 18 months, defendants were attempting to compel plaintiff to take up 50 £1 qualification shares, although they had never been issued. The plaintiff was employed by defendants in 1902, before the attempted conversion, at a salary of £2 a week and 1½ per cent. bonus on all instruments calibrated in plaintiff's department. His salary was subsequently raised, but it had not been paid. For a portion of the time he received a portion of the salary.

Mr. E. H. SAUNDERS, for defendants, said it was quite untrue to say the company was an abortion, for it was a going concern.

Mr. THOMPSON said that might be, but the company was unable to pay its debts. The agreement by the plaintiff to purchase qualification shares had become impossible. In May, 1903, the company passed a resolution saying that, in consequence of Mr. Brooker, Mr. Goss, Mr.

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Cruttenden and the plaintiff, the original directors, having failed to qualify within the proper time, Mr. Brooker, Mr. Goss and Mr. Edwards were appointed directors of the company. Two of the directors were the same as those who had failed to qualify, and plaintiff was turned out. There had been no allotment of shares and the plaintiff could not qualify. Therefore the counterclaim for £50 could not hold.

Judge RENTOUL said he did not see any possibility of making plaintiff liable on the counterclaim.

Mr. BROOKER, in support of the counterlaim, said plaintiff was not engaged at £2. 10s. a week definitely, but only provisionally. He admitted that plaintiff's salary was £2. 5s. a week, but he said the promise to increase it was only given on condition that the business of the company enabled them to do it. He did not want to discharge plaintiff, as he was a useful servant. The company was short of money owing to stagnation of trade.

PLAINTIFF denied that there was any arrangement that he was only to be paid £2. 10s. per week if the company could afford it.

Judge RENTOUL found for the plaintiff on both claim and counterclaim, with costs.

Workmen's Compensation.

At Salford County Court on Monday Mr. Jordan applied to Judge Parry on behalf of the British Westinghouse Co. for the reduction or termination of a weekly payment made to one Thomas Jones in respect of an accident sustained in the company's works at Old Trafford in December last. It appeared that Jones was an oiler, and while oiling some machinery injured his thumb, which had to be amputated. At the time of the accident he was earning 30s. a week, and without coming into Court the company paid him 15s. a week, and had continued the payment up to the present time. A doctor saw Jones in June and reported that he was able to resume work. The company offered to reinstate him in his former employment, but he refused to accept the offer.

Jones now said that without his right thumb it was impossible for him to use his oil-can. In using the can with the left hand he was in danger of being drawn into the machinery. In reply to Judge Parry, Jones said he had not sought other work. He had asked for £150 to start him in business on his own account.

The JUDGE said if there had been no Compensation Act was it to be supposed that a man who had lost his thumb would sit down and starve?

A representative of the company said work would be found for Jones in a week or so, and it was arranged that the matter should stand over till Dec. 12.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Southwark (London) Borough Council invite applications for the position of chief engineer and manager of their electric light undertaking. Salary £300, rising by annual increments of £20 to £400 per annum. Applications to the town clerk (Mr. J. A. Johnson), Town Hall, Walworth-road, S E., by noon Oct. 5.

Dartford District Council require a resident electrical engineer to take charge of their electricity supply undertaking. Commencing salary £250 per annum. Applications to the clerk (Mr. W. Kay), Council offices, Dartford, Kent, by Oct. 6.

Applications are invited for the position of lecturer and demonstrator in electrical engineering at the school of engineering, electricity and technical science, Canterbury College, University of New Zealand. Salary £300 per annum, with saloon passage to New Zealand. Particulars of qualifications and forms of application from the Agent-General for New Zealand, 13, Victoria-street, London, S.W., to whom applications by Oct. 29. See also advertisement.

A lecturer in physics is required for Swindon and N. Wilts. Technical School. Salary £150. Applications by Oct. 3.

A junior demonstrator in physics is required at University College of Wales, Aberystwyth. Applications by Oct. 15.

An assistant lecturer in engineering is wanted at Swansea Technical College. Salary £145. Particulars from secretary.

An assistant in electrical engineering is wanted for 1904-5 session at Queen's College, Galway. Further information from registrar.

At last night's meeting of Marylebone (London) Borough Council the Electric Supply committee reported that they had received 55 applications for the post of resident engineer. They had interviewed nine of the candidates, and had selected the undermentioned gentlemen to appear before the Council:—

Mr. Francis A. Wilkinson, electrical engineer, Walthamstow Council.
Mr. W. M. Rogerson, borough electrical engineer, Halifax.
Mr. C. C. Fowler, assistant manager, Brighton Corporation Electricity Works.

The committee recommended that Mr. Wilkinson be appointed, and the recommendation was adopted. The salary attached to the appointment is £600 per annum.

Oldham Corporation have appointed Mr. Lewis Slattery, general manager Blackpool, St. Annes & Lytham Tramways Co., to the position of general manager of the municipal electric tramways at a salary of £300 per annum. The other five candidates selected for final interview were: Mr. J. Dugdale, general manager Oxford & District Tramways Co.; Mr. A. Wolstencroft, traffic superintendent at Oldham; Mr. G. B. Spurr, manager Ilford District Council tramways; Mr. W. Hutchins, traffic manager, South Lancashire Tramways Co.; and Mr. J. Telfer, manager Warrington Corporation tramways.

Mr. Walter T. Kerr, assistant engineer at Crewe electricity works, has been appointed (out of nearly 100 applicants) borough electrical engineer at Hereford at £400 per annum.

On Tuesday Willesden District Council appointed Mr. John Geo. Bruce, assistant distributing engineer to St. Pancras Borough Council, resident electrical engineer.

Mr. A. J. Ryan has been appointed chief assistant engineer at Gillingham (Kent) electricity works at £150 a year.

Exeter Electric Lighting committee have appointed Mr. Davis station superintendent at £2. 5s. per week.

Mr. F. T. Callis, senior engineer-in-charge at Sheffield, has resigned to take up an appointment at Newcastle-on-Tyne.

Mr. T. Hall has been appointed assistant electrical engineer at Burton-on-Trent at £150 per annum.

Mr. E. J. Williams, of Hawick, has been appointed resident engineer at Inverness.

Mr. W. A. Gilbert, of Ealing, has been appointed mains assistant at West Ham.

Mr. J. B. Shaw, Wh.Ex., of the Municipal Technical College, Swansea, has been appointed assistant lecturer on mechanical engineering at Battersea Polytechnic.

EDUCATIONAL NOTICES.

University of Liverpool.—The session 1904-5 commences on Oct. 3. The courses of study in the faculty of engineering leading to the ordinary B.E. degree or the certificate in engineering are so arranged as to afford a general scientific training for those intending to become engineers or to enter any allied profession. There is an honours course for students who desire to specialise in some branch of the profession and opportunities are afforded for post graduate work and research. Prospectuses from the Registrar. Included in the staff of professors and lecturers are Mr. A. Bromley Holmes (who is associate professor in municipal electrical engineering) and Mr. J. A. Brodie (associate professor in municipal engineering).

University of Glasgow.—The next session begins on Oct. 13, and continues to the end of March. After that date the students enter engineering works or offices for the six summer months, returning to the University for the next winter session. Particulars of classes and regulations for the degree of B.Sc. in engineering may be obtained from the syllabus, which will be supplied on application. The new James Watt engineering laboratories for students in civil, mechanical, electrical and mining engineering are in full working order, and are thoroughly equipped for experiment and research in most branches of engineering.

University College of South Wales and Monmoutshire, Cardiff.—Particulars of the courses of instruction given in this college (a constituent college of the University of Wales) in engineering and in mathematics, physics, chemistry, &c., may be obtained from the registrar, Mr. J. Austin Jenkins, B.A. These courses quality for the B.Sc. degree in engineering in the University of Wales and for the college diploma in engineering. The next season commences Oct. 4.

Durham College of Science (Newcastle-on-Tyne).—Courses are provided at this college for students proceeding to the degrees in Science, and special facilities are offered for the study of agriculture, chemistry, mining, engineering and naval architecture. Lectures begin Oct. 4. Prospectuses from the Secretary.

Merchant Venturers' Technical College, Bristol.—Courses of instruction are given at this college in civil, mechanical and electrical engineering, chemistry, architecture and building; also for matriculation, intermediate and final B.Sc. (including engineering degree) of the University of London. In addition to the professors, the college staff includes 79 assistant lecturers, demonstrators and skilled artisans. There are 11 laboratories, eight workshops, a dynamo room, engine house and an electric light installation. The calendar (price 6d.) or short prospectus (free) may be obtained from the registrar. The former is a volume containing much interesting information concerning Merchant Venturers' College, which was established as far back as 1856.

Birkbeck College, London.—The new session begins on Monday, Oct. 3. There are day and evening classes and systematic courses of instruction (lectures and laboratory) for the degrees of Science and Engineering of the University of London. Further information can be obtained from the Principal. Birkbeck College has just completed 81 years of educational work in the metropolis. During last session 71 students passed some university examination, while a large number gained successes at various public examinations. The modern language classes at this institution are a distinctive feature.

Borough Polytechnic Institute, London, S.E.—The 1904-5 session commences on Oct. 3. There are evening classes (lectures

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and laboratory work) in inorganic and organic chemistry, electrochemistry, electricity and magnetism and electrical and magnetic measurements. Prospectuses from the Principal (Mr. C. T. Millis). The course in electrical and magnetic measurements is intended for electrical engineers, instrument makers and others engaged in electrical work. See also an advertisement.

Hackney Technical Institute.—The session commenced on Sept. 19. There are special courses and laboratory work in electrical engineering, including electrical measurements, dynamo and motor design and telephony. Prospectus from the secretary, Dalston-lane, London, N.E.

Northampton Institute.—Full day courses in the theory and practice of mechanical, electrical and horological engineering will commence on Oct. 3. The courses for mechanical and electrical engineering include periods spent in commercial workshops and extend over four years. Students also prepare for the degree of B.Sc. in engineering at the University of London. Particulars as to fees, &c., can be obtained at the Institute, St. John Street-road, London, E.C., or on application to the principal (Dr. R. Mullineux Walmsley). The evening technical classes in all branches of electrical and mechanical engineering commenced on Monday. There are well equipped laboratories for all kinds of electrical testing.

American Correspondence.—We can fully endorse a complaint made by a correspondent to "The Times" ("Philalethes"), who writes :—

I would draw attention to a small matter in which it is possible for some of our trans-Atlantic cousins to make their practice at once more courteous and more businesslike. The number of insufficiently-paid letters that have reached me from every country, save one, may be counted on the fingers, but the infractions by citizens of the United States of the first duty of a correspondent have been so numerous and sometimes so flagrant, the surcharge occasionally running into shillings, that I have been compelled to give directions that all communications bearing the American postmark and charged with excess postage be returned to the senders. By this method, which I recommend to such of your readers as have suffered in the same way, I am gradually awakening my American correspondents to a sense of their responsibilities.

We fear this is a general experience. By one mail we have ourselves been surcharged as much as 10s. 4d. on 17 letters.

Artificial Percha.—It is announced that two Dutch inventors have registered a patent for the manufacture of "Liconite," an insulating substance claimed to be a good substitute for gutta-percha, and said to be proof against the action of acids, alkaloid, and water. The journal "La Quinzaine Coloniale" is responsible for these and other particulars concerning this compound.

Australian Patents.—Messrs. Collison & Co., patent agents, Collins-street, Melbourne, and Adelaide, inform us that

The Australian patent law and Federal patents are now established facts and the Central Patent Office is established at Rialto-buildings, Melbourne. The law is to a great extent based upon the existing British system, but the official staff before issuing a patent, make an examination to ascertain whether the invention described has been previously patented, or a patent applied for, in any of the States of the Commonwealth, An invention can now be protected throughout the whole of the Commonwealth for 14 years by one patent for each invention, at approximately one-third the cost formerly involved when six State patents had to be obtained. The State Patent Offices are only continued as offices of record where the specifications of applications filed will, after their acceptance, be exhibited for public information. The act ensures that the patents obtained in the several States shall remain in full force with all the rights granted. Commonwealth patents will be granted for 14 years, and will be subject to the usual conditions of British patents, with the exception that if one claim is found by a Court to be invalid it shall not affect the validity of any other claims, or of the patent, so far as it relates to any valid claim. Patents have effect against the Crown, but the Government of the Commonwealth may use the patented invention upon such terms as are agreed upon with the patentee, or, in default of agreement, are settled by arbitration, or the Commonwealth or a State may, if thereto authorised by Act of Parliament, direct the patentee to assign his rights, the amount of compensation being decided by agreement or arbitration. An invention may be assigned to the Commonwealth before patenting, and the act provides that the communication of an invention to the Minister for Defence, and proceedings thereunder, shall not be deemed publication, or prejudice the validity of any patent thereafter granted. In the bill as originally introduced there was a provision requiring the invention to be "worked" as a condition of its maintenance, but that was eliminated in passage through the Parliament. The nearest approach to such provision is a power conferred upon the Commissioner or the Court to arrange or order a licence to be granted to a person wishing to use a patented invention in respect of which "the reasonable requirements of the public have not been satisfied." The ordinary powers of amendment and extension are provided for, and the act contains provisions under which the Commonwealth is enabled and probably will become a party to the International Convention. The procedure of application for patents by petition accompanied by provisional or complete specification is somewhat similar to that of the British Patent Office.

Barnes.—On the recommendation of the electrical engineer (Mr. C. S. Davidson) the following sliding scale of discounts to large power consumers has been adopted :—500 units per month, 2d. per unit, 2½ per cent. discount; 1,000 units, 2d. and 5 per cent.; 2,000 units, 2d. and 10 per cent.; 4,000 units, 2d. and 15 per cent. Monthly accounts payable within 7 days.

Barnstaple.—The Council have approved a recommendation by the Lighting committee to substitue pairs of incandescents for Nernst lamps in High-street, thus rescinding the previous decision to erect arc lamps.

Basingstoke.—An inquiry was held here last week into the application of the Town Council to borrow £16,450 for electricity supply. The Council have entered into an agreement with the National Electric Construction Co. for the erection and maintenance of the works for a number of years, the company paying interest and sinking fund charges on the capital outlay. Evidence was given by the consulting engineer (Mr. R. P. Wilson) and the manager of the company (Mr. W. B. Cownie).

Battersea (London).—The Council have decided that the public electric lighting of the Shaftesbury and Beaufoy Estates is to be completed at a cost of £447.

Belfast.—The Tramways committee considered on Monday a communication from the borough surveyor of Wolverhampton explaining the Lorain surface-contact system of traction, but it was decided to abide by the decision to adopt the overhead system.

The tramways manager (Mr. A. Nance) submitted a report recommending that the first 170 cars be ordered without tops, but with the top deck so designed as to admit of a cover, and that when experiments with top covers on other tramways had been brought to a successful conclusion tops be put on all the Corporation's cars. Mr. Nance has drawn the specifications so that the contractor is required to contract for the cars with or without tops and to supply drawings of his idea of the best tops to be provided.

The committee adopted the report, but decided that all reference to any particular type of car should be eliminated from the specification.

Birmingham.—The work of excavating and laying the foundations of the new generating station on the site of the old General Hospital is nearing completion, and arrangements will shortly be made for building the station. The ultimate capacity of the generating plant will be 22,000kw. and the estimated cost £510,000, including £130,000 for buildings. At the outset only 8,500kw. is to be installed, at a cost of £260,620. The scheme has been so planned as to admit of easy extension from time to time as demand arises.

Blackburn.—Mr. A. S. Giles, borough electrical engineer, has tendered his resignation, in consequence of his acceptance of a foreign appointment at a salary of £1,800 per annum. The Electricity committee have accepted Mr. Giles' resignation with regret, and agreed to release him at the end of November.

Bradford.—In place of the former charges of 1d. and 2d. for current for electric energy for power, the Corporation electricity department now charge 1⅛d., 1½d., 1¾d. or 2d. per unit on a graduated scale corresponding with the horse-power of the motors used and the continuity of the demand. The minimum has been increased by ⅛d., as 1d. does not give a margin of profit.

Bury, Rochdale and Heywood Tramways.—At a further conference between representatives of Bury, Rochdale and Heywood Corporations, terms have been approved for the conversion to electric traction and the operation of the tramways of the Bury, Rochdale & Oldham Steam Tramways Co. These draft terms provide that Heywood shall buy up the company's property in the borough; reconstruct and electrically equip the lines, and supply current, but Rochdale and Bury Corporations will provide the cars and work them. The fares in Heywood are to be taken by Heywood, and a fixed charge for working expenses is to be paid to Bury and Rochdale. The purchase price of the company's undertaking is £162,675, to be contributed by the local authorities as follows:—Rochdale and Wardle, £70,390; Littleborough, £7,033; Royton, £15,544; Heywood, £20,436; Bury, £38,441; Tottington, £4,191; Unsworth, £3,016; Whitefield, £3,620.

Change of Name for Cable Steamer.—The Western Telegraph Co. are applying for sanction of the Board of Trade to change the name of the cs. "Norseman" to the cs. "Norse."

Cheltenham.—The work of constructing the extensions of the Cheltenham and District Light Railway to Charlton Kings and Leckhampton has been commenced.

Chile.—A concession has been granted to Don Alberto Consiño for the construction and working by steam or electricity of a railway from the port of Quintero to a junction with the Government railway from Santiago to Valparaiso, either at Calera or at Nogales.

A law has been published relating to electrical concessions in Chile, from which the following is an extract :—

The grant of concessions for electrical enterprises falls within the functions of the President of the Republic, who is also to take measures for the inspection of electrical tramways, railways and other enterprises from the point of view of public safety. Concessions for electrical undertakings with underground wires may be granted for 20 years, but the term of those with overhead wires is not to exceed 10 years.

In Santiago, Valparaiso, and other towns where electric tramways exist, the electric telephone wires, electric lighting wires, and other

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electric conductors for distributing electric power are to be placed underground. A term of four years is allowed for the replacement of existing lines by underground lines. Lines exclusively used for tramway service are excepted from this regulation.

Within six months from the publication of the Law certain safety apparatus, in conformity with details to be specified in regulations to be issued by the President, are to be installed in every electric tramcar.

The "Official Diario" containing this law can be seen at the Commerciai Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

Commercial Instruction in Germany.—The British Consul at Stuttgart (Dr. Frederic Rose) has made a further report concerning commercial instruction in Germany. This has just been issued by the Foreign Office, and forms instructive reading. There have been 18 previous reports made to the Foreign Office on the methods of instruction on technical subjects in Germany, of which the latest is by no means the least important, as it shows that there are 429 commercial schools where higher, secondary, or lower commercial instruction is given, and this not including private commercial schools or commercial schools for women. The price of the report, which is a voluminous one, is 7d. post free.

Coventry.—Sanction to a loan of £30,388 for electricity extensions (repayable in 26 years) has been obtained by the Council.

Crompton.—The Council have applied for an extension of time for carrying out the terms of their provisional electric lighting order, 1901.

Customs Decisions.—By a recent decision of the American Customs department, porcelain insulators coated with a single glaze are dutiable as porcelain only, not ornamented nor decorated. The duty is 55 per cent. ad val.

Dartford.—In a supplementary return of the Electric Lighting committee the net deficiency on the past year's working of the electricity undertaking is put at £1,619.

At the Council meeting last week the chairman (Mr. Hesketh) said that though the returns were not satisfactory, the position was not as bad as it appeared. The receipts had been sufficient to cover working expenses and leave a small gross profit, but interest (£910) and repayment of loans (£709) made the debit balance £1,619. They had not expected that the undertaking would pay within the first two or three years. The committee's recommendation was adopted to seek the advice of the consulting engineers (Messrs. Hawtayne & Zeden) and to place the works in charge of an expert for a month, for the purpose of a report on the working.

Dover.—Out of 5,908 ratepayers' votes a majority of 134 has been secured against the proposal to run electric tramcars on Sundays.

Dublin.—Further correspondence in continuation of that set out in our last issue (pp. 907, 908) has been published concerning the past and future working of the Corporation's electricity undertaking. Dated 19th inst., Mr. Mark Ruddle has replied to Mr. Robert Hammond's letter of Aug. 25, in which Mr. Hammond offered to take over and work the undertaking for a number of years on certain terms, and at the same time discussed various matters concerning the estimates made by Mr. Ruddle. In his reply, Mr. Ruddle takes exception to certain quotations made by Mr. Hammond from a report sent in by Mr. Ruddle to the Lord Mayor of Dublin in March, 1901, and sets out the exact terms of this report, supplementing these by reference to an estimate which was prepared in December, 1902, in connection with the then annual estimates. Mr. Ruddle's reply concludes as follows:—

Mr. Hammond refers to "pessimistic views" of the cost of production, and I am glad to state that, from the very satisfactory demand which has been made for connections during the past year, and the inquiries for future supplies, I certainly do not hold such views. I am not prepared to enter into competition with Mr. Hammond for the privilege of running the undertaking for a term of years, but I am prepared to undertake, now that the plant is in my charge, to produce the energy at as low a cost as Mr. Hammond can possibly produce it, provided the Council give me, as city electrical engineer, as free a hand as Mr. Hammond has had in the working and management of the undertaking during the 12 months of his supervision agreement.

The Corporation will, on Monday next, consider reports, &c., concerning electric lighting.

Dundee.—The city electrical engineer (Mr. H. Richardson) has reported to the Tramways committee upon the explosion which occurred on the evening of Aug. 25, when two old rubber-covered mains in Tay-street gave way, and arced on to the cast-iron piping in which they were laid, igniting some gas in a manhole box.

Mr. Richardson did not wish to say anything definite about what sort of gas was in the manhole, but, according to the statements of some of his men there was a strong smell of coal gas; he was not himself present at the time. One point in favour of the new cables being laid solid (continues Mr. Richardson) was that they prevented to some extent the accumulation of gas in the manholes, but all they could really rely upon was the thorough periodical inspection of the manholes. In answer to the probable suggestion that gas was given off by the bitumen, he pointed to the fact that explosions had taken place in Dundee before the new mains laid in bitumen or pitch were put in.

On Monday the committee authorised (on the recommendation of Mr. Richardson) certain extensions of the mains at an estimated cost of £500.

East Ham.—An inquiry will shortly be held into the application of the Corporation to borrow £10,320 for electric lighting extensions.

Egypt.—The electricity works at Tantah of the Société Elec trique de la Basse Egy pte were opened on 15th ult.

The Société Électrique d'Ismailia are equipping electricity works at Suez and Port Tewfik and will shortly commence supply for public and private lighting.

Electrical Exports from America.—The value of the total exports for the 12 months ended June 30, 1904, of electrical machinery from the United States shows a small reduction over the corresponding period of 1903, the figures being $5,645,809, compared with $5,779,459. There was an increase, however, in the exports of electrical and scientific instruments from $7,130,508 for 1903 to $8,297,723 for 1904.

Electricity in Shipyards.—In the new buildings at William Simons & Co.'s Renfrew yard there is a complete electric lighting installation, and electric travelling cranes have been erected in the new boiler shop and in each bay of the new engine shop.

Enamel for Enclosed Engines.—We have received the following inquiry for enamel:—

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should be glad to hear the name of any enamel suitable for the insides of enclosed engines, one which will fix any foundry sand, and will not be destroyed by either an oil and water bath, or by the oil used for forced lubrication.—Yours, &c., SANDY.

Surrey, Sept. 23.

Fatality.—An inquest was held on Wednesday on the body of a youth named Thompson, who met with an accident at the St. Nicholas sub-station of the Scarborough Electric Supply Co. on Tuesday:—

George Arnott, electrician, said he found the deceased, who had had three years' experience, apparently dead in the sub-station with one elbow resting on a switchboard which he had been dusting. His head was 3in. from one of three live terminals. He had on the regulation rubber gloves; he was dusting the switches at the sub-station, of which he had a thorough knowledge. The assistant manager (Mr. J. Moseley Williams) said the voltage of the terminal was 130. Dr. Maingay, who gave medical testimony as to the cause of death, said there was no known minimum voltage to cause death. A verdict of death by electric shock was returned.

Finland.—Electrical machinery, apparatus and accessories to the value of only £23,029 was imported into Finland in 1903, compared with £28,106 in 1902.

Fire.—A fire which broke out on Saturday night on the premises of Mr. W. Seymour, electrical engineer, 188, Walton-street, Chelsea, caused considerable damage.

Fochabers (Morayshire).—Electric lighting is to be adopted at Gordon Castle, and the Duke of Richmond and Gordon has been petitioned by the inhabitants to make provision for the supply of current for public and private lighting of Fochabers The petitioners have been informed that if the equivalent of 950 8 c.p. lamps are guaranteed his Grace will supply current at 5s. per 16 c.p. lamp per annum, which will include 1s. per lamp per annum for interest on capital outlay.

Glasgow.—The Tramways committee have approved the proposals of the tramways manager (Mr. John Young) for extensions of the Corporation electric tramways.

Handsworth.—The Council and the South Staffordshire Tramways Co. have settled their differences as to the tramway route between the West Bromwich boundary and New Inns, and on Wednesday the Council ordered its seal to be affixed to the lease of the Council's tramways in Holyhead-road to the company.

Hanley.—At the meeting of the Council last week the Electric Lighting committee's minutes contained a reference to the breakdown at the electricity works on July 23, and to the report of the borough electrical engineer (Mr. C. A. Cowell) thereon. The committee have, we learn, asked Mr. Cowell to send in his resignation.

Hull.—The North-Eastern Railway Co. have applied to the municipal Electricity department for a supply of current for 222 16 c.p. lamps at Paragon station and also for working signals.

A Mr. F. Costello has made a claim against the Corporation for £10 for loss of trade during a temporary suspension of electricity supply on Sept. 13. The Electricity committee repudiate liability, as current was only cut off (after notice) in the daytime while making certain alterations.

Kanturk.—There is no public lighting here and a movement (supported by Canon O'Connell, P.P.) is on foot for introducing the electric light.

Lancashire.—The Lancashire Electric Power Co. is negotiating with a number of local authorities for a supply of electricity in bulk. With a view to obtaining better terms from the company the authorities have decided to hold a conference at Wigan to discuss terms and to take united action.

Leicester.—On the presentation of the accounts of the gas and electric lighting departments on Tuesday, Councillor Edwards stated that the total capital expenditure on the electricity department was

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£218,874. The receipts for the past half-year were £13,154, an increase of £1,504; the expenditure for that period was £5,414. After paying interest and sinking fund instalments the profit on the half-year was £2,570. 11s. 9d., an increase of £1,269 over the corresponding half of last year.

The Council have pecided, on the recommendation of the Tramways committee, to apply for a loan of £60,000 for additional tramcars, generating plant, &c.

Councillor Flint stated that the tramway undertaking had been fairly successful. The receipts were not as good as he had hoped for. Roughly, the receipts were £1,000 a week more than last year, and the number of passengers had been doubled. The committee were considering the use of canopied tops for the cars. The delay in construction of the uncompleted lines rested with the contractors, and the committee were in no way responsible.

Leeds.—An inquiry was held here on Tuesday into the application of the Corporation to borrow £100,000 for extensions of the electricity supply undertaking.

The town clerk (Mr. R. E. Fox), the city accountant (Mr. Wm. Derry) and the city electrical engineer (Mr. Harold Dickinson) gave evidence,

Mr. Fox sketched the progress of the undertaking. There were 3,988 consumers in March, representing the equivalent of 307,849 8 c.p. lamps connected for lighting and motor power. The connections in motors were equal to 2,963 H.P. The capital expenditure was £752,509. The capacity of the plant installed was 8,740kw., the maximum load being 5,040kw. The units sold in the year ended March last were 6,271,186, and the revenue for the year was £76,721. The surplus profit last year was £3,431.

Mr. Dickinson gave technical details. Generally speaking, the present application was in respect of additional plant, nothing being included for mains, sub stations or meters.

Little Lever.—The Council will apply for a provisional electric lighting order. Electricity in bulk is to be supplied by the Lancashire Electric Power Co.

Maidstone.—The Council have discussed the question of running Sunday tramcars, and have decided that they shall not be run between 10:30 a.m. and noon, nor between 6:30 p.m. and 8 p.m.

Marylebone.—In their report the Electric Supply committee state that the Board of Trade has not yet fixed the date for the commencement of the new provisional order, there still being some outstanding questions as to title to property. In the meantime, under the terms of the order of 1889, which remains in force, the committee had inserted in the press the notice of intention to apply to London County Council for approval to the alteration of the standard pressure of supply. Particulars of the appointment last evening of a resident engineer will be found under "Appointments."

Municipal Telephony.—On Wednesday, Portsmouth Telephone committee decided to recommend the Council to apply for sanction to a further loan of £20,000 for such extensions of the municipal telephone system as may from time to time be decided upon by the committee.

New South Wales Tramways.—In the annual report of the New South Wales Railway Commissioners it is stated that during the past year 125 miles of tramway were open for traffic, the capital cost being nearly 3½ millions. The gross earnings were £803,000, and the net return (after paying working expenses) £129,360, or 3¾ per cent. on capital, and yielding a slight profit to the State. Most of the tramway lines are in the vicinity of Sydney and Newcastle and are worked electrically. 137,000,000 passengers were carried during the year.

Newquay.—A site has been secured for the projected electricity works.

Oulton Broad.—On Wednesday the Council decided to postpone their application for a provisional order, provided Messrs. Barber & Croft, who propose to apply for an order, also postpone their application.

Pontypridd.—The arbitrator (Sir Colin Scott Moncrieff) appointed by the Board of Trade to ascertain the value of the local tramways, has fixed Oct. 21 for his inspection of the lines. The arbitration proceedings are to be held in Pontypridd.

The Council have decided to appoint a resident electrical engineer to manage the electricity supply and tramways undertakings at a salary of £300 per annum.

Rowley.—The Council have decided to raise a loan of £4,600 from the Metropolitan Life Assurance Society for the electrical equipment of the tramway between Old Hill and Blackheath. The agreement with the Quarry Bank and Brierley Hill Councils for the construction of a joint tramway has been sealed.

Royal Parks Lighting.—The arrangements for the electric lighting of St. James, Green and Hyde Parks (London) by H.M. Office of Works will shortly be completed. All the necessary cables under the roads have been laid, but those under the Admiralty garden to the Mall will not be laid until the work of the extension of the magnificent thoroughfare into Trafalgar-square is in progress. From near Drummond's Bank overhead electric wires will be erected temporarily as far as the Admiralty building, where underground communication will be made with the Mall cables.

St. Andrews.—The Dean of Guild Court passed on Friday the plans for the generating station of the Electric Supply Corpn., who expect to have supply available by January next.

Sewage Purification.—A demonstration took place last week at Guildford of the "Oxychloride" process of sewage purification, which consists of the electrical decomposition of salt and water, or sea water, in a specially designed electroliser having a large superficial area of electrical surface. The demonstration was carried out by Dr. Rideal, the well-known specialist in this branch of work, who explained in detail to a large company the merits of the process. A large building has been erected at Guildford, and in this experiments have been carried on for some time past.

School Lighting.—Govan School Board have resolved to wire 10 of their schools. Current will be taken from the Corporation mains.

Solihull.—It is proposed to obtain information as to the desirability of establishing electricity supply.

Southend.—The Council have applied for sanction to a further loan of £56,000 for extension of the plant at the electricity works, including three steam dynamos, four boilers, economiser, mains and services.

The Light Railways committee recommend that Parliamentary powers be sought for supplying electricity in bulk, for the supply of electric fittings and motors on hire and for undertaking hire purchase or assisted wiring.

The electrical engineer (Mr. W. E. J. Heenan) reported last week that the equivalent of 40,508 8 c.p. lamps are connected, and submitted a scheme for increasing the capacity of the generating plant to 80,000 lamps, which he calculated would carry them over the next 10 years. The scheme provides for three steam dynamos, four boilers, an economiser, auxiliary machinery, engine room and boiler house extensions, electric light mains, public street lighting and consumers' services. The cost of the new plant is put at £20,490. 15s., and of the extension of mains in 53 streets, feeders, &c., £35,509. 5s., total £56,000. The Electric Lighting committee had considered and adopted Mr. Heenan's scheme, and recommended that sanction be applied for for borrowing the sum mentioned.

After discussion the recommendation was carried by nine votes to eight.

Stepney (London).—On Wednesday, the Council decided to ask London County Council to sanction a loan of £20,000 for the eastern extension of the electricity undertaking and £3,960 for meters.

Stourbridge.—The draft agreement with the Midland Electric Corpn. for Power Distribution for the supply of electricity in bulk was approved by the Council on Monday.

Tramway and Railway Competition.—The East and West Yorkshire Union Railways Co.'s passenger service between Leeds and Rothwell will be discontinued after to-day, this step being, apparently, necessitated by the competition of the electric tramways between Leeds and Wakefield.

The Great Northern Railway Co. have reduced their fares between Leeds and Wakefield and Leeds and Bradford for similar reasons.

Transvaal Imports.—The value of the imports of electric cables, wires and fittings into the Transvaal for the six months ended June 30 last was £38,000, compared with £34,000 in the corresponding period of 1903. Tramway material stands for £38,000, compared with £50,000 in 1903.

Village Lighting.—Mr. Mager, surveyor to Walsall Rural Council, has prepared a scheme for the electric lighting of the parishes of Rushall and Pelsall, but it has not yet been decided who is to carry out the scheme, a company or the Councils.

Walthamstow.—At Friday's meeting of the Council, the consulting electrical engineer (Mr. J. Enright) reported that the total costs and charges of generation and distribution of electric energy for the 12 months ended March 31 last were £10,171, or 2·99d. per unit (compared with £7,093, or 3·13d., in the previous year). Working costs were now only beaten by two electricity undertakings in and around London—viz., Hackney and Stepney—where the units sold were far in excess of Walthamstow. Mr. Enright reported that satisfactory progress is being made with the erection of the new tramway plant.

An inquiry was held on Wednesday into the application of the Council for sanction to borrow £46,000 for extensions of the electricity undertaking. The works have been in existence three years, and last year a profit of £3,000 was made. Since 1902 the number of consumers has increased fourfold. The proposed extension of the generating station is partly required in connection with the Council's tramway undertaking, 11½ miles of which are being constructed. Mutual running powers have been obtained between the Tottenham system (owned by the Metropolitan Electric Tramways, Ltd.) and the projected system of the Leyton Council, by which Walthamstow and Epping Forest will be linked up with the North of London through Tottenham, Stoke Newington and Finsbury Park, and East London through Straford and Leyton.

Walton-on-Thames.—Weybridge Council have asked the Board of Trade to give them an opportunity of objecting to the grant of a

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licence to the Urban Electric Supply Co. to supply electric energy in Walton. As announced in our last issue, Walton Council have given permission to the company to erect a temporary station in Walton in consequence of the refusal of Weybridge Council to permit Walton to be supplied from the company's Weybridge works.

Water Power in Brazil.—The Foreign Office have received particulars relating to the possibility of generating electric power for industrial purposes from the Paulo Alfonso waterfalls. The British vice-consul, who has visited the Falls, expresses his confidence that they are eminently adapted for the generation of large electric power. Triumphs, the prospective mining district of Pernambuco, where valuable minerals are said to exist, is 113 miles rom the Falls.

Wellington (Salop.)—A report on electric lighting, prepared by the surveyor, will be discussed at a special meeting of the Council.

West Ham.—On Tuesday the borough treasurer reported that the deficiency on the electricity undertaking for the year ended March was £3,788. 6s. 10d., making the total deficiency to date £4,458. 19s. 6d. On the current year's working, he said, there would be a probable further deficiency of £3,400. On the other hand, he thought the tramways department would be able to give £8,000 in relief of rates.

The report was adopted, and it was resolved to apply to the Board of Trade to borrow £58,500 for the construction and equipment of electric tramway extensions.

The treasurer also reported that the whole of the last issue of £500,000 Corporation stock had been subscribed, and £127,254. 7s. 8d. was available for tramways and £97,889. 1s. 6d. for electric lighting.

An agreement has been entered into with Jackson Bros., a local firm, who undertake to pay half the cost of extending the mains to their premises and guarantee to take a minimum of 6,000 units per annum for three years.

Plans for the electrification of the new tramway routes were approved, and directions given for preparing specifications for 35 new cars.

It was decided to retain the Harvey patent signalling apparatus fixed a couple of months ago in Plaistow-road on trial, and to purchase another set.

Wickwar.—Messrs. Arnold Perrett & Co., who are laying down electric lighting plant for their own works, have offered to provide a supply of current for public and private lighting in the district.

Willesden.—On Tuesday a statement of receipts and expenditure of the electric lighting undertaking for the first complete year's working was submitted.

The total expenditure is £8,363, including repayments of loan raised for sub-stations and mains £2,787, generation of electricity to Feb. 8, 1904, £1,607, purchase of electricity in bulk from Feb. 8 to date £1,478, management expenses £1,449, public lamps £360, distribution cost £346, rent, rates and taxes £188, law and Parliamentary expenses £119. Receipts were £8,519, including £5,362 from private consumers, £2,821 from public lighting, and £200 meter rentals. Allowing for bad debts the net profit was £177. The Electricity committee reported having considered a suggestion for the adoption of a flat rate, but they had come to the conclusion that the maximum demand system at present in use, under which consumers paid an average of only 3·74d. per unit should be adhered to. With regard to charges for power the committee recommended that an additional alternative scale be allowed, the charge to be on the two-rate meter system 1½d. per unit during the hours of daylight, and 4d. per unit during the excepted hours, as already fixed for intermittent supply.

The report and recommendations were adopted, and main extensions, estimated to cost £782, were sanctioned.

Wood Green (London).—The decision of the Local Government Board with regard to the application of the Council to borrow £43,000 for electricity supply has apparently greatly disturbed Councillor Reed, who, at yesterday's meeting, attacked in most vigorous fashion the Local Government Board collectively, and the Board's inspector at the recent inquiry in particular, for their action in regard to this matter. The worthy Councillor imputed political bias to the Board, but this was only his playful way. He then strongly advised the Council to have nothing to do with private companies, and ended by moving a resolution that the Council should adhere to its policy of obtaining a municipal supply of electricity, and instructing the Electrical committee to consider and report upon the situation generally. This proposal was carried.

Workhouse Lighting.—Ormskirk Guardians have decided to establish independent electric lighting and power plant at the workhouse, the initial cost of the undertaking being estimated at £3,100 (including £1,500 already expended for extra high-pressure boilers, &c.).

Wolstanton and Burslem Guardians have engaged Mr. Ashton Bremner, borough electrical engineer at Burslem, to prepare an electric lighting scheme for the workhouse.

York.—The City of York Tramways Co. have offered to sell their undertaking to the Corporation. The Streets and Buildings committee have rejected the company's offer, and have appointed an expert to value the tramways, including cars, horses, buildings and rolling stock, and will negotiate on the basis of this report.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Visitors committee of *Cumberland and Westmorland Lunatic Asylum*, Garlands, Carlisle, invite tenders for the supply, delivery and erection of two Lancashire boilers, feed pumps, steam exhaust and water pipes and valves; two 50kw. and one 30kw. steam dynamos, and a 5-ton travelling crane; economiser; underground bitumenised cables and boxes; wiring of buildings, switchboards, motors, fans, &c. Specifications, &c., after Oct. 3 of the clerk to the visitors, Mr. C. W. Allan Hodgson. Specifications may also be inspected (but not obtained) at the offices of the consulting engineer (Mr. F. R. Batty), electricity works, Northallerton, Yorks. Tenders to Mr. Hodgson, The Courts, Carlisle, by Nov. 1. See also advertisement.

London County Council invite tenders for the work to be done (including wiring and fittings) in connection with the electric lighting of the Ranger's House, Blackheath. Specifications, &c., from the Council's chief engineer (Mr. Maurice Fitzmaurice, C.M.G.), County Hall, Spring Gardens, S.W. Further particulars are given in an advertisement. Tenders, addressed to the Clerk of the Council, County Hall, Spring Gardens, London, by noon Oct. 11.

Rochdale Corporation invite tenders for supply, delivery and erection of three ejector condensers, three electrically-driven circulating pumps and the necessary extensions of the steam and water pipes, valves and accessories. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Sillar & Leigh), 2, Queen Anne's-gate, Westminster, S.W., and 70, King-street, Manchester, and may be obtained from the former office. Tenders to the town clerk (Mr. W. H. Hickson) by Oct. 10. See also advertisement.

The directors of the *Great Western Railway Co.* invite tenders for supply of various stores for the year ending Nov. 30, 1905, including telegraph instruments, apparatus (insulators, &c.), ironwork, tools and drysalteries, electric wire and cables, carbons, incandescent lamps, &c., indiarubber goods, acids, varnishes, oils, colours, wire, ironmongery, &c. Samples and patterns may be seen at Swindon from Oct. 5 to 14, and specifications with forms of tender can be obtained at the stores department, Swindon. Tenders to the secretary (Mr. G. K. Mills), Paddington Station, London, W., by Oct. 17. See also an advertisement.

Tottenham District Council invite offers (based upon certain arrangements, particulars of which are set out in the form of tender) for the exercise of the Council's powers under their provisional electric lighting order, 1902. Particulars, on and after Oct. 7, from the clerk (Mr. E. Crowne), 712, High-road, Tottenham, Middlesex, to whom tenders by noon Oct. 21. See also advertisement.

Wandsworth (London) Council invite tenders for the installation of electric lighting at the Council House, and the provision and fixing of an electric fan for the Council Chamber. Specification, &c., may be seen and form of tender obtained at the office of the consulting engineer (Mr. P. W. P. Adams), 28, Victoria-street, London, S.W. Tenders at the Council House, Wandsworth, S.W., by Oct. 18. See also advertisement.

The Municipality of *Philippopoli*, Bulgaria, announce in an advertisement in another column that the electric lighting and electric tramway concession was not adjudicated upon on Aug. 3/16 last, and that a new adjudication will take place on Oct. 2/15, at 10:30 a.m. in the Town Hall, Philippopoli. Offers should be submitted in the Bulgarian language and in sealed envelopes. Tenderers should supply references (under separate cover) showing that the tenderer has already successfully executed a similar foreign enterprise, and has deposited at the Banque Nationale Bulgare 150,000fr. (£6,000) as security. Conditions, &c., in Bulgarian and French, may be obtained on payment of 20fr. (16s.) A readjudication will take place on the following day (Oct. 3/16) if by 10:30 a.m. of that day a reduction of 5 per cent. on the price per kilowatt hour on the prior offer is made.

The Directors of the *Lancashire and Yorkshire Railway* invite tenders for the supply of the company's ordinary requirements of stores during the 12 months ending Oct. 31, 1905. The articles required include ironmongery, reflectors, oil, sponge cloths, steel and files, sundry tools, twist drills, indiarubber, iron chain, hinges, sheets, &c., also spikes and steel fish bolts for way materials. Tender forms, &c., from Mr. Duffin, stores department, Osborne-street, Manchester. The sample room will be open till to-morrow, Oct. 1. Tenders (addressed to the directors) to the secretary (Mr. R. C. Irwin), Hunt's Bank, Manchester, by 10 a.m. Oct. 3.

The directors of the *Metropolitan Railway Co.* are prepared to receive tenders for the supply of general stores (electric lamps, wires and cables, carbon brushes, &c., telegraph battery jars, zincs, insulators, &c.) during the 12 months ending October, 1905. Tender forms, &c., from the secretary (Mr. R. H. Selbie), 32, Westbourne-terrace, London, W., after 27th inst. Samples and patterns may be seen at the offices of the company's storekeeper, adjoining Neasden station, N.W. Tenders to the secretary by 10 a.m. Oct. 8.

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Brighton Corporation invite tenders from persons willing to enter into an agreement for the right to place painted or tablet advertisements on the tramcars belonging to the Corporation. Tenders to the town clerk (Mr. Hugo Talbot), Town Hall, Brighton, by 10 a.m. Oct. 10.

Manchester Electricity committee invite tenders for supply of ampere-hour and watt-hour meters. Tenders to chairman of Electricity committee, Town Hall, Manchester, before Oct. 4.

Tenders are required for the supply of an induced draught fan on hire for two months for *Redditch* electricity department.

Barrow-in-Furness Corporation invite tenders by noon Oct. 18 for arc lamps, columns, &c.

Ghent (Belgium) Municipality invite tenders for 10 electric cranes. Specification can be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C. Tenders to College Echevinal, Ghent, to be posted by Oct. 17.

TENDERS RECEIVED AND ACCEPTED.

West Ham Corporation received the following tenders for the electrical equipment of the High-street, Romford-road and Leytonstone-road tramways:—

Robt. W. Blackwell & Co. (*accepted*)	£3.851	0	4
Macartney, McElroy & Co.	4,911	10	8
West Ham Corporation Electrical Department	4,887	5	2
Dick, Kerr & Co.	4,579	2	2
British Electric Equipment Co.	4,567	13	6
British Insulated & Helsby Cables (Ltd.)	4,502	2	6
Brush Co.	4,141	2	9

The Bolivian Government have placed a contract with the Power Gas Corpn. (Ltd.), 39, Victoria-street, Westminster, for one of their patent gas plants of 600 H.P. capacity. This contract forms part of the equipment of the generating station at La Paz, Bolivia, which is to supply electric energy for lighting and tramways. The equipment of the station includes Premier gas engines at 400 H.P. each.

Hull Corporation have placed orders with Oliver & Co. for arc lamps for lighting Jameson-street at £228 and with the Keighley Electrical Engineering Co. for Nernst lamps for New Clarence-street at £88.

The following tenders have been received by Maidstone Council for feeder cable.

Callender's Co. (*accepted*)	£471 12	W. T. Henley's Co.	£490 0
St. Helen's Cable Co.	575 15	W. T. Glover & Co.	480 0

Walthamstow Council have accepted the tender of C. Isler & Co. at £52 for supplying and fixing a steam pump for the sumpt at the generating station.

Wrexham Council have accepted the tender of the St. Helens Cable Co. for distributing cable, street and service boxes and wood troughing at £2,138. 17s.

Southend Council have accepted the tender of Messrs. S. Rawlinson & Sons, Blackburn for a motor tower waggon at £330.

The Yarmouth Guardians have instructed Mr. Wade to execute certain electrical work at the workhouse during the ensuing half-year.

Torquay Corporation have accepted the tender of P. Myles for the erection of a chimney shaft at the new electricity works at £3,057.

BUSINESS NOTICES, &c.

Pers na'.—Mr. Bertram S. Giles, M.I.E.E., for many years responsible for the design of Messrs. Mather & Platt's electrical machinery, and has acted as their technical representative and adviser, has joined Messrs. Johnson & Phillips as manager of their electric light and power works, for the manufacture of generators, motors, transformers, resistances, switchboards, arc lamps, &c.

Messrs. E. Goossens, Pope & Co. have removed to more commodious premises at 5, Arthur-street, New Oxford-street, London, W.

The partnership hitherto subsisting between Messrs. Joseph Marks and Hugh Clarkson, electricians and electrical engineers, 4, Gothic-arcade, Snow-hill, Birmingham (trading as Marks & Clarkson), has been dissolved as from 21st inst. Debts and liabilities will be received and paid by Mr. Marks, who will continue the business at the same address.

Messrs. W. H. Bradbury and J. Marsden, electric light fittings makers, &c., 39 and 40, Woodcock-street, Birmingham, have dissolved partnership. Debts by Mr. Bradbury.

The British Electrical Trade Supply & Bitumen Co. announce the appointment of Messrs. Rumney & Rumney, 39, Victoria-street, Westminster, as sole agents for the sale of their goods bearing the "Trinidite" trade mark.

BANKRUPTCIES, LIQUIDATIONS, &c.

Ferranti Limited.—Meetings of unsecured creditors, of the holders of first mortgage debenture stock, and of preference shareholders in Ferranti Limited were held at Winchester House, London, E.C., yesterday (Thursday), under the presidency of Mr. John M. Henderson (liquidator).

The CHAIRMAN said the meeting had been convened with the object of inviting the unsecured creditors to decide by vote as to the acceptance or otherwise of the "Scheme of Arrangement" which had been circulated. They were all acquainted with the recent history of the company which led up to the present position. Those responsible for the scheme before the meeting considered it held out good prospects of profit-earning in the future.

Mr. A. W. TAIT said that the present position of the company was such that it was in the interest of all parties to continue the business, which showed that, now certain economies in working had been effected, there was good prospect of profits to be made in those branches of the business which it had been decided to continue. After passing in review the particular features of the "Scheme of Arrangement," Mr. Tait said the nett surplus of the business as a going concern, allowing for everything of a doubtful kind, and after providing a large sum for litigation costs, was some £257,635. He had received a majority of the proxies in favour of the scheme, which he thought the creditors should agree to.

After a discussion of several points in the scheme, the meeting decided unanimously to adopt it.

At the meeting of preference shareholders which followed (Mr. Henderson presiding) an amendment to the scheme—that the word "cumulative" should be omitted as applying to the preference dividend—was carried.

A meeting of holders of the first mortgage debenture stock was subsequently held, with Mr. Henderson in the chair, the scheme being approved.

The Court's assent to the scheme as amended will be applied for in due course.

A receiving order has been made against J. Marsden, electric fittings maker, 39 and 40, Woodcock-street, and 4, Grove-road, Sparkhill, Birmingham.

The trustee in the bankruptcy of H. J. Furniss, electrician, 5A, Queen-street, Derby, has been released.

A receiving order has been made against Hy. Coles, electrical engineer, 10, York-street, Swansea.

The Bath Electric Mfg. Co. (Ltd.) have passed and confirmed resolutions to wind up voluntarily (with Mr. A. C. Comley, Albion-chambers, Bristol, as liquidator), with a view to an amalgamation with H. V. Kramer & Co., of Bath, and Drewett & Hood, of Bristol, under the title of "Kramer Limited."

A meeting will be held at 12, Mount Stuart-square, Cardiff, on Oct. 31, to receive an account of the winding-up of the Marquand Accumulator Co. (Ltd.).

A first and final dividend of 4d will be payable on Oct. 3 at 4, Egypt-street, Warrington, in the liquidation of the Warrington & District Electric Light & Power Co. (Ltd.).

Claims against the Electrical Machinery Developments Co. (Ltd.), must be sent by Nov. 19 to Mr. F. N. Lowther, 151, Cannon-street, London, E.C.

Claims against the London Electrical Synd. (Ltd.) must be sent by Oct. 31 to Mr. G. Pearson, 196, Abbotts-road, Poplar, London, E.

Sale by Auction.—Messrs. Fuller, Horsey, Sons & Cassell will sell by auction at the works of Electric Lighting Boards, Ltd. (in liquidation), 80, York-road, King's Cross, London, N., on Thursday and Friday, Oct. 13 and 14, plant and machinery, electric lamps and fittings, and a large quantity of accessories, material and sundries, of which further particulars will be found set out in an advertisement elsewhere. Catalogues are obtainable from Messrs. Dolman & Pritchard, solicitors, 9 and 10, Cheapside, E.C., of Messrs. Golding & Hargrove, solicitors, 99, Cannon-street, E.C., and of the auctioneers, 11, Billiter-square, E.C., London.

Plant for Sale.—A complete 700 H.P. power plant (now supplying direct current at 550 volts to the trains on the Harrow branch of the Metropolitan District Railway) is for sale. Delivery March, 1905. Particulars from Mr. H. B. Twyford Hamilton House, Victoria Embankment, London, E.C. See advertisement.

Messrs. W. H. Allen, Son & Co., Queen's Engineering Works, Bedford, have for immediate delivery two 200kw. steam dynamos. See advertisement.

Messrs. Wheatley Kirk, Price & Co. have for sale some electric generating sets for power and lighting, in first-rate running order, which have been displaced by larger units. For further particulars see advertisement.

Plant, &c., Wanted.—A 150kw. or 300kw. gas engine, new or second-hand, is wanted to drive electric plant. Apply to G. E., care C. & E. Layton, 56, Farringdon-street, London, E.C. See advertisement.

Overhead cable, suitable for transmitting 40 H.P. to 50 H.P. a distance of 2 miles, is required. Prices, &c., to Mr. Parkyn, 32, Queen Victoria-street, London, E.C. See advertisement.

Shops to Let.—There are three fine shops, with basements, to let in the Strand, London, on a 21 years' lease. Particulars from the secretary's office, Room 41, West Block, Hotel Cecil, Strand, London, W.C. See advertisement.

Electricity Meters.—We are informed by the British Westinghouse Co. that they have commenced an action against Ferranti Limited for infringement of their patent rights in connection with alternating-current meters.

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Automatic Points.—A demonstration of the working of the Zylberlast patent automatic points is to be made at 2:30 to-morrow (Saturday) afternoon on the electric tramway at Trafford Park, Manchester. Arrangements have been made for a visit to the Westinghouse works.

Polyphase Motors.—Messrs. Johnson & Phillips, who claim to have been the first manufacturers of polyphase machinery in this country, have issued a new catalogue on polyphase motors for various purposes. The following particulars in regard to these machines are given:—

The field cores are built up of thin iron or steel plates of best magnetic quality, insulated from each other by paper. They are contained in a strong cast-iron cylindrical case, and so fixed that decentring is impossible. The slots for the winding are carefully cleared and smoothed before insulating, and care is taken to provide ample insulation between the coils of the different phases. The armature core is built up of varnished iron or steel plates mounted directly on the shaft in the case of small motors, and on a spider in the case of large ones. The bearings are very long, and are lubricated automatically by oiling rings. Ample ventilation is provided and it is claimed that the motors will work at full normal load continuously or overloaded for considerable periods without overheating. A standard frequency of 50 ∿ per second has been adopted and the best performance of the motors will be obtained at this frequency. They can, however, be run at any frequency between 40 and 60, the normal speed being reduced or increased pro rata, but the power remaining approximately the same. All

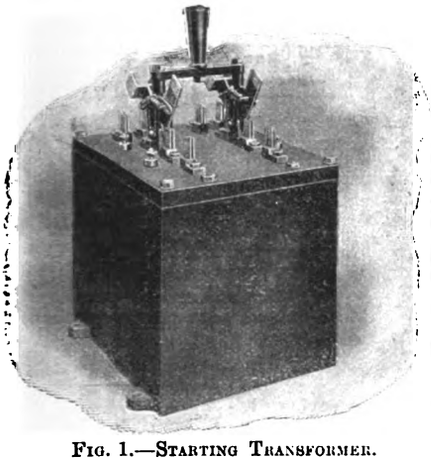


Fig. 1.—Starting Transformer.

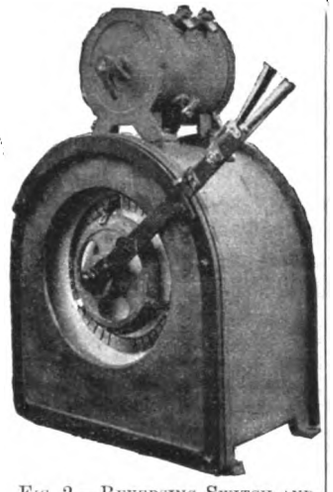
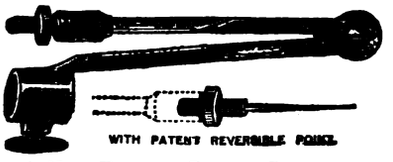


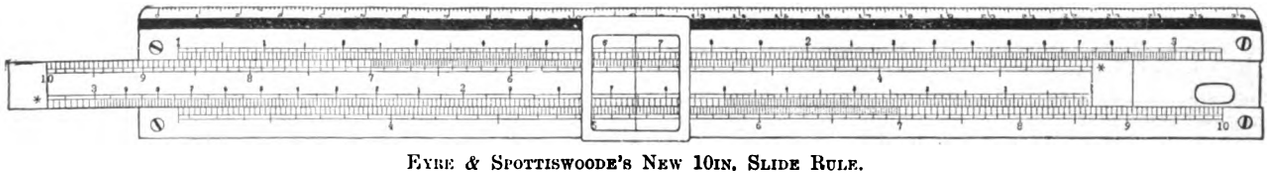
Fig. 2.—Reversing Switch and Starting Resistance.

motors working at normal frequency and supplied with the pressure for which they are wound can be overloaded to the extent of 75 per cent. before they will stop by falling out of step. They will carry an overload of 20 per cent. for one hour without overheating. The motors are supplied either with a short-circuited or a wound armature, according to the nature of the work to be done. The standard types of polyphase motors with short-circuited armatures range from ½ H.P. to 50 H.P., while the motors with wound armatures are built in standard sizes from 5 H.P. to 200 H.P. Much more information of an interesting and practical nature, relating in particular to the speeds, efficiencies, power-factors and prices of the motors and their accessories, may be found in the price list referred to. Fig. 1 shows a starting transformer and Fig. 2 the very compact pattern of reversing switch and starting resistance manufactured by Messrs. Johnson & Phillips.

Mathematical Instruments.—Messrs. Eyre & Spottiswoode, of Great New-street, London, E.C., are now placing on the market a new 10in. slide rule. By means of a special construction all likelihood of warping or binding of the slide is avoided. The celluloid parts, which, under the influence of changes of temperature or rough treatment, were formerly liable to come away from the wood, are now secured by screws. To enable the cursor to be worked at the extreme ends of the scale, the rule has been extended at both ends, an advantage which will be appreciated by those who use slide rules frequently. This particular rule is made in five sizes: 5in., 8in., 10in., 15in., 20in. and as a 5in. pocket rule ¼in. thick, with a comparative scale of inches and centimetres on the back. A special feature are the numerous, but not confusing marks, indicating mathematical constants frequently used. The symbols Q+1 and P−1 at opposite ends of the rule facilitate the often ill-understood method of obtaining the correct decimal point in quotients and products. The rule is a strongly-made, serviceable instrument and is as inexpensive as other types. Messrs. Eyre & Spottiswoode have also recently introduced a cheap pocket compass, in which the point is protected when not in use by being screwed into a hollow leg. This device should prove of value to students in the laboratory and lecture theatre, as it may be used in conjunction with an ordinary pencil. The illustrations show both slide rule and pocket compass.



A New Form of Pocket Compass.



Eyre & Spottiswoode's New 10in. Slide Rule.

Catalogues, &c.—"Continuous Current Motors" is the title of a pamphlet just issued by the Electrical Co., 121-125, Charing Cross-road, London, W.C. The particulars include a set of instructions for the maintenance and supervision of continuous-current machinery and some general information which will prove of interest to buyers and installers of this class of plant. A specification of E.G. dynamos and motors and diagrams of connections are included.

The Union Electric Co., 151, Queen Victoria-street, London, E.C., have ready a new pamphlet list of "E.V." arc lamps. The "E.V." lamp is successor to the company's old "D.V." pattern lamp, the improvements consisting chiefly in the diminution of size, easier fitting of the globes and reduction of price. Longer lamps can, however, be supplied than those shown in the list.

The Brush Electrical Engineering Co. have issued a neat pamphlet treating of Brush-Vienna incandescent lamps, and illustrating the various types of these lamps which can be supplied by the company.

The latest circular price list issued by Ernest F. Moy (Ltd.), Camden Town, London, N.W., illustrates and describes supports for stage arc lamps.

Messrs. Ferranti Limited, in their newly-issued catalogue lists, Nos. 9 and 10, deal with alternating reversed current time limit relays for automatic switches and edgewise type of moving coil instruments for continuous currents. Both lists are illustrated and copies can be obtained on application to the works, Hollinwood.

A new price list of "English manufactured arc lamps" is issued by Mr. G. Braulik, of Upper Thames-street, London.

A catalogue of the "Trinidite" brand of refined bitumen and box compound is issued by the British Electrical Trade Supply & Bitumen Co., in which full particulars concerning this compound are given. Bitumen and tar boilers are illustrated and described in a separate list.

"Field Rheostats" and "Motor Starting Rheostats" are separately dealt with in two pamphlets (Nos. 173 and 174) issued by the British Thomson-Houston Co. Both pamphlets are fully illustrated.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Sept. 21 to 27, with the ports of destination:—

Africa—Alexandria, £46; Cape Town, £13; Chinde, £65; Delagoa Bay, £333; Durban, £1,592; East London, £507; Sekondi, £90. *Argentina*—Buenos Ayres, £238 (including £120 telegraph apparatus); Rosario, £27. *Australasia*—Fremantle, £2,221 (telegraph cable); Hobart, £45; Melbourne, £229; Perth, £1,189; Sydney, £4,247 (including £51 telegraph material); Wellington, £1,961 (including £633 telegraph material). *Canada*—Montreal, £169; Toronto, £39; Victoria, £104. *Ceylon*—Colombo, £340. *China*—Shanghai, £795. *Cuba*—Havana, £180. *Germany*—Hamburg, £647 (including £630 telegraph material). *Gibraltar*, £42. *Holland*—Amsterdam, £120; Flushing, £62. *Hong Kong*, £203. *India*—Bombay, £1,116; Calcutta, £788; Madras, £73. *Japan*—Nagasaki, £34; Yokohama, £592. *Malta*, £411 (including £111 telegraph material). *Russia*—Odessa, £156. *Siam*—Bangkok, £65. *Spain*—Grenada, £31. *Straits Settlements*—Penang, £24; Singapore, £347 (including £31 telegraph material). Total, £18,771, against £31,070 in the corresponding week last year (Sept. 23 to 29).

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COMPANIES' MEETINGS AND REPORTS.

DICK, KERR & CO. (LTD.)—At the meeting on Tuesday, the chairman (Mr. John Kerr, M.P.) said that though the net profits for the year were only £84,170. 17s. 2d., against £110,449. 1s. 10d. for 1903, they did not feel, in view of the severe competition in all departments, that any explanation was necessary. Apart from maintaining the works and machinery in the most efficient manner and charging the same to revenue, the plant and machinery had been amply depreciated. Clause 31 of the trust deed provided for that. The large amount carried forward (£39,922. 11s. 4d., against £35,544. 18s. 7d. last year) was a source of strength to the company. Their operations were not confined to the United Kingdom. In the Far East and in India important contracts had been concluded or were in course of completion. A large piece of work was being carried out in Tokyo in the smoothest manner possible, notwithstanding the war. Australia, South Africa, Canada and Argentina had proved good customers. Europe practically and America completely, by reason of their high protective tariffs, might be accepted as markets which would be of litile account to them. The electrification of the line between Liverpool and Southport on the L. & Y. Railway had been completed and was working successfully. That was the largest scheme of railway electrification of a main line so far carried out in this country. There was the possibility of a considerable development of work in that direction in the near future. The experience they had gained should prove most useful. As regarded cost and quality of production, they need not fear comparison with foreign or other rivals. It was the desire of the board to closely study in every manner possible the means of lowering the cost of manufacture without reducing the high standard at which they had always aimed. With the experience of the past and the ever-increasing reputation of the firm for the excellence of their work, the directors had every reasonable hope of presenting accounts in the future of a favourable character. He (Mr. Kerr) desired to express the directors' great appreciation of the untiring service of the staff and the workmen. They had been free from anything of the nature of a strike, and the best of relationship exists between them and their employés.

ELECTRIC RAILWAY & TRAMWAY CARRIAGE WORKS (LTD.)—At the meeting last week the chairman (Mr. Geo. Richardson) said that the trade of the country had not been in as prosperous a condition as heretofore, and that was especially so in connection with their business. There had been a decrease in output during the year. Municipalities had not been able to order the number of cars that they would have done under normal conditions. They had met with serious competition, but two of the works which had been their greatest competitors had now gone into liquidation. Consequently they might now look forward to obtaining better prices than hitherto for their manufactures. Last year, too, expenses had been greater in consequence of the diversity in the style of cars, which had increased very much the number and the cost of drawings. One of the awkward points which they had to deal with was the position taken up by the engineers' trade union, which was acting with great zeal in endeavouring to do away with overtime and also to abolish bonuses for prompt and quick delivery. Sometimes manufacturers got a bonus for quick delivery, and the union made out that this was detrimental to their trade, and contended that every man should have the same amount of money whether he were a good or bad workman. That was a point which would have to come up for serious consideration later in connection with the general business connected with engineering generally.

MERSEY RAILWAY CO.—The chairman (Mr. James Falconer) stated at the meeting on Tuesday that the company had now reached that stage of electrical working when practically the only consideration was as to the results and the cost of bringing them about. The receipts were increasing and the cost of working also was better, but the board looked forward to an increase in receipts as the public realised the advantages which the present system of working provided and as the traffic in the district extended and developed. They also looked forward to an improvement as regards cost of working. The number of passengers carried (excluding season ticket holders) was about 4,500,000, against 3,200,000 in the corresponding period of 1903, an increase of about 40 per cent. The receipts were £33,715, against £26,136, or 29 per cent. increase. There had been a substantial increase in the number of season ticket holders. The total increase of receipts had been £8 640, or about 25 per cent. Working expenses, including exceptional charges, were £33,591, against £32,061 for the corresponding period of last year. In measuring the effect of the change from steam to electric traction it was necessary to take into account the fact that they had been giving to the public a greatly increased service, and that the working expenses for the half-year represented practically twice the amount of work done in the corresponding half of the previous year. During the past half-year the train mileage had been 411,683, against 218,208. To compare the cost of working an electric service with a steam service on the Mersey Railway they must look at the cost per train-mile. Excluding exceptional charges for pumping and ventilation, the cost per train-mile during the half year ended June 30, 1903 (when the railway was worked four months by steam and two months by electricity) was 30·1d. During the past half-year the cost was 17·35d., a reduction of 42 per cent. If they included the exceptional charges, the cost per train-mile during the first period was 35·25d. and during the second 19 58d. Those figures conclusively established the extraordinary superiority of electric traction over steam for the working of such a railway as theirs. But this was not all, for the cost at which the existing traffic had been carried represented the cost for which they could carry practically double that traffic. They had demonstrated that, at 1s. 7½d. per train-mile, they could carry any number of passengers that were likely to come to them. At present their earnings from all sources amounted to about 2s. per train-mile, and the whole future of the company depended upon the increase of that figure. The 1s. 7½d. per train-mile was made up as follows:—Way and works, 1·79d.; locomotive and generating power, 5·71d.; repairs to carriages, 1·90d.; traffic (excluding cost of lifts), 5·96d.; general charges, 1·61d.; rates and taxes, 0·89d.; law costs, 0·119d.; pumping, 1·63d ; ventilation, 0·10d.; and lifts, 0·50d. Since the last meeting they had settled the differences between themselves and their contractors amicably.

SOUTH LANCASHIRE ELECTRIC TRACTION & POWER CO. (LTD.)—The report for the year ended June 30 shows a credit balance of £2,573, making, with £778 brought forward, £3,351. The liabilities to contractors for works not certified by consulting engineers and accrued preference dividends have not been provided for in the accounts, which are also debited with £58,701. two years' debenture interest. The whole of the tramways and light railway constituting the first constructional scheme of the company have been in operation since 1903. The receipts have not quite realised expectations owing to trade depression. The debenture interest not having been paid, the Court has appointed Messrs. J. M. Henderson and J. R. Sadler joint receivers and managers. Negotiations are pending, however, and there is reason to hope that a reconstruction of capital may be possible, and that the additional capital required to proceed with the construction of the authorised lines may be obtained at a reasonable rate. On 7th prox. a meeting will be held to consider the advisability of winding up the company voluntarily. Sir John A. Willox, M.P., has, through continued ill-health, retired from the board, and Messrs. J. Beecham and H. R. Hogg have joined the directorate.

WESTERN UNION TELEGRAPH CO.—This company have issued their report for the quarter ended Sept. 30, 1904. The following statement, dated Sept. 14, shows the condition of the company at the close of the quarter ended June 30, 1904:—

Surplus April 1, 1904, as per last quarterly report ...		$14,588,205 04
Net revenues, quarter ended June 30, 1904		1,802,791 99
From which deducting for—		$16,390,997 03
Dividend of 1¼ per cent. paid July 15	$1,217,018 75	
Interest on bonded debt	292,550 00	
		1,509,568 75
Left a surplus July 1, 1904, of		$14,881,428 28
The net revenues of the quarter ending Sept. 30, based upon nearly completed returns for July, partial returns for August, and estimating the business for September, will be about		2,100,000 00
From which appropriating for—		$16,981,428 28
Interest on bonds		297,550 00
		$16,683,878 28
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,217,018 75
Deducting which leaves a surplus, after paying dividend, of.....		$15,466,859 53

In view of the preceding statements, the committee recommend that a dividend of 1¼ per cent. on the capital stock of the company be declared.

WILLANS & ROBINSON (LTD.)—The directors, in their report for the half-year ended June 30, regret that the results are so unfavourable. Apart from losses at Queen's Ferry, the company's operations at Rugby have for the first time in its history resulted in a loss. After making an increased allowance for depreciation (£7,601. 18s. 11d.) there is a loss of £3,345. 5s. 9d. in respect of Rugby. The loss at Queen's Ferry (after writing off £9,937. 12s. 1d. depreciation) is £25,902. 16s. 5d., and there is, further, a debit balance of £7,932. 4s. 9d. from the preceding half-year The loss at Rugby is attributed chiefly to extreme badness of trade, under the stress of which orders are taken by many firms at prices which make profit impossible. The directors have striven to open up new branches of business, with a growing success upon which they found strong hopes for the future, but such work cannot yield a profit at first, and in its initial stages is bound to be a source of loss. This affects not only the half-year under consideration, but also the current half-year, and probably the next half-year as well. Nevertheless, the directors are satisfied that, in developing these new branches of work, of which steam turbines and gas engines are the chief, they are taking the surest course for the ultimate revival of the company's prosperity. They are also endeavouring to economise in every way and have effected large reductions in expenses. The utmost is being done to maintain the reputation of the company for excellence of manufacture and to keep the Willans engine in its old position of supremacy. It is not possible to operate the Queen's Ferry works upon a sufficiently large scale to make a profit, or even to pay expenses, without raising more capital for plant and for working. This is out of the question at present, and, therefore, the works are kept employed only to the extent necessary to complete one important contract. While the works are thus maintained as a going concern (except the steel works, now closed, but capable of being readily re-started), the directors are endeavouring to find a purchaser for them. The increased loss at Queen's Ferry is largely due to the increase in depreciation (£2,688 more than last half-year). An unexpected source of loss has also arisen in the necessity for rejecting, and valuing only as scrap, a quantity of material made in the earlier stages of the work and believed at the time to be satisfactory. This source of loss is not likely to recur, but under present conditions at Queen's Ferry some loss cannot be avoided, even if the works be closed entirely. Everything that is possible is being done to reduce expenses and to increase efficiency. The directors have given constant attention to the improvement of the financial position of the company, which is the dominant factor in the situation. The directors are glad to say that the financial position during

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the past few months has much improved. Money has come in comparatively freely from debtors, and shares in other companies (received in part payment under contracts) have been sold at favourable prices. The bank debt has been paid off, and an ample balance created, without selling the whole of the reserve fund investments; investments remain which, at cost, represent £27,053. 4s. 6d. The loss upon realising the securities sold, at present low prices, has been charged against reserve fund account, which has also been debited with an amount written off from other investments of the company, which the directors have rigorously valued down to what they believe to be thoroughly safe figures. The opinion was expressed at the last meeting that the remuneration of the additional directors should be provided by deductions from the salaries of existing directors. As the directors are remunerated under separate agreements for service, and not collectively, this question, as was explained at the meeting, could only be dealt with by the directors individually, and not by the board as a whole. Mr. Robinson and Sir Gilbert A. Clayton East accepted reductions as from March 31 last, equivalent to their pro rata proportions of the new directors' salaries. Mr. Arthur Lazenby expressed, and still desires to express, his willingness to follow the same course, but at the wish of some of his colleagues he has deferred action until they could bring the matter as affecting him before the shareholders at the ensuing meeting.

LIENS REGISTERED, &c.

MORTGAGES AND CHARGES.

BOWEN'S ELECTRIC AND MOTOR BOATS (LTD).—£4,000 debentures, created Aug. 12 and dated Sept. 7, 1904, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

BURNAND TRANSFORMER CO. (LTD.)—£1,000 debentures, created Aug. 31, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

DUDLEY, STOURBRIDGE & DISTRICT ELECTRIC TRACTION CO. (LTD.)—An acknowledgement of indebtedness under seal dated Sept. 15, 1904, acknowledging in respect of £10,000 further debenture stock, making indebtedness, with £60,000 previously acknowledged, £70,000, supplemental to trust deed dated May 29, 1904, securing debenture stock not exceeding one-half of company's subscribed share capital for time being, has been registered. Property charged, company's assets, present and future. Trustees, Electric & General Investment Co.

CITY NOTES.

MEMORANDA (Sept. 29).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26¾d. per oz. Consols 88⅜—88½ for money, 88⅜—88½ for account; 2½ per cent. annuities 87—87½. Consols Pay Day, Oct. 5; Stocks and Shares Continuation Days, Oct. 11 and 25; Ticket Days, Oct. 12 and 26; Pay Day, Oct. 13; Mining Share Carry-over Days, Oct. 10 and 24.

CALCUTTA TRAMWAYS CO. (LTD.)—The directors have declared an interim dividend of 3s. per share, or 6 per cent. per annum, for the half-year to June 30.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—An interim dividend at the rate of 8 per cent. per annum has been declared on the ordinary shares for the half-year ended 30th inst.

DIRECT WEST INDIA CABLE CO. (LTD.)—The net profit for the year ended June 30 was £3,617. 6s. 6d., compared with £1,430. 4s. 5d. for the previous year. An interim dividend of 3 per cent., tax free, has already been paid, and a further equal payment, tax free, was sanctioned at the meeting yesterday, leaving £1,817. 6s. 6d. to be carried forward.

EVERED & CO. (LTD.)—An interim dividend for the half-year ended June 30 at the rate of 7½ per cent. per annum has been paid.

FOLKESTONE ELECTRIC SUPPLY CO. (LTD.)—An interim ordinary dividend at the rate of 4 per cent. per annum for the half-year ended June 30 will be paid on 1st prox.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—At the meeting yesterday the directors reported that for the year ended June 30 the net profit was £2,692. 5s. 3d., compared with £3,244. 15s. 11d. for the previous year. An interim dividend of 2½ per cent., tax free, has already been paid, and it was proposed to make a further equal payment, tax free, leaving £192. 5s. 3d. to be carried forward. The company's cable continued to work efficiently. The report was adopted.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to appoint a special settling day in and to grant a quotation to a further issue of £100,000 4½ per cent. first mortgage debenture stock of *Callender's Cable & Construction Co. (Ltd.)*, and also to allow a further issue of 16,000 £5 fully-paid ordinary shares of the *Urban Electric Supply Co. (Ltd.)* to be quoted.

SWANSEA IMPROVEMENTS & TRAMWAYS CO. (LTD.)—The gross earnings for the half-year ended June 30 were £13,835, and after deducting working expenses and interest the net profit was £3,935, added to the balance from previous half-year. £1,000 is transferred to reserve in reduction of amount due to British Electric Traction Co., and the usual preference dividends are declared.

TRAMWAYS & GENERAL WORKS CO. (LTD.)—For the year ended June 30 the profit was £1,360. Adding £547 from last year, and deducting £1,500 distributed as dividend in April, the balance of £408 is carried forward.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept. 24	1,451	+ 208	17	27,518	+ 5,094
Airdrie	,, 16	216	...	32	6,398	...
Ayr Corporation	,, 24	305	+ 22	19	8,095	+ 470
Barnsley	,, 16	171	- 8	37	6,316	- 442
Barrow	,, 16	242	...	32	6,297	...
Bath Electric Trams, Ltd.	,, 21	805	...	38	24,643	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	...	...	...	...	...	...
Birmingham Corporation	,, 24	298	...	38	11,608	...
Birmingham Tramways Co.	,, 24	5,396	- 283	12	64,997	+ 2,689
Blackburn Corporation	,, 23	1,014	+ 165	26	25,570	+ 2,514
Blackpool Corporation	,, 22	1,760	+ 166	25	26,701	+ 5,101
Blackpool and Fleetwood	,, 24	985	+ 81	12	17,390	+ 177
Blackp'l, St. Anne's & Lytham	,, 22	628	+ 82	47	18,867	+ 7,112
Bolton Corporation	,, 25	1,860	+ 14	26	49,360	+ 478
Bournemouth Corporation	,, 21	1,311	+ 118	‡25	30,633	+ 1,788
Bradford Corporation	,, 24	4,774	+ 725	25	120,983	+ 21,648
Brighton Corporation	,, 25	1,062	+ 72	25	28,630	+ 2,940
Brisbane Tramways	Aug. 10	2,997	+ 74	6	14,088	- 28
Bristol Trams & Carriage	Sept. 23	5,172	+ 21	7	97,457	+ 1,149
Buenos Ayres & Belgrano	Aug. 28	2,080	+ 96	19	60,579	+ 2,980
Burnley Corporation	Sept. 24	1,053	+ 105	26	27,869	+ 6,184
Burton Corporation	,, 25	343	- 90	¶25	9,437	+ 1,912
Calcutta Tramways Co.	,, 24	a38,078	+ a313	18	a486,906	+ a45,810
Camborne-Redruth	,, 26	117	+ 5	21	2,489	- 110
Cardiff Corporation	,, 24	2,041	+ 86	25	54,127	+ 1,865
Carlisle Tramways Co.	,, 24	206	- 8	38	7,709	+ 287
Central London Railway	,, 24	6,397	+ 309	12	70,547	- 1,118
Chatham & Dist. Lt. Rys.	,, 22	641	+ 24	38	23,740	+ 2,208
City & South London Rly.	,, 25	2,678	+ 31	13	30,926	- 1,103
Colchester Corporation	,, 22	274	...	8	2,908	...
Cork Electric Trams Co.	,, 22	519	- 31	38	18,010	- 2,360
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 16	575	+ 41	37	20,116	+ 3,298
Dover Corporation	,, 24	236	- 17	26	6,421	- 177
Dublin & Lucan Railway	,, 23	141	+ 10	12	1,757	- 4
Dublin Southern District	,, 23	1,086	+ 108	} 12	67,222	- 3,027
Dublin United	,, 23	3,974	- 132			
Dudley—Stourbridge	,, 15	942	+ 69	37	32,702	+ 1,852
Dundee Corporation	,, 21	871	+ 33	...	...	...
East Ham Council	,, 24	707	- 21	25	19,619	+ 1,409
Gateshead & Dist. Trams	,, 16	924	+ 35	37	33,682	+ 1,464
Glasgow Corporation	,, 24	15,247	+ 613	†17	241,398	+ 14,806
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 16	282	+ 4	37	9,755	+ 749
Gt. Northern & City Rly.	,, 24	1,108	...	32	30,625	...
Greenock & Port Glasgow	,, 16	720	+ 28	37	21,657	+ 1,142
Halifax Corporation	,, 14	1,512	+ 189	} 25	40,175	+ 3,381
	,, 21	1,620	+ 153			
Hartlepool Tramways	,, 16	807	+ 15	37	11,180	+ 1,022
Huddersfield	,, 24	1,299	+ 382	25	35,226	+ 2,427
Hull Corporation	,, 24	2,111	+ 199	25	55,220	+ 7,511
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	...	...	...	...	...	...
Ipswich Corporation	,, 24	507	...	25	13,818	...
Isle of Thanet Co.	,, 24	847	- 15	¶52	34,857	+ 1,827
Kidderminster & District	,, 16	144	+ 11	37	4,978	+ 37
Kirkcaldy Corporation	,, 21	247	- 37	38	8,819	...
Lanarkshire Trams Co.	,, 22	751	+ 70	38	24,536	...
Leeds Corporation	,, 24	5,845	+ 89	25	155,803	+ 10,145
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	,, 17	10,646	+ 206	38	394,119	+ 12,602
Liverpool Overhead Rly.	,, 25	1,529	- 180	†13	21,574	- 731
*London County Council	,, 17	13 907	+ 3,498	§25	311,866	+ 65,047
Lowestoft	...	...	...	...	...	...
Maidstone Corporation	,, 22	183	...	10	1,866	...
Manchester Corporation	,, 24	12,685	+ 75	25	314,977	+ 12,587
Mersey Railway	,, 24	1,414	+ 76	12	17,272	+ 1,215
Merthyr	,, 16	206	+ 1	37	7,527	+ 120
Metropolitan Elec. Trams	,, 23	2,064	+ 658	12	23,788	+ 5,685
Middleton	,, 16	339	+ 7	37	12,455	+ 191
Nelson Corporation	,, 21	133	+ 86	} 26	3,185	+ 1,056
	,, 23	127	+ 20			
Newcastle-on-Tyne Corp.	,, 24	3,839	- 59	12	44,210	+ 2,570
Newport (Mon.)	,, 24	498	- 11	25	13,464	+ 1,277
Oldham, Ashton & Hyde	,, 16	562	+ 6	37	20,535	- 880
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams.	,, 23	1,220	+ 75	38	49,626	+ 6 003
Peterborough	,, 16	170	- 21	37	5,770	- 124
Poole and District	,, 16	332	+ 17	37	11,594	- 33
Portsmouth Corporation	,, 24	1,948	- 8	§25	55,981	+ 4,757
Potteries	,, 16	1,802	+ 125	37	63,172	+ 5,188
Reading Corporation	,, 22	666	+ 29	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 16	166	- 12	37	6 054	- 83
Salford Corporation	,, 26	4,866	- 24	25	106,927	+ 7,253
Sheerness	,, 14	77	+ 1	37	2,423	- 474
Sheffield Corporation	,, 25	4,517	- 238	§26	123,955	+ 2,884
Southampton Corp'ation	,, 22	1,048	...	25	26,847	- 1,711
Southend Corporation	,, 21	443	+ 59	25	10,999	+ 1 206
Southport Tramways	,, 16	848	- 40	37	19,588	+ 598
S. Staffordshire Trams.	,, 16	749	- 242	37	22,549	- 4,107
Stockport Corporation	,, 23	625	+ 214	25	15,615	+ 6,498
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	,, 16	515	+ 4	37	20,572	+ 1,012
Taunton Trams	,, 16	57	- 1	37	2,118	- 193
Tynemouth and District	,, 16	315	- 84	37	11,383	- 941
Tyneside Trams Co.	,, 21	442	+ 92	38	14,912	+ 2,399
Wallasey District Council	,, 24	759	+ 2	§25	20,452	+ 1,237
Walsall	,, 24	486	...	37	18,526	...
Warrington Corporation	,, 22	336	+ 14	25	8,228	+ 263
West Ham Corporation	,, 22	1,141	...	30	27,268	...
Weston-super-Mare	,, 14	213	- 9	37	5,404	+ 383
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 16	394	- 41	37	14,623	- 84
Worcester	,, 16	348	+ 191	32	10,448	+ 4,935
Wrexham	,, 16	121	- 14	37	4,201	- 593
Yorkshire Woollen District	,, 16	587	+ 110	37	22,336	+ 8,580

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 8 days. ‡ Minus 2 days ¶ Plus 8 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Sept. 28.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business, Week to Sept. 28. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	..	Anglo-Argentine Ordinary Shares	6½–6¾	..	April, Oct	6½	6⅜
5	2/6	Do. 5% Cum. Pref.	5⅝–5¾	4 7 0	..	5⅞	5¾
St.	6%	Do. Permanent 6% Deb. Stock	139 –142	4 4 10	..	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	100 –102	4 19 3	..	102¼	101½
10	6%	Barcelona Tramways Ord.	9 –10	3 0 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 –10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 –96	4 14 0	..	..	..
100	5%	Do. 5 per Cent. Debs.	98 –101	4 19 6	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	⅝–¾	..	..	..	..
1	..	Do. 5% Cum. Pref.	¾–1	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½–2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾–4¼	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96 –101	4 9 3	..	98½	..
10	8%	Bristol Tramways and Carriage Ord.	19 –20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 –10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107 –109	3 13 4	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	97 –100	6 2 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	100 –103	4 18 0	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10½	4 15 3	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	104⅝–106⅝	4 6 7	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 –100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	9⅛–10	6 0 0	..	9⅜	9⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾–11½	5 6 7	Feb, Aug	11	10⅞
St.	5/0	Do. 5 per Cent. Perpetual Debs	117 –120	4 4 9	..	118½	..
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	94 –97	..	..	..	..
5	1/6	Buenos Ayres and Belgrano Ord.	3½–3⅝	6 8 6	..	3⅝	3½
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼–5⅜	5 4 4	..	5⅜	5⅛
5	3/0	Do. "B"	4⅜–5¼	5 14 4	..	5⅜	5⅛
St.	5%	Do. 5 per Cent. Debs.	105 –108	4 12 8	..	107	106½
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102 –105	4 16 3	..	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd, 5% Deb. Stk.	94 –99	5 2 3	..	..	..
5	3/6	Calcutta Tramways	7½–8	3 15 0	..	7¾	7¾
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 –108	4 4 0	..	10..	..
1	1/0	Cape Electric Tram Shares	1⅝–1¾	5 6 3	..	1¾	..
St.	4%	Central London Ordinary Stock	85 –87	4 12 0	June, Dec	87	86
St.	4%	Do. 4 per Cent. Pref. Stock	100 –102	3 18 3	..	..	..
St.	4%	Do. Deferred Stock	79 –81	4 18 9	..	80½	..
100	4%	Do. 4 per Cent. Debs.	106 –109	3 13 5	..	108¾	107
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½–5	5 0 0	..	5	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 –101	3 19 2	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	48 –50	4 10 0	Feb, Aug	49½	47¾
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 –125	4 0 3	Feb, Aug	..	..
St.	5%	Do. (1896)	117 –120	4 3 6	..	117½	..
St.	5%	Do. (1901)	115 –118	4 5 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	105 –108	3 14 9	May, Nov	107¼	107
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	101 –104	4 18 0	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13 –14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	..	..
10	3 0½	Gt. Northern & City Rly. Prf. Ord. (4%)	5 –5½	..	..	..	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 –10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 –20	4 10 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½–14¾	4 1 4½	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109 –111	4 1 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¼–4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 –91	4 7 11	..	..	..
10	1½%	Liverpool Overhead Railway Ord	2⅜–3⅜	3 15 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 –10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10¼–11	4 10 11	..	10⅝	10⅜
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 –105	3 16 4	..	104½	103¾
St.	..	Madras Elec. Trams 5% Deb. Stk.	102 –105	..	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6 –9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 –15	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅞–1	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞–1	5 0 0	..	..	..
St.	13/7	Do. 4½% Deb. Stock	98 –100	..	..	99¾	99½
100	5%	Montreal St. Ry. St'g 5% Mrt. Dbs.(1908)	100 –103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs.(1922)	103 –105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 –2	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	102 –105	4 16 6	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 –9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½–9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 –104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	86 –89	3 7 5	June, Dec	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	⅞–1	5 14 2	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	⅞–1	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾–6	6 13 4	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¾–6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 –104	4 6 7	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	100 –102	4 8 6	..	..	..
5	3/0	British Westinghouse 6% Pref.	2⅞–3¼	9 4 6	..	2⅞	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	86 –89	4 10 9	..	..	..
2	..	Brush Electrical Engineering	¼–¾	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1 –1½	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	94 –97	4 12 10	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	70 –75	6 0 9	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½–10½	5 14 3	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	101 –105	4 5 8	Nov, May	104	103½
1	9d.	Castner-Kellner Alkali Co. (fully paid)	¼–¾	5 6 8	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 –93	4 16 10	..	..	..
1	1/2½	Chadburn's (Ship) Telegraph Ord.	¾–1⅜	8 0 0	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½–2	3 15 0	Jan, July	1⅜	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	90 –95	5 6 5	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7½–8	..	..	..	..
5	3/0	Do. 6% Cum. Pref.	5¼–5⅜	5 4 4	..	..	..
St.	4½%	Do. 4½% Deb. Stock	103–106	4 5 9	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅜–¾	..	Feb, Aug	⅜	..
5	..	Do. (£5 paid)	1 –2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 –82	4 18 1	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 –83	6 3 8	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6⅛–6⅜	5 9 9	H'lf-yearly	6¼	6⅛
5	3/0	Do. 6 per Cent. Cum. Pref.	6 –6¼	4 16 0	..	6⅜	6⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105 –108	4 3 10	..	..	..
2	1/7½	Electric Construction Co.	1 –1½	6 8 0	July	..	..
2	2/9⅜	Do. 7 per Cent. Cum. Pref.	2 –2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	96 –99	4 0 9	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 –9½	5 5 3	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 –98	4 1 8	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½–11½	6 1 9	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 –5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 –111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½–19½	5 2 6	Feb, Aug	19⅛	19
100	4%	† Do. 4 per Cent. 1st Mort. Deb (red.)	99 –102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½–11	4 10 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	35 –38	6 6 3	Mar, July	36¾	35½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 –104	3 17 6	Jan, July	..	..
5	..	Willans and Robinson Ord.	1 –2	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	..	..	..	..	..

Share.	Last Dividend	Name.	Price Wed., Sept. 28.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business, Week to Sept. 28. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½–12½	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½–10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½–11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 –106	4 5 9	..	105	..
5	..	Bromley (Kent) El. Lt. & Power Shares	5½– 5¾	..	..	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 8 3	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10⅜–11½	4 8 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10½–10¾	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7½–8	4 7 6	..	7¾	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	107 –110	3 13 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8 –8½	4 14 3	Feb, Aug	8½	8¼
5	2/3	Do. 4½ per Cent. Pref.	5½–5⅝	4 1 10	Feb, Aug	5⅝	5½
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅝–5	4 10 0	..	4⅝	..
5	2/3	Do. Do. (1903)	4¾–5	..	..	4¾	4⅝
St.	4%	Do. 4% Deb. Stock (red.)	102 –104	3 17 0	..	103½	102¾
5	2/3	Chelsea Electric Supply Ord.	6½–7	4 2 2	March ..	6¾	6½
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108 –111	4 1 9	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10½–10¾	4 13 0	Feb, Aug	10⅝	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	120 –125	4 0 0	Jn, Dec ..	123½	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 –105	4 5 9	..	..	..
10	4/0	County of London Elec. Supply Ord.	8 –9	4 8 11	..	8¾	8½
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12	5 0 0	Mar, Sept	11¾	11⅝
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	105 –108	4 3 6	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 7 10	..	..	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 –93	5 7 6	..	..	..
5	3.6	Folkestone Electricity Supply Co. Ord.	5¾–6¼	4 8 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 –103	4 8 3	..	..	..
10	..	Havana Electricity Co. Shares	9½–10½	..	..	..	..
5	5 0	Hove Electric Lighting Ord.	7½–8½	5 0 0	..	7⅞	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St (red.)	101 –103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅞– 1⅛	..	..	..	..
5	5/0	Kensingtn & Knghtsbdge Ord.	12 –13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 –105	3 16 6	..	..	..
3	..	London Electric Supply Ord.	1⅜–2½	..	..	..	..
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 9 1	..	5⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	97 –100	4 1 0	Mr, Jn, S, D	98¼	98⅛
10	9/0	Metropolitan Electric Sup. Ord.	15⅜–16½	5 10 8	April, Oct	16⅝	16⅜
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅜–5⅝	4 0 0	Jan. July	5⅜	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	111 –116	3 18 6	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 – 99	3 10 6	..	98¼	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93 –96	4 13 9	..	..	..
10	6/0	Notting Hill Electric Ord.	14½–15½	3 17 6	March ..	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	100 –103	3 18 3	..	..	..
5	2/6	Oxford Electric Ord.	5¾– 6	5 4 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99 –102	3 19 2	..	..	..
1	..	Rand Electric	1 1/16–1 1/8	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	100 –103	4 7 9	April, Oct	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	14½–15½	4 13 7	Feb, Aug	14¾	..
5	3/6	Do. 7 per Cent. Pref.	8 –9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 –100	3 10 2	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2⅜–3½	6 3 1	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 –87	4 12 6	..	..	..
5	3/0	South London Electric Supply Ord.	4½–4¾	3 3 1	..	4 1/16	4 1/16
1	..	South Metrop'n Elec. Ltg. & Power Ord.	¾–1	..	..	⅞	..
1	0/8½	Do. 7% Cum. Pref.	1¼–1½	4 13 4	..	..	..
St.	..	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	105 –109	4 3 0	..	..	..
5	2/6	Urban Electric Supply Ord.	4¾ 5¼	4 15 3	..	5	4¾
5	2/6	Do. 5% Cum. Pref.	4¾–5¼	4 15 3	..	5	4¾
5	2/6	Westminster Electric Supply Ord.	12½–13½	5 0 0	Mar, Sept	13 1/16	12¾
5	2/6	Do. 5 per Cent. Cum. Pref.	6 –6½	3 16 11	..	6 1/16	6⅛
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	£8 –102	3 19 0	Jan, July	..	..
10	..	Amazon Telegraph	2½–3½	..	Jn Dec ..	..	..
St.	12/6	Anglo-American	50 –53	5 5 9	F, My, Ag, N	51	50½
St.	25/0	Do. Preferred	98 –98	5 12 8	F, My, Ag, N	97⅞	96⅝
St.	2/0	Do. Deferred	8 –8½	1 3 2	F, My Ag, N	8⅛	8¼
100	£2	Commercial Cable Capital Stock	170 –190	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 –97	4 3 3	Jn Ap, Jy, O	96½	..
10	5/0	Cuba Submarine Ord.	7 –8	7 10 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15 –16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½–3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 –8	6 5 0	April Oct	..	..
5	2/0	Do. 4½ per Cent. Deb.	98¾–101¾	4 9 2	Jan, July	..	..
50	4½%	Direct United States Cable	10½–10¾	5 11 3	Ja, Ap, Jy, O	10¾	..
20	3/0	Direct West India Cable 4½% Rg. Db. (rd.)	99 –101	4 9 2	Jn, Dec ..	..	..
100	4½%	Eastern Ordinary	129 –134	5 4 5	Ja, Ap, Jy, O	133½	131
St.	65/0	Do. 3½ per Cent. Pref. Stock	87 –90	3 18 6	Ja Ap, Jy, O	88½	88
St.	17/6	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	87 –90	3 18 6	Ja Ap, Jy, O	..	..
St.	4%	Eastern Extension	106 –109	3 14 3	May, Nov	108	..
10	2/6	Eastern Extension	12¾–12⅝	5 12 9	Ja, Ap, Jy, O	12¾	12⅝
St.	4%	Do. 4 per Cent. Deb. Stock	105 –108	3 14 3	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	99 –102	3 18 9	Feb, Aug	100¼	100
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100⅝–103⅝	3 18 6	May, Nov	..	..
10	5/0	Gt. Nrthn. (of Copenhagen)	29 –30	5 0 0	Jan, July	28½	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 –101	4 9 2	June, Dec	..	..
25	37/6	Indo-European	44 –47	5 6 4	May, Nov	46	45½
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 –100	4 0 0	June, Dec	..	..
10	6/0	West African Telegraph Shares	6 –7	5 14 3	..	..	..
2½	..	West Coast of America	⅛–⅜	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 –100	4 0 6	Jan, July	..	..
10	..	West India and Panama	⅜–½	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½–7	8 11 5	May, Nov	6¾	..
10	..	Do. 6 per Cent. 2nd Pref.	5 –6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	100 –103	4 17 10	Jan, July	..	..
10	3/C	Western Telegraph	12¼–12¾	5 9 9	Mr, Jn, O, D	12⅜	12⅛
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 –104	4 16 3	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 –104	3 17 6	..	..	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5 –5½	6 7 8	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	⅞–1 1/16	..	..	..	..
St.	6%	National Co. Pref. Stock	104 –106	5 13 9	..	105½	104½
St.	5%	Do. Def. Stock	91 –93	5 7 6	..	95⅛	94¼
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 –14	4 5 8	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 –13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5¼–5⅝	4 13 0	Feb, Aug	5⅜	5¼
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 –99	3 10 8	June, Dec	97⅝	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104 –106	3 15 9	..	..	..
..	5/9	Do. Do. Prov. Certs, 35% to be pd.	67 –69	..	..	105	104¾
1	0/8½	Oriental	1⅛–1 1/16	6 6 3	April, Oct	1	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 1/16–1 1/8	5 0 10	..	..	..
5	5/0	United River Plate	6 –6½	6 3 3	July.....	6½	6⅜
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾–5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 –106	4 14 4	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾–5¼	5 14 3	..	..	..
10	2/0	Globe Telegraph and Trust	9¼–9¾	5 12 8	Ja, Ap, Jy, O	9⅞	9⅝
10	3/0	Do. 6 per Cent. Pref.	13¾–14¼	4 4 3	Ja, Ap, Jy, O	14	13⅝
100	6%	Submarine Cables Trust (Cert.)	118 –122	5 18 9	April, Oct	..	..

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THE ELECTRICIAN:

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NOTES.

WE are able to confirm the announcement in our last issue that a telegraph cable is to be laid to Iceland. Proposals for such a cable have been made many times during the past few years, but it was realised that a cable to Iceland could not pay its way unless a considerable subsidy were granted. The Danish Government has now entered into an agreement with the Great Northern Telegraph Co. by which a yearly subsidy of £3,000 will be paid by Denmark and £2,000 by Iceland, and the cable is to be opened to traffic in two years' time. The cable will not be direct from Iceland to Denmark, but merely from Iceland to the Shetland Islands via the Faröe Islands, the Great Northern Telegraph Co. having obtained landing rights on the Shetland Islands from the British Government. From the Shetland Islands the existing cables will be made use of. This conclusion of the negotiations for a cable to Iceland will be a severe disappointment to the wireless telegraph companies, for if there is anything in the claims for long-distance wireless telegraphy it would appear that from the Shetland Islands to Iceland would be an ideal route. This distance is only 480 miles—considerably less than a quarter the distance which Mr. MARCONI claims to have covered with commercial messages between England and America—and, moreover, it might be assumed that large power transmitting stations in Iceland and in the Shetland Islands would not be a serious cause of disturbance to other wireless telegraphic work. The matter is the more significant, as a report was circulated some time ago that the Marconi Company proposed to establish communication with Iceland.

MR. A. L. C. FELL'S Paper read before the Municipal Tramways Association last week, and published in full on another page, did not receive the attention it deserved. In dealing with "mixed" systems of traction, the author, who is General Manager of the London County Council tramways, referred primarily to the methods necessary when it is desired to continue running the old horse tramways during the reconstruction period. In a busy town the loss occasioned by only partial stoppage of traffic is far greater than would be supposed by the layman, who knows nothing of tramway management—in South London it amounted to no less than £24,000. This is, of course, quickly made up when the electric tramways are running; in fact, an examination of our traffic returns on p. 1011 will show that during the 177 days of the present year £325,657 were earned by the L.C.C. tramways, as compared with £257,893 during the corresponding period last year, a difference of £67,764. This represents an increase of 26 per cent. for an increase in track-mileage from 39⅞ to 47½, or 18½ per cent. Notwithstanding a subsequent increase in traffic, however, any method of lessening the temporary loss of income during reconstruction is worthy of consideration.

THE present deplorable slackness of trade is affecting not only the less stable and robust manufacturing concerns, but also those which possess solid foundations and world-wide reputations. At the half-yearly meeting of Messrs. WILLANS & ROBINSON, held on Wednesday, the Chairman drew a very gloomy picture of the trade prospects, and expressed his inability to find language which would exaggerate "the badness of business." It is not so surprising that new boiler manufacturing and steel works should have been unsuccessful, considering the troublous times in which they were launched, but that such a well-established concern as that which produces the famous Willans engines has ceased to be prosperous is indeed sad. As Mr. MARK ROBINSON explained, however, even the reputation of the firm could not save them from

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disastrous competition, and when once other efficient high-speed engines were placed on the market success or failure depended solely upon price. The result has been that orders have had to be accepted at "ruinously low" prices, and hence the present unenviable position of the company. Competition must, of course, continue, and the only remedy, therefore, is for the firm to maintain, and, if possible, enhance their present reputation, at the same time reducing expenses to the smallest possible limit. We trust that the crisis has been passed, and that Messrs. WILLANS & ROBINSON have now better times in store for them.

AN article on the different effects of continuous and alternating currents on the dielectric strength of insulators, which appears in another column, raises certain points of considerable interest. It appears that when tested, five different insulators gave results showing that their capability of withstanding high voltages was in favour of continuous-current in ratios varying from 1·6 to 1·31. In this respect, therefore, there is an advantage on the side of the continuous current, but so near are the above figures to the ratio between the maximum and the effective voltage, that we cannot agree with the opinion expressed in the article that the greater destructiveness of the alternating current was due to dielectric hysteresis. As a matter of fact, losses due to this cause are extremely small—according to some tests made in Germany some time ago (*The Electrician*, Vol. LII., p. 678) no more than 2·45 watts per insulator at 50,000 volts and 50 ∾ per second.

IT is acknowledged, even by the most ardent supporters of municipal trading, that the proper working of undertakings under the management of local authorities is greatly impeded by a want of continuity in management. This has been well illustrated by recent events in Newcastle-upon-Tyne. The Chairman and a number of members of the Tramways Committee recently resigned on account of a difference of opinion that had arisen on the question of running powers, and it has thus fallen upon a new Committee to present the report of the previous year's work of their predecessors. These predecessors are presumably rivals in local politics—and the fateful day of the municipal elections is approaching. The new Committee review the results of the year's working in a highly critical spirit, and an impartial observer, forgetting that October precedes November in the calendar, might imagine that the undertaking was on the verge of financial disaster. Certainly an unusually large amount of money has been spent on "Maintenance and Renewals" during the period in question, a large proportion of this having been necessitated, it is stated, by the insufficient strength of the original permanent way specified by the consulting engineers. As a consequence of this expenditure there is (as in the majority of municipal undertakings) insufficient balance to set aside for depreciation; but if the true cause of this is the cost of strengthening the permanent way the tramway management is hardly to blame for it. In fact, the most serious charge against them is apparently that the Standing Orders of the Council have not been complied with, material having been bought in connection with the repairs without the contract having first been placed before the Council for approval.

THE article relating to the use of selenium for photometry, which appears in this issue, is of considerable interest for various reasons. It would be a great gain if we could find in selenium a substitute for the human eye in photometric measurements, but it appears from Mr. TOWNSEND'S experiments that no preparation of selenium has been obtained so far which affords a practicable means of comparing the candle-powers of different sources of light. The primary objection to its employment for this purpose is the inordinate length of time which must be allowed to elapse between consecutive measurements. Selenium may be compared, for the purpose of analogy, with that class of elastic substances which, after being stretched, require a long time to regain their original dimensions. Another serious objection is that lights of equal intensity but varying in wave-length produce different changes in resistance, and its behaviour in this respect may, therefore, be likened to that of the human eye, which also cannot be relied upon to compare the intensities of lights of different colour. Mr. TOWNSEND'S article is of value, however, if only for the descriptions of the methods of preparing selenium cells and its review of the properties of this somewhat capricious material.

Anonymous Donation to University College, Bristol.—The treasurer of University College, Bristol, received, on Wednesday, a Bank of England note for £1,000 from an anonymous donor.

The Institution of Electrical Engineers' Tour.—The Institution tour to America was brought to a conclusion on Saturday, when the party arrived at Liverpool on the White Star liner "Arabic."

Opening of the Radcliffe Electricity Works.—The formal opening of the Radcliffe District Council electricity works took place on Wednesday. A description of the plant appeared on p. 377 of *The Electrician* of June 24th.

Underground Telegraph Cable to the North.—The underground telegraph cable connecting London with the North of England and Scotland was taken into Cumberland last week, and it is anticipated that Penrith will be reached in a few days.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Cayenne—Paramaribo	July 13, 1904 ..	—
Cap Haitien—Mole St. Nicholas	Aug. 20, 1904 ..	—
Bundaberg—Gomen (New Caledonia)	Aug. 30, 1904 ..	—
Marseilles—Barcelona	Sept. 16, 1904 ..	Oct. 2, 1904
Cap Haitien—Puerto Plata ..	Sept. 26, 1904 ..	—

Durham College of Science.—Sir Isambard Owen, M.A., M.D. Cantab., has been appointed principal of the Durham College of Science, in place of the late Dr. Gurney. The new principal has been prominently associated with medical education in London and with higher education in Wales. Among other appointments which he has held are those of vice-dean of the medical faculty in the London University, physician to and lecturer in medicine in St. George's Hospital, vice-president of the Medical Society of London and examiner in medicine to the Royal Army Medical Corps, the University of Cambridge and the Royal College of Physicians of London. At a meeting of the governors it was decided to change the title of "Durham College of Science" to "Armstrong College, Newcastle-upon Tyne, in the University of Durham."

Glasgow Local Section of the Institution of Electrical Engineers.—The opening meeting of the 1904-5 session of the Glasgow Local Section of the Institution of Electrical Engineers will be held on Tuesday, November 8th, at 207, Bath-street, Glasgow, when the chairman, Mr. Robert Robertson,

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will deliver his inaugural address. Monthly meetings will thereafter be held as usual. In order to bring the members of the local section and their friends together prior to the opening meeting, it has been arranged to hold the third annual dinner in the new Banqueting Hall of the Grosvenor Restaurant, Gordon-street, Glasgow, on Friday, October 28th. Tickets can be obtained from Mr. E. G. Tidd, hon. secretary, 25, Gordon-street, Glasgow. The Lord Provost of Glasgow will attend. A smoking concert will take place later in the session.

Wireless Telegraphy Overland.—A detachment of the Telegraph Battalion of the Royal Engineers will shortly make experiments with overland wireless telegraphy in North Wales. Field stations are being established at Llanrwst in the Valley of Conway and in Sir William Preece's grounds at Penrhos, Carnarvon. Penrhos is only about 100ft. above sea level and the field at Llanrwst, where the other station is placed, is only about 25ft. above sea level, the distance between the stations being approximately 20 miles. Between them, however, there is a range of mountains including the peaks of Elidyr Fawr (3,029ft.) and Carnedd Dafydd (3,426ft.). The Lodge-Muirhead field installation described in *The Electrician* of October 16, 1903, will be employed. It may be mentioned in this connection that similar experiments extending over several weeks have been made in Kent, and long distances over land have been overcome in spite of intervening hills.

A Record in Permanent Way Construction.—The construction of the permanent way for the Birmingham Corporation tramways has been carried out in an incredibly short space of time. It was an essential condition of the contract that the system should be completed very quickly, and, since the line traverses the centre of the city where the traffic is unusually heavy, it was highly important that interference to the streets should be reduced to a minimum. The contractors were set no easy problem, however, for in addition to completing the work quickly they had to preserve a portion of the road intact not only for ordinary vehicular traffic but also for a complete tramway line over which the steam cars could continue to run. Notwithstanding the many difficulties, Messrs. Dick, Kerr & Co. have actually completed the work, comprising 9,820 lineal yds. single track and 11 junctions with 20,000 sq. yds. of new paving outside the tramways, in 12 weeks. To effect this the work for several weeks was completed at the rate of over 2,300yds. per week, a performance probably unparalleled in tramway construction, having regard to the exceptional difficulties which were encountered.

Iron and Steel Institute Meeting in America.—On Monday evening, October 24th, the opening meeting will be held in New York at Sherry's and will be followed by a reception. For the days in the Pittsburg district an elaborate programme has been drawn up, including on November 1st a visit to the Westinghouse plant and to the Edgar Thomson and Homestead Steel Works. On the second day there will be a trip to McKees Rocks to visit the works of the Pressed Steel Car Co., the Pennsylvania Car Wheel Co. and others. Probably on the third day there will be visits to works in the Pittsburg district. While in Cleveland the reception committee will take the party in a special train to Newburg on Friday, November 4th, to visit the works of the American Steel and Wire Co. On Saturday morning the members will probably be split up into small parties and visit different works.

Personal.—Mr. John Young, general manager of Glasgow Corporation tramways, has resigned in order to take up the position of general manager of the Metropolitan District Railway. In intimating to the Corporation his decision to resign, Mr. Young states that he has been "unexpectedly offered an important post by Mr. Charles T. Yerkes as his right-hand man in the control of the tubes and tramways of his companies," a proposition which had come to him in such a way that he could not find any sufficient reason for declining it. He leaves Glasgow at the end of this month and will at once enter into active work in his new post. Mr. Young, who is 59 years old, devoted himself to the study of agriculture in his early life, but in 1875 he entered the service of the Glasgow Corporation as superintendent of cleansing. Mr. Young's organising and administrative ability quickly manifested itself, and in 1892 he was appointed manager of the Corporation tramways department, which was formed in that year. After the tramway system had been run for a few years by horses, a commencement was made, under Mr. Young's superintendence, to convert it to electric traction, and the undertaking was run wholly by electricity in 1902. In the same year Mr. Young was elected the first president of the Municipal Tramways Association of Great Britain. Mr. James Dalrymple, the deputy manager, accountant and cashier at Glasgow, who, it will be remembered, expressed very sound views on the formulation of tramway accounts at the Liverpool Congress of the Municipal Tramways Association of Great Britain last week, has been appointed manager temporarily.

The degree of Doctor of Science has been conferred by Columbia University upon Sir William Ramsay.

Electricity in a Bread Bakery.—Mr. H. W. Heinz, in an interesting communication to the *Electrical World* of New York, gives the following information with regard to the electric plant used in the bakeries with which he is connected. The Ward-Mackey Co.'s bread plant at Pittsburg is driven by individual motors. There are in the mixing room six machines, each of which handles 1,400lb. of dough per mix. This dough requires a 25-minute run, and each machine was formerly driven through gearing by a 50 H.P. motor. This mixing dough is a peculiar body to handle in the machine owing to continual shifting of its centre of mass, and on this account trouble was experienced through hammering of the motor bearings, the machine revolving at 60 revs. per min. In order to overcome this difficulty a 4in. Morse silent chain was tried as an experiment, having 22in. between the centres of wheels. This chain has proved a success in every way. Before resorting to the chain drive the motors consumed 280 amperes, but with the chains the motors take only 135 amps. These chains require little lubrication and are noiseless. The flour comes in from the railway siding, is unloaded on a slide into the cellar and stored. From there it is electrically conveyed to the storage bins on the top floor, from whence it is transferred to individual automatic scales and dropped directly into the mixer. There it is mixed and left ready for the bread men on the floor below, where the baking is done. After coming from the oven the product goes down to the first floor and is shipped. The electrical plant at the bread bakery consists of Harrisburg standard engines and Westinghouse generators of 200kw. capacity. The entire building is wired on the conduit system, with individual control at switchboard in power house and at motors.

The Late Prof. Finsen.—Thursday, September 29th, on which day the funeral of the late Prof. Finsen took place, was recognised as a day of general mourning in Copenhagen. Among those present at the funeral service were King Christian, King George of Greece, Queen Alexandra and all the other royalties resident in Copenhagen at the time. In addition, there also attended the Danish Ministers of State, members of the Diplomatic Corps, the President of the Danish Parliament, the burgomasters of Copenhagen and the chief provincial towns, and many representatives of foreign scientific societies and universities. The Copenhagen correspondent of *The Times* states that a deep impression was made when some 200 persons, whom Finsen had gratuitously cured of lupus, entered the church and took their seats among the mourners. They were followed by a representative body of Danish medical men and foreign professors. King Edward was represented by the British Minister, Sir W. E. Goschen, who placed a splendid wreath on the coffin. The German Emperor, Count Von Bülow, the Imperial Chancellor, and Dr. Studt, the Prussian Minister of Public Instruction, conveyed their sympathies through Prince Henry of Reuss, the Secretary of the German Legation in Copenhagen, who laid wreaths on the coffin. Among other wreaths were one from the Tsar and another from King Oscar. It appears that some comment has been aroused in Copenhagen by the fact that the officiating clergyman, who paid a warm tribute to Prof. Finsen in his sermon, omitted to mention that he gave away to benevolent societies nearly the whole of the Nobel prize of 150,000kr. (£8,333), which he received last year. The State has decided to grant a pension to Mrs. Finsen, and a number of Danish medical men have issued an appeal for the erection of a monument to Prof. Finsen by voluntary contributions.

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Results of a Blown Fuse.—The South Wales papers publish an amusing and sensational account of the blowing of some fuses at the Swansea electricity works. It is stated that Mr. Prusmann, chief electrical engineer, at 11 a.m. on the 29th ult., noticing a flash through the fanlight of his office, went to the switchboard gallery to see what was the matter:

"Opening the door, Mr. C. Prusmann was met with a shower of hot fuse metal which was descending in showers, the while several of the switches were blown over the gallery on to the floor below. The switchboard was almost entirely enveloped in a weird blue flame. In short, to use the words of the engineer, it was a second siege of Port Arthur. Fortunately, the automatic safety device on the main generator operated, which prevented a calamity. Attempts were made to put the main generators on to the town, but the automatic devices continued to operate. The last time the attempt was made the main machine battery fused, and it was found that the fault was of such magnitude that it was impossible for the machinery to deal with it. Consequently, the supply of the town was discontinued, but matters were put right, so far as the town was concerned, by 12:30, excepting a small section at the bottom of High-street, which was 'righted' by 1 o'clock. It was found that the 'fault' had occurred on one of the main feeder cables running from the works along Oxford-street, and in the early afternoon the exact spot had not been located. . . . Another feeder during the afternoon took the Oxford-street 'lode.' Some time ago the Electrical committee gave Mr. Prusmann power to spend £500 with a view of fusing the general system of mains, so that in the event of a fault such as that happening on Thursday only that section on which the fault occurred would be disconnected. . . . The officials are to be highly commended for the prompt manner they dealt with the breakdown, irrespective of the risks they ran. And these were by no means small, for the heavy fuses on the switchboard shot out of their sockets, and had they caught anyone the result would have been disastrous to life. It is fortunate the breakdown occurred on the morning of early closing day, rather than at the time of a heavier 'lode.'"

In another account it is stated that the actual damage will be covered by £5.

German Telegraph Cable Jubilee.—So familiar have the feats and growth of submarine telegraphy become to a generation surfeited with newer wonders, that the jubilee in 1901 of the first successful cable between England and France (laid in 1851) passed practically without public notice. Messrs. Felten and Guilleaume of Cologne have communicated to the *Journal Télégraphique* for September an article in which they commemorate the fiftieth anniversary of the first German telegraph cable. It appears that the Prussian Telegraph Administration installed, in 1850, across the Rhine, near Cologne, a telegraph wire, insulated with gutta percha, protected by jointed metal pipes and a heavy chain. The communication was, however, soon broken by a ship's anchor, and this experience led Mr. Theodore Guilleaume, the then head of the now world-famed firm, to propose to place the insulated conductor within an armouring of metal wires, as is still done. It is, therefore, claimed that had the Prussian Administration at once accepted Mr. Guilleaume's suggestion, the first armoured telegraph cable would have been manufactured and submerged by Germany instead of by England. The cable in question was not, however, laid until 1853. From this small beginning the growth of the telegraph cable industry (submarine and subterranean) in Germany has been great, and our readers are aware that two Atlantic cables, via the Azores, have of recent years been made and laid under the auspices of Messrs. Felten and Guilleaume. This branch of their business was, however, transferred to the Actien-Gesellschaft Norddeutsche Seekabelwerke, which possesses two large and well-equipped cable steamers, and is now engaged in the manufacture of cables to connect Menado (Dutch Indies) with the island of Yap and thence, via Guam and Shanghai, with the United States, via the new Pacific American cable, on the one hand and on the other with the Chinese and Siberian telegraph lines.

Electrical Affairs in Canada.—Our Canadian correspondent calls our attention to an interesting case which has recently come under his notice. It appears that between the city of Quebec and the town of Levis there is a prescribed area in the River St. Lawrence within which ships are forbidden to anchor, this area being set apart for telegraph, telephone and electric light cables. In July last, the United States training ship "Essex" anchored in the St. Lawrence just above the prescribed area. From some cause she drifted, and her anchor caught on the main cable of the Canadian Electric Light Co. supplying the city of Quebec with 1,000 H.P., and so strained this cable that the insulation broke down, rendering it useless for operation. The ship further dragged on to the cables of the telegraph and telephone companies, damaging them to such an extent that they had to be lifted. These three companies now have claimed $10,000 against the United States Government for damages caused apparently by the action of the ship's crew in letting down the anchor while foul of the chain, and by that of the ship's master in failing to put out his second anchor when the wind and tide made it advisable. There does not seem to be any doubt on the part of the companies regarding the validity of their claim, as the Admiralty Court of Canada has decided that where negligence is proved, the ship is responsible for damage caused. Submarine telegraph and telephone cables, being necessary for the public convenience, they naturally require legal protection. Another case was that of the "Canadian Electric Light Co. *v.* the Levis County Railway Co." The former company furnishes power for working the Levis County Railway Co., and the contract stipulates that 400 H.P. shall be regularly delivered. As they are not able to use 400 H.P. during all hours of the day, the railway company claim that they are entitled to more than 400 H.P. at other periods to make up the average of 400 H.P. over the whole day. After some considerable discussion between the parties' legal representatives, the matter has been left to arbitration.

Automatic Transformer Switches. — In describing the German visit of the Institution of Electrical Engineers mention was made (see *The Electrician*, Vol. XLVII., p. 863) of a transformer switch designed by the Schuckert Co. for automatically interrupting the primary circuit of a transformer whenever the secondary circuit was opened manually. This arrangement was calculated to avoid iron losses which would otherwise occur even while the secondary was not loaded at all. Since that time the design has undergone many modifications, and the following is a brief description from an article by Herr J. Schmidt, contributed recently to the *Elektrotechnische Zeitschrift*, of the newest form of transformer switch made by the Siemens-Schuckertwerke. While the older switch related to a transformer supplying current to one or more motors, which were either all working or else idle, the new switch works in conjunction with a lighting transformer. In this case the arrangement is such that the transformer circuits—both on the primary and secondary side—are automatically opened whenever the current consumption on the secondary side falls below a predetermined value. Such a device obviously allows a low-tension circuit to be fed with a continually varying number of transformers, the actual number at any instant being automatically regulated to give the most economical results. The switch contacts are mounted on three upright grooved porcelain bodies, the middle one being free to turn. Rotating this middle portion one way or the other effects the opening or closing of the switch. Springs are interposed in the mechanism in such a manner that both the opening and the closing of the contacts is done quickly. The operations of switching on and off are controlled by a device similar to that often used for regulating alternating current arc lamps. This device consists chiefly of an aluminium disc, upon which a torque is exerted by two magnetising coils, one of which is connected in series with the secondary circuit, while the second one is energised in shunt. The torques corresponding to the two magnetising coils are opposed to each other, and may be regulated in strength not only by varying the windings of the coils, but also by shifting their position relatively to the disc. It is obvious, therefore, that the disc may be made to turn one way or the other when predetermined conditions as to load exist. If the current in the secondary circuit drops, for instance, below a certain point, then the torque arising from the action of the shunt coil overcomes the less powerful torque relating to the series coil. Consequently, the disc turns in a certain direction, and in doing so closes an auxiliary circuit. A small magnet is thereby made to attract an armature, this in its turn causing the main switch to open against the pull of a spring. If the load in the secondary increases above a given value, the disc turns in the other direction. Another auxiliary circuit is closed, a catch is released, and the switch is closed by the force of the spring which previously had been compressed.

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THE AMERICAN TOUR OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

BY OUR SPECIAL CORRESPONDENT.

(*Continued from p. 938.*)

Friday, September 9th.

Niagara Falls station was reached early in the morning, and no time was lost in taking advantage of the unique attractions of the programme prepared by the local committee. The natural features of the falls and river gorge have become so familiar by frequent descriptions that to attempt a new version would be out of place, but to those who visited the district 10 years ago, it may be well to remark that it is now possible, by a conveniently planned tramcar route, to see the many wonders of the gorge and falls within the short space of two hours.

The engineering work in the construction of the track is remarkable in itself. For years engineers considered the scheme impossible, but in 1895 it was completed and opened, thus affording an opportunity of passing through the gorge from end to end instead of merely peering down into it at the few accessible spots. Special cars conveyed us, first of all, on the route alongside the river, within a few feet of the foaming rapids, as far as the lower suspension bridge. Afterwards we climbed up and crossed to the Canadian side, and from the high bank obtained splendid views of the whirlpool and rapids, finally arriving close to the Horse-shoe Falls. The greatest activity in the further utilisation of the water power was apparent on the Canadian side. One undertaking proposes to send its energy as far as Toronto, while the Ontario Company is designing its installation on the largest scale hitherto proposed in the district, amounting to 180,000 H.P. The huge steel flume, 18ft. diameter, with its intake well beyond the rapids above the falls, is now nearing completion. The situation of the power house on the river bank below the falls renders it unnecessary to have a deep wheel-pit and vertical generators, while the relative position of the intake and tail race increases the head due to the cataract alone by nearly 55ft.

In comparison with these precautions to secure the best result per gallon of water it was regrettable, in an engineering sense as well as displeasing in an æsthetic sense, to see the older power houses on the American side with their tail races discharging at one-third of the available height.

Owing to the recent heavy rainfalls the volume of water from the Upper Lakes was considerably above the average, thus rendering the effect of the cataract more than usually imposing, and concealing the possibility of deterioration of the spectacle which those who are not engineers fear will one day be the result of these operations. That this deterioration will be perceptible to any extent, even when the present schemes are completed, is not credited by those who have made the necessary calculations. The probability is, however, that the industrial development which is now taking place will ultimately make the "setting" of the view so materialistic, that the minor point of the diminution in the volume of water will be quite overlooked.

After sufficient time had been allowed to the visitors to obtain a mental picture, or—if provided with a camera—a sun picture of the view, the river was again crossed, and, by invitation of the local committee, lunch was provided at the International Hotel. During the afternoon there was no hard-and-fast programme, but the smaller attractions of the district, such as a descent to the Cave of the Winds or a trip almost up to the wall of water in the little steamer "Maid of the Mist" claimed the attention of many. Not unnoticed either was the remarkable old woman who successfully passed over the Canadian Fall in a barrel two years ago, and who held a little court of electricians opposite the hotel, to whom she gave a plain and modest description of her daring feat.

The only official visit of the day was that to the Niagara Falls Power Co.'s installation, and had not afternoon tea been announced as one of the attractions, it is doubtful if many would have torn themselves away from the fascinations of the falls to examine the wheel-pits of power houses or the details of umbrella-type generators. There was once a time when the plans for this undertaking proved one of the most polemical subjects at the Institution meetings, and those who refer to the *Proceedings* or to their *Electrician* file can find therein all the particulars of the plant in power house No. 1, together with a multitude of reasons for the novel departures in the design and construction of the electric generators. A word or two may be said, however, as to the magnitude to which the installation has now grown, and the variations which have been recently introduced in the character of the plant.

In the original power house there are 10 sets of 5,000 H.P. each, and in the second power house 11 sets of 5,500 H.P. each. The turbines are all placed in a wheel-pit about 140ft. below the floor level, the automatic hydraulic governors being placed on the floor itself. The generators are two-phase, with a working pressure of 2,200 volts, and all but the five machines last installed are of the external revolving field or "umbrella" type.

The newer ones with internal fields have obvious advantages in simplicity and accessibility. The distribution system is divided into three parts. The first supplies the customers close at hand, and the generator voltage of 2,200 is quite sufficient for the purpose. Next there is a certain area where the distance demands a higher pressure of 11,000 volts for economical transmisson; and, thirdly, there are the customers in Buffalo and the neighbourhood, approximately 23 miles off, to supply whom the voltage is raised to 22,000 volts. At the power house the transformer plant is all located in a separate building, thus reducing the risks of bringing extra high pressures into the machinery room.

In the Buffalo transmission lines it has been found more economical to use aluminium than copper at present prices, while the former, possessing greater tensile strength in comparison with its dead-weight, considerably reduces the cost of poles. It is not possible to give even an outline of the number and variety of industries which have grown up in Niagara Falls City within the last few years, but appearances certainly point to its becoming one of the chief manufacturing centres of the United States.

With commendable forethought, our special train had been run down to the power house siding, and at 5:30 we had again joined it to continue our journey westward. The route taken was on Canadian soil as far as Detroit, and then across the ferry on the Chicago line. Many privileges fall to those who have a special train, and on this occasion we availed ourselves of one of them to stop at a beautiful spot just opposite the Canadian Fall, where we had our last look at the great spectacle.

Saturday, September 10th.

In the morning we found ourselves passing along the shore of Lake Michigan, and shortly after through the apparently unending suburbs of Chicago, until finally we arrived in the "windy" city. Mr. Samuel Insull, president of the Edison Company, and his colleagues were at the hotel to welcome us, and no sooner was breakfast despatched than they took us in hand in a manner which showed us that the city of "hustlers" justified its name. There were many alternatives in the way of interesting sights for electrical men, but most seemed to prefer seeing the latest thing in central stations—*i.e.*, that of the Commonwealth Company (which is under the same control as the Edison Company) at Fisk-street. The whole party was provided with automobiles so that the widest latitude in sight-seeing was possible.

This station has been referred to on several occasions at Institution discussions and in the columns of *The Electrician*, but a brief recapitulation of its chief features may be useful. The subdivision of each class of generating or operating plant into individual units has been carried out here in the completest fashion. There is associated with each 5,000kw. Curtis turbine generator a complementary set of units consisting of steam regulators, electric switches, boilers, smoke-stack, and even coal-conveyor. This principle, which we have had occasion to mention in other towns, is carried out very drastically in Chicago, and even the high-tension switches are provided with a building to themselves, leaving only the relay circuits to be operated from the engine room. There are no fuses in the high-tension mains, but the quick-break switches themselves act as substitutes under the control of time-limit relays.

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Some disadvantages must necessarily follow; but if the cardinal policy of the engineer is to give continuity of service, much can be said for this type of central-station design, in which trouble or breakdown of any kind is localised and confined.

One of the Curtis turbines has been running here since November, 1903, and has on occasion been worked up to 7,500kw., so that Mr. Insull has every reason to be proud of his pioneer installation. The ultimate capacity of the station will be 70,000kw., thus making it one of the biggest steam-operated plants in the world. To guard against strikes in the freight services, in which even the principle of individual units would be unavailing, provision has been made to obtain coal either by rail or in barges on the adjoining canal, and the conveyors have been fitted up to work from either source of supply.

A word might here be said to clear up the misconceptions which have arisen in the minds of some of the visitors regarding the selling price of electricity in Chicago and other large cities. The hand-books distributed to us at each town contain much accurate information, but are hardly equivalent to balance-sheet figures, so that although it be stated that 20 cents per unit may be charged in some cities and even in Chicago, still, in point of fact, the average revenue secured in that city is of the order of only 5 cents per unit. Naturally, with an output of over 80,000,000 units this is easily able to cover the enormous investments, and leave a substantial margin of profit.

To return from these large figures to the department of "weak currents," as the Germans phrase it, is not necessarily uninteresting in Chicago, where, under this category, we had the privilege of inspecting a remarkable telephone system in which the fallible human element is dispensed with. The Automatic Electric Co. of Chicago has now at work in that city a system of purely automatic telephones to the extent, it is stated, of nearly 10,000 which, according to all reports, have rendered excellent service during 1904, their first year of working.

It is difficult in a few words to describe the apparatus, but the principle may be briefly enunciated, and readers must refer to back numbers of *The Electrician* for details. In using the calling device, the subscriber rotates a disc until each digit of the number is in succession brought down to the bottom stop. At the exchange the subscriber's switch responds to this on a selector system, with 15 lines connecting each group. Thus a subscriber calling up 7,654 would, by the first movement of the dial, automatically select one of the trunk lines of the 7,000 group; the second movement would put him in the seventy-sixth group of hundreds; the last two movements would select the party desired or give him the "busy" signal if the line were engaged.

The same company in providing for its underground cables introduced a novel system for handling goods in concentrated warehouse districts. This consists of a network of tunnels containing the ducts and large enough for electric cars to run on rails. Into these cars the goods can be put at the railway yards and run direct to the dealer's basement. The architects in Chicago are now making a standard practice of running their basements down to meet these service tunnels. The idea is one which might very profitably be developed in other cities, as the proper place for the human cargo is above ground and not underground.

It would be impossible to give more space to what we saw in Chicago except to say that in addition to entertaining us most hospitably at lunch and dinner the local members furnished us with the use of automobiles all the afternoon to enable us to make a tour through the system of beautiful parks and boulevards which surround the otherwise very dirty and smoky city. In the evening, at 11 o'clock, we started once more on another instalment of our railway journey, thoroughly tired out, but delighted with our reception and what we had seen.

Amongst the many cities we have visited certainly Chicago easily bears the palm for the strenuous efforts to permit us to see all that was to be seen in an absurdly short time.

(*To be continued.*)

THE BUDAPEST TELEPHONE EXCHANGE.

When, in 1897, the Hungarian Telegraph Administration took over the Budapest Telephone Co., it was well known that not only would the subscribers' lines need to be changed from single wire to metallic circuits, as had already been done in the other Hungarian exchanges, but also that a new and modern switchboard must replace the four antiquated central offices. After a careful study of the local conditions it was decided to concentrate all the Budapest subscribers in a single central office in order to attain the highest operating efficiency. Since, in spite of unfavourable circumstances, the number of subscribers was already between 5,000 and 6,000, it was desirable to make the new central office of very large capacity.

Tenders for the new plant were invited and that of the Western Electric Co. was accepted, in combination with the Hungarian United Electric Society of Budapest-Ujpest. The central battery system was adopted, with a preliminary equipment for 10,000 subscribers and a capacity of 20,000. The switchboard occupies one side of the switch room, on the other side of which is space for a second board of the same capacity, so that the new exchange will be capable of accommodating 40,000 subscribers. We believe that no single central office of these dimensions has yet been built anywhere, and a description of the main technical features of this plant will, therefore, be of interest.

For the building 2,500 sq. metres of ground was purchased at about the centre of the exchange system. A six-storey building was erected at a cost of £60,000, and was fitted with modern heating, lighting and ventilating appliances. This building occupies the whole space between two parallel streets, and the switch room, 64 by 10 metres and 7 metres high, runs lengthwise of the building. Fig. 2 shows the switch room and switchboard. Immediately under the switch room is a low storey, 2·30 metres high, containing the intermediate distributing board, the relay racks, &c. There is a passage to the lower room under the switchboard at each operator's place. The switchboard cables thus pass directly to the intermediate distributing board and the relay rack. Similar openings are provided in the floor on the other side of the room for the second switchboard. Three spiral staircases lead from the switch room to the floor below, and near the central one is a broad staircase for the use of the operators in entering and leaving the switch room. There are two chief operator's desks set near the wall opposite the switchboard, destined to be moved to the centre of the room when the space is wanted for the second row of switchboards.

The present row of switchboards begins with a trunk junction section for three operators, each of whom has 40 single cords connected to the trunk room. All the subscribers' jacks are multipled in this section, so that these operators can give direct connection to any subscriber in the excharge when required for the trunk service. This section, which is provided with nine panels of jacks, is slightly separated from the 22 subscribers' sections which follow.

Each of the latter has three operators' positions equipped for 150 subscribers each, there being a 67th position equipped for 100 subscribers, thus making a total equipment for exactly 10,000 subscribers' lines. "Dummy" sections are provided at the beginning and end of the row, repeating one-third of the 10,000 subscribers' jacks in the usual manner. The subscribers' sections are 1·80 metres long and contain 10 panels of jacks, so that the numbering with a thousand jacks in each row of hundreds is decimal and perfectly symmetrical. Each operator's position is provided with 15 pairs of plugs and cords and with the corresponding listening and ringing keys arranged in the usual manner. The circuit is shown in Fig. 1, where the calling subscriber I is shown connected with the exchange, while the called subscriber's jack is being tested. The number of connections at each operator's position is registered by the operator who, on pressing the button G, actuates the recording mechanism S, after completing each connection.

For the detection of earth faults, the B-line is connected through a lamp L_2 with the negative pole of the battery, the A-line being connected with the 'bus bar of the ninth cell

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through the line relay R_1. If there is an earth on the A-line, the line relay R_1 is operated, whereas in case of an earth on the B-line the lamp L_2 is lighted by current from the 11-cell battery. The subscribers' transmitters are supplied from the entire storage battery.

The street cables are lead-covered, and have been laid in cement conduits of the Hultman type. They enter the building in the basement, where the main distributing board is placed. From here, small lead-covered cables pass up through a cable shaft to the switch room. The power plant and storage battery are placed in close proximity to the switchboard and the relay racks, thus making the battery leads very

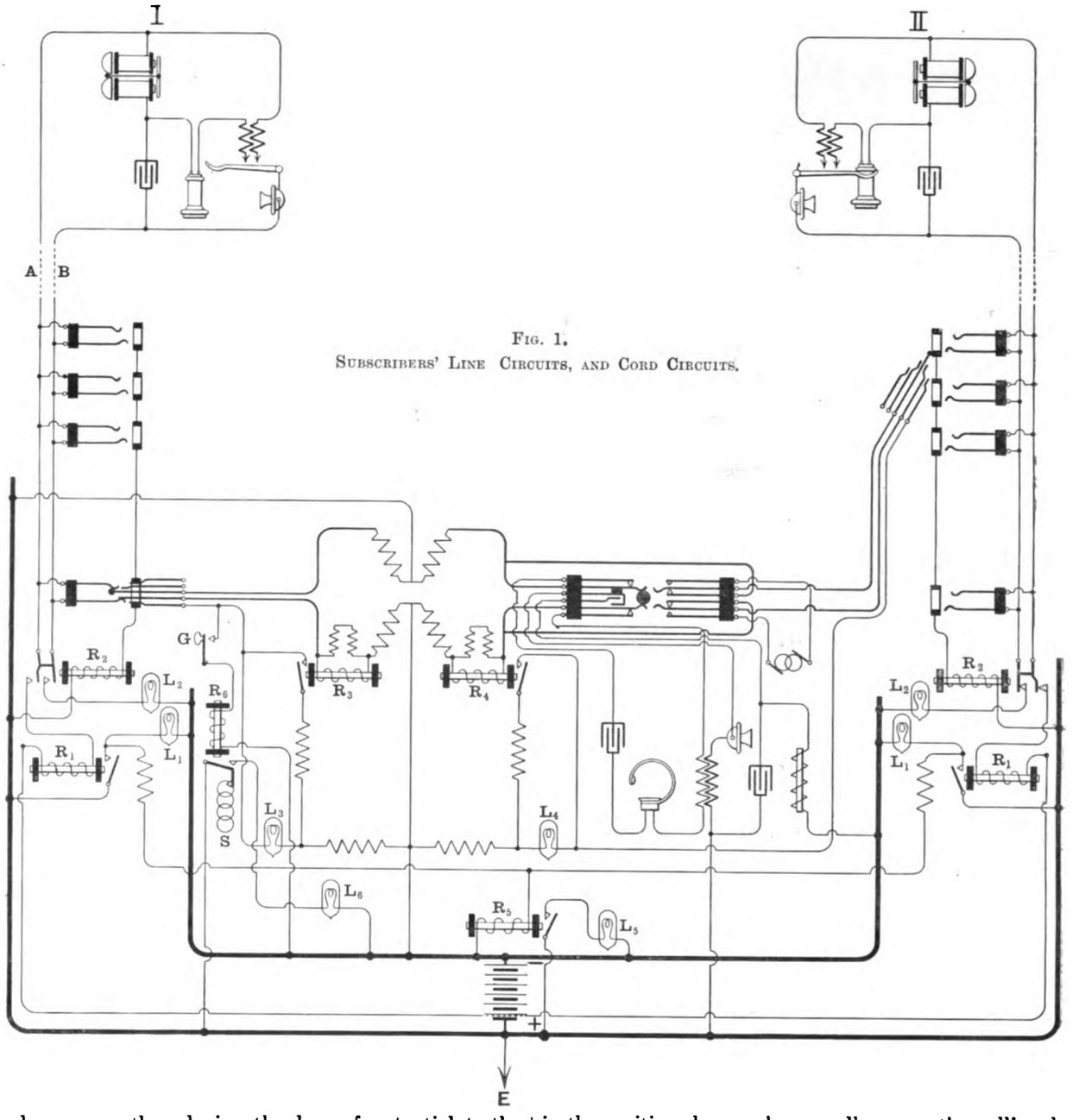

FIG. 1.
SUBSCRIBERS' LINE CIRCUITS, AND CORD CIRCUITS.

short and consequently reducing the drop of potential to the requisite limits.

Adjoining the main switch room is the trunk room, where all trunk line connections are made. The plant here includes one test board, one transit or through trunk board with two operators' positions, three rows of trunk boards with six positions each and six trunk lines per position, one subscribers' recording board, and one trunk recording board for 120 special trunk-line subscribers whose lines end directly on this board. This latter board has three operators' positions for 40 lines each, and the lines of these special trunk subscribers are multipled on the trunk boards and the transit board.

As the trunk lines in Hungary are used for simultaneous telegraphy and telephony and also for duplex working, it was found necessary to devise special circuits, shown in Fig. 3, to adapt the lines to these requirements. Section I. represents the transit board circuit, which is used during the day for completing through trunk line connections; at night all trunk connections are made on this board. Section II. shows the circuits of the trunk boards. Section III. shows the circuits in the trunk junction section, which is located in the general switch room.

The trunk line L_1D_1 comes first to the transit board, whence it passes through a break jack to the trunk board, there ending in a line relay, R_1, with a retaining coil. If the key K_0 is in the position shown when a call occurs, the calling lamp L_1 is lighted. Plugging the jack actuates the relays R_2 and R_3. Relay R_2 lights the lamp L_2 on the transit board, notifying the operator there that the circuit in question is engaged. Relay R_3 interrupts the circuit of the retaining coil of the calling relay R_1. If the trunk line is in use at the transit board, relays R_3 and R_4 are actuated, and through R_4 the lamp L_3 is lighted, notifying the trunk line operator that the line is engaged at the transit board. To concentrate the whole trunk line service at the transit board, the lever of key K_0 is thrown over, and now all the calls are received on the lamp L_4 of the transit board. The two portions of the cord circuit L, that is, the trunk to the left and the local subscriber to the

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right, are connected by a repeating coil, including on one side a condenser, and on the other the central battery which supplies current to the subscribers' transmitters. The trunk circuits are, therefore, completely insulated, and simultaneous or duplex operation is in no way hindered.

Plugging into the junction jack at T_1 actuates the differential relay R_d and lights the lamps L_5 and L_6. The number of the desired subscriber is given to the operator at the trunk junction board in the general switch room over the order wire V. With the plug J of the junction line corresponding to the jack T_1, the operator tests the jack of the desired subscriber's line. Through the normal contact of the test relay R_e the tip of the plug is in connection with the third winding of the induction coil of the operator's set, so that, if the subscriber's line is already connected to a local circuit, the operator hears a click in her telephone. If, on the other hand, the subscriber's line is connected with a trunk line, she hears a buzz or tone. In the first case the connection

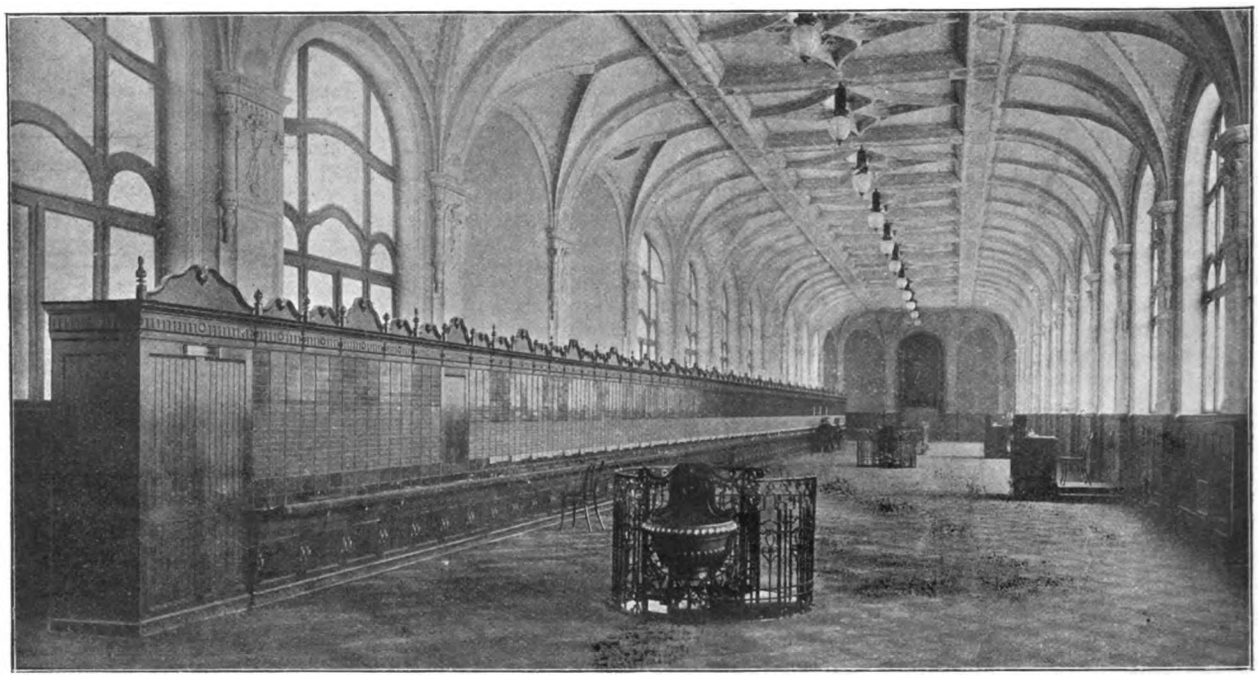

FIG. 2.—THE SWITCH ROOM.

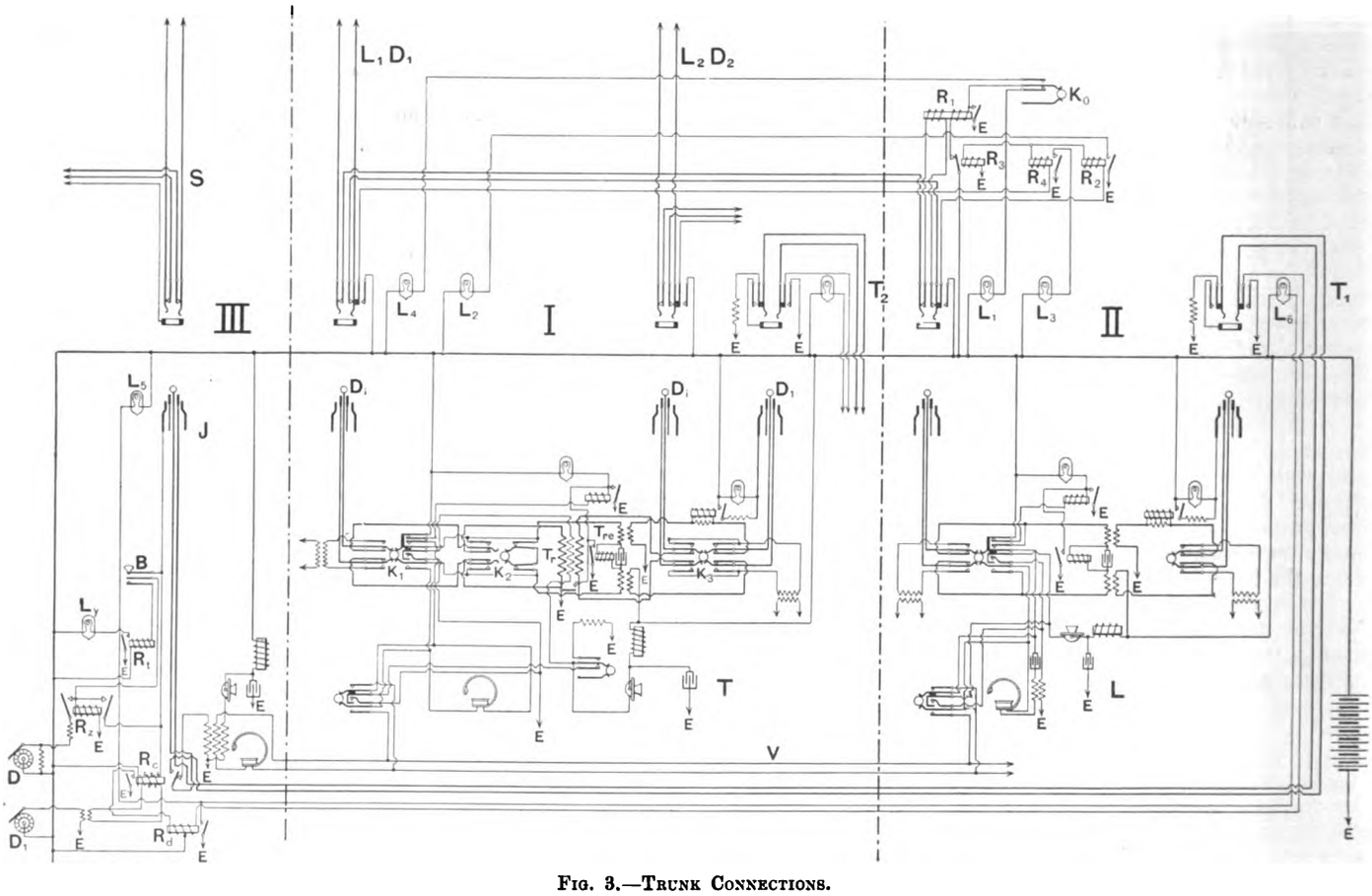

FIG. 3.—TRUNK CONNECTIONS.

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is cut off, as toll-line connections are always given precedence over the local service; in the second case, the line is not disturbed. This cutting off is readily done, as each subscriber's line passes through a break jack on the trunk board in the general switch room, as already mentioned. In order to explain the interruption to the second subscriber (the first being picked up at once by the toll operator), and to disconnect him quickly, the trunk junction operator depresses the key B associated with each cord circuit, which locks the relay R_s to the third core conductor. The low-speed interrupter D is thus connected to the test ring of the subscriber's line, and causes the supervisory lamp at the subscriber's operator's position to flash at distinct intervals. On perceiving this unmistakable signal, the subscriber's operator tells the second subscriber that the first has been called by the trunk room, and disconnects the line. This disconnection causes the relay R_s to drop its armature, thus cutting off again the intermittent current from the third conductor. Pressing the key B also actuates the relay R_t and lights the lamp L_y, indicating that the intermittent current circuit has been completed.

As already mentioned, it is also possible to ascertain by testing whether a subscriber is in connection with a trunk line: Through the third conductor of the cord, which places testing potential on the test-rings of the multiple jacks, the battery current traverses the winding of the test relay R_c. This relay has, however, a second winding which, by induction, superposes, on the constant current flowing, an intermittent current of high frequency from the high-speed interrupter D_1. In testing, the operator then hears a buzz or tone in her headgear receiver, informing her of the trunk line connection.

As already mentioned, the transit board performs a double duty. In the hours of heavy traffic the through connections of trunk lines are made here. During light traffic it can be arranged that all trunk room connections, including those of the recording and trunk subscribers' lines, can be effected in addition to inter-connecting trunk lines. For this purpose the board is provided with three sets of cords and plugs. Plug D_i can be used only for trunk line jacks, being too small for the local jacks, whereas the plug D_1 fits the latter. If the third key K_3 is in the position shown only the two plugs D_1, D_i can be removed, the plug D_1 being held in place mechanically. Therefore only a connection between trunk lines can be made, and this only through the translator T_r. This latter is designed to serve also as clearing relay controlling the clearing lamp. If, on the other hand, a trunk line is to be connected to a subscriber's line, the lever key K_2 is thrown over, thus freeing the plug D_1 and mechanically locking the neighbouring plug D_i. The cord connection is then completed through the repeating coil T_{re}, which is of the same construction as the repeating coil of the trunk line cords and similarly connected. The trunk line circuits are thus kept separate.

All order tickets are sent to the different boards, and thence after use to the counting office by means of a special pneumatic tube distributing system, in which the tickets themselves are transported without carriers. The duration of trunk-line conversations is timed by three-minute clocks, the exact time being recorded on the tickets by a calculagraph. The operators at the recording tables are informed of the number of orders for each trunk line at any moment by coloured lamps, and are thus able to inform the subscriber beforehand approximately when the trunk line called for will be available.

The operation of the entire installation is very regular and goes on with precision, ease and smoothness. The whole installation has proved very satisfactory and does credit to both manufacturers and designers.

Electric Lift for the Statue of Liberty.—It appears that the famous statue of Liberty at New York Harbour has suffered considerably owing to exposure and want of proper attention. The United States War Department has, therefore, undertaken its renovation, and among other improvements will be an electric lift, instead of the old stairway, for passengers who desire to ascend to the top.

OVERHEAD EQUIPMENT: NOTES ON ITS CONSTRUCTION AND MAINTENANCE.*

BY J. M. McELROY.
(General Manager, Manchester Corporation Tramways.)

The opinion has often been expressed that many modern inventions—of which our electric tramway systems may be considered a type—have to a large extent had the effect of subduing or rendering less active the æsthetic side of our nature and of bringing into greater and increasing prominence the utilitarian side. In the present "hustling" days it is urged that we have neither time nor inclination to appreciate those things which add to the beauty of our cities and towns, and that we appear to be perfectly satisfied with any modern inventiou, however inartistic, which brings with it anything in the shape of material advantages. The great benefits, therefore, which our tramways have afforded to the community in the shape of cheap and rapid transit have appealed strongly to the utilitarianism which characterises our modern civilisation.

Notwithstanding its ornamental scroll work, tastefully painted poles, gilt finials and rosettes, by no stretch of the imagination can the forest of steel poles and the network of wires which we describe as the "overhead equipment" be considered an embellishment of our towns. It represents a condition of things in which utility absolutely predominates, and æsthetic considerations occupy a very minor place. So say the critics! But with all the objections urged against it, we—in the provinces, at any rate—have been driven on economic and other grounds to adopt the overhead system as being the only one commercially possible at the present time. It is, therefore, desirable that we should consider and compare notes as to the best and most suitable methods of constructing and maintaining the equipment.

Points to be observed in Erection.—The four principal points which ought to be observed in the equipment are: (1) Its general stability. (2) Its adaptability to the safe, reliable and easy running of the cars. (3) Its erection so as to be the least objectionable from the æsthetic standpoint. (4) Its erection so as to reduce the wear and tear to a minimum. Each of these points requires careful consideration. Opinions differ as to their relative importance, as will be seen by the replies to the list of queries embodied in the report accompanying this Paper.

Centre-running v. *Side-running Trolleys.*—The general types of construction adopted in this country may be divided into two—namely, (1) Those adapted for side-running trolleys, and (2) those adapted for centre-running. Twenty-six towns have adopted the former and nine the latter type, and 10 have adopted both types. A glance at the replies will show that several towns which have adopted side-running now express their preference for centre-running lines. The reasons in favour of side running as opposed to centre-running equipment are that: (1) It is neater in appearance. (2) It is less costly to construct. (3) It is safer for passengers on the cars. (4) It is more easily adapted for running round curves and through junctions, &c.

The reasons in favour of centre-running as opposed to side running equipment are that:—(1) It is more flexible, and there is less liability of the trolley leaving the wire; in other words, it is more adaptable to the reliable and easy running of the cars. (2) The pressure of the trolley wheel on the wire need not be so great, and, in consequence, there is less wear and tear.

Centre-pole Construction.—The principal reason which has led many towns to adopt centre-pole construction is, I believe, that it is or can be made more artistic than span-wire construction. Opinions, however, differ widely as to the desirability from a practical standpoint of adopting this form of construction. It is urged that:—(1) It is not so elastic as span wire, and (2) the poles form an obstruction to the ordinary vehicular traffic. On the point of elasticity there can be no two opinions, but on the question of obstruction 17 towns report that they consider the poles *do* form an obstruction, and nine towns think otherwise, and, in fact, some urge that they tend to regulate the traffic. This question of obstruction is one which local conditions of traffic must largely enter into. Also the width of the streets in which the centre poles are erected. In very wide streets, like Oldham-road in Manchester, which is in parts 72ft. between kerb and kerb, we have not found much to complain of in the way of obstruction, but in streets 35ft. to 40ft. wide the obstruction is apparent to those who drive about the streets.

Trolley Wire.—The size of the trolley wire adopted varies from 0 to 0000. It would be interesting to learn the reasons which led to the adoption of the several gauges. Several towns have adopted or experimented with phono-electric wire. It appears to be giving good results, but the replies indicate that it requires more careful handling during erection than copper wire. It is stated also that

* Paper presented to the Municipal Tramways Association of Great Britain. To be discussed at the forthcoming Managers' meeting in Birmingham.

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it has a higher resistance than copper wire. Some further information on this point would be interesting.

Automatic Frogs.—With the exception of Glasgow, and, I think, Aberdeen, who use fixed trolley heads and rigid frogs, all of us are interested in the subject of automatic frogs. From the replies it will be seen that experiments have been and are being tried with some amount of success in many towns. Samples of some of the frogs in use will be exhibited.

Lightning Arresters.—The principal lightning arresters in use are the Garton, the Wurtz and the British Thomson-Houston. No trouble appears to have been experienced by the majority of the towns due to the arresters being burnt out and rendered useless. Cardiff, however, appears to have had difficulty in this direction, and this has been our experience, too, in Manchester.

Automatic Devices for Cutting off Current in Cases of Falling Wires.—The replies to the query as to the adoption of devices for automatically cutting off the current in case of trolley wires falling show that little has been done in this direction, and that nearly all the towns depend solely on the circuit breakers. In Oldham they have adopted a device described as follows :—"Insulated guard wire connected to rails through a solenoid which trips the circuit breaker in the feeder pillar. An arrangement on the guard wire at each arm or span wire to make the guard wire alive if the trolley wire drops." In Leeds they have six poles fitted with Hall's patent mechanical ear, but up to the present these have not been operated. In Dundee a bamboo pole and piece of cable is carried on each car to make a "dead earth" in case of emergency. In Nottingham they adopted a patent short-circuiting device, which gave considerable trouble and had to be discarded.

Anchoring of Section Insulators.—The question as to the best method of anchoring section insulators is one which ought to receive careful consideration. Several towns—Aberdeen, Sunderland, Leicester, Bradford, Preston and Dundee—do not anchor their section insulators at all. They consider it unnecessary. Many towns, principally those with side-running systems, anchor vertically by suitable attachments to the bracket arms. Very few of those who anchor horizontally admit that they form a trap for the trolley.

Insulation of the Line.—To maintain the perfect insulation of the trolley line is an important matter. The replies show that several well-known makes of insulating material appear to be chiefly adopted. It is interesting to notice that double insulation is resorted to by all the towns except three. In Manchester we have adopted triple insulation throughout. In Wallasey they are adopting triple on reconstruction work, and in East Ham they adopt triple on the part of the line exposed to fumes from chemical works. Very few towns appear to have experienced any serious trouble owing to the failure of the insulation.

Inspection of Line.—Careful and constant inspection of the line is of paramount importance if we are to satisfactorily maintain the equipment and to prevent accidents. "Nightly," "daily," "weekly," "fortnightly," "monthly" inspections—these are the replies under this head from the various towns.

Standardization of Various Types of Poles.—The replies to the query indicate almost a consensus of opinion in favour of the standardization of poles on the lines suggested by the Engineering Standards Committee.* In Cardiff, however, they prefer the single section taper pole much better than the three-section telescope type, and in Glasgow they state that the dimensions of the poles as agreed upon by the Standards Committee do not suit their requirements in every respect.

Pressure of Trolley Wheel on Wire.—It is claimed by some of the advocates of centre-running trolleys that one of their advantages is that less pressure may be used by the trolley wheels on the wire. In actual practice we find that for side-running trolleys the pressure varies from 18lb. to 32lb., and for centre-running trolleys from 16lb. to 25lb., although many towns with side-running trolleys are running at less pressure than towns with centre-running trolleys. The pressure considerably affects the wear and tear of the equipment, and the figures given by the various towns indicate that this is a subject which ought to claim our careful attention.

Ears.—The type of ear adopted and the method of suspension has a most important bearing upon the wear and tear of the equipment. An ear which firmly supports the wire and yet at the same time possesses no appreciable thickness is the desideratum. The ordinary type of ear which is clipped round the wire and soldered is by no means perfect. No matter how well the ears are tapered they cause the trolley wheels to "jump" to a greater or lesser extent each time they travel under them. The consequence is that the wire at the trailing ends of the ears soon begins to show signs of wear. It behoves us, therefore, to consider whether this defect can be remedied and, if so, how? Several types of mechanical ears are exhibited, and may prove of interest to members.

* See *The Electrician* of August 26, 1904, p. 738.

Guard Wires.—All guard wires, we must assume, are fixed and "earthed" so as to comply with the Board of Trade regulations. Some towns, however, "earth" them at less distances than the maximum prescribed by the Board of Trade. In only one town are the earth wires disconnected when linesmen are working on "live" wires.

Section Insulators, &c.—The general type of section insulator adopted is the air-gap. I have requested all our members who have adopted or experimented with any special type of section insulators, frogs, crossings or other line material to forward me samples for exhibition at the conference.

Wear of Trolley Wire.—The wear of the trolley wire is an important matter, and some reliable data from the various towns would be valuable. In Liverpool we are informed that the life of their 0 wire is about five years. In Glasgow the records show that their 00 wire has a life of three years with a service of 2½ cars per minute. In Dover the reply is:—"Portions of the 0 wire taken from curves near depot had flattened near ears, and that at point of greatest wear, instead of a sectional area of 0·082448 sq. in., there remained only 0·054964 sq. in. after four years and two months with a six minutes' service and constant shunting operations." In Oldham we are told that the wire is wearing flat in the sides at the ends of the ears. In Cardiff, where they use 000 wire, they have found the wear very great in places and renewals have taken place. In Burnley the experience is:—"No appreciable wear in three years except close to section insulators." The Leeds experience is remarkable. Here they use 0000 wire, and on their oldest line, which has been in operation over seven years, and on portions of which there is a maximum service of 1½ minutes, the wear on the wire on straight line is imperceptible. The wear on curves is very slight, and will not necessitate renewal of the wire for a considerable time yet. In Bradford the wear on their 0000 wire is inappreciable. In Blackburn the oldest line is five years. They use a 0 wire, and the wear on straight track is very slight. In Dundee it is stated that up to the present no wear in the trolley wires is noticeable.

Motor Tower Waggons.—The adoption of motor tower waggons in lieu of horse waggons for emergency work is gradually taking place, and they appear to be giving satisfaction. Mr. Hamilton, of Leeds, states the advantages of the motor waggons very tersely as follows:—We prefer a motor tower waggon for emergency calls for the following reasons:—(1) Can reach scene of breakdown more quickly. This is especially the case on a long run. (2) It deteriorates horses to gallop two or three miles with a load approaching 2 tons and then stand for a considerable time whilst the repairs are being executed. (3) There is always the possibility that, no matter how well trained, horses may start suddenly whilst the men are at work on the derrick—in fact, unless carefully watched, they are very likely to be restive, as there is nearly always a crowd gathered where a breakdown has occurred.

Span Wire.—The action of the atmosphere on span wires, and the means adopted to prevent it, was inadvertently omitted from my list of queries. We in Manchester are finding that the atmosphere is seriously affecting our span wires, especially in one district, where there are a number of chemical works. We have used vaseline, and also several so-called "rust-preventing" mixtures, but nothing so far has been effective. It would be interesting to have the experience of other towns on this matter.

Working of Trolley Lines Separately.—In operating a tramway system, it is desirable from a traffic point of view that the trolley lines should be worked separately, and this appears to be the general practice. In the large cities, however, the practice appears to be to work in parallel the lines in the busiest routes.

Trolley Wheels.—Fixed trolley heads are in use in Glasgow and, I think, in Aberdeen. All the other towns, I believe, use the swivelling head. The principal objection to the fixed head is that it tends to produce greater wear and tear on the overhead work at curves. On the other hand, it admits of the adoption of rigid frogs, and that is an advantage. The swivelling head has been constructed in a variety of forms. This is one of the parts of tramway equipment upon which inventors have been particularly keen. I should not be at all surprised to learn that no two towns have adopted precisely the same type of trolley head. The samples exhibited show some of the varieties. For the same gauge of wire the grooves vary considerably. The make of trolley wheel and the groove adopted has an important bearing on the life of the wire, and daily attention ought to be given to the examination of the trolley wheels with a view to renewing those which have become worn. This has an important bearing on the life of the overhead equipment.

Conclusion.—In conclusion, it is needless for me to point out that I have not attempted to deal with all the possible questions which could be raised in connection with the construction and maintenance of the overhead equipment. What I have done is to present to you some of the points which have from time to time presented themselves to me in the construction and maintenance of the Manchester equipment, and I trust they will lead to an interesting and instructive discussion.

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METHODS OF DEALING WITH MIXED SYSTEMS OF TRACTION.*

BY A. L. C. FELL.
(Chief Officer, London County Council Tramways.)

In this short Paper I only propose to deal with the question of "mixed traction" in a very broad manner. In the majority of instances in this country electric tramways have been installed as a development of some other system of traction, so that for a short time, at any rate, nearly every manager of an electric tramway has had to consider the question of "mixed traction." The subject may be roughly divided under the following headings:—(1) Temporary mixed traction during reconstruction; (2) mixed traction under normal conditions; (3) mixed traction in connection with running powers.

The problem to be faced during reconstruction is a very complicated one. It is to maintain, as far as possible, a useful and fairly efficient service without incurring serious loss. The larger the city the greater the difficulty, as competing omnibus companies, tubes, underground, overhead and surface railways are only too anxious to absorb the traffic and provide increased accommodation. In smaller cities and towns, where the tramway has practically a monopoly, the question of opposition need not be feared, but any dislocation or stoppage of the tramways is a matter of vital importance to the travelling public.

Each tramway authority has to consider the following questions before the work of reconstruction is commenced:—(1) Will it be necessary to close the road for vehicular traffic? (2) What is the best method of arranging the work, so that the tramways can be kept running? (3) Can the work be carried out properly and expeditiously if a short length of single line is reconstructed and temporary crossovers are used? (4) Will it be advisable to lay a temporary track on one side of the road and reconstruct a fairly long length of single line? (5) Will it not be better to stop the tramways? The answers to these questions depend entirely on local conditions

In London in the majority of cases the roads have been kept open for vehicular traffic, and the tramways have, with two exceptions, been kept open, but the loss in receipts last year, due to the disorganisation of the traffic during reconstruction, amounted to upwards of £24,000. Where the tramways have been kept running a temporary track has been laid at one side of the road. In two instances the tramways were stopped during reconstruction. In the first instance, the route was an unimportant one, and electrical running was not commenced until the whole route was complete; in the second instance, one track was reconstructed at a time; when about one-third of the route was completed work was commenced on the other track, in this way half the roadway was kept open for vehicular traffic. Whenever possible, mixed traction and the necessity for changing cars has been avoided.

If the original system is a horse or a steam tramway, and it is desired to reconstruct for an overhead electric tramway system, it is advisable to complete the whole of a route before the electric cars are put in operation, and so avoid "mixed traction" if possible; but if it is a question similar to that which recently had to be dealt with in London, it is not possible. The special instance was as follows:—

A horse tramway originally ran from the Westminster and Blackfriars bridges to Brixton. About 10 years ago a portion of this route was reconstructed and extended, and a cable system of traction was installed, as the gradients were considered too steep on the extension to be profitably worked by horse traction. For the convenience of the passengers, the horse cars on the other portion of the route were fitted with cable grippers, so that they could be run over the whole route, the change-over at the junction of the two systems being made very rapidly. In 1903 the portion of the route operated by horses was reconstructed, and a conduit electric traction system was installed. Owing to obstructions in the roadway, it was not possible to carry the conduit sufficiently far to enable the cars on the cable and electric systems to be brought close to one another, and it was necessary to draw the cable cars over the intervening space by means of horses. The original intention was to temporarily operate the electric cars over the cable system, and they were fitted with cable grippers and plough-lifting devices, but it was found that the cable was not strong enough to draw the heavy electric cars, and it became necessary to transfer the passengers from the electric to the cable cars, and vice versa. As this very mixed system was very inconvenient and expensive, it was arranged to reconstruct and electrify the cable portion on the conduit system.

The cable had to be stopped during reconstruction, and the question of operating the cars by horse traction was discussed, but as four horses would have been necessary to draw each car, it was decided, after very careful consideration, to stop the tramways altogether during reconstruction, but to allow the ordinary vehicular traffic to use one half of the road, as the thoroughfare was a very important one. The work was carried out in this manner, and not only was a very heavy loss on the disorganised working prevented, but it was possible to open the first portion of the road in 6½ weeks and a second portion in 1½ weeks, and the remainder in three weeks, or a total of 8½ miles of double track in 11 weeks from the date on which the cable tramways stopped running. The result from the traffic point of view is that the receipts from this portion of the route have been doubled, and the receipts on the portion of the road previously reconstructed for electric traction have been increased by over 25 per cent., clearly demonstrating that a through route not operated by mixed systems of traction is what the travelling public require.

The cost of operating the above route by horse and cable systems was 9·99d. per car-mile. The cost of operating by electricity, horse and cable was 7·92d. per car-mile. The cost of operating by electricity only is 7d. per car-mile, including all charges for power supply. We hope that when we obtain the necessary power from our permanent generating station at Greenwich that the cost of operation will be reduced to less than 6d. per car-mile.

Some municipal authorities may think it advisable to permanently operate several different systems of traction, and under special circumstances this may be the best policy to adopt, although as a general rule a uniform system is most easily and efficiently worked. Taking London as an example, where mixed traction has been somewhat freely used and will still be used, although only to a limited extent, horse, cable and electric traction have all been in operation at one time, and in one instance already mentioned the whole of these systems were for a short time in operation on one route. The London County Council has abolished the only cable line which it possessed, and the majority of the horse lines in the south of London have been reconstructed and are now worked on the conduit system. The remaining lines will very shortly be dealt with, and reconstructed, either on the conduit or the overhead trolley system. If necessary, the Council will not hesitate to mix these two systems. The complications introduced present no unsurmountable difficulties to the management, as the method of changing from one system to the other is very simple and expeditious, the whole operation being carried out in about 15 seconds. The conduit plough has simply to be wound up by a winch and the trolley arm is released, and the trolley placed on the overhead line, the only drawback being that the cars have to be fitted with both trolley standards and plough carriers; in other respects the equipment of the cars is identical. In London, in all probability, the conduit system will be installed in all crowded thoroughfares and on every route which can be profitably operated. I only hope that as time goes on we shall be able to materially decrease the cost of construction on the conduit system, and also reduce the cost of operation, so that practically the whole of the London County Council's tramways may be on the conduit system. For London, I am convinced that the conduit system is the ideal system, and the only one that is likely to prove an unmixed blessing.

The London County Council are now constructing a shallow tunnel on the north side of the river between Southampton-street and the Victoria Embankment. This tunnel will form the main connection between the Council's northern and southern tramways as soon as Parliamentary powers are obtained for lines over Westminster and Blackfriars bridges and along the Victoria Embankment. It will only be possible to work single-decked cars through this tunnel, as it is only 13ft. high. It will be necessary, so that full advantage may be taken of the tunnel, to run through cars from one end of the system to the other. To do this the majority of the cars will have to be of the single-deck type with vestibules, which can be either open or closed, in which passengers desiring to smoke can be accommodated. The double-deck cars will be used for short-distance journeys and on other than through routes.

Local difficulties with regard to "mixed traction" may be easily dealt with. Special routes can generally be arranged on which each system may be operated, but "mixed traction" is a more serious question when through running over tramways belonging to outside authorities is contemplated, as not only have different systems to be dealt with, but the subject of standardisation has to be faced. Unhappily, up to the present time, there has been no uniformity—the so-called standard gauges are not identical. The sections of rails vary greatly, and in several instances the dimensions of the cars vary to such an extent that, although the rails may be laid to a standard gauge, a sufficient clearance cannot be obtained between the cars. A great deal is at present being done with a view to standardising where possible, but it will be a very long time before these standards can be introduced—in fact, I very much doubt if the standards will ever be uniformly adopted in this country. In numerous instances the authorities have decided to continue the development of the local tramway system, so that the various parts of the undertaking will be interchangeable. This can quite readily be understood when it is considered that when the majority of the undertakings were started no definite standards were recognised, and each pioneer authority had to make its own standards.

* Paper read before the Municipal Tramways Association of Great Britain on September 27th.

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If any members of this Association wish to realise to what extent traction can be mixed, I would recommend them to visit Paris. A short time ago I saw no less than 12 systems of traction in operation in Paris in one day. The systems were as follows:—(1) Conduit; (2) overhead trolley; (3) accumulator; (4) steam cars drawn by locomotive; (5) superheated steam cars; (6) gas cars; (7) oil cars; (8) horse cars; (9) Diatto surface-contact system; (10) Dolter surface-contact system; (11) tube railway, third-rail; (12) electric locomotive drawing ordinary steam railway trains into passenger station.

Taking the first 10 on above list as an example of what may be done on any tramway undertaking, the following arrangements might be made:—

The conduit cars could be run over the trolley, surface-contact and accumulator systems, but to do this the cars would have to be fitted with ploughs, trolley standards and accumulators.

In certain cities in Germany the cars are equipped with both trolleys and accumulators, as overhead traction is not permitted in the most important thoroughfares; but I understand that the cost of operation is abnormal, and the working is very unsatisfactory. In my opinion, it would be less expensive to instal the conduit system in the restricted area.

In Paris the overhead and conduit systems are extensively used in conjunction with one another, and the results are most satisfactory. I understand that a similar mixed system in Bournemouth also works satisfactorily.

There would be no difficulty in fitting up cars for trolley and surface-contact systems, but I am afraid that it would be a more complicated matter to equip cars for the conduit and surface-contact systems, as the plough and the necessary lifting gear takes up all the available space between the motors, and the surface-contact skates would have to be divided, and very short.

Horse, steam, gas, oil and other self-contained systems might be operated on any of the other systems, but the electrically-equipped cars would be useless on the lines operated by these systems unless the routes were electrically equipped throughout.

Attached hereto will be found a tabulated statement to the list of queries which I circulated amongst the members of the Association with a view to ascertaining what is being done with regard to "mixed traction" under various conditions. It will be noted that nearly every local authority has tried to avoid "mixed traction." It appears that very few authorities stopped running the tramways during reconstruction, In the majority of cases, short lengths of single line have been reconstructed, and temporary cross-overs have been used to keep the tramways open. Very few instances are given where through "mixed traction" is in operation on the same route. The answers to some of the questions seem to denote that they have not been quite clear. This is especially noticeable with regard to question 10. Under this heading, it was simply the items of "gauge" and "clearance" about which information was desired, and not about running powers.

1.—Have your tramways been reconstructed for electric traction? 34 Corporations: Yes.—12, No.—5, Part of the lines.—3, Electric traction was the first system.—1, Lines now under construction.

2.—Was the work done by contractors? 18, Yes.—14, No.—14, partly by Corporation and partly by contractors.

3.—During reconstruction—(*a*) Did you stop the ordinary vehicular traffic? 12, Yes.—34, No.

(*b*) Did you stop running the tramways? 15, Yes.—24, No.—3, Only in a few instances.

(*c*) Did you close the roads altogether? 6, Yes.—34, No.—1, In a few cases.—1, Only track portion.—1, Not all; some side roads.

4.—If you continued running the tramways, did you reconstruct one track at a time:—(*a*) With temporary cross-overs? 23, Yes.—5, No.—7, Yes.—4, No.

(*b*) With a temporary track laid at one side of the road? 8, Yes.—1, Yes, in one case.—10, No.—1, Yes, for single track.

5.—Have you more than one systen of traction in operation regularly? If so, please give particulars. 6, Yes.—44, No.

6.—Did you run through cars over more than one system? 8, Yes.—35, No.

7.—If so, how did you operate the cars? 1, By lifting plough from conduit and connecting trolley arm.—1, The horse cars were fitted with cable grippers.

8.—On a route where more than one system of traction is in operation, do passengers change cars at the end of each system? 4, Yes.—6, No.—1, Except in one case.

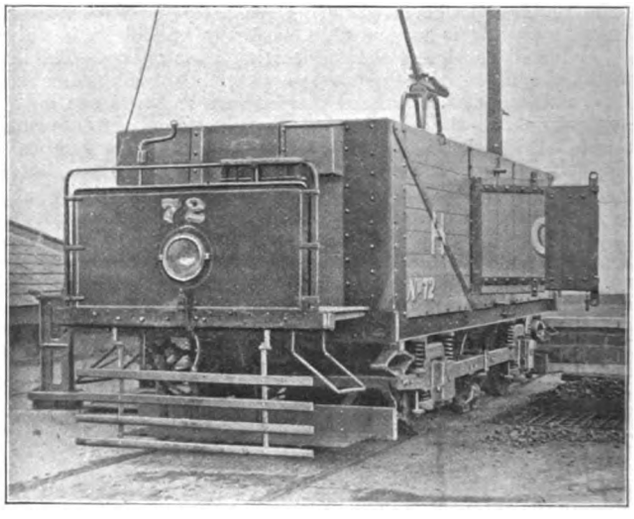
9.—If so, do you issue through transfer tickets? 2, Yes.—1, Yes, in one case.—9, No.

10.—If outside authorities or companies having running powers over your lines, have you experienced any difficulty—(*a*) With regard to the gauge of the track? 19, No difficulty experienced.

(*b*) With regard to the clearance betweeen the cars? 19, No difficulty experienced.—1, Difficulty anticipated in one instance.

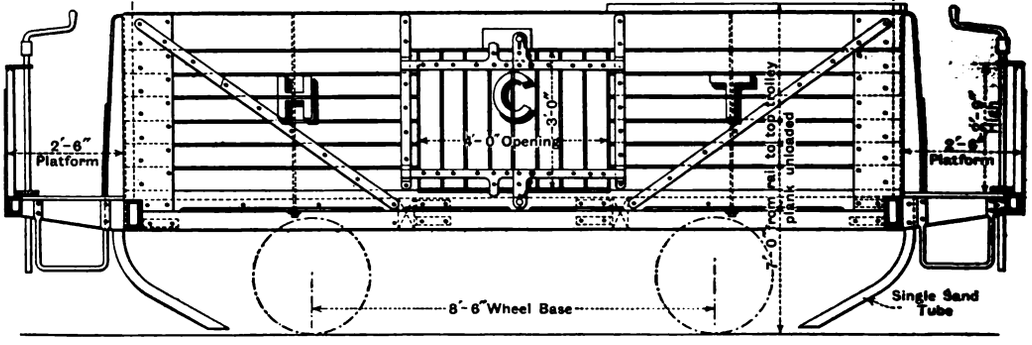
COAL HAULAGE ON TRAMWAYS.

In *The Electrician* of September 9th brief reference was made to a system of coal haulage which has recently been inaugurated on the Huddersfield Corporation tramways. Parliamentary powers to haul coal over the tramways were obtained in one of the Corporation's various acts, and the matter was considered even when the tramways were worked by steam, but the idea was not carried into practice until the present time. By an arrangement with the London and North Western and Lancashire and Yorkshire Railway Companies sidings have been placed at the disposal of the Corporation, but as they are in a very awkward position, and the coal shoots are only 7ft. from the ground, considerable difficulty has been experienced in designing suitable waggons and in erecting the overhead equipment. The sidings are about a quarter of a mile from the nearest line of tramway route and a special branch line has, therefore, been laid down to connect them. A contract has been entered into between the Corporation and a firm of local mill-owners (Messrs. Martin & Sons) for the supply of 45 tons of coal per week, the total distance from the sidings to the mill yard being between 3 and 4 miles.



ELECTRICALLY-DRIVEN COAL WAGGON.

Waggons for the conveyance of the coal have been designed to carry 10 tons, but owing to the fact that they are electrically driven there is no possibility of discharging them by means of openings in the floor, and side doors have, therefore, been provided giving an aperture of 4ft. by 8ft. They can be driven from either end, and are mounted on Brush radial trucks, each of which is equipped with two Westinghouse motors and controllers. The normal rating of each motor is 42 H.P., thus enabling the waggon to be propelled at a speed of 10 miles per hour with a draw-bar pull of 1,375lb. Westinghouse magnetic brakes are employed, and the wheels are 30in. in diameter. The waggons themselves have platforms 2ft. 6in. in length, with steel dash sheets and dash lamps in the centre, the life-guards being of the Simplex gate type. Single-deck type trolley bases are fitted on trolley planks extending to about one-third of the length of the waggon. The sole bars are plated with ¼in. steel plate in order to stiffen them. Messrs. G. C. Milnes, Voss & Co. built and supplied the waggon bodies.



ELEVATION OF WAGGON.

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A NEW CABLE GRIP.

A novel manner of drawing cables, employed by Mr. Rowland Hibbins, of the Corporation electricity department, Sheffield, has been brought to our notice. The photograph (Fig. 1) depicts a feeder cable being drawn with a Felten and Guilleaume cable grip attached to a powerful traction engine. Most engineers will at once appreciate the enormous strain upon the grip, which holds on with

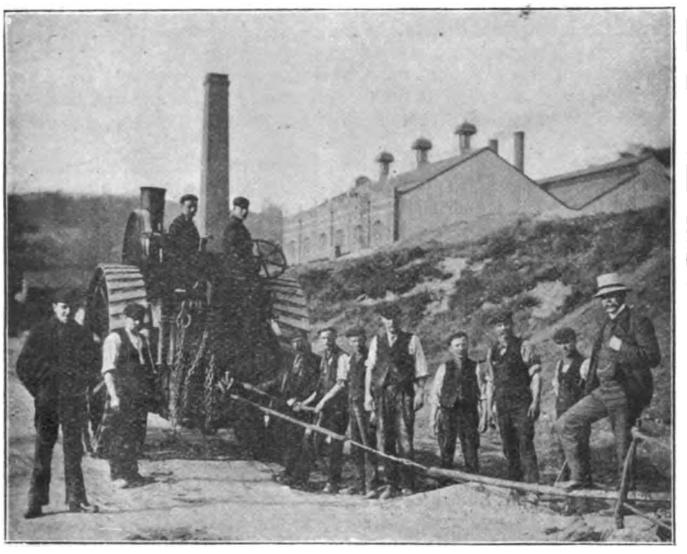

FIG. 1.—TRACTION ENGINE DRAWING CABLE BY MEANS OF NEW GRIP.

such tenacity that either the rope or the cable will have to give way before a failure in drawing can occur, as, on account of the construction of the grip, the greater the pull the more securely it holds. Although the severest strains have been put upon the grips, we are informed that they have given every satisfaction, and have come out of the ordeal successfully. Fig. 2 shows the grip in detail and the method of affixing it to the cable. 7/22 galvanised steel wire is used in its construction, and it enables the cable to be

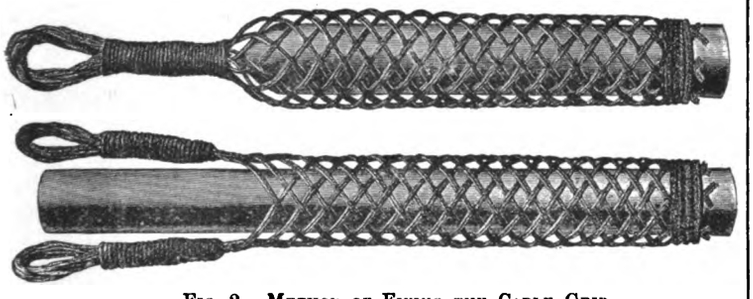

FIG. 2.—METHOD OF FIXING THE CABLE GRIP.

drawn without the lead sheathing being cut, as is usually the case. We may add that the grips can be obtained from Messrs. W. F. Dennis & Co., 49, Queen Victoria-street, E.C.

PHOTOMETRIC EXPERIMENTS WITH SELENIUM.*

BY FITZHUGH TOWNSEND.

The peculiar properties of selenium have only been generally known for about 30 years. In 1873 Willoughby Smith made use of selenium as an ohmic resistance in connection with experiments in telegraphy, and he accidentally discovered that the resistance of this peculiar metal was lessened by exposure to light. A valuable investigation of this property of selenium was carried out by Siemens in 1875, and his experiments threw a great deal of light on the various forms which selenium assumes under different conditions. He also employed a sensitive resistance for the purpose of measuring candle-power. Most of the succeeding work since these experiments had been in the direction of practical applications rather than scientific investigation, and resistances sensitive to light have been repeatedly used in methods of transmitting sound and in light telegraphy. It will be found that there is very little literature on the subject which gives really accurate information with regard to the preparation and the properties of selenium.

* From the *Electrical Review* of New York.

This element, which was discovered in 1871 by Berzelius, can be obtained in various forms. After being melted and cooled quickly the selenium assumes a translucent vitreous formation, and upon being held up to the light it will be seen to have a rich dark red colour. While in this condition it is a dielectric, and can be electrified by friction, like glass. If the molten selenium is, however, cooled slowly it will assume a gray crystalline formation, and it is then opaque to light and conducts electricity. This latter property, according to the electromagnetic theory of light could not be present if the material were to remain translucent, and it is well known that all conducting metals are opaque to light. While in this condition the specific resistance of the element is extremely high, and in general too high to be put to any practical use. It is, however, sensitive to light. By heating for a number of hours either the vitreous form or the crystalline form just described, the conductivity of the metal becomes greatly increased, and, if the temperature is reduced very slowly to atmospheric temperature, a high degree of sensitiveness to light is attained. It is in this conducting crystalline form that selenium is employed for signalling purposes. The vitreous form of the element melts at 210°C., but the crystalline forms have a considerably higher melting point.

Selenium, even when in metallic crystalline form, has an extremely high specific resistance, and it is necessary, therefore, to construct a rheostat made of it in such a way as to offer a great many paths for the current between one terminal and the other. One of the most usual methods is to cut two parallel threads in a refractory tube made of glass or lava, or some such material. A pair of parallel wires are then put on the tube so that they run spirally side by side along the threads. These two wires form the opposite electrodes. The tube is then made to spin in a lathe, and at the same time heated somewhat above 210°C. The vitreous selenium is then run along the tube, to which it clings in a thin sheet. This method of construction necessitates the use of a parabolic mirror, because otherwise the light rays would only fall on one-half of the sensitive material. In order to obviate this, resistances can be constructed so as to be plane

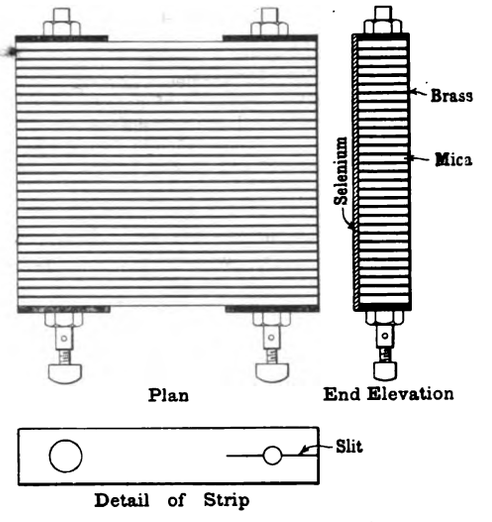

FIG. 1.—Frame for Selenium Resistance.

instead of circular. Such a construction is illustrated in Fig. 1, which shows a series of metallic plates grouped together and separated from each other by mica. Alternate plates are connected together and to one of the binding posts.

Another way of accomplishing the same result is to wind two parallel wires close together along a broad piece of refractory material, such as slate. In order to cut down the ohmic resistance it is necessary to bring the adjacent wires or steps as near together as possible. This distance should be in any case considerably less than 1mm. The selenium must be put on so as to form an extremely thin coating, because the light appears to act only on the surface of the metal, it being opaque; therefore, if any appreciable thickness is allowed, a great deal of current will be conducted from one electrode to the other through a part of the material which is not affected by the light, and it is desirable to cause the current to flow along the surface where the resistance is altered by the effect of the light rays. It is obvious, since the two electrodes are composed of a series of wires or plates extremely close together, that the effect of any moisture deposited on the surface will be very noticeable, and that the surface must be kept dry, if the resistance is not to be affected by atmospheric conditions. In the latest developments by Prof. Ruhmer, of Berlin, the selenium resistance is enclosed in an exhausted glass bulb, this having been found to give the best results.

Either brass, copper or silver may be used in the construction of a selenium resistance. One of the difficulties in the construction is to make the molten substance stick fast to the electrodes. The

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selenium appears to combine to some extent with the surface of the metal on which it is deposited when in a molten state, forming an extremely thin layer of selenide; this, however, is brittle when cold and extremely liable to chip off. If the copper or brass is slightly tinned, the adhesion of selenium is facilitated. After the selenium has been successfully laid over the electrodes in the form of a thin sheet, the resistance thus formed should be baked in an oven at a temperature of approximately 190°C. for a period of three hours, after which it should be slowly cooled, this process occupying possibly another three hours.

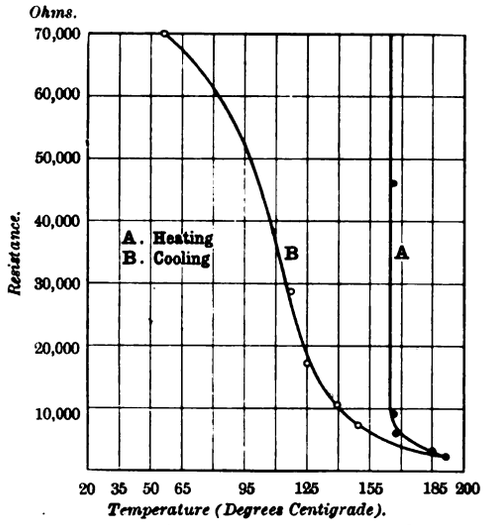
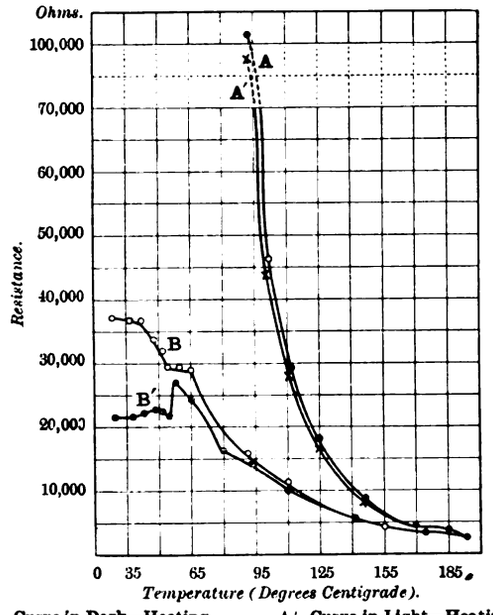


FIG. 2.—Baking Curve. Initial Resistance, 746,000 ohms. Final Resistance, 261,000 ohms.

Fig. 2 shows the result of baking a resistance formed of vitreous selenium. The treatment was imperfect. It will be seen from the curve A that the material went over into the crystalline form at a temperature of about 170deg. In this experiment, readings for which are given in Table I., the selenium was maintained at about 180deg. for 1¼ hours, and on cooling it was found to be sensitive to light.

Fig. 3 illustrates the result of a second baking on the same resistance. In this case a lamp was placed in the oven and the



A. Curve in Dark—Heating. A'. Curve in Light—Heating.
B. Curve in Dark—Cooling. B'. Curve in Light—Cooling.

FIG. 3.—Baking Curve showing effect of Light at various Temperatures during treatment.

variation of resistance with light was observed at successive temperatures. The results show that at the start the resistance was 100,000 ohms and that there was only a slight sensitiveness to light. As the temperature increased the sensitiveness diminished rapidly, disappearing entirely at about 170deg. As shown in Table II., the temperature was maintained at about 180deg. for a considerable time, and slowly reduced to that of the surrounding air. The curve sheet shows that the material began to be sensitive to light on cooling at about 130deg., and at 60deg. there was a marked increase in the reduction of the ohmic resistance produced by turning on the light, and this remained as a permanent property of the resistance. It will also be noticed that the selenium on being cooled slowly did not return to the original high resistance, but that this was reduced to about 37,000 ohms in the dark and 21,000 in the light.

Other similar experiments showed that on cooling slowly the marked increase in the difference beween the curve for darkness and the curve for light occurs always at about 60°C. It will be noted, therefore, that the prolonged baking and slow cooling have the effect of reducing the ohmic resistance and increasing the sensitiveness. Experiments were carried on to determine the effect of slight impurities in the selenium used, and it was found that 1 or 2 per cent. of copper selenide or nickel selenide could be present without affecting to a marked extent the sensitiveness of the resulting resistance.

The idea of using a sensitive resistance for the purpose of measuring light is a very attractive one, in that it involves reducing photometry to a mechanical process. The reading of a current-indicating instrument being substituted for the opinion of the observer would make the results more definite. The main difficulty lies in the fact that selenium is more sensitive to some wave-lengths than to others; therefore, at present, it seems difficult to use selenium as a light standard. It can, however, be used for purposes of comparison between similar lights. Its properties in this respect can be judged from the results to be described.

Fig. 4 gives the variation in the resistance during exposure to light in a plate made of pure selenium; an incandescent lamp was used, giving 7 c.p., its voltage being maintained constant. The distance between the surface of the selenium and the axis of the lamp was 40cm. The curve illustrates the characteristic behaviour of selenium during exposure to light. A kind of fatigue appears to exist in the sensitive material, and, as the time elapses, the ohmic resistance drops at a nearly uniform though slow rate for a very long time. This is apparently not due to a change in temperature, because the temperature of the resistance undoubtedly reaches a constant value well inside of 400 minutes on account of the small mass and large radiating surface. The curve shows the characteristic sudden decrease in resistance when the light is turned on at zero time.

Table I.

Time.	Temp. Degrees.	Resistance in ohms.	Time.	Temp. Degrees.	Resistance in ohms.
10:50 A.M.	20·0	..	12:20 P.M.	179·0	4,030
11:00 ,,	70·0	7,460,000	12:35 ,,	185·0	3,280
11:15 ,,	165·0	70,000	12:40 ,,	190·0	2,770
11:28 ,,	165·0	46,000	12:50 ,,	185·0	3,080
11:30 ,,	165·0	21,000	1:00 ,,	181·0	3,590
11:32 ,,	165·0	12,300	1:15 ,,	176·5	4,100
11:35 ,,	165·0	9,540	1:30 ,,	169 0	4,850
11:37 ,,	165·0	8,870	1:45 ,,	156·0	6,820
11:42 ,,	166·0	7,880	1:50 ,,	149·0	7,880
11:46 ,,	171·0	6,700	1:55 ,,	140·0	10,300
11:50 ,,	174·0	5,600	2:05 ,,	135·5	13,220
11:52 ,,	174·5	5,330	2:12 ,,	124·0	18,530
11:56 ,,	175·0	4,840	2:20 ,,	116·0	27,000
12:00 M.	175·0	4,730	2:23 ,,	115·0	29,200
12:10 P.M.	178·0	4,270	3:00 ,,	31·0	2,610,000
12:15 ,,	179·0	4,150			

Table II.

Time. p.m.	Temp. Deg. C.	Resist. in darkness.	Resist. in light.	Time. p.m.	Temp. Deg. C.	Resist. in darkness.	Resist. in light.
12:04	..	928,000	230,000	5:32	189·0	2,700	..
12:16	81·5	164,000	140,800	5:50	173·0	3,890	..
12:20	93·5	101,700	94,700	5:56	159·0	4,570	..
12:28	103·0	44,600	44,500	5:58	155·5	4,780	..
12:36	107·0	36,000	34,600	6:01	152·5	4,300	..
12:42	111·5	29,100	28,500	6:04	147·0	5,420	..
12:50	118·0	21,300	21,000	6:06	141·5	5,930	..
12:58	125·0	17,300	17,200	6:15	138·0	6.890	..
1:04	135·5	13,080	12,830	6:18	128·0	7,880	..
1:08	137·5	11,770	11,600	6:22	126·0	8,290	..
1:13	147·0	8,280	8,080	6:29	111·0	10,760	10,480
1:14	155·0	6,890	6,830	6:33	102·0	12,830	12,200
1:15	160·0	6,080	..	6:37	92·0	15,430	14,220
1:17	169·0	4,810	..	6:39	81·5	18,530	16,250
1:19	170·0	4,340	..	6:42	70·0	24,600	21,300
1:23	172·0	3,990	..	6:44	64·0	28,500	24,700
1:41	175·0	4,010	..	6:45	58·5	29,650	27,500
1:47	182·5	3,010	..	6:47	54·5	29,700	21,350
1:49	183·5	3,140	..	6:50	48·0	33,200	22,150
1:53	185·0	3,070	..	6:54	42 0	36,000	22,200
1:55	189·5	2,860	..	6:57	36·0	36,600	21,250
1:56	192·0	2,660	..	7:05	31·0	37,500	21,400

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The construction used in this case was that shown in Fig. 1; it was employed mainly because it enabled the same frame to be used for a series of tests. A wire-wound resistance gives better results because the adhesion of the material is stronger, and the flow of current is more along the surface on account of the fact that the material sinks down between the wires.

Fig. 5 shows results obtained with a selenium plate made by Ruhmer; it shows the same slight decrease in ohmic resistance during exposure to light, and also indicates the gradual way in

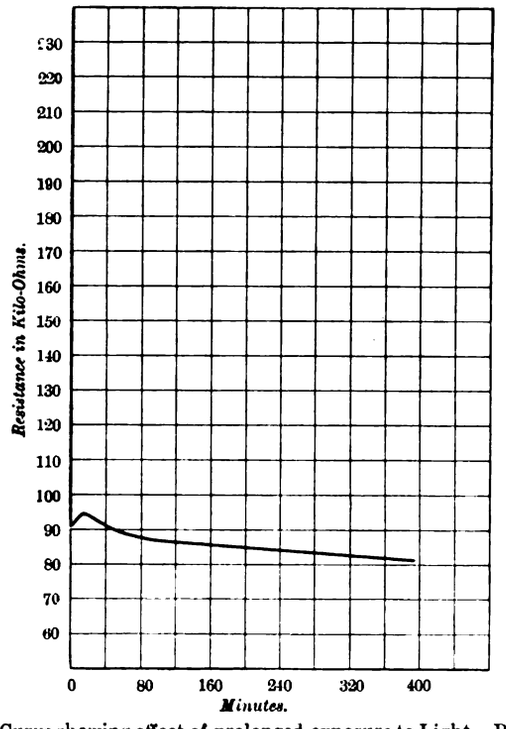

FIG. 4.—Curve showing effect of prolonged exposure to Light. Resistance used of type shown in Fig. 1 coated with Pure Selenium.

which the resistance recovers on turning off the light. Complete recovery requires 20 hours. It was found that, under proper conditions, the same curve between time and candle-power can be obtained from day to day at the same temperature, and this matter was investigated quite thoroughly. A cylindrical Ruhmer cell contained in an exhausted bulb was used in connection with a parabolic mirror. The source of light was maintained at a distance of 150cm. from the selenium. The connections were as shown in Fig. 6, in

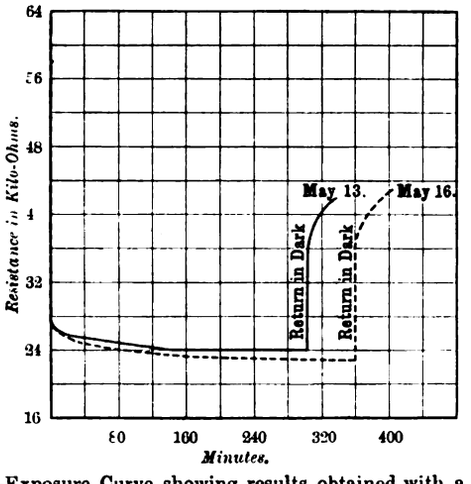

FIG. 5.—Exposure Curve showing results obtained with a Ruhmer Resistance of the Flat Type.

which a double-throw switch is used to compare the reading of the millivoltmeter when connected to the selenium resistance with its value at the same voltage when connected to the adjustable ohmic resistance R. Fig. 7 shows a curve giving the behaviour of a cell of this type during exposure to light. It will be seen that the change between the resistance in the dark and in the light is very great, and that there is a slight variation in the value of the resistance during the exposure. It was found that the time during which the selenium had remained in the dark, the intensity of the light to which it had been previously exposed and other conditions affected the curve thus obtained, and it was necessary to determine some method by which the same reading of resistance could be reproduced by the same candle-power from day to day.

After trying several methods, the following was found to give very good results:—Having allowed the resistance to stand in the dark for about 20 hours, the battery current is then sent through the selenium resistance after the voltage has first been adjusted to the desired value, by noting the deflection obtained, using the resistance R in Fig. 6. This voltage was then maintained constant, and the double-throw switch was allowed to remain thrown, so as to connect the battery permanently to the selenium resistance. This is kept in the dark with the current flowing through it for 10 minutes. At the end of this time it is exposed to the first lamp, and at the end of five minutes the reading of the millivoltmeter is taken; the

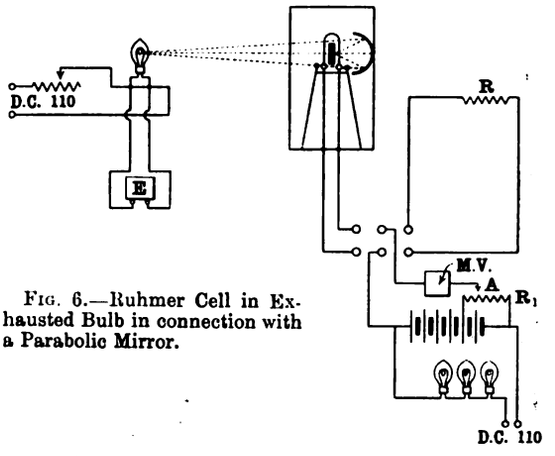

FIG. 6.—Ruhmer Cell in Exhausted Bulb in connection with a Parabolic Mirror.

light is cut off at the end of five minutes' exposure, and the deflection is allowed to drop to some value above the minimum deflection which would be obtained by keeping the resistance permanently in the dark. In this case the deflection dropped to 100, the minimum deflection corresponding to permanent darkness being in the neighbourhood of 84. Upon reaching this value the selenium was exposed to the next light in the series for five minutes and then darkened. The deflection having been again allowed to drop to the same value as before, it was exposed to the next succeeding lamp for five minutes. In this method each successive lamp must be of a higher candle-power than the preceding, and the results obtained furnished a calibration curve, which is indicated by the letter A in Fig. 8, and it is possible to reproduce this curve from day to day. The method described, however, is altogether too slow for convenient use, and it

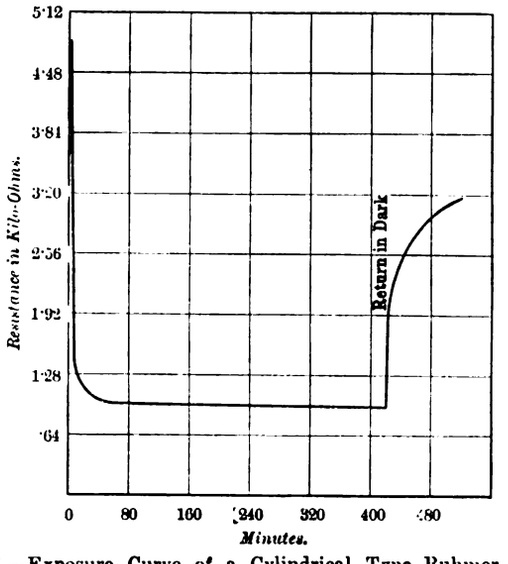

FIG. 7.—Exposure Curve of a Cylindrical Type Ruhmer Resistance enclosed in an Exhausted Bulb.

would be impossible to be sure that after testing one lamp the next one would be higher in candle-power.

The second method will overcome this difficulty and is as follows:—The resistance is exposed to a high candle-power lamp for about 45 seconds, and the deflection is then allowed to drop in the dark to a value somewhat above that used in the case given before. This value was taken at 110. When the deflection reaches this value, the resistance is exposed to the first light of the series for

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five minutes; it is then darkened and the deflection allowed to drop again to 110; this process is repeated for a succession of different lamps. By this method the curve B was obtained with a number of lamps, and it may be taken as a calibration curve for the selenium resistance in question. The curves A and B illustrate in an interesting way the effect of the different methods of taking readings on the results obtained. The curve shown in Fig. 9 gives the temperature variation in the conductivity of the same specimen, the readings being taken with the selenium in darkness.

The impression obtained from the results of these experiments is that at present a selenium resistance is hardly as good as the well-known forms of photometer with all their drawbacks, and that at best it should only be used to compare lights substantially similar

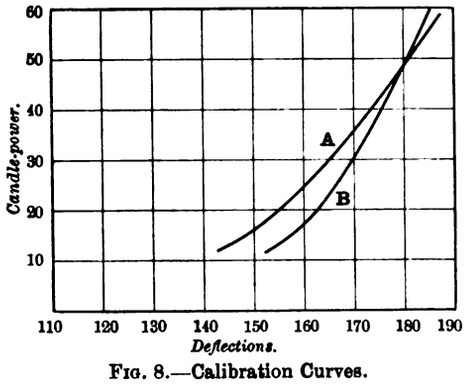

FIG. 8.—Calibration Curves.

in colour. For measuring the illumination of a room, however, it is extremely convenient and quite accurate enough. It is, no doubt, possible to increase the value of the selenium resistance as a means of measuring light by further investigation and development. The difference between the results obtained with a crude construction, as shown in Fig. 4, and an improved type of resistance which gave the values of Fig. 7, indicate what can be done in this way, and there is at least reason to hope that when as much time has been spent upon the development of a selenium photometer as on that of prevailing types very different results may be obtained.

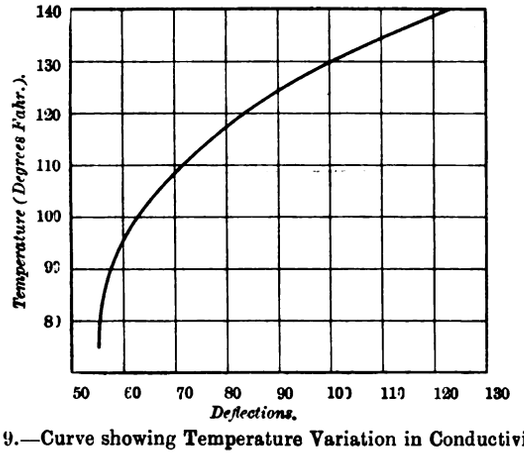

FIG. 9.—Curve showing Temperature Variation in Conductivity.

The experiments described were carried on in the laboratory of the electrical engineering department of Columbia University, and the writer desires to acknowledge the assistance of Messrs. J. E. O'Shea, M. Palmer, C. Baumgarten, C. F. Strong and G. W. Hochsprung, students in the department, who have assisted in carrying on the experiments from year to year.

AUTOMATIC POINTS FOR TRAMWAYS.

The Zylberlast Patent Points Syndicate, of Manchester, are putting on the market new automatic tramway points which they are manufacturing under Mr. Zylberlast's patents. The object of the device is to provide means whereby the tram driver may direct the vehicle to the left or to the right-hand track by setting the switch points of the tramlines (and also of the overhead wires) from the platform of the moving car itself. The overhead switches, in case of an electric trolley traction, are brought back to their "normal" position independently of the underground points, thus making them adaptable for different lengths of the trolley arms. Each platform of the car is fitted with a foot-pedal, which is connected by a chain or wire to a bell-crank lever. The latter is attached through a flexible joint to a vertical rod, which slides in a metal guide fixed to a bracket on the truck of the car in front of the wheels. Rollers, the object of which we will see presently, are fixed between the rod arrangement at each end of the car and the wheels. In general construction the switch points themselves do not differ from the ordinary hand-operated points, but there are certain additional parts to render possible the operation of the point tongues by the depressed sliding rod. There is, first of all, a point box cast in one with the switch point. This box, situated directly underneath the movable tongue, is about 3in. deep and inclined at both ends upwards to meet the normal depth of the grooves of the tramway rails. A flat projection, cast to the bottom of the movable tongue, extends from the thin end of the latter. This extension rests on the bottom of the box, and its free end, which is cut obliquely to the direction of the track, lies normally across the rail groove, so that it is forced aside by the sliding rod advancing through the groove. In this manner the points are set at the will of the driver. After having set the points, the driver releases the foot-pedal, which is drawn back by a counter-weight. Should the man forget to do this, the pedals are automatically forced back by the sliding rod coming into contact with the inclined ends of the point box.

It must be understood that this setting of points only takes place when the driver wants to turn off in one certain direction (say to the left), the points being normally set to the right if the driver does not depress his pedal. In the latter case the point tongues rest in their normal position, the sliding rod is entirely out of the rail groove and the flanges of the running wheels pass clear above the projection of the tongue. If required, the oblique extension to the tongue can be made so long that the driver can see for himself whether the points have been properly set or not before he runs his car over the siding. In order to ensure safe working of the points, even if any dirt or stone gets in between the point tongue and the point box, a drain box is provided which communicates with the point box by means of large openings left in the division plate of the box. The bringing back of the point to its normal position after the car has passed over it is effected as follows:—A third box, called the "side box," is cast to the point box. It is level with the street surface and opposite to the drain box and is provided with a hinged lid which normally projects above the level of the ground by about 1in. Whenever the points are out of their normal position, this lid is raised by a bell-crank lever arrangement. The top of the lid is rounded off on all sides and is chequered. The rollers on the car, which were briefly alluded to above, are fixed to the end of levers hung from the truck. These levers are pivoted in such a manner that the front roller, on striking the raised lid, is lifted, thus passing over this obstacle without depressing it. The second roller, which is placed quite at the back end of the car beyond the last wheel, does not give way when struck in the same direction. On the other hand, it forces the hinged lid down, and this in its turn occasions the point tongues to be shifted back into their normal position.

The makers state that they are prepared to alter existing points to work on this principle. The overhead wire switches are set by an arrangement of wires and bell-crank levers from the switch tongues. The only point which needs elucidation is the manner in which the overhead switch is held in position until the trolley, which trails usually some distance behind the last wheel of the car, has passed. The overhead switch, after being pulled out of its normal position by the wires, is securely locked against returning by a suitable catch. This, in its turn, is mechanically connected to a fork arrangement, between the two prongs of which the trolley wire passes. The fork overhangs the trolley wire on that side of the switch which is the last to be passed by the trolley. Thus, the overhead switch will remain in the deflected position until the fork is lifted by the trolley; this action releases the catch and the overhead switch returns to its normal position by the pull of a spring.

A practical demonstration of this system took place at Trafford Park, Manchester, on Saturday last.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

"The Electric Furnace." By Henri Moissan. Translated by A. T. de Moulpied. (London: Edward Arnold.) 10s. 6d.

"Proceedings of the Incorporated Municipal Electrical Association," 1904. Published under the supervision of the Editing Committee. (Ipswich: W. S. Cowell, Ltd.) 3s. 6d

"Science Abstracts." September, 1904. Section A, Physics; Section B, Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

"Reflections Suggested by the New Theory of Matter." By the Right Hon. A. J. Balfour, M.P. Presidential Address to the British Association, Cambridge, 1904. (London: Longmans, Green & Co.) 1s.

"Proceedings of the Royal Society." Vol. LXXIV. No. 499. (London: Harrison & Sons.) 2s.

"Fortschritte der Electrotechnik." Edited by Dr. Karl Strecker. 1903. Part 4. (Berlin: Julius Springer.) 11m.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Wireless Telephony.—Q. Majorana describes a system of wireless telephony for which he claims a transmitting power of several miles, though the actual distance hitherto traversed is only between the extreme ends of the Physical Institute of Rome. The principle is the following:—A succession of 10,000 sparks per second is produced by a Hertz oscillator. A means is found of lengthening or shortening the spark-gap, leaving the frequency unchanged. The lengthening and shortening is produced by the sound-wave itself, which attacks one of the terminals of the spark-gap, whereas the other remains rigidly fixed. If the sparks are examined by means of a revolving mirror, they show a succession of lines which lengthen and shorten in a succession of waves corresponding to the sound waves. These waves are transmitted by the antenna, and may be received by a magnetic or other detector. The steady succession of sparks at the rate of 10,000 per second does not interfere, as it produces a hissing note so high as to be practically inaudible. The author prefers to obtain the sparks from an induction coil of 40cm. sparking length, operated from the mains at 40 $\sim$ per second. The frequency of the sparks increases as they go on, on account of the air being heated. They are, therefore, often more frequent than 10,000 per second, and can no longer be analysed by the revolving mirror. Blowing air or carbonic acid across the gap serves to reduce the temperature to a steady state. But in order to obtain a constant pitch, the author introduces a magnetic tuning fork. To reproduce the sounds of the microphone current, the author employs a jet of mercury as one terminal. This jet is set into the proper vibration, and has the advantage of having no proper period of its own. The author refrains for the present from giving further details. Human speech is reproduced with as great a fidelity as it is by the phonograph or the telephone.

[Q. MAJORANA, *Nuovo Cimento*, July, 1904.]

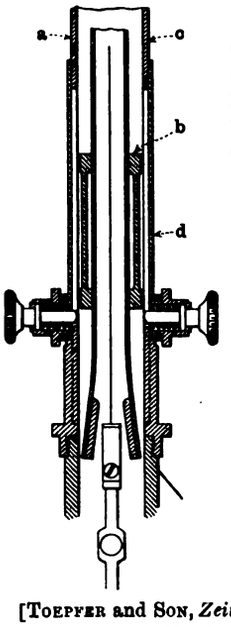
Decay of Excited Radio-activity.—When a negatively-charged metal plate has been exposed in the presence of thorium emanation for two or three days the radiation from the activity excited on the plate steadily decays after removal according to an exponential law, and falls to half its original value in about 11 hours. If, however, a plate is exposed to the emanation for only a short interval of time it was found by Rutherford that the radiation from a body thus excited increases at first after removal, reaches a maximum in the course of a few hours and then decays at the same rate as the radiation from a plate exposed for a long interval. If the excited activity on a negatively-charged conductor is due to the deposit on it of positively-charged carriers, the initial increase can be explained by supposing that the positive carriers undergo a double change, the first part of which takes a few hours to be completed and is unaccompanied by radio-activity. Miss H. Brooks has endeavoured to determine the laws underlying the two changes. The curve of decay for an exposure of 10 minutes shows that half the matter undergoes the first change in about 55 minutes. She finds that both changes follow an experimental law with the time, and may be represented by the equation $N_t = N_0 e^{-\lambda t}$, where N_t represents the number of particles present unchanged after an interval, t, and N_0 the original number. If λ_1 is the coefficient of the primary change, and λ_2 the coefficient of the secondary change, the authoress obtains the values $\lambda_1 = 0{\cdot}00021$ and $\lambda_2 = 0{\cdot}0000175$. She found that in the case of thorium emanation the presence of dust was sufficient to completely mark the initial rise. This was not the case in radium, where the processes are much more rapid and there are no less than three changes. The first change gives rise to α-rays only, and is very rapid, half the matter being changed in about three minutes. The second change produces no rays, so that the curve shows a flat portion, lasting about 40 minutes for very short exposures. The third change has a period of about 28 minutes, and gives rise to more α-rays. In actinium, as in thorium, there is a "rayless" change in the excited radio-activity, but it is extremely rapid, half the matter being changed within a minute and a-half. The active deposit may be removed in all three cases by boiling in dilute hydrochloric acid.

[H. BROOKS, *Philosophical Magazine*, September, 1904.]

Röntgen Rays for Testing Cables.—W. Otto describes an instrument, constructed by the Sanitas Electric Co., of Berlin, for the testing of cable insulations by means of X-rays. The cable to be tested is passed over rollers through a box provided with a spyhole at the top and an X-ray apparatus below. The box also contains a "Wodal" interrupter, a motor for driving same and switches for regulating the main current. The eye of the observer is protected from external light, so that the room need not be darkened. He observes a screen placed just above the cable, and is thus enabled to detect any foreign bodies, air bubbles, &c., which may have found their way into the insulation. The instrument is said to have answered well in practice.

[W. OTTO, *Deutsche Mechaniker-Zeitung*, September, 1904.]

Protection of Suspension Fibres.—O. Toepfer und Sohn have devised an arrangement for the protection and safe transportation of silk and quartz fibres, which is illustrated in the diagram. The fibre is contained in a narrow brass tube, *a*, the lower end of which is split into strips which spring out, and are provided with ivory cheeks. A muff, *b*, runs along the tube and is in turn surrounded by a second brass tube, *c*. An outer collar, *d*, bears two spring plugs which run in a groove cut along *c*, and can grip the muff *b* from above or below. When the thread is to be removed, *d* is raised until the plugs are above the muff. The plugs are then pressed in and down, whereupon the muff closes the cheeks and grips the carriage. The inner tube *a* can now be lifted out with absolute safety, and another thread can be substituted. The arrangement is chiefly intended for temporary observatories, where the mounting and testing of fibres is a lengthy and troublesome task.



[TOEPFER and SON, *Zeitschrift für Instrumentenkunde*, September, 1904.]

Electrode Fall and Contact Potential.—C. A. Skinner has made a further study in the relation between the electrode fall of potential and the contact-potential series, announced in 1901. He finds that the fall of potential at the cathode in a given gas decreases as the electro-positive value of the metal increases; the anode fall, on the other hand, decreases as the electro-negative value of the metal increases. The metals tested were platinum, silver, gold, copper, steel, nickel, bismuth, antimony, tin, lead, calcium, zinc, aluminium and magnesium. These metals were tested in hydrogen, nitrogen and oxygen. The electrode fall may be represented as a continuous function of the contact potential of the electrode. The curves show, however, some interesting exceptions. Platinum exhibits a slight tendency to drop below its normal value as cathode, but is in line as anode. Gold appears in general to be displaced in the electrode series to the neighbourhood of tin and lead. This may, however, be due to mercury vapour. In nitrogen, cadmium and zinc are displaced to the platinum end in the electrode series, the cathode fall being for these metals abnormally high, while the anode fall is abnormally low. In oxygen, copper drops as cathode slightly below its normal position, but steel and nickel form interesting exceptions in being displaced to the vicinity of zinc in the electrode series. A similar inconsistency is exhibited by these metals when the potential series in sulphuric acid and that given by the heat of combination of the metals with it are compared. The electrode fall is not a constantly increasing quantity in passing from one end of the potential series to the other. But, starting with a minimum value at one end, it approaches at a decreasing rate a constant maximum value for the rest of the series. This is clearly marked for all curves, except that giving the anode fall in nitrogen.

[C. A. SKINNER, *Philosophical Magazine*, September, 1904.]

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TRAMWAY OVERHEAD EQUIPMENT.

It was a good idea that led Mr. McElroy to collect and summarise, in the Paper which we print elsewhere, particulars of the overhead equipment and remarks as to its maintenance in some important respects from most of the municipal tramway undertakings in the kingdom. To complete the statement of contemporary practice, a similar collection from tramway companies is needed. The information collected, however, suffices to show that there is a considerable diversity in construction. Foremost comes the question of centre *v.* side trolley. Trolley wires can only be central to the track or out of centre, so all systems fall into either the central or side-wire; but if a question as to the average or maximum side-reach permitted had been put, a much larger range would have been revealed by the answers. On this point prevailing practice is not in accordance with general opinion, for while 26 towns have side wires, nine towns centre wires, and 10 a mixture of the two, a majority of the replies show a preference for the central wire, and some towns are altering side wires to central wherever they can. This is a striking instance of the way in which expert knowledge has to give way to amateur views when new things are introduced into an old and settled country. The span wire was voted horribly ugly; the span wire is necessary to central trolley wires, *ergo*, the central wire must not be used, although it is evidently the best job. And in a few years the central wire is quietly substituted for the side wire, no one noticing the difference, though some one has to pay for the double work. On the question of centre poles there is considerable diversity of opinion. On a straight road the centre pole makes a very satisfactory construction (excepting that the trolley-wire attachments are less elastic than with span wire) and may be of pleasing appearance. But it does not lend itself to curves and junction work, so that it is practically impossible to use it throughout a tramway system. The effect upon general vehicular traffic depends upon the width of the road and the density of the traffic. In a very wide road, or with small general traffic, centre poles may be unobjectionable, but wherever the traffic is heavy in relation to road width the centre pole is an obstruction and a danger. It is true that the police are said to like them as assisting to regulate the traffic,

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but the police point of view is not always identical with that of the public using the streets.

Not much information is to be got as to the most useful size of trolley wire or on what grounds various towns have chosen sizes from No. 0 to No. 0000. Further experience will, doubtless, show the relation between frequency of service and gauge of wire which gives the most economical results; but the question is complicated by the fact that heavier wire calls for heavier poles, bracket arms, span wires and insulators. It does not always get them, we know, and there are some overhead constructions in which the margin of safety of some portions of the equipment is very low in consequence. As might be expected, the reports on the wear of trolley wire are very divergent. Glasgow estimates the life of trolley wire at three years with a service of 2½ cars per minute. Leeds, in seven years finds the wear imperceptible on straight track and very slight on curves, with a service of 1¼ minutes, while in Dover, Cardiff, and Oldham, for instance, the experience is very different. Many elements influence this wear. Probably there is not much difference between the hardness of various samples of trolley wire, but trolley wheels are made of all kinds of alloys. It is economical to make the trolley wheel the wearing member of the couple. Atmosphere is probably of great importance; unfortunately, questions as to its influence were not included in Mr. McElroy's catechism, an omission he acknowledges, and which we hope he will remedy. Glasgow has certainly a badly-polluted atmosphere. Leeds is hardly less smoky, but, quite probably, is less contaminated with sulphur and other acids. However, the facts as to the nature of the wear will be more useful than much speculation, and we trust they will come out in the discussion. Glasgow has used "phono-electric" wire on some busy routes and at most curves with "very good results." This wire is a hard bronze, probably has better wearing qualities than copper, and may be worth while using where mechanical wear is heavy. But its electrical resistance is much higher than that of copper, so that additional feeder copper and more feeding points may be necessary, and it is a nice question whether it would not be better worth while to use a heavier copper wire.

Many trolley wire replacements are caused by wear or pitting at ears, especially on curves and at special work. Side-wire systems are especially affected by this trouble, the comparatively rigid attachment (even with bow-string suspensions) giving rise to more severe blow effects than span wire, and the lateral pressure causing a rubbing friction and consequent rapid wear. It is suggested that rigid trolley heads cause more rapid wear on special work and curves than the swivel trolley head. This is a nice question, and we incline to the opposite view. Rigid trolley heads can only be used on central wires, and no others should be used there. A swivel head is merely a nuisance tolerated to make side wires possible. The swivel head is necessarily much heavier than a fixed head, and its inertia is responsible for a great deal of wear and a great deal of damage. Much ingenuity has been spent upon it, but the very large number of patterns in use is strong evidence of its intrinsic vices. Mr. McElroy mentions that in parts of Manchester span wire is very quickly corroded, and no protection has yet proved effective. This trouble is a very old one to telegraph engineers. It has been met in some very bad cases by the use of bronze span, pull-off and guard wires, and this is the best remedy we can suggest. In the same circumstances, the usual tramway insulators have given great trouble, which has been got over by the use of porcelain shackles as span-wire insulators. There seems to be no reason why porcelain should not be used generally for trolley-wire secondary insulation, which is not exposed to blows and need not be in tension. It is at once cheaper and more durable than the strain and globe insulators with shellac compounds in general use, and there is no real necessity for providing turnbuckles or other means of adjusting the tension of span or pull-off wires. The only mention of porcelain in the returns is that Bolton uses a section insulator with porcelain insulation. The automatic disconnection of a fallen trolley wire has only been attempted in a few cases, and abandoned in several of these. The general opinion seems to be that such a provision is unnecessary; the cost of it would certainly be better spent in improved construction. A considerable diversity of practice is shown by the replies to some of the other questions put. For example, the anchoring of section insulators—and here, again, opinion and practice are not always in accord. It does not seem to be recognised that anchoring is not merely a device to provide against the mechanical failure of a section insulator, or that horizontal anchoring, which is far more effective than vertical, can be free from the danger of trapping a dewired trolley. Glasgow, indeed, says that it has no such trouble, but then Glasgow uses a rigid trolley head, which goes a very long way in reducing overhead wire trouble—always given a well-centred trolley wire.

The discussion on Mr. McElroy's Paper had to be postponed, but it will probably benefit from the opportunity given to study the answers at leisure, and should be of great interest and value. The returns as given show that many tramway officers are using an equipment with which they are not satisfied, and which they would not repeat if they had the opportunity and a free hand. The reasons for this state of things are not far to seek, and no doubt in a few years there will be much less diversity both in practice and opinion than at present exists. Meantime, the diversity is useful, and must lead to improvements of general value. It would be very useful to have a statement of the actual cost of the overhead construction in various towns, and also of the annual cost of maintenance and repairs, due information being given in each case of the age of the line, the service given over it and the average amount of interruption due to breakdowns of the equipment. These, after all, are the test figures indicating the true efficiency of the work and they will eventually determine what standard types of construction and detail fittings will survive.

Whilst overhead work in this country has suffered from amateur engineering to a quite appreciable extent, it has also been benefited by the application of fresh minds already trained to ingenuity in other branches of the profession, and by the application of criticism of all sorts. Such an environment is highly productive of variation, and survival of the fittest is only a question of time, but the development and subsequent elimination of useless "sports" is a somewhat expensive process. Comparison and discussion of different methods and their results must tend to indicate the true path of progress and discourage individual eccentricities.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Die Dampfturbinen. By Dr. A. Stodola. 2nd edition. (Berlin: Julius Springer.) 1904. 10m.

The present, the second, edition of this work is a considerably enlarged issue of the first edition, which appeared in the autumn of last year. It treats both of the theory and the practical design of the chief types of steam turbines constructed so far, besides discussing in a more or less detailed manner various suggestions from different sources with regard to the subject dealt with. A short chapter is appended at the end of the book in which the gas turbine is discussed in a

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theoretical way. The theoretical portions of the book are, as is generally the rule with Continental writers, built up on an elaborate mathematical foundation, but the mathematics themselves are not beyond the capacity of readers acquainted with the more elementary part of the differential calculus. But the theoretical treatment is sometimes sketchy, and the wording is not always happily chosen, and some parts, therefore, form difficult reading. The conclusions, however, are always concisely and clearly stated, and may thus be appreciated by the reader who lacks either the ability or the inclination to follow the mathematical investigations through. On the other hand, a thorough acquaintance with the principles of thermodynamics is essential for a proper appreciation of the contents of the book. Several important experimental investigations are recorded, among which are experiments relating to the mechanical resistance of steam in pipes, the wavy form of distribution of steam pressure which occurs along nozzles in certain conditions, the contraction of the lines of steam when entering different forms of nozzles, the occurrences which take place at the nozzle outlets and the friction of turbine wheels when rotating in steam of varying density. In the next part of the book the author deals successively with the individual mechanical parts of a steam turbine, treating the subject both from a mechanical and thermodynamical point of view. A large number of representative designs are illustrated and discussed. Prof. Stodola then reviews in a thoroughly detailed manner 10 different types of turbines, included in which are all the well-known patterns about which so much has been heard lately. In most cases the results of tests are given. A brief historical chapter follows, after which the author proceeds to discuss critically some of the more promising novelties recently patented. A couple of pages are then devoted to the application of steam turbines to ships, and a similar space is taken up by a comparison, chiefly from a steam-consumption point of view, of the reciprocating engine and the steam turbine. The reader's attention is then drawn to a number of special problems with which the designer of turbines is confronted. In this category fall the determination of the so-called critical speed of rapidly-rotating shafts; the discussion on the resonance effects which may be produced in turbine foundations; the transport of heat through the shaft and casing of turbines, and so on. The book concludes with a number of short chapters pertaining to the pure theory of thermodynamics. Perhaps the most interesting amongst these is the one in which the author passes a critical review on some novel methods proposed lately for bettering the low thermodynamical efficiency of present-day heat engines. The book is well printed and profusely illustrated. It can be confidently recommended to the steam engineer in general and to the steam turbine designer in particular.

Governors and Governing Mechanism. By H. R. Hall. Manchester: The Technical Publishing Co., Ltd.) 2s. 6d. net.

This useful little book will no doubt attract many readers amongst practical engineers. The author first establishes the well-known relation between the controlling force, speed, radius and mass of the governor balls, and then goes on to describe Watts' governor and many modern forms of spring governors. The author very properly emphasises the point that "isochronism" is not the criterion by which to estimate the capabilities of a governor. Questions of regularity, steadiness and lightness are discussed with the aid of many examples of a practical kind. Many well-known combinations of governor and valve gear are described and illustrated. These include examples of automatic slide-valve "cut-off," Corliss gears and trip gears. Gas engine governors, relay governors and inertia governors, all receive attention. The subject is treated in quite an elementary way and mainly by geometry. The drawings and illustrations are well done, and students will find the book interesting.

Static Electricity. By Hobart Mason. (New York: McGraw Publishing Co.) $2.

The author complains of the treatment meted out to the subject in the numerous books on "Electricity and Magnetism," and proceeds to a thorough exposition of the phenomena and machines met with when dealing with static electricity. Whether such an exhaustive treatment is really required is by no means certain; but now that very high-voltage schemes are coming into vogue in this country, practical electrical engineers might, with considerable advantage to themselves, make a study of the subject which is dealt with in the book under notice. The author's theoretical treatment is unquestionably sound, and his description of condensers and electrostatic instruments is well worthy of perusal.

THE DUPLEX BALANCING OF TELEGRAPH CABLES

BY W. GAYE.

(Continued from page 907.)

A point of some importance is that the resistance is responsible, not only for the delay in, and the limit of, the *rise* of potential, but for some retardation (increasing with the resistance) in its *fall* as well. Thus, curve 1 is crossed by any one of those initially below it, although this is not clearly shown in the figure. After this intersection—which occurs at a time that becomes more remote as r is increased—the curves diverge to some maximum distance apart (also dependent upon the magnitude of r), and thereafter continually approach each other, ultimate exact coincidence

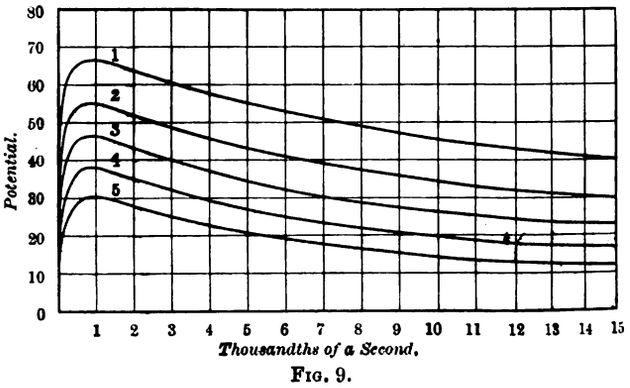

Fig. 9.

occurring at $t=\infty$ when, for the reason quoted above, $V=0$. In the case of curve 6 the greatest distance it rises above 1 is about 1·3 per cent. of e, this occurring in the neighbourhood of 0·015 second. In addition to the intersection of 1, curve 6 crosses, also, all those at first above it, a proceeding that is, indeed, followed by them all. It will be remembered that the potential *began* its *rise* as if the condenser were short-circuited; it is now seen that it *completes* its *fall* as it does when the resistance is short-circuited.

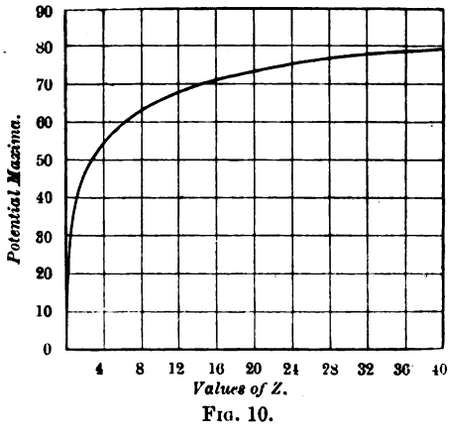

Fig. 10.

Fig. 9 illustrates the effects of a variation of the core ratio R/S while s and r are constant, their ratio r/s having the value of 7·85 ohms per microfarad. Curve 1 is a result when R/S = 78·5 ohms per microfarad, z having a value, therefore, of 10. 2, 3, 4 and 5 represent cases where R/S is reduced respectively to 31·4, 15·7, 7·85 and 3·925 ohms per microfarad, z becoming 4, 2, 1 and 0·5. It is noticeable that while the core

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ratio controls the rise and fall of potential it is not responsible for the time at which this attains its maximum value.

The two more important deductions resulting from a study of the preceding three figures are :—

1. If $\frac{sR}{rS}(z)$ is maintained of the same value the curve is the same, the scale of the abscissæ or the time-rate-of-change-of-potential varying only as Sr^2/R.

2. The maximum value reached, and greatest stress, therefore, upon the cable's dielectric, varies according to sR/rS, and occurs when $2Rt/r^2S = \sqrt[3]{3}sR/rS$—that is to say, in all cases at $t = \sqrt[3]{3}sr/2$ seconds.

If we insert the above value—viz., $\sqrt[3]{3}z$—for $2a$ in the expressions (3A) and (3C) the curve in Fig. 10 results : it shows the maxima in percentages of e as z increases from 0 to 40.

The fundamental expression for the current at the beginning of the cable, when the resistance r and the condenser's capacity s are both of finite value, is $C = \frac{e}{r + \frac{1}{sp} + \left(\frac{R}{Sp}\right)^{\frac{1}{2}}}$.

At $t=0$ the second and third terms of the denominator both $=0$, and the commencing current when the key is depressed is, therefore, e/r. For the derivation of subsequent values, no shorter method seems to present itself than by expansion and development of the fundamental above. This operation, if the values are in percentages of the commencing value e/r, and, as before, $Rt/Sr^2 = a$, $St/Rs^2 = b$, and $sR/rS = z$, leads to :

$$C = \frac{e}{r}\left[1 - \left(\frac{4a}{\pi}\right)^{\frac{1}{2}}\left\{1 + \frac{1}{3}\cdot\frac{2a}{z}(z-2) + \frac{1}{3\,.\,5}\cdot\left(\frac{2a}{z}\right)^2\left(z^2 - \frac{4z}{\lfloor 1} + 3\right) + \frac{1}{3\,.\,5\,.\,7}\cdot\left(\frac{2a}{z}\right)^3\left(z^3 - \frac{6z^2}{\lfloor 1} + \frac{4\,.\,5z}{\lfloor 2} - 4\right) + \&c.\right\}\right.$$
$$\left. + \frac{a}{z}(z-1) + \frac{1}{\lfloor 2}\cdot\left(\frac{a}{z}\right)^2\left(z^2 - \frac{3z}{\lfloor 1} + 1\right) + \frac{1}{\lfloor 3}\cdot\left(\frac{a}{z}\right)^3\left(z^3 - \frac{5z^2}{\lfloor 1} + \frac{3\,.\,4z}{\lfloor 2} - 1\right) + \&c.\right]$$

$$C = \frac{e}{r}\left(\frac{1}{4ab^2\pi}\right)^{\frac{1}{2}}\left\{1 - 3\,.\,\frac{z}{2a}(z-2) + 3\,.\,5\,.\left(\frac{z}{2a}\right)^2\left(z^2 - \frac{4z}{\lfloor 1} + 3\right) - 3\,.\,5\,.\,7\left(\frac{z}{2a}\right)^3\left(z^3 - \frac{6z^2}{\lfloor 1} + \frac{4\,.\,5z}{\lfloor 2} - 4\right)\right.$$
$$\left. + 3\,.\,5\,.\,7\,.\,9\left(\frac{z}{2a}\right)^4\left(z^4 - \frac{8z^3}{\lfloor 1} + \frac{6\,.\,7z^2}{\lfloor 2} - \frac{4\,.\,5\,.\,6z}{\lfloor 3} + 5\right) - \&c.\right\}$$

or

$$C = \frac{e}{r}\left[\left(\frac{1}{a\pi}\right)^{\frac{1}{2}}\left\{\left(1 + \frac{2}{z}\,.\, + \frac{3\,.\,4}{\lfloor 2z^2} + \frac{4\,.\,5\,.\,6}{\lfloor 3z^3} + \frac{5\,.\,6\,.\,7\,.\,8}{\lfloor 4z^4} + \&c.\right) - \frac{1}{2a}\left(1 + \frac{4}{z} + \frac{5\,.\,6}{\lfloor 2z^2} + \frac{6\,.\,7\,.\,8}{\lfloor 3z^3} + \&c.\right) + \frac{3}{(2a)^2}\left(1 + \frac{6}{z} + \frac{7\,.\,8}{\lfloor 2z^2} + \&c.\right)\right.$$
$$\left. - \frac{3\,.\,5}{(2a)^3}\left(1 + \frac{8}{z} + \frac{9\,.\,10}{\lfloor 2z^2} + \&c.\right) + \frac{3\,.\,5\,.\,7}{(2a)^4}\left(1 + \frac{10}{z} + \&c.\right) - \&c.\right\} + \frac{2}{z}\left(\frac{b}{\pi}\right)^{\frac{1}{2}}\left\{\left(1 + \frac{4}{z} + \frac{5\,.\,6}{\lfloor 2z^2} + \&c.\right) + \frac{1}{3}(2b)\left(1 + \frac{6}{z} + \&c.\right)\right.$$
$$\left. + \frac{1}{3\,.\,5}(2b)^2\left(1 + \frac{8}{z} + \&c.\right) + \&c.\right\} - \frac{1}{z}\left\{\left(1 + \frac{3}{z} + \frac{4\,.\,5}{\lfloor 2z^2} + \&c.\right) + b\left(1 + \frac{5}{z} + \frac{6\,.\,7}{\lfloor 2z^2} + \&c\right) + \frac{b^2}{\lfloor 2}\left(1 + \frac{7}{z} + \&c.\right) + \frac{b^3}{\lfloor 3}\left(1 + \frac{9}{z} + \&c.\right) + \&c.\right\}\Bigg]$$

The limitations of these are much the same as the corresponding potential expressions. Their use affords the curves in Fig. 11, where—the ordinates being percentages of e/r—there are illustrated some effects upon the current produced by a

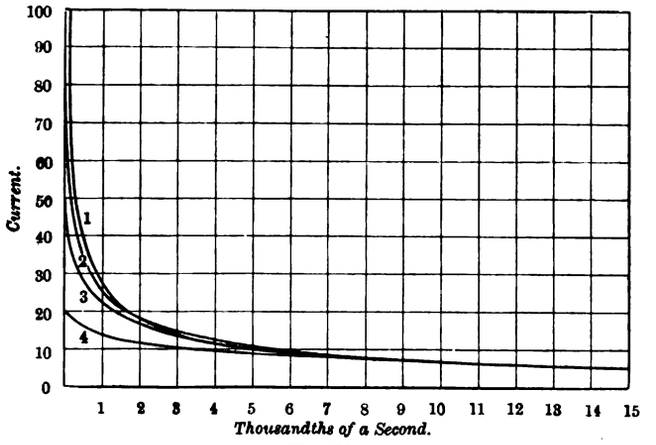

FIG. 11.

variation of the resistance r, while the capacity of the condenser s is kept constant, Rs^2/S having the value 0·1274. Curve 2 represents an instance of sR/rS or $z=20$; that is to say, in those examples we are using—viz., the cables A, B and C—where r and s are of the values respectively of 100ω and $63{\cdot}693\phi$, $41{\cdot}137\omega$ and $154{\cdot}818\phi$, and $618{\cdot}18\omega$ and $10{\cdot}303\phi$. Curves 3 and 4 show the result of increasing r to $2r$ and $10r$. Curve 1 is a case of $r=0$, in which, of course, the commencing current is ∞.

If the areas enclosed by 1, 2 and 3 are compared, it is seen that a moderate amount of resistance has but little effect upon the quantity of charge that has entered the cable even at so early a period as 0·015 second. In the end, of course, it has no effect at all. As a further indication of the speed with which the charge enters the cable, if we take the case of cable A and assume e to be 100 volts, the total quantity of charge this voltage is capable of displacing into the cable from the condenser is $100 \times 63{\cdot}693$ or 6369·3 micro-coulombs. But r being 100ω the commencing current is (e/r) 1,000 milliamperes—that is to say, the charge starts entering the cable at the rate of 1,000 micro-coulombs per 1/1000th of a second.

It is noteworthy also that although the commencing current varies inversely as r the curves 2, 3 and 4 rise above 1, the point of intersection becoming more remote as r is increased. Each one of them also is crossed by all those starting initially beneath it. It is as if to compensate somewhat for the reduction of the commencing current, which an increase of r entails, the values in the later stages are maintained somewhat higher. The writer was much struck some years ago when experimenting on a cable of considerable length, by the great extent by which the usual period of battery contact could be reduced without materially affecting the amplitude of the signals at the distant end. This was subject to the battery resistance being of the usual moderate amount and naturally to *the earthing not being immediately consequent on the cessation of the battery contact, but a period of insulation allowed to intervene.* The reason is, that under

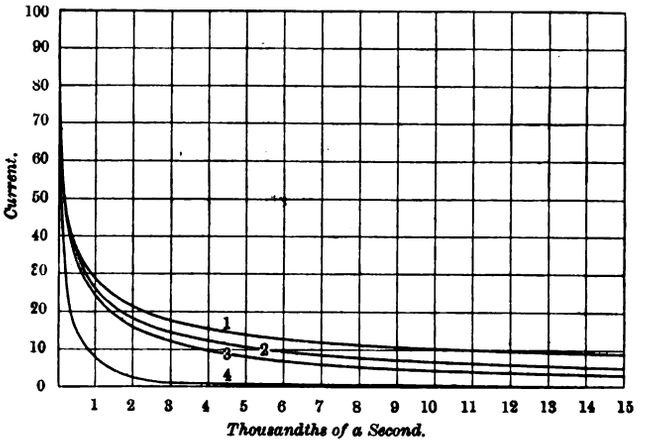

FIG. 12.

such circumstances the speed at which the charge begins to enter the cable is so enormous, that during the later and greater period of an ordinary battery contact (of a duration, say, of 0·05 second) there is but little more of the charge to go.

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With the contacts of their usual period it is evident that the battery resistance (which may be taken as comprised under r) is not of very great significance. The speed with which the charge enters the cable being so great as compared with its propagation that the little delay caused by a moderate amount of resistance is altogether inappreciable at the distant end. Indeed, regard for the life of a battery and the stress to which the dielectric of the cable is subjected, might lead one to say that some resistance is even desirable. Fig. 12 represents some effects upon the current when r is maintained constant while the capacity of the condenser s is varied. Sr^2/R has the value 0·00031846, that is, with cables A, B and C, r is of the value respectively of 100ω, 41·137ω and 618·18ω. Curve 1 illustrates the instance in which, the condenser being short-circuited, $s=\infty$. Curve 2 shows the result when s is of such value as to make z or $sR/rS=20$, *i.e.*, 63·692ϕ with the A cable, 154·818ϕ with the B, and 10·303ϕ with the C; 3 and 4 show the effect of reducing s to $s/2$ and $s/10$. The effect of the magnitude of s upon the quantity of charge in the cable is sufficiently marked at $t=0·015$ second, but, as the period becomes further increased, the quantity varies more and more closely with s, and at $t=\infty$ it does, of course, exactly so. Fig. 13 illustrates a variation of the core ratio R/S, while r and s are both constant, being of such value as to make their ratio $r/s=1·57003$ ohms per

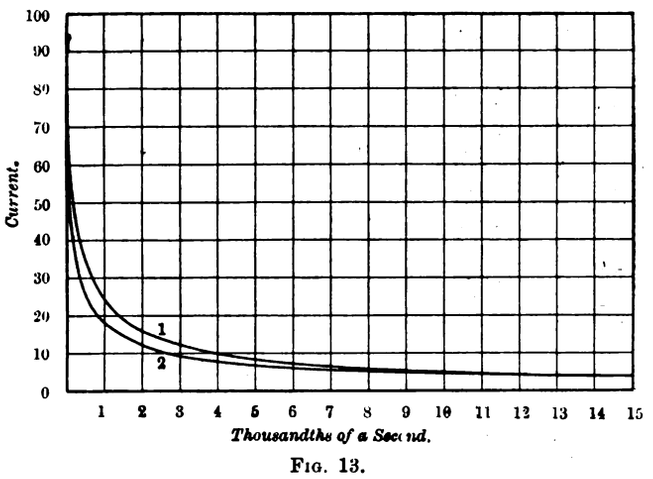

Fig. 13.

microfarad. Curve 1 represents the current when R/S=31·4006 ohms per microfarad and curve 2 that resulting when this is doubled. A point worth observance is that the current in all cases *starts* at $t=0$, as if the condenser were short-circuited, and ceases at $t=\infty$, as if the resistance had been so.

(To be concluded.)

EFFECTS OF CONTINUOUS AND ALTERNATING CURRENTS ON THE DIELECTRIC STRENGTH OF INSULATORS.

BY G. W. O. HOWE, M.SC., WH.SC.

The Compagnie de l'Industrie Electrique and Mécanique of Geneva have recently carried out a series of very interesting experiments which show the advantage of continuous over alternating current, for long-distance power transmission, in so far as the insulation of the line and other parts of the system is concerned. A summary of the results obtained was given in a recent issue of the *Elektrotechnische Zeitschrift*, from which the following is taken.

The experiments consisted of a series of comparative tests of the disruptive strengths of various insulators and insulating materials, including air, under high voltage, continuous and alternating current. To obtain the high voltage necessary for the tests, three continuous-current dynamos were employed, one for 20,000 volts, and the others for 25,000 volts, the allowable current being 1 ampere in each case. When connected in series a pressure of 70,000 volts could thus be obtained. The alternating pressure was obtained from a 75kw. 50 ∿ machine, connected to a suitable transformer. The pressure curve was a flat-topped sine curve, with a ratio of maximum to effective of 1·255. This form of curve favoured the alternating current more than a peaky curve would have done. Every material tested stood a far higher voltage under continuous current than under alternating current, in addition to which the former showed an entire absence of noise and static discharge, except in the neighbourhood of the breakdown pressure. The following is a summary of the results obtained.

The Disruptive Voltage for Air.—Figs. 1 and 2 give the relations between distance and breakdown pressure for electrodes of various shapes. Fig. 1 refers to continuous, and Fig. 2 to alternating current.

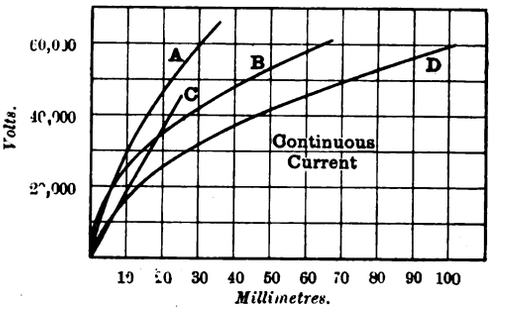

Fig. 1.

The influence not only of the form, but also of the polarity of the electrodes is very interesting. At a pressure of 40,000 volts, the breakdown distance between a point and a plane is 22·5mm., when the point is the negative pole, whereas it is 45mm. when the point is positive.

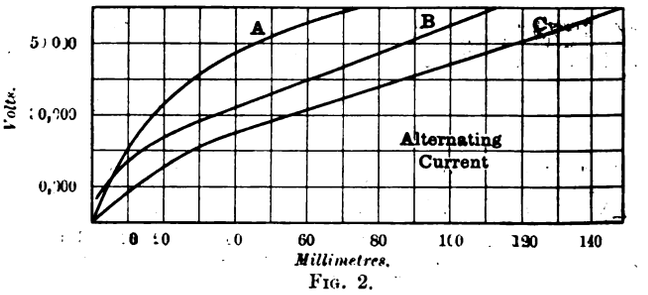

Fig. 2.

Breakdown of Line Insulators.—Five different types of insulators gave the following results for the breakdown voltage:—

Type.	A.	B.	C.	D.	E.
Continuous voltage.....	24,000	34,000	40,000	34,500	40,800
Alternating voltage.....	15,000	21,400	27,000	24,700	31,160
Ratio.....	1·6	1·59	1·48	1·35	1·31

Breakdown of 5mm. Pressphn:—

Alternating Current.

Seconds under pressure.	Pressure (volts).	Results.
90	9,000	None.
30	11,000	
120	9,000	Heavy brush discharge.
135	9,000	Broken down.

Continuous Current.

Minutes under pressure.	Pressure (volts).	Results.
2	10,000	None.
2	15,000	,,
2	18,000	,,
2	20,000	,,
4	25,000	Broken down.

Breakdown of 20mm. Marble.—With alternating current breakdown occurred after 75 seconds under 20,000 volts, and after 2 minutes under 15,000 volts. With continuous current it broke down after 15 minutes, during which the pressure was raised from 10,000 to 45,000 volts, in steps of 5,000 volts every 2 minutes. These results are probably largely due

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to the absence of dielectric hysteresis when continuous current is employed.

There is a danger, however, with direct current of the electrolytic destruction of certain insulating materials; this can be avoided by employing only such materials as are entirely free from water, such as glass, porcelain, mica, &c. These experiments point to the possibility of employing a much higher continuous current voltage than that which is so successfully used on the St Moritz–Lausanne 60km. transmission—viz., 22,000 volts. A pressure of, say, 70,000 volts would enable much water-power, at present running to waste on account of its remote locality, to be employed successfully and remuneratively.

NEW SWISS ELECTRIC RAILWAY.

A light electric railway, connecting Palézieux, Châtel-St. Denis, Bulle and Montbovon, has recently been completed, and was described in the *Schweizerische Elektrotechnische Zeitschrift* of August 20th. As may be gathered from the accompanying map, the route traversed by the line in question, which is 29 miles long, lies in a mountainous district, the altitudes of some of the principal points of the line being as follows:—Palézieux, 2,200ft.; Semsales, 2,820ft.; and Estavennes, 2,330ft. The maximum gradient of the line is, nevertheless, not very excessive, being 3·21 per cent. The track is built partly on existing roads and partly on its own ground. Of the bridges which had to be erected, the two principal ones are 80ft. and 105ft. long respectively. There are also two tunnels, one 655ft. the other 328ft. long, both lying on curves of 328ft. radius. These curves have the smallest radius of any in the line, and a straight length of about 90ft., equal to the length of an ordinary train, is built between any two curves. The gauge is 1 metre, and the rails, which are in lengths of 12 metres (39ft.), rest on wooden sleepers impregnated with a solution of zinc chloride. Where the permanent way has been especially built, rails of the Vignoles type weighing 48lb. to the yard are used, while in other portions of the line, and particularly where the railway traverses inhabited places, grooved rails of the tramway type weighing 80lb. to the yard are made use of. The line is single with passing places at the stations, and is worked with continuous current at 750 volts.

Electric energy for working the system is generated as three-phase current at 8,000 volts in two water-power stations, the combined capacity of which is 10,000 H.P. It appears, however, that one of the generating stations only—*i.e.*, the one situated at Montbovon—is intended to supply the line in normal conditions, the other station, at Hauterive, being apparently considered as a stand-by. For converting the high-tension three-phase current to continuous-current, a number of sub-stations have been erected along the line. Three of these, situated in Châtel-St. Denis, Semsales and Albeuve respectively, are equipped identically, each having two 90kw. motor-generators which supply continuous-current at between 750 and 1,000 volts. A fourth sub-station is to be built in Bulle, and will, when completed, contain two 170kw. converting sets. In the case of the three small sub-stations, the high-tension three-phase current is first transformed down to 500 volts before being led to the motors, but in the case of the sub-station at Bulle, the motors are to be supplied directly by current at 8,000 volts. In the first three sub-stations alluded to, an accumulator battery, consisting of 375 cells of a capacity of 115 ampere-hours, is directly connected across the terminals of the continuous-current generator, no cell switch being used. As a rule, the feeders are carried by the poles which support the overhead equipment. The feeder between Châtel-St. Denis and Semsales consists of two wires of a diameter of 11mm. (0·432in.); that between Semsales and Bulle of one 9mm. (0·354in.) wire; that between Bulle and Albeuve of one 8mm. (0·315in.) wire, and that between Albeuve and Montbovon of one 6·7mm. (0·264in) wire. Every third or fourth pole is fitted with a lightning arrester. Double-petticoated insulators support the feeders at heights varying between 24½ft. and 26ft. above ground. All poles are of impregnated wood, spaced from 65ft. to 130ft. apart. They are 33ft. in length, of which about 6½ft. is let into the ground; they carry iron brackets, from which the trolley wire is flexibly suspended, the distance between trolley wire and pole being nearly 7ft. The trolley wire has a diameter of 9mm. (0·354in.), and is trebly insulated from earth. At stations, crossings, and wherever the line runs along the road, the trolley wire is fixed at a height of 21·3ft. above the rails, but on special track the height is reduced to 18ft., and in tunnels it is only 14·75ft. Connection between the trolley wire and the feeder running parallel to it is made about every quarter of a mile, and section switches are inserted into the trolley line approximately every 1,100yds. Current returns by way of the rails, which are cross-bonded every eighth of a mile.

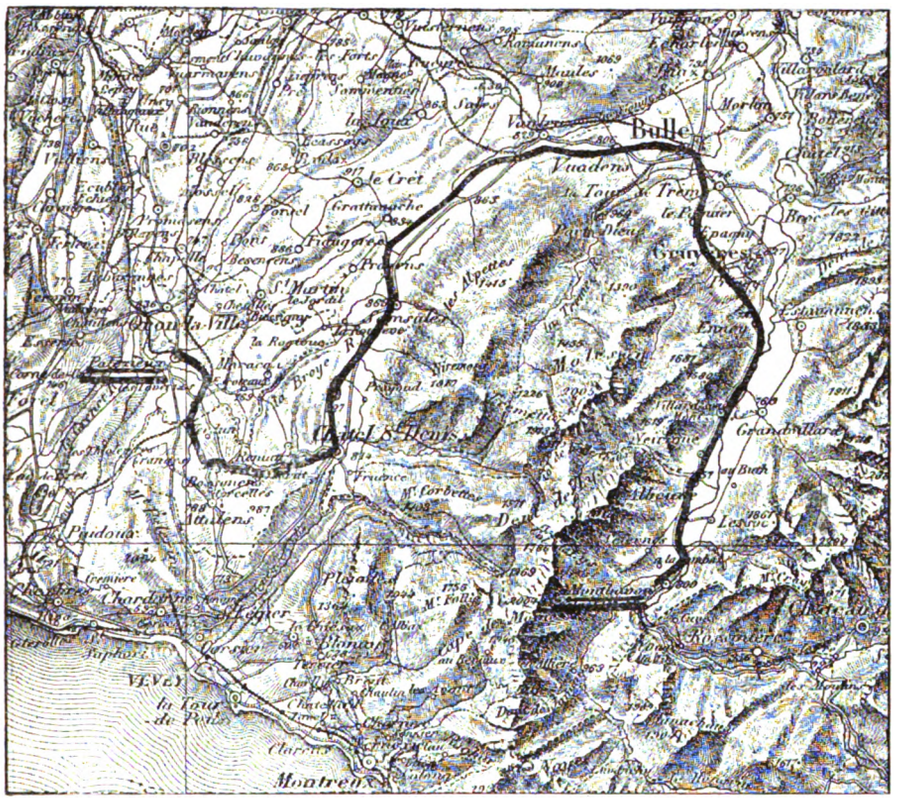

FIG. 1.—MAP SHOWING PALÉZIEUX-BULLE-MONTBOVON ELECTRIC RAILWAY.

At present the rolling stock consists of 10 motor cars and a number of trailers; there is also a number of 10-ton goods waggons. Current is conveyed from the overhead line by aluminium bow collectors, two of which are fitted to each motor car. Eight of the 10 motor cars are equipped with four 35 H.P. motors, and are capable of running trains weighing 47 tons at a speed of 12·4 miles per hour on the maximum gradient of 3·21 per cent. Goods trains, weighing anything up to 60 tons, may also be handled by these motor cars, but, of course, at a correspondingly slower speed. Two motor cars have been fitted up with four 80 H.P. motors, which suffice to haul a train up to 130 tons at a little over 10 miles an hour on the gradient already mentioned. Two motors are, in all cars, permanently connected in series, and are treated as a unit. A single reduction gear is used for transmitting the power from the motors to the car axles. Speed regulation is effected on the series-parallel system, and brakes of both the electric and pneumatic type are provided. The electrical part of this railway undertaking was carried out by the Elektrizitäts-Gesellschaft Alioth, Bâle, Switzerland.

Curious Breakdown at Limerick.—The cause of a breakdown at the Limerick electricity works on Saturday was a very unusual and curious one. Limerick is a gas-driven station. On attempting to start the engines, the driver, who, it is said, was suffering from "temporary incapacity," omitted to close the electrical ignition circuit. Each engine is provided with a separate air compressor for starting purposes, and as a result of the driver's aberration these compressors became exhausted. They then had to be re-charged by hand, this operation occupying 1½ hours.

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NEW ELECTRIC CLOCK.

An electric clock of new design, originating from Germany, is at present being exhibited by the Self-Winding Clock Syndicate. In principle, the clock may be said to be the combination of the ordinary type of clockwork with an electrically-operated mechanism which keeps the clock continually wound up. The following is a brief description of the electrical part :—

Referring to Fig. 1, 5 denotes a soft-iron armature, which is pivoted as shown. This armature swings between the pole-pieces of the two electromagnets, and, when attracted by the latter,

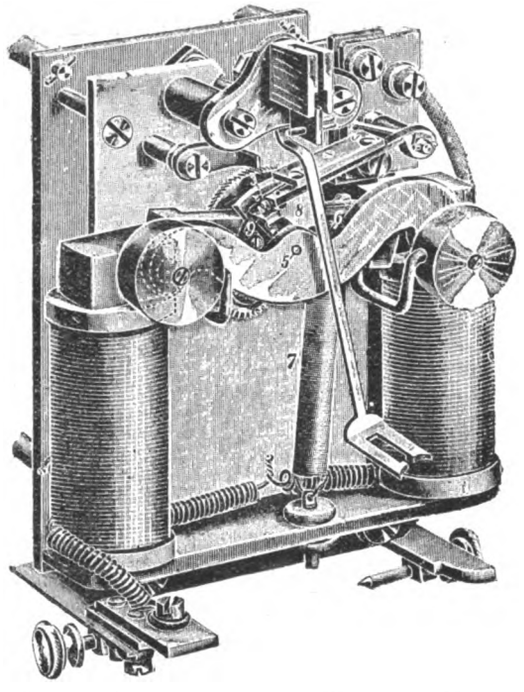

FIG. 1.—GENERAL ARRANGEMENT OF THE WINDING-UP MECHANISM OF ELECTRIC CLOCK.

assumes a horizontal position, thus stretching the spiral spring 7. The tension of this spring drives the whole clockwork through a pawl attached to the armature, engaging with a ratchet wheel connected with the gear train of the clock. As the clock runs on the armature is more and more deflected from the horizontal. When this deflection has reached a predetermined value, a current impulse is sent through the magnets by the device shown in detail in Fig. 2, and the armature is again drawn back into the horizontal position. To ensure continuity during the fraction of a second occupied by this action, the clock movement is driven by a second

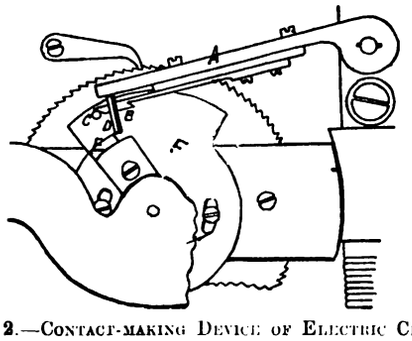

FIG. 2.—CONTACT-MAKING DEVICE OF ELECTRIC CLOCK.

small spring, which is put under tension by the movement of the armature itself. Two dry batteries are generally employed for furnishing the current.

One terminal, E (Fig. 2), consists of a metal segment, which is carried on a plate, F, secured to the armature. The other terminal, D, consists of a pin which is secured to a swinging arm, A. Fastened to this arm, but insulated therefrom, is a flat spring provided at its free end with a head or cam, B, adopted to engage a pin, C, on the plate F. The ends of the cam B are bevelled, as illustrated, so that when the armature moves away from the poles, the cam will ride over the pin C, lifting the contact pin D out of engagement with the segment E. When the pin C passes the inner end of the cam, the pin D will drop on to the segment B, completing the circuit through the magnet coils and causing the armature to swing back, and the cam, then riding under the pin C, will press the terminal D down against the segment E, ensuring a good contact.

The clock can be made to strike the hours, &c., the necessary power being supplied by a second spring, which is wound up by the movement itself whilst running, or can be worked by a similar self-winding movement manipulating the striker only. The clock may be regulated to a nicety by adjusting the tension of the spring, and the escapement may be worked either by a balance wheel or a pendulum. We understand a company is being formed for manufacturing the clock in this country.

According to an official report of the Berlin Reichsanstalt on a clock submitted for inspection, the amount of current taken at each contact was 0·017 ampere-seconds, and the time between two consecutive contacts decreased from six minutes in February, 1902, to four minutes 48 seconds in March, 1903. Duirng these 13 months the voltage of each of the two cells used had dropped from 1·52 to 1·46 volts, the clock not having stopped one second in the meantime,

EVERETT, EDGCUMBE & CO.'S EXHIBIT AT ST. LOUIS.

It will doubtless be remembered that the Royal Commission appointed to look after the interests of the British section at the St. Louis Exhibition decided to select a few representative firms and to invite them to co-operate in the formation of a thoroughly comprehensive national exhibit. In view of the distance, it was decided to restrict the exhibit to firms who had specialised in the lighter branches of electrical engineering, and more particularly in the manufacture of electrical measuring instruments. In coming to this decision, the Commission were doubtless influenced by the consideration that in this particular branch—viz., the manufacture of electrical measuring instruments—this country can more than hold her own with other nations. That this expectation was amply justified is shown by the fact that the British combined exhibit is acknowledged on all sides to be distinctly superior to any other in this particular branch.

The exhibit of Messrs. Everett, Edgcumbe & Co. is a very comprehensive one, and some particulars of a few of their more important instruments are of interest. In their new form of inkless recorder, which is quite a new departure, the chief advantages claimed are the absence of friction between pen and paper and no ink to clog the pen or to dry up and blot the record. This instrument is also fitted with a special form of clock which requires no winding, and in the case of a number of recorders can be synchronised with the switchboard clock, so that no uncertainty as to the timing of individual recorders is possible. Another exhibit is the latest form of rotary synchroniser, which has gone through numerous improvements before reaching its present state of perfection. This instrument, which is constructed on the principle of a two-phase alternating-current motor (*The Electrician*, Vol. L., p. 422), not only replaces the ordinary synchronising voltmeter or lamp, but also shows at a glance, by its direction of rotation whether the incoming machine is running too fast or too slow. An addition which has recently been made consists of an auxiliary contact by means of which coloured lamps, or other signals, can be actuated at any required distance from the synchroniser. This addition has proved extremely useful in several large stations.

A three-phase power-factor indicator, constructed on a principle somewhat analogous to that of the synchroniser, is also shown. In most power-factor indicators the accuracy of the indications depends on a correct phase displacement being maintained between the currents in two coils, and this phase displacement is usually produced by means of a choking-coil. In Messrs. Everett, Edgcumbe & Co.'s instrument, however, the phase displacement of the system itself is employed, so that the reading is absolutely independent, not only of the voltage, but also of the frequency and wave form. The instruments are equally applicable to two or three-phase circuits, balanced or unbalanced. Taking, as an example, a power-factor meter for a three-phase balanced load, the moving system consists of three coils fixed at an angle of 120deg. to each other and having their inner ends joined together so as to form a neutral point. The three free ends are connected, through suitable resistances, one to each phase. Acting on this moving system is a fixed current coil in series with whichever of the three mains may be preferred. When the load is unbalanced three current coils are employed, one in each circuit, in which case the instrument indicates the average power-factor of the entire system instead of that of one phase only, as in the former case.

Fig. 1 shows the connections for such an instrument when used for an unbalanced three-phase system. The arrangement is such that two voltage transformers and two current transformers alone are required. This arrangement is preferable, owing to the fact that the necessary transformers are, as a rule, available in connection with the integrating wattmeters which now usually find a

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place on the switchboard. When the load can be regarded as balanced—as, for example, in the case of a motor—only one coil is necessary; but even in this case it is better, when possible, to use three coils, as shown. A special feature of the connections shown in Fig. 1 consists in the connection of the third current coil in series with the other two, whereby only two current transformers are necessary. Seeing that the current in the third line must be equal at each instant to the resultant of the currents in the other two, it is unnecessary to connect this third line to the instrument. In place of the two single-phase volt transformers, one three-phase transformer can, of course, be employed, and in the case of low-tension systems the volt transformers are replaced by a star resistance.

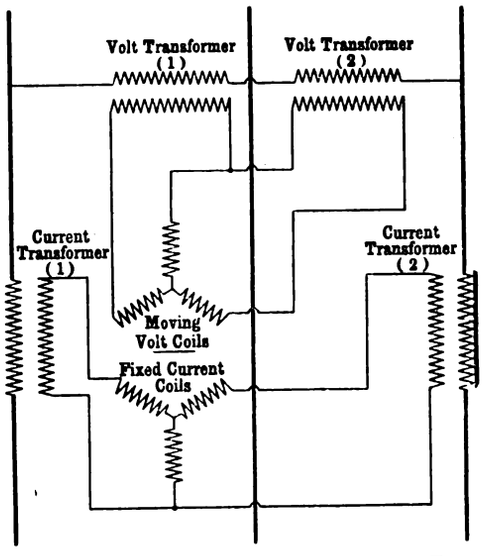

FIG. 1.—DIAGRAM OF POWER-FACTOR INDICATOR ON THREE-PHASE UNBALANCED SYSTEM.

Among other items of the exhibit is an indicating wattmeter constructed on the dynamometer principle, in which every possible precaution has been taken to eliminate errors due to eddy-currents, self-induction and capacity, so that accurate measurements can be obtained even at the lowest power-factors. In order to get over the difficulty of the extremely small deflections obtained with low power-factors, an arrangement is provided whereby the reading can be doubled, thus greatly increasing the accuracy.

Mention should also be made of the latest type of portable glow-lamp photometer. Since this instrument was first described (*The Electrician*, Vol. XLIX., p. 954), a considerable number of improvements and modifications have been made; the grease spot has been replaced by a Trotter grid, while the direct-reading scale takes the

FIG. 2.—NEW FORM OF DIRECT-READING RESISTANCE INDICATOR.

form of a spring tape. The apparatus is so constructed that it can be employed, if required, in broad daylight, and the box which contains the whole outfit, including lamp-holders and standard lamp, is leather covered and measures only 8in. by 7in. by 5¾in.

A new departure in Wheatstone bridges has also been made. The overall size of this instrument, as shown in Fig. 2, is 9¼in. by 6¼in. by 6¼in., this including a direct-reading slide-wire Wheatstone bridge, complete with standard resistances and a D'Arsonval galvanometer. The normal range is from one-tenth of an ohm to 11,000 ohms, but for special purposes various other ranges can be supplied; for example, the instrument can be constructed, without increase of size, so as to read from one-tenth of an ohm to 200 megohms. The general arrangement is the same as that of the insulation set described in *The Electrician*, Vol. LII., p. 186, which proved so successful that it was decided to bring out the resistance indicator. Both instruments are direct-reading, and the resistance indicator can be provided with a battery inside the case itself, so that in order to measure a resistance it is merely necessary to connect it to the two terminals on the instrument. A very similar set is supplied for the purpose of testing the conductivity of lightning arresters, only in this case, in order to eliminate errors due to earth currents and electrolytic E.M.F.s, an alternating current is employed, a small induction coil being fitted in the case, while a telephone replaces the galvanometer. This set, which can also be used for the measurement of all ordinary resistances, provided the self-induction or capacity is small, is particularly useful for the measurement of the resistance of batteries or electrolytes.

SIMULTANEOUS TELEGRAPHY AND TELEPHONY.*

BY JOSEPH HOLLOS.

The question of simultaneous telegraphy and telephony is not of recent date. While, however, in some places good results have been obtained, in others the advantages reached by this combined using of telephonic circuits are hardly worth mentioning, and in view of the difficulties experienced in the service it was thought preferable to abandon the scheme.

If we look closer at the question we can at once observe that wherever the telegraph and telephone services are under the supervision of one and the same interested person the results obtained are excellent. Where, however, the two systems are in different hands the result is unsatisfactory. Thus, in America, where the financial interest of the telephone companies is involved, because of the desire to increase income by leasing lines for simultaneous telegraphy, and where, for this reason, these two operations are under the control of one technical staff, the result is excellent. The results are also fair in the European services if the same technical officer supervises both telegraphy and telephony and one service is co-ordinated with the other. The result is, on the contrary, very poor in all cases if the telegraph and the telephone services are in different hands. This is evident, if we consider how greatly the one system interferes with the other—that is, that careless handling of the one interferes at once with the proper functioning of the other, the two systems thus being brought into mutual opposition. For this reason the service must be arranged in such a manner that the two systems cannot interfere with each other, and in as far as troubles are unavoidable they must be reduced to a minimum. If they should exceed, certain arrangements must be provided to hold out the less important service without delay. In this direction the Hungarian telegraph and telephone service can show good results by comparison with similar installations, and, therefore, it will not be without interest to outline the principles which were followed in the formation of the system.

Above all, the simultaneous installation must be the simplest possible, because only thus and with the fewest possible instruments may undisturbed working be obtained. For this reason the method of simultaneous working, founded on the Wheatstone bridge principle, was made the basis of procedure. The telephone circuit is closed through two inductive branches. At their point of intersection the battery branch is led off to the group of telegraph apparatus, while the telephone apparatus is placed in the so-called galvanometer branch. It is thus evident that the connecting-in of the telephone apparatus—namely, the leading of the telephone circuit through the switchboard—requires some care, because if there is a ground in the switchboard connections the telegraph working is disturbed. Even if one telephone circuit is directly connected to another, and there be simultaneous working on the latter, the two telegraph simultaneous systems are brought into contact, which again causes marked disturbance. This may also be caused by the operators ringing simultaneously on several circuits from the same common source of ringing current. Even if only one of the circuits fed from the common ringing source is connected for simultaneous telegraphy, such working will still be slow, because in ringing on the simultaneous conductor we ring also on five or six other conductors. However well insulated these circuits may be individually, the insulation of the simultaneous telegraph circuit will be so far reduced by the connection that it will hardly be possible to maintain continuous telegraph working.

It is true that we can remove all these difficulties at one stroke by connecting the incoming telephone circuit, before leading it to the switchboard, to a repeating coil, and working then only on the other half of the repeating coil. But by this plan the difficulty is only transferred to the other side—the telephone side. Above all, we have a loss of energy in the repeating coil to which are added losses inevitably occurring in the signalling apparatus, and it may happen that with such an arrangement the telephone subscriber does not get as much as 50 per cent. of the incoming

* Paper read before Section G of the International Electrical Congress of St. Louis.

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speaking energy into his receiver. We must strive, therefore, that along with the undisturbed working of the telegraph, the telephone working be kept at the same relative level that would exist in the absence of simultaneous working. Moreover, the repeating coil not only weakens the speaking current but also the calling current, and we must, therefore, take precautions in this direction. Under these conditions it is inadvisable to connect the circuit first to the repeating coil. As long as the circuit is on the calling apparatus there is no danger of disturbing the simultaneous working. The disturbance arises only at the moment of connecting. For this reason it would be sufficient to place the repeating coil in the connecting cord, but in the same path there is also the clearing-out signal, and a great loss of energy might thus be incurred. This we may, however, remedy if the repeating coil is constructed in such a manner as to serve at the same time as the clearing-out signal.

The clearing-out signal is, as a rule, connected in the bridge between the two branches of the circuit, and its duty is by its great self-induction to prevent the wasting of any considerable part of the speaking current. How far it is able to satisfy this demand might be readily ascertained by inserting a receiver in the shunt path. In spite of thus increasing the impedance of the bridge we still obtain intelligible speaking even with a clearing-out signal of 2,000 ohms resistance, if the latter is entirely embedded in iron. These currents do not so rigidly follow the rules which apply to strong currents, and, therefore, inferences drawn from such rules do not apply in this case, as may be shown by a simple experiment. With such a clearing-out indicator 30 per cent. of the energy is lost on the average, and 70 per cent. only is available, as I have been able to ascertain myself. With a well-constructed repeating coil, if arranged as a clearing-out signal, the loss is not greater. Consequently, if we insert such a repeating coil into the connecting cord, simultaneous working without affecting the telephone is secured. The repeating coil transformed into a clearing-out drop naturally possesses a closed iron circuit. In European practice this plan is avoided and an open-circuit repeating coil is generally preferred. The question whether the repeating coil has an open or closed magnetic circuit does not affect the high frequency involved, and for weak currents this is of much less importance than the other losses that arise in an open-circuit repeating coil.

For relatively strong signalling currents the closed iron circuit is of decided advantage, because with open-circuit repeating coils, it is only exceptionally possible to ring through with alternating current, while it is always certain when there is a closed iron circuit. From the point of view of simultaneous working it only remains to separate the ringing currents. This may be accomplished if alternators are used by branching the ringing current at each operator's position on a separate repeating coil. Where batteries are used, which are to-day exceptional, each operator's position must be given its separate battery. This is a matter for the technical department. As for the operating department, it is only desirable that the telephone and telegraph operators should be able to communicate with each other quickly, so that they can co-operate in case of troubles. In the simultaneous working apparatus itself the branching coil is of the highest importance. It is most important that the inductance on the two sides should be equal. This is more important than the exact equality of their ohmic resistance. This, however, determines not only the resistance of the coil, but also the size of copper wire to be used. From the point of view of choking, it is desirable to use long coils; such coils, however, by reason of the phenomena of dispersion, prevent the complete neutralisation of the telegraph currents, and, therefore, it is necessary to select short coils. With such an arrangement the operation of the telegraph apparatus is not perceptible on well-balanced telephone circuits. In the Hungarian telephone system the results hitherto obtained with simultaneous telegraphy and telephony in the manner above described have been excellent.

CORRESPONDENCE.

BOILER-HOUSE ECONOMIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A very interesting Paper under the above title was read by Mr. R. S. Downe at the recent I.M.E.A. Convention at Derby, and it is rather unfortunate that, despite the special interest which a Paper of this kind must necessarily have for central station engineers, the limited time available for discussion prevented more than three or four members of the Convention from speaking thereon. One of the most interesting features of Mr. Downe's Paper is the tabulated statement of the coal consumptions per unit generated in central stations in various parts of the country, an examination of which reveals the fact that stations working under apparently similar conditions as to fuel, load-factor and condensing facilities, differ in their coal consumption per unit generated by nearly 100 per cent. In the face of these facts, the claim which is so often put forward on behalf of station engineers that they "have made great progress in this special branch of steam engineering" (see closing paragraphs of Mr. Downe's Paper) seems hardly justified, and it would appear that further and more detailed inquiry into the causes of the present inefficient use of fuel would be of great benefit to an important branch of the electrical industry.

It may be that in certain cases the apparently high consumption of coal per unit generated is due rather to the unfavourable engine-room conditions than to uneconomical working in the boiler house; but, nevertheless, it is impossible to entirely absolve the boiler house from blame in the matter. In the tabulated statement previously referred to, particulars are given of the conditions prevailing at 29 central stations with load-factors varying from 10 to 28 per cent. In 13 of these stations mechanical stokers are in use, in 9 stations hand firing is used and the remainder adopt a mixed system. The average coal consumption per unit generated at those stations which depend entirely upon mechanical stoking is 7·41b., whilst the corresponding average in the case of the stations relying on hand firing only is 6·51b., a difference of about 13¼ per cent. in favour of hand firing.

These figures rather contradict the too-easily accepted theory that mechanical stokers are an infallible cure for heavy fuel bills. I have had considerable experience with both methods of firing, and have carried out experiments lasting several months with different classes of mechanical stokers, and in every case the result has shown that the machine stoker is inferior to the human variety in respect both of steam-raising capacity and economy. It is true that in large stations the adoption of mechanical stokers will somewhat reduce the wages bill; but if, in a station like Edinburgh, the maintenance of the stokers worked out to 6·68d per ton of coal consumed, the net saving must be very small indeed.

I find that at Wolverhampton the cost of hand firing is approximately 9d. per ton of coal burnt, whilst the cost of maintenance of fire-bars is practically nil, only five fire-bars having had to be replaced, at a total cost of £3, on all the boilers in the course of nearly 10 years' working. It is interesting to note that at the Willesden power station of the North Metropolitan Supply Co., which was described in your last issue, the Babcock and Wilcox boilers are to be hand-fired, although this is a type of boiler upon which mechanical stokers are supposed to give specially good results.

The bonus system for firemen, advocated by Mr. Downe, would appear likely to be productive of excellent results, but, in fairness to the men, it would be better that the basis upon which the bonus is calculated should be the pounds of water evaporated per pound of coal burnt, rather than the pounds of coal burnt per unit generated. In the latter case the firemen may be penalised by various conditions over which they have no control, such as failure or inefficiency of condensing plant or abnormal steam consumption of the generating sets.

In dealing with the question of fuel analysis, Mr. Downe refers rather unfavourably to two of the most useful adjuncts to the test room of a central station—namely, the calorimeter and ash-testing apparatus. It is possible to fit up a complete equipment for testing the calorific value and ash percentage of any sample of fuel for about £15, and it is no exaggeration to say that an apparatus of this description will, if regularly and systematically employed, effect a large saving in the fuel cost per unit generated. I have had an apparatus of this description in use for some years, and every boat-load of coal that is delivered at the boiler-house wharf is carefully sampled and tested for calorific value, and if any sample fails to come up to a certain standard, the boat from which it is taken is sent back to the colliery.

I find that this constant testing results in a steady improvement in the quality of the coal supplied, the calorific value having increased nearly 20 per cent. during the last three years, although the coal has been supplied from the same seam at the same colliery during the whole of that period.

Much has been written about the inefficiency of steam-driven auxiliary plant, with especial reference to steam feed pumps,

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but if the exhaust steam from the whole of the auxiliary plant is turned into a feed-water heater and utilised to raise the temperature of the feed water before it enters the economisers it is questionable whether a combination of this description is not actually more efficient than the more complicated and costly, and frequently less reliable, electrically-driven auxiliaries.

I feel that I have already trespassed too much on your valuable space, but I am especially anxious that the important question of the better utilisation of the raw material in central stations should be more fully discussed.—Yours, &c.,

C. E. C. SHAWFIELD,
Borough Electrical and Tramways Engineer.

Wolverhampton, Sept. 30.

LEGAL INTELLIGENCE.

Damper v. National Telephone Co.

In July last plaintiff obtained judgment in Tonbridge County Court for £10 compensation for damage done by defendants by the erection of poles on plaintiff's land at Fordcombe. At the same court, on Friday last, Mr. Barton, on behalf of defendants, asked for a new trial owing to the discovery of fresh evidence—viz., the testimony of the company's district manager (Mr. S. J. Smith) that plaintiff had consented to the erection of the poles.

At the suggestion of the judge an arrangement was arrived at, the parties agreeing to the damages being reduced to £2, with costs, the company also paying £5. 5s. towards plaintiff's costs of that application.

Tramways Amalgamation in Buenos Ayres.

In the Vacation Court on Wednesday, Mr. Justice Warrington heard an application by the City of Buenos Ayres Tramways Co. (Ltd.) and its liquidators to sanction a scheme of arrangement under the Joint Stock Companies' Arrangement Act, 1870. Counsel stated that after the sale to the Anglo-Argentine Tramways Co. had been carried out the petitioning company would hand over to the new company to be formed certain property, with instalments to be paid by the Anglo-Argentine Co. The companies owned rival systems of tramways, and the present arrangement was to enable the Buenos Ayres Co.'s lines to be electrified, when the two systems would be worked together. There was no opposition.

His Lordship sanctioned the scheme subject to the usual formalities.

Liabilities of Tramway Owners.

At Oldham County Court last week Judge Bradbury gave judgment for defendants, with costs, in an action for damages against Oldham Corporation for injuries to a girl who had, in crossing a road to enter one of defendants' cars, stepped in front of a car proceeding in the opposite direction. Judge Bradbury held that the public must themselves take precautions against such risks.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A London Borough Council require an assistant distributing engineer. See advertisement.

Second-class engineers (aged 22-24) and second-class technical officer (24-30) are required for the engineer-in-chief's department, General Post Office. Applications, on forms to be obtained from the secretary, Civil Service Commission, Burlington-gardens, London, W., by Oct. 20. See also advertisement.

A junior tester is required for calibrating electrical instruments and general factory testing. Applications to Ferranti Limited, Hollinwood, Lancs. See advertisement.

Loughborough Corporation require a switchboard attendant accustomed to three-wire system and batteries. Applications to the town clerk (Mr. Harry Perkins) by 5 p.m. Oct. 13. See advertisement.

A designing engineer, accustomed to D.C. motors, boosters, &c., is required by a leading firm of manufacturers in the North of England. See advertisement.

Pontypridd Council require a resident electrical and tramways engineer. Salary £300 per annum. Applications by Oct. 12.

A shift engineer is required at Hornsey electricity department. Applications by 15th inst.

Woolwich (London) Council require a station engineer. Applications by 17th inst.

A junior demonstrator in physics is required at University College of Wales, Aberystwyth. Applications by Oct. 15.

Applications are invited for the position of lecturer and demonstrator in electrical engineering at the school of engineering, electricity and technical science, Canterbury College, University of New Zealand. Salary £300 per annum, with saloon passage to New Zealand. Particulars of qualifications and forms of application from the Agent-General for New Zealand, 13, Victoria-street, London, S.W., to whom applications by Oct. 29.

For the position of shift engineer at Burton-on-Trent there were 52 applications, and this number was reduced to seven—viz., Messrs. J. H. Thompson (Dewsbury), W. A. Blackburn (Doncaster), E. Grime (Ealing), E. W. Haywood (Croydon), V. Horman (Brompton & Kensington Co.), W. C. Perry (Camberwell power station) and E. W. James (Eccles). Mr. Thompson was ultimately appointed, but a second vacancy for a shift engineer occurred subsequently and this appointment was given to Mr. Blackburn of Doncaster.

Mr. J. W. A. Binner has resigned his appointment as chief assistant engineer at Bermondsey (London) electricity works in consequence of having been appointed engineer to the Havana Electricity Co.

Mr. M. S. Halliwell has been appointed by the Crown Agents of the Colonies assistant electrical engineer at Lagos, West Africa.

Mr. A. J. Foord has been appointed acting foreman of electrical fitters at Chatham Dockyard.

Mr. Ambrose Wilkinson, B.Sc., of Sheffield Secondary Schools has been appointed demonstrator in physics at University College, Nottingham.

EDUCATIONAL NOTICES.

University of Glasgow.—The next session begins on Oct. 13, and continues to the end of March. After that date the students enter engineering works or offices for the six summer months, returning to the University for the next winter session. Particulars of classes and regulations for the degree of B.Sc. in engineering may be obtained from the syllabus, which will be supplied on application. The new James Watt engineering laboratories for students in civil, mechanical, electrical and mining engineering are in full working order, and are thoroughly equipped for experiment and research in most branches of engineering.

Durham College of Science (Newcastle-on-Tyne).—Courses are provided at this college for students proceeding to the degrees in Science, and special facilities are offered for the study of agriculture, chemistry, mining, engineering and naval architecture. Lectures began Oct. 4. Prospectuses from the Secretary.

Merchant Venturers' Technical College, Bristol.—Courses of instruction are given at this college in civil, mechanical and electrical engineering, chemistry, architecture and building; also for matriculation, intermediate and final B.Sc. (including engineering degree) of the University of London. In addition to the professors, the college staff includes 79 assistant lecturers, demonstrators and skilled artisans. There are 11 laboratories, eight workshops, a dynamo room, engine house and an electric light installation. The calendar (price 6d.) or short prospectus (free) may be obtained from the registrar. The former is a volume containing much interesting information concerning Merchant Venturers' College, which was established as far back as 1856.

Royal Technical Institute, Salford.—Special courses of lectures are now commencing in engineering estimates and specifications, dynamo and electrical machinery design, electrical distribution (mains and central stations), iron and steel structures, &c. Prospectuses from the director of education, Mr. Ogilvie Duthie.

An Electric Club.—We have received from Mr. W. Dalby, 187, Amberly-road, Sparkbrook, Birmingham, a communication setting out particulars of a proposal to establish an electric club for the Birmingham district, to provide a means of social and fraternal intercommunication between persons engaged in electrical pursuits in the district. Mr. Dalby informs us that the proposal has been heartily welcomed by persons engaged in the railway and postal telegraphs, the National Telephone Co., the technical schools and in electric lighting and traction and other works and offices. There is to be a meeting of sympathisers with the proposal to-morrow (Saturday) at the Colonnade Hotel, Birmingham, at 7 p.m. The title of the club will be The Electric Club. Associated in the essential preliminaries of the formation of the club are Mr. W. Dalby (Midland Railway telegraphs), Mr. M. G. Waggott (chief mechanician, G.P.O.) and Mr. W. H. Whitehouse, M.I.E.E.

Alleged False Pretences.—At the Guildhall, London, last week, Ernest Shoals, manager of the Bridge Accumulator Syndicate (Ltd.) was charged before Ald. Burnett with obtaining by false pretences a cheque for £27. 10s.. It was alleged that defendant, who was known to prosecutors (Messrs. H. Abrahams & Co.) as manager of the Bridge Syndicate, on Aug. 25 last represented that he had 500 accumulators in stock which he wanted to sell at once for cash, as the syndicate had not sufficient money to pay the men. It was agreed that 250 accumulators should be supplied on the following day, and on that understanding a cheque for £27. 10s. was handed to defendant. The accumulators were not delivered next day and had not even yet been received. For the defence it was urged that it was only a trade debt, and that prosecutors had attempted to obtain a civil debt by criminal process. Prosecutors' manager admitted receiving 42 "accumulators," which (according to the syndicate's list price) were valued at nearly £25. The Alder-

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man said no jury would convict on the evidence before him and the summons must be dismissed. Prosecutors were bound over to prosecute under the Vexatious Indictments Act.

Argentina.—The "Official Bulletin" of Aug. 31 publishes a decree authorising the Ministry of War in Buenos Ayres to obtain in Europe the machinery, apparatus and material for electric lighting and power installations in connection with the construction of new barracks.

In a dispatch from the British Consul at Buenos Ayres it is pointed out that the tramway companies in that city were originally British, but that the German interest is now predominant over four of the undertakings, including the oldest and best. These four companies own about half the tramway mileage of the city. Outside Buenos Ayres the German element does not appear to have yet got a hold of the tramway business. The tramway routes are all being gradually converted to electric lines, and large sums are being spent on this work.

Armagh.—The Council have decided to take steps to obtain a provisional electric lighting order and to erect electricity works.

Aston Arbitration Award.—The arbitrator (Mr. Robert Green, of Pritchard, Green & Co.) has issued his award in connection with the purchase by the Council of the local tramways of the City of Birmingham Tramways Co. The amount awarded is £26,045, with interest at 4 per cent. per annum from Jan. 1, 1904, the Council taking the profits of the undertaking as from that date.

Ayr.—The accounts of the electricity department for the year ended May 15 show capital expenditure £87,525, an increase of £4,015 on the year.

Revenue amounted to £11,257. 18s. 7d., an increase of £647. 7s. 8d. Expenditure was £5,807. 19s. 5d., decrease £76. 2s. 8d. Interest and sinking fund absorbed £4,822. 4s. 2d., leaving gross profit £627. 15s., increase £326. 19s. 11d. Works cost was 1·030d. per unit, against 1·117d. in 1903, the total costs being 1·329d. and 1·375d. respectively. The number of units sold was 1,047,781, including 277,601 for private lighting, 430,864 for public lighting, 15,159 for power and 324,157 for traction. The maximum load was 528kw. Motors equivalent to 64·8 H.P. were connected to the mains.

Barking.—In reply to the Council's inquiry as to how the deficit in the electricity undertaking (the subject of the recently-remitted surcharge of £2,223) should be dealt with, the Local Government Board state that they have no power to sanction the raising of the amount by rate or loan.

The electrical engineer (Mr. A. H. Seabrook) has reported to the Council that the output of the electricitry works from April to August inclusive exceeded that of the corresponding period of last year by 41 per cent. The revenue of the light railways was increasing and the loss upon them decreasing.

The Council has authorised the preparation of an estimate of cost, &c., of railway extensions, with a view to obtaining a light railway extension order.

It has been provisionally agreed that for the next three years Ilford Council shall pay, in respect of the privilege of running their tramcars over the Barking lines, such rent as would pay interest and repay in 21 years the capital spent on track construction and equipment, current to be taken from Barking Council at 1½d. per unit, Ilford to pay Barking a small proportion of any profits earned by their cars on the Barking lines, and Barking to make good any loss in the same proportion.

Barrow-in-Furness.—Owing to the increasing demand for electricity for lighting and power the Electricity committee are considering a recommendation of the borough electrical engineer (Mr. H. R. Burnett) to put down additional generating plant.

Bath.—Bath Electric Tramways (Ltd.) are considering the question of introducing motor vehicles on certain of their routes.

Beckenham.—The Crystal Palace District Electric Supply Co. have sent in their formal claim, amounting to £7,897. 12s. for the purchase by the Council of so much of the company's undertaking as lies within the area of the Beckenham Council. The electrical engineer (Mr. A. J. Hedgcock) has been instructed to report upon the claim.

Belfast.—The Tramways committee have decided that it shall be a condition in the specification for the new tramways that all goods shall be of British manufacture.

Bermondsey (London).—The Electricity committee reported on Tuesday to the Council that the laying of the cables through the Surrey and Lavender docks had been completed. The material difficulties encountered in crossing the locks with the feeder cables were increased by the attitude of the Dock Company's engineer, the result being that the contract price with the British Insulated & Helsby Cables was increased from £670. 0s. 10d. to £2,644. 8s. 6d.

The committee further reported that the whole of the public lighting of Rotherhithe had been completed.

The report was adopted.

Bexhill.—The expenditure of the electricity supply department for the ensuing half-year is estimated at £4,289 and the receipts at £4,109.

Birmingham.—The new Corporation tramways bill will seek authority for the expenditure of £1,000,000. This includes the cost of the proposed Harborne tramways.

Bournemouth.—The Corporation's electric tramways are shortly to be extended to Christchurch.

Bury.—The General Purposes committee recommend the extension of the Corporation's electric tramways to the borough boundary on the Bolton-road, Limefield and Jericho routes, to meet the projected extension of the Bolton tramways, which in turn connect with the Liverpool system.

China.—In a report upon the foreign trade of China for 1903, Mr. J. W. Jamieson, H.M. Commercial Attaché at Peking, states that the value of imports of electrical materials and fittings was £51,385. No figures are available for previous years.

Chorley.—The Council have resolved to transfer their provisional electric lighting order to Mr. O. Hansom on payment of £384 and half the cost of preparing the formal transfer.

Customs Decisions.—By recent decisions of the Department of Trade and Customs of the Australian Commonwealth, the duty on electro-medical batteries has been fixed as for "electrical machinery and appliances" at 12½ per cent. ad val. Rheostats not an integral part of electrical appliances or machines are admitted as "electrical materials," free of duty. Pipe fittings, or tubing, or conduit, in cast iron or malleable cast steel, whether plain, screwed, insulated or uninsulated, up to 2in. internal diameter, is classed as "electrical machinery and appliances," and bears a duty of 12½ per cent. ad val.

Dartford.—The Board of Trade have refused to grant the District Council an electric lighting licence for supply of current to Wilmington.

Devonport.—The Electric Power committee have agreed to lay mains to supply current to Stoke High School, the Royal British Fema'e Orphan Asylum and other customers in their vicinity. With regard to the proposed additions to the generating plant at Stonehouse electricity works (at an estimated cost of between £7,000 and £10,000), the deputation who have recently inspected various steam engines and turbines at the makers' works have reported against the adoption of turbines.

Dover.—The minutes of the Electricity committee on Tuesday referred to the report prepared by the electrical engineer (Mr. L. W. Woodman) on the wiring of premises on the hire-purchase system.

Alternative schemes were submitted under which the Corporation would get one or more electrical contractors to wire premises at a fixed price per light, and select standard types of fittings to be included in the wiring schedule. Alternative prices were given for wiring, also estimates of quarterly payments extending over three, five or 10 years, and instalment system for larger properties. A copy of the report has been forwarded to the Local Government Board, and a canvass is to be made of householders.

Dublin.—The discussion of electric lighting matters occupied the attention of members of the Corporation on Monday.

The chairman of the Lighting committee (Mr. IRWIN) moved the suspension of the standing orders to allow of the consideration of a report recommending application for sanction to a supplemental loan of £1,000 for the supply of electrical energy to the old electric lighting area. He said it would be seen from the report that Mr. Ruddle's statements had been borne out by what was contained in the reports issued by Mr. Hammond. There was another report which would come up for consideration at the first meeting in November which contained much contentious matter, and he suggested that any discussion as to Mr. Hammond's position be postponed. A Local Government Board inquiry was to be held on the 18th inst., and the committee did not desire any squabble as to the merits or demerits of Mr. Hammond, until they obtained their loan of £21,000, to which they were already committed.

The motion for the suspension of the standing orders having been carried, Mr. IRWIN moved the adoption of the report. The work they proposed to do was of a very urgent character. Mr. Hammond had undertaken to increase the carrying capacity of the old single-phase lines by 50 per cent. Nothing had, however, yet been done as to the area as a whole. At present they wished only to make provision for getting over their difficulties for the coming winter. The question of completely overhauling the old area must, however, be faced very soon. All the mains in the old area were overloaded, and the three-phase mains which it was proposed in the report to lay were urgently required.

Ald. REIGH said he thought the present report should be approved on the understanding that Mr. Ruddle confined himself strictly to carrying out what was absolutely necessary for the purpose of continuing the winter supply of electricity.

Ald. IRELAND said it was absolutely necessary the work should be carried out. With regard to electric lighting matters generally, one of two things must happen—they must either carry out Mr. Hammond's proposals or those of Mr. Ruddle. According to Mr. Ruddle an expenditure of about £25,000 would be necessary before the electric lighting of the city would be in proper order.

Mr. HARRINGTON said that the work it was now proposed to do was portion of the work which, in his opinion, Mr. Hammond was entitled to carry out. By proceeding as at present proposed, the Council might be

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landed in a loss, whereas no harm could be done by postponing the passage of the report for a month. To do that work in the absence of their consulting engineer, without submitting it to him or asking his advice, was the worst way of smoothing over difficulties. The consulting engineer had his agreement with them to carry out the scheme and any works dependent on it. He was quite certain Mr. Hammond was clever enough to be able to see his advantage. It was entirely wrong for the Council to pronounce on the matter at such short notice.

Ald. COLE considered it would be better to postpone the matter for the opinion of Mr. Hammond.

In reply, Mr. IRWIN said the committee had no desire to condemn one of their engineers and uphold the other. Mr. Hammond made certain proposals which he admitted were of a tentative nature, and merely to tide them over the present winter. Mr. Ruddle said he did not consider Mr. Hammond's plan the best one under the circumstances, but something must be done if they were going to maintain the lighting of the city and escape penalties. The committee, having considered both reports carefully, were of opinion that Mr. Hammond's suggestion should be carried out. In Mr. Hammond's words, this suggestion was :—"As regards the carrying out of the work, I recommend that the new cable be ordered from the British Insulated & Helsby Cables under their contract, but that the laying should be carried out by the mains staff." The committee's recommendation was that they be empowered to forthwith carry out under the directions of the city electrical engineer the whole or such portions of the work as was proposed by Mr. Hammond, without having to employ any more expensive clerks of works, and that they be authorised to apply to the Local Government Board for the loan set forth in Mr. Hammond's report. The question of whether Mr. Hammond was entitled to 5 or 50 per cent. on the job was one that the committee did not consider. If he was entitled to a percentage he would get it. They could not in October or November start a large system of opening streets that would upset the public before Christmas. By the original scheme, for which Mr. Hammond was responsible, it was declared that for £254,500 he would carry out certain works, and deal with the old area. He would, he said, utilise the present site and system of mains, increasing the carrying capacity of the mains by 50 per cent. He had not done so, and the scheme had cost over £300,000. The question of the old area had drifted on, involving further expense, and nothing had been done to deal drastically with it.

The report was adopted by 42 votes to 14.

Subsequently Mr. IRWIN moved the adoption of a report of the Public Health committee, which stated that, previous to the termination of Mr. Hammond's period of supervision, he had, in conjunction with the chairman of the Lighting committee, the secretary and the city electrical engineer, and in accordance with the arrangement made at the time of the provisional appointment of the electrical staff, considered their position at the close of their temporary engagement, and fixed their positions and rate of remuneration, the appointments to be subject to a month's notice. After a brief discussion this report was referred back to the Lighting committee.

An inquiry will be held on the 18th inst. into the application of the Corporation for permission to borrow, among other sums, £21,000 for electric lighting extensions.

Dumbarton (County).—The Caledonian Water Power Electricity Co. have asked the County Council for 50 years' wayleave for their cables. A sub-committee on Monday reported unfavourably, taking exception to the length of the term, and were instructed by the Council to continue negotiations.

The County Council themselves propose to apply for electric lighting and tramway orders, but the Road board advised the Council not to apply for lighting orders at present, and are also of opinion that there is no demand for tramways, except, perhaps, between Clydebank, Duntocher and Dumbarton, and between Dumbarton and Balloch.

The report was adopted.

Dundee.—The question of making provision for stand-by supply in the case of consumers having independent generating plant has been reported upon by the city electrical engineer (Mr. H. Richardson) who advises the Corporation to

Have a clause included in a Corporation order to the effect that no person should be entitled to demand or to continue to receive from the Corporation a supply of electric energy to premises having a separate supply unless they had previously agreed to pay to the Corporation such a minimum annual sum as would give the Corporation a reasonable return on the capital expenditure and other standing charges incurred by the Corporation to meet the possible maximum demands of such persons. As regarded minimum charges, Mr. Richardson finds that a charge of £7 per kilowatt per annum was the general one.

The Tramway committee on Tuesday had before them a report by Mr. Richardson on recent breakdowns in the supply of current and it was decided, on Mr. Richardson's recommendation, to discard copper strip and to substitute modern cables at an estimated cost of about £3,000.

Dunfermline.—The Fife Electric Power Co. expect to be able to give supply of electric current by the end of November.

Dungannon.—The Council have applied for an extension of 12 months in which to comply with the terms of their provisional electric lighting order, 1901.

Durham.—A conference has been held here to consider the advisability of promoting an electric power scheme by the County Council, or jointly with other local authorities in the county.

Mr. JOSEPH BRUCE, who presided over a good attendance, said the county had been invaded by companies to the extent of one-fifth of the area. They had captured about one-third of the rateable value and nearly one-half of the population, but there yet remained a large field for the development of a public scheme.

Mr. JOSEPH HOPPER, who organised the conference, said it was proposed to draw up a plan of municipal campaign in order to secure for the common service of the county the great advantages of electricity supply.

A resolution was adopted urging local bodies to withhold their support from private promoters pending the development of a public scheme.

Edmonton.—Four offers have been received by the District Council for the transfer of the Edmonton Provisional Order, 1902, and for the supply of electricity in the district. On the consideration of these tenders a section of the members will endeavour to get the Council to commit itself to a municipal scheme.

Electricity in Mining.—At the meeting of the Dunderland Iron Ore Co. the chairman (Sir David Dale, Bart.) stated that the power station building was completed. The boilers were erected and the erection of the engines and generators was rapidly proceeding. All the engines and generators were on the site. The station had a capacity of 3,500kw. All motors, &c., on order (to the number of 84) had been delivered and erection was proceeding. They were engaged in fitting up a temporary electric lighting station, so that they would be able to push the erection of machinery, &c., during the coming dark months. The overhead cables would be carried on poles. At Guldsmedvik they had commenced operations on the briquetting plant. The foundations for the power house were completed, as were also the engine and boiler foundations. Erection of the boilers, engines and generators would be commenced at once, as they were all on the site. The capacity of this plant would be 1,575kw.

Ellon (Scotland)—The advisability of erecting electricity works will be a "plank" at the approaching municipal elections. The local gas company have presented their works to the Council, but as it will cost £1,000 to put these works in order and make a necessary extension of the mains to Auchter-Ellon, the alternative of establishing electricity supply is under consideration. Dollar electricity undertaking is the model upon which it is proposed to work, and a small gas-driven plant, with overhead wires, will probably be put down. The initial cost is estimated at £3,000, the annual total cost at £291 and the net annual profit at £49.

Exeter.—Mr. H. D. Munro (city electrical engineer) reports that interruptions in the supply of electricity to some consumers occurred on Sept. 10 and 16 as a result of excavations by the telephone and gas companies and the water department. Mr. Munro intends to guard to some extent against similar troubles in future by duplicating the cables in the main streets where possible.

Exhibitions—We would remind our readers that an interesting exhibition opens on Monday at the Baths, Pitfield-street, Hoxton, London, N., under the auspices of Shoreditch (London) Borough Council. The exhibition will be opened by the mayor, Mr. H. B. Bird, J.P., at 4 p.m. Mr. C. Newton Russell, the borough electrical engineer, has, we understand, received an excellent response to his invitations, and the exhibition promises to be of more than usual extent and importance, due mainly to the fact that the opportunities for the application of electricity to industrial purposes in the Shoreditch district are more numerous than in most of the London areas.

An exhibition of electrical plant, promoted by the Corporation with a view to stimulating the demands for electric energy for lighting and motive power, was opened at Ilkeston on Monday by the mayor (Ald. C. Maltby).

Lord Armstong opened, at St. Ann's Parish Hall, Newcastle-on-Tyne, on Monday, an industrial exhibition, which included exhibits of electrical plant and apparatus.

Felixstowe.—At a special meeting of the Council last week the Lighting committee recommended the sealing of an agreement for the purchase of the Suffolk Electricity Supply Co.'s Felixstowe undertaking and the working of the same by the company for a term of years, without prejudice to the Council's rights in respect of certain undisclosed covenants, and providing that the company indemnify the Council in respect of any adverse consequences resulting therefrom. The proposal was adopted.

Fenton.—The Council will apply for an extension of time to carry out the terms of their provisional electric lighting order, 1899. Electricity in bulk is to be taken from the North-Western Electricity & Power Gas Co.

Frome.—The Council have asked the Prudential Assurance Co. to loan them £15,000 at 4 per cent. for electricity supply extensions.

Halifax.—The borough electrical engineer (Mr. W. M. Rogerson) was recently offered by a London company an important appointment at £700 per annum, and in order to induce him to remain at Halifax the Electricity committee recommend that the salary of Mr. Rogerson be advanced from £400 to £500 per annum on Jan. 1

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next, with further advances of £50 per annum on Jan. 1, 1906, and Jan. 1, 1907, subject to Mr. Rogerson entering into an agreement to remain in the service of the Corporation for three years from Jan. 1, 1905.

Hammersmith (London).—On Wednesday it was reported that there are 1,502 consumers on the electricity department's books.

Inquest.—At Formby on Saturday last an inquest was held on the body of a reservist named Nolan, who was killed on the previous day at Hall-road, near Formby, on the Liverpool-Southport section of the L. & Y. Railway.

A lad named Harwood gave evidence that he saw Nolan on the live rail of the electric railway. He and another lad did all they could to try and prevent trains from coming up. There was a stone wall (6ft. high) and a gate, over which Nolan had to climb to reach the railway. The spot where Nolan climbed was a long way off the point which would be used by passengers in the ordinary way. Deceased had been told not to go on the line. When he and his companion first saw Nolan he was kicking and writhing and shouting out. A baggage car came from Liverpool, and witness managed to stop the car within 30yds. The men on this car took deceased off the live rail. Artificial respiration was resorted to, but without avail.

Dr. F. Carter said when he was called death had ensued. There was a burn on deceased, and the cause of death was shock and heart failure, due to electric shock.

A verdict to this effect was returned.

Islington (London).—The Council have approved a recommendation of the Lighting committee to substitute combined feeder pillars and arc lamp columns in certain thoroughfares. 12 of these combined pillars are to be supplied by the British Insulated & Helsby Cables (Ltd.) at £77. 5s. each; total £927. The committee also recommend extensions to mains at an estimated cost of £200.

The Finance committee recommend that £30,000 now required for electricity supply extensions and other purposes be raised by means of small short-term mortgages. The idea is that a good portion of the loan will be taken up locally.

Italy.—The Italian Ministry of Posts and Telegraphs have received legislative authority to establish telephonic communication between Brescia and Bergamo, Lecco and Bergamo, Cremona and Piacenza, Genoa, Pisa and Leghorn; Naples, Foggia and Barletta; Naples, Reggio, Calabria and Messina.

The municipal authorities of Rome propose to build an electric railway between the city of Rome and Civita Castellana.

The Venetian municipal authorities have decided to purchase a number of electric launches for use on the city's canals.

The Adriatic Railway Co. has under consideration the building of an electric route from Chiasso to Como and Chiavenna.

Kent and Sussex Tramway Project.—A bill will be introduced next session to authorise the construction of electric tramways between Ramsgate, Dover, Folkestone, Littlestone and Hastings.

King's Norton.—A provisional order is to be applied for by the Council to authorise the construction of an additional tramway route.

Lancaster.—Mr. James Heald, electrical engineer, has acceded to the unanimous request of the members of the Council to accept the mayoralty for the ensuing year. Mr Heald is chairman of the Electricity committee and holds other important local appointments.

Leeds.—The Corporation will apply for a provisional order to authorise the construction of two new tramway routes.

Leigh (Lancs.).—The Council have decided to proceed with extensions at the electricity works without waiting for formal sanction to a loan.

Leith.—The sub-committee who recently inspected certain electric tramways in England and Scotland recommend the overhead electric system as most suitable for the Leith tramways on the ground of economy, and for the further reason that the conduit and surface-contact systems increase the liability of horses to slip.

A sub-committee has been charged with the work of re-constructing and equipping the tramways as far as possible by the town's department. The scheme is being carried out by Mr. Rutherford, burgh electrical engineer, Mr. Findlay, burgh surveyor, with Mr. More, C.E., as consulting engineer.

Light Railways.—The Board of Trade have confirmed the Tickhill and the Brackenhill Light Railway (Extension of Time) Orders.

Liverpool.—It has been decided to promote a bill to authorise the construction by the Corporation of additional tramways in ootle and Liverpool.

London County Council.—At Tuesday's meeting (the first after the recess) the Finance committee reported that the estimate of further sums required for tramway purposes to Dec. 31 next was £153,000. This estimate was approved of.

Mr. Collins said a great number of motor omnibuses were being placed on the roads, and he thought they should seriously consider whether it would not be wise to stop the expenditure on tramways.

Mr. A. Baker said they did not look upon motor 'buses as serious rivals. The Council could generate their electricity and work so much cheaper than the 'buses.

London, Camberwell and Dulwich Tramways.—The Highways committee submitted an estimate of £6,600 for the purchase of the above tramways.—Agreed.

Mr. Baker said the Highways committee had visited Bermondsey and Rotherhithe with reference to the electrification of the tramways. They found the roads very narrow. The matter under consideration.

The late South London Tramways Co.'s Undertaking.—The Highways committee reported that no definite conclusion had been come to as to the system of electric traction to be adopted on the lines formerly belonging to the South London Tramways Co, but in view of the fact that whether an underground or an overhead system of traction be adopted, plant, machinery, car sheds, &c., would have to be provided, they recommend that the Council should purchase certain freehold interests at a cost of £1,825.

Free Fares for School Children.—A debate took place on a motion of Mr. Sanders to give free rides to school parties attending the Council's parks and other institutions for educational purposes, but the motion was withdrawn on the understanding that the matter would come before the Education committee.

Reduced Fares for Clerks, &c.—A motion by Dr. Cooper to the effect that the committee consider the question of granting workmen's fares for clerks and women travelling on the Council's cars before 9 a.m. was defeated, Mr. Allen Baker stating that, in the existing state of the tramway business, further facilities for workmen were impossible.

Linking up the Tramways.—It was referred to the Highways committee to report upon a scheme to be brought before Parliament next session for joining up the Council's tramways at Blackfriars and Westminster Bridges by means of tramways over the bridges and along the Victoria Embankment.

Lowestoft.—An inquiry was held here on Wednesday into the application of the Council for power to borrow £3,600 for acquiring property for extensions to the electricity station

Maidstone.—The Council have decided to apply for a light railway order to construct two additional electric tramway routes, and the consulting engineer (Mr. Stephen Sellon) has been instructed to prepare specification and estimates.

Manchester.—On Wednesday the Corporation authorised the construction of tramways on certain roads in the areas of the Bucklow Rural and Cheadle and Gatley Urban District Councils.

On the presentation of the minutes of the Electricity committee, the deputy chairman (Mr. Hesketh) protested against the assumption that the fire at St. Chrysostom's church on the previous Saturday night was in any way due to a defect in the electric installation.

It had been suggested (said Mr. Hesketh) that the fire was caused by the fusing of electric wires, but the suggestion was not true. Wiring installations were always inspected by competent men before supply was given, and that was done in the case of the church. The installation was examined on Saturday, and was found to be in perfect condition. The current was switched off at seven o'clock, and the fire broke out at 20 minutes past 11. Under those circumstances he felt certain the fire could not have been caused by any defect in the installation.

Melrose (Scotland).—The Council have made arrangements with the Electric Supply Corpn. for lighting the principal streets electrically.

Municipal Telephony.—On Wednesday an inquiry was held at Swansea into the application of the Corporation for sanction to borrow £2,000 for telephone extensions.

The town clerk (Mr. J. Thomas) appeared in support of the application and Mr. Denman Benson opposed on behalf of some local firms.

Mr. Thomas explained that the Corporation had expended £19,158.19s.4d., leaving £1.447. 0s. 8d. unexpended. There were 176 further applications for connections, and it was with regard to these that the £2,000 was required.

The consulting engineer (Mr. A. R. Bennett) said the total length of junction lines erected was 13¼ miles, leaving 18¾ miles still to do, the estimated cost of which was £1,009. Against that they had, with plant unused, £2,230. 16s. 6d. Within the borough, instead of the 750 lines originally contemplated, 1,006 were now working. Deducting the capital still unexpended and the value of the material in hand, it was found that the 1,006 lines had cost £15,769. 3s. 7d. (£15. 14s. 6d. each), and, including cost of building the exchange and offices, which was not in the original estimate, the line cost came to £18. 0s. 2d. When the junction lines were completed individual subscribers would have to be joined up, and then extra money would be required. But at the same time revenue would be increasing.

Mr. Benson submitted that a number of subscribers had only agreed to join on the undertaking that there should be inter-communication, and that a large portion of the revenue would, consequently, be irrecoverable.

Mr. Bennett said that at present only 22 subscribers held out.

The borough accountant (Mr. Hopton) said the revenue was nearly £4,000.

The inquiry was then concluded.

The municipal telephone exchange system of the Hull Corporation has been connected with the trunk telephone service of the country as from 3rd inst.

Bournemouth Corporation decided on Wednesday to apply to the Postmaster-General for a licence to establish a municipal telephone service.

Natal.—In a report from Natal of the imports from France, Germany and the United States for the first half-year of 1904, elec-

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trical machinery stands for £20,000, of which Germany supplied £10,000, United States £9,000 and France £1,000. Electrical fittings stand for £4,000, of which Germany supplied £3,000 and the U.S. £1,000.

Newcastle-on-Tyne.—The estimates of the income and expenditure of the Tramways committee for the year ending March, 1905, were again presented to the City Council on Friday last.

The committee recommended that last year's surplus should form the nucleus of a depreciation fund. It was hoped by a thorough revision of the whole system to considerably augment the renewal fund year by year. There appeared to have been no previous provision made for depreciation, as required by a section of the Newcastle-upon-Tyne Tramways and Improvement Act, 1899.

The Chairman (Ald. Baxter Ellis) said that considerable delay had occurred owing to the resignation of the chairman of the committee (Mr. Cail) which took place at the time when the estimates were under discussion. Several mistakes were found, and a special committee was appointed to go into the matter. They decided not to send the estimates in the usual way to the Finance committee until the actual result of last year's working had been ascertained. The estimates included a total estimated income for 1904–5 of £209,700, less £3,300 reduction in connection with workmen's fares, or £206,400. The estimated expenditure was £189,125, leaving a gross profit of £67,275. Interest and redemption required £64,734, leaving an estimated balance of £2,541. The committee had agreed that this should form the nucleus of a depreciation fund. He admitted sorrowfully that that was a small and a very unsatisfactory amount to commence with to lay on one side for that purpose. The estimated total expenditure (£139,125) was, in the opinion of the committee, far too high, and the committee had determined that the amount should and must be reduced. A special reorganisation committee had been appointed. They had already had two meetings, with the result that the staff had been reduced and a saving to the extent of over £3,000 per year effected. They had every expectation that that amount might be increased at least four-fold. They had decided to retain only a sufficient staff to do their own repairs in their own car sheds. When there was not sufficient employment for those men they were to be employed upon building new cars to the extent required. They had also appointed a special committee to go into the question of fares, fare stages and other matters, to see how it was possible to increase their income. That was absolutely necessary. He thought the small balance last year was due to the enormous expenditure in maintenance. This expenditure amounted to £28,099, whilst the amount for the previous year was only £13,608. Another cause was the large amount for interest and redemption, being £64,734 this year, against £51,534 last year. That increase was a distinct proof that their system had been seriously over-capitalised. In 1903 they paid £23,414. 5s. 6d. for interest, and £19,445. 11s. 1d. for redemption, making £42,859. 16s. 7d. In 1904 they paid £28,896. 9s. 4d. for interest, and £22,638. 3s. 8d. for redemption, making £51,534. 4s. They had had to pay back to the Finance committee £21,278. 0s. 11d. for interest and redemption during construction. That enormous increase in maintenance was never provided for in their estimates. They spent £4,500 in purchasing anchors to anchor down their lines. He had failed to trace any order either of the committee or the Council for those. As they all knew, a standing order of the Council was that no committee should spend £100 or more not provided in their estimates without the sanction of the Council. Strange to say, at the same time that that was done, the work of track maintenance, which had been laid down chiefly by Mr. Edge and Mr. Laws, was transferred from the city engineer to the tramways department, and since then the work had been done by that department. They knew nothing of that. The committee had now decided to hand back the work to the city engineer, feeling that the department having the responsibility of laying down the track should have the responsibility of maintaining it. Of course, Mr. Edge would have to do that work for the Tramways committee, and he would have to send in his estimates every year. They had also found that there had not been one single farthing paid for rent to the Estate and Property committee for the land for the car sheds, &c., up to the present time. A satisfactory arrangement had been arrived at, and the whole back rent had been paid. They had also provided for that portion of rent coming against them during the present year. They had also never paid anything towards auditors' fees from the commencement until a few weeks ago. Those were now paid. They made provision to the extent of £3,105 in their estimates for income tax, but they did not understand that matter. He always understood that income was paid upon the amount of money made. If that were the case, it seemed a serious item to debit £3,105 to meet that demand. With respect to depreciation, it would, he thought, be urged that they ought to provide something like £24,700 for that purpose. The question to determine was how and when was that to be done. Were they to begin doing that before the system was complete and in full working order? If it had to be done, it could only be done by levying a rate of 2d. in the £. That was all they had the power under the Act of Parliament to levy. That would only raise a little over £11,000. The balance could be raised by increasing the fares, but it could also be done by reducing their working expenses, so that their rev nue should as nearly as possible meet their expenditure. That was the Council's first attempt at municipalisation. The tramway system was born of the people, in the best interests of the people, and he could not believe that those who had done so much to bring the system into existence would do anything to destroy it. It was necessary that the system should be put on a sound commercial basis, and the committee asked for the confidence of the Council in their proposals.

Mr. Cail gave an account of the action of the Tramways committee, and showed that the question of depreciation was several times considered in committee. They ought to have a reserve fund in cash to pay for renewals of track when needed. Their money was borrowed for 30 years, and until the whole of the loan was paid off they could not borrow again. The only way to get the money was to build up a reserve. It was imperative, indeed, that the track should be made now to pay enough to form a reserve fund to keep it in repair. As to electrical equipment, the general manager estimated that in eight years they would require £119,000 to renew it. As they could not borrow again until they had paid off the present loan, they must have money in hard cash to renew those depreciations when required. He pointed out how they might largely increase their revenue by higher fares, by fewer workmen's cars, and by carrying parcels. He denied that anything was done without the knowledge of the Council.

Ultimately it was agreed that the question of depreciation should be referred back to the committee for four months, when the committee is to bring forward a definite report.

North London Tramways.—Delegates are to be sent by Bethnal Green Council to the conference convened for next month by London County Council to discuss the proposed electrification of the northern tramways.

North-South Shields Electric Railway.—South Shields Improvement committee have authorised the sinking of a bore-hole at Mile End Old-road in connection with the construction of this railway.

Obituary.—The death recently occurred of Mr. William Digby, one of the promoters of the Madras electric tramways scheme, and chairman of the original Madras Electric Tramway Co.

The death is also announced of Mr. Henry C. Payne, Postmaster-General of the United States, in his sixty-first year. Mr. Payne was connected with several railway, electrical and telegraph companies, and was appointed Postmaster-General in 1902.

Oulton Broad.—Some time ago Messrs. Barber and Croft intimated their intention to apply for a provisional electric lighting order. Thereupon a special meeting of the Council was convened to authorise a municipal application being made. But the Council, not being anxious to proceed, approached Messrs. Barber and Croft, and suggested that neither party should apply.

At the meeting of the Council on Wednesday the clerk said an agreement had been concluded between the parties which provides that for five years from Sept. 30 ult. neither the Council nor the firm, without the written consent of the other party, should make application for an order unless in the meantime some other person or corporation should give notice to the Council of their intention to apply or should have made application for an order for any part of the district, and if such other application should be made the Council will not give its consent nor assist such application.

Peru.—The electric tramway between Lima and Chorrillos is now open for traffic, and the work on the electric line between Lima and Callao is far advanced.

Phœnix Fire Office Rules.—The 34th edition of these rules (first issued in February, 1882) have just been issued.

Pontypridd.—At their meeting on Tuesday the Council decided to agree to pay the reduced price of £5,500 asked by the British Electric Traction Co. for the tramway between Pontypridd and Hafod. Sir Colin Scott Moncrieff, who has been appointed arbitrator in this matter, will not now be required to officiate. The Council propose to reconstruct the line for electric traction.

Poplar (London).—The Electricity committee have decided that in future all contractors doing work for the department must pay their carmen a minimum wage of 5s. per day.

Provisional Order Revocation.—The Board of Trade have revoked the Handsworth (Yorks.) Electric Lighting Order, 1901.

Pudsey.—An agreement has been entered into between the Corporation and the Yorkshire Electric Power Co. for a supply of electricity in bulk for 15 years at a price not to exceed 1·8d. per unit for three years, "the current to be transformed into continuous current and delivered at some place selected by the Corporation in the centre of the town." At the end of 10 years the Council may ask for a revision of charges, but the company cannot make an increased charge. The company guarantee supply of electricity in January next, and the Council have undertaken that they will be ready to take it by the end of April.

Ravensthorpe.—The Council, who have entered into an agreement with the Yorkshire Electric Power Co. for the supply of electricity in bulk, have decided to apply for a provisional electric lighting order.

Reciprocating Engines v. Turbines.—At the meeting of the Metropolitan Asylums Board on Saturday, the Training Ship committee recommended the use of steam engines for the electric generating plant for the new ship instead of steam turbines, as originally intended.

The report stated that the naval architects had informed the committee that, having lately fitted two new steamers, in one of which the electric lighting plant consisted of two sets of reciprocating engines and dynamos, and in the other of two sets of turbine dynamos, they were now better able to give a definite opinion on the relative merits of the two systems. They found the results were not favourable to turbines, as, although they were free from vibration, they were not silent. The high speed at which

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they were driven caused a disagreeable sound, which could be heard some distance away. Reciprocating engines worked very well, being free from both vibration and noise, and, therefore, they strongly urged the adoption of reciprocating engines for the new ship. The captain-superintendent had also visited the two new ships, and as his report was entirely in favour of reciprocating engines, the committee authorised the adoption of that type of engine, and had given the necessary directions to Messrs. Vickers, Sons & Maxim, with whom the order for the plant had been placed.

The report was adopted.

Rio de Janeiro.—There have been many rumours of late concerning electrical development in Rio de Janeiro, and we may call attention to a report by Mr. Vice-Consul Rhind on the trade of the Rio de Janeiro district for 1903, which has just been published (price 3½d. post free). There is much in the report that will interest manufacturing firms in all branches of industry.

Electric traction is now employed on all the more important sections of the Rio tramways, and recently a concession was granted for the construction and working of a subterranean electric railway between Rio and Nictheroy, on the opposite side of Rio Bay. A concession has also been recently granted for a railway line on the same electric system between Rio and Petropolis.

Ripon.—The Council have obtained an extension until March 31 to carry out the terms of their electric lighting order, 1901.

Royal Parks Lighting.—In connection with the scheme for the electric lighting of St. James' Park, Green Park, &c., a sub-station has been constructed in the Green Park by the Charing Cross & Strand Electricity Supply Corpn.

Rotherham.—On Wednesday the heads of an agreement with Sheffield Corporation for through tramway traffic between Sheffield and Rotherham were approved.

Russian Railway Enterprise.—It is stated that a project is on foot to construct a funicular railway, 23 versts (about 16 miles) in length, to be worked by electricity, on the line which connects European Russia with Trans-Caucasia. This is intended to supersede a mountainous section of the existing Kars line, and will, if constructed, be the first funicular railway in Russia.

Southampton.—The auditors (Messrs. Cash, Stone & Co.) appointed by the Corporation to audit the accounts have presented their report, which says—

That both in the tramway and electric light undertakings reserve and renewal funds are absolutely necessary, as in both cases the auditors believe substantial sums will have to be expended on large renewals long before the statutory sinking fund will have provided for the amount of the original expenditure. The sum standing to credit of tramway depreciation and renewal fund is £7,289. 3s. 5d., and this is considered quite inadequate, and the Corporation are advised that no further sum in aid of rates should be appropriated until a sufficient sum has been placed to renewal fund to provide for all reasonable renewal expenditure which is likely to be required in the next four or five years The amount of the electric light depreciation and renewal fund is £1,410. 0s. 8d., and is also considered inadequate. The auditors remark, however, a relatively large sum in respect of capital expenditure has been, during the last financial year, provided from revenue, and that no appropriation in aid of rates has been made, so that they hesitate to say that proper provision has not, in fact, been made during that year, but they recommend that the renewal fund should in this department also be increased so as to cover all large renewals during the next four or five years.

Spain.—A concession has been granted to Don Francisco Alfonso y Goñe for the construction of an electric tramway in Bilbao.

Sutton Coldfield.—On Wednesday the Council authorised the erection of additional plant at the generating station at an estimated cost of £3,800.

The Telephone on the Continent.—Mr. Herbert Laws Webb spent the holiday season in visiting the new common battery telephone systems of Budapest, Moscow, Warsaw and St. Petersburg, and found that the Budapest exchange was rebuilt last year and now occupies one of the finest telephone buildings in Europe. In the three great Russian cities the new systems which have been in course of construction for the past two years are just now beginning operations. In each case complete new plants have been provided, comprising the most modern devices in switchboard equipment and extensive systems of underground service. Mr. Webb also visited Christiania, Stockholm and Vienna, and everywhere found telephonic development making steady progress.

Walthamstow.—The accounts of the electricity department for the year ended March 31 show total capital expended £112,474. 11s., an increase of £36,953. 7s. 6d. on the year.

The amount sanctioned is £100,653 and the amount borrowed £99,562. The annual revenue was £13,171. 16s. 8d., and the total expenditure £4,662. 17s. After paying interest (£3,003. 8s. 6d.), sinking fund (£2,504. 17s. 7d.) and crediting £3,083. 10s. 1d. from last account, the balance (£3,000. 13s. 7d.) was applied to local rate. 1,019,326 units were generated, 601,404 were supplied to private consumers and 212,787 to the public lamps (94 arcs and 1,281 8 c.p. incandescents). The total maximum supply demanded was 600kw.

The total amount handed over to relief of rates from the commencement of supply is £6,007, equal to a rate of over 4½d. Reductions in charge for current for both public and private lighting took place during the past year.

Wednesbury.—Sanction has been received to a loan of £465 for the electric lighting of the town hall, municipal offices, &c.

West Fife.—A company is to be formed for promoting an extensive tramway scheme for West Fife, including lines from Dunfermline to Lochgelly via Crossgates, Cowdenbeath, and Lumphinnans; (2) from the junction at Lumphinnans to Oakfield, Kelty; and (3) from Dunfermline to Inverkeithing via Hospitalfield. The county surveyor has been instructed to report upon the project.

Wexford.—Efforts are being made to form a company for the erection and equipment of electricity works in this town.

Willesden.—Kensington Council have declined to undertake, jointly with Willesden, the electric lighting of that portion of Harrow-road in which their boundaries are situated. Hammersmith Council has, however, adopted Willesden's similar proposal with regard to their part of the road. The Willesden mains are being laid in the latter portion for both public and private lighting.

Wilmslow.—The Council have opened negotiations with the Alderley & Wilmslow Electric Supply (Ltd.) for public electric lighting.

Woolwich (London).—The question of extending the electric lighting mains to Shooter's Hill, Eltham, and Lee Green, was discussed at the last meeting of the Council and was referred back.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Tottenham District Council invite offers (based upon certain arrangements, particulars of which are set out in the form of tender) for the exercise of the Council's powers under their provisional electric lighting order, 1902. Particulars, on and after Oct. 7, from the clerk (Mr. E. Crowne), 712, High-road, Tottenham, Middlesex, to whom tenders by noon Oct. 21. See also advertisement.

Sunderland Corporation invite tenders for two 300kw. three-phase generators (5,500 volts) to couple to existing Belliss engines, and two 300kw. synchronous three-phase motors (5,000 volts) to be coupled to existing multipolar Silvertown dynamos. Specifications, &c., from the borough electrical engineer (Mr. John F. C. Snell). Tenders (addressed chairman of Electricity and Lighting committee) to the town clerk (Mr. Fras. M. Bowey), Town Hall (Sunderland, by noon 28th inst. See also advertisement.

Ipswich Corporation require tenders for continuous-current meters for the ensuing 12 months. Specifications from the chief engineer and manager (Mr. Frank Ayton), Ipswich. Tenders by 24th inst. See also an advertisement.

Fulham (London) Borough Council invite tenders for the supply and erection of a 3,000-volt main generator switchboard. Specifications, &c., from the borough electrical and consulting engineer (Mr. Arthur J. Fuller). Tenders to the town clerk (Mr. R. M. Prescott), Town Hall, Fulham, S.W., by noon Oct. 19. See also advertisment.

Tamworth Corporation are prepared to consider offers for the construction and maintenance of electricity works. Particulars from the town clerk. See advertisement.

The directors of the *Great Western Railway Co.* invite tenders for supply of various stores for the year ending Nov. 30, 1905, including telegraph instruments, apparatus (insulators, &c.), ironwork, tools and drysalteries, electric wire and cables, carbons, incandescent lamps, &c., indiarubber goods, wire, ironmongery, &c. Samples and patterns may be seen at Swindon up to Oct. 14, and specifications, &c., obtained at the stores department, Swindon. Tenders to the secretary (Mr. G. K. Mills), Paddington Station, London, W., by Oct. 17.

The Visitors committee of *Cumberland and Westmorland Lunatic Asylum*, Garlands, Carlisle, invite tenders for two Lancashire boilers, feed pumps, steam exhaust and water pipes and valves; two 50kw. and one 30kw. steam dynamos, and a 5-ton travelling crane; economiser; underground bitumenised cables and boxes; wiring of buildings, switchboards, motors, fans, &c. Specifications from and tenders to Mr. C. W. Allan Hodgson, The Courts, Carlisle, by Nov. 1.

London County Council invite tenders for the work to be done (including wiring and fittings) in connection with the electric lighting of the Ranger's House, Blackheath. Tenders to the Clerk of the Council, County Hall, Spring Gardens, London, by noon Oct. 11.

London County Council also invite tenders for 12 months' supply of stores, including electric fittings, cables, engineers' goods, &c. Tenders by 24th inst.

Rochdale Corporation invite tenders for three ejector condensers, three electrically-driven circulating pumps and extensions of steam and water pipes, valves and accessories. Tenders to the town clerk (Mr. W. H. Hickson) by Oct. 10.

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Wandsworth (London) Council invite tenders for the installation of electric lighting at the Council House, and the provision and fixing of an electric fan for the Council Chamber. Tenders at the Council House, Wandsworth, S.W., by Oct. 18.

Tenders are required for six months' stores, including electric lamps and fittings, &c., to *Glasgow* Parish Council and Lunacy District Board. Forms of tender, &c., from 266, George-street, Glasgow, until 21st inst.

Middleton Corporation invite tenders by Oct. 25 for erection of dust destructor, Lancashire boilers, superheater and extensions to steam piping, &c.

Manchester Tramways committee invite tenders by 8th inst. for 380 Canary pine boards.

Ilford District Council require tenders by 10th inst. for additions to tramway offices and stores at Ley-street tramcar sheds.

The Municipality of *Philippopoli*, Bulgaria, announce in an advertisement in another column that the electric lighting and electric tramway concession was not adjudicated upon on Aug. 3/16 last, and that a new adjudication will take place on Oct. 2/15, at 10:30 a.m. in the Town Hall, Philippopoli. Offers should be submitted in the Bulgarian language and in sealed envelopes. Tenderers should supply references (under separate cover) showing that the tenderer has already successfully executed a similar foreign enterprise, and has deposited at the Banque Nationale Bulgare 150,000fr. (£6,000) as security. Conditions, &c., in Bulgarian and French, may be obtained on payment of 20fr. (16s.) A readjudication will take place on the following day (Oct. 3/16) if by 10:30 a.m. of that day a reduction of 5 per cent. on the price per kilowatt hour on the prior offer is made.

TENDERS RECEIVED AND ACCEPTED.

With regard to the contract for the system of tramways for Lincoln Corporation, we learn that this was sealed on Tuesday evening with Messrs. W. Griffiths & Co. for the equipment on the "G.B." surface-contact system. Messrs. Griffiths will execute the permanent-way work, and the "G.B." Surface Contact Co. will undertake the electrical equipment. The amount of this contract is about £24,000, and includes the equipment of 3 miles of single track and an unusual amount of special work, including two level railway crossings.

Graham, Morton & Co. have received a contract for supply and erection of coal-handling plant at Chatham Dockyard in connection with the Admiralty's electric light and power scheme. The contract stipulates that the men employed shall be British subjects, and the material used of British manufacture.

Kingston-on-Thames Council have accepted the following tenders: E. Chamberlain, extensions to engine house at electricity works at £475; W. T. Glover & Co., ½ mile 50-ampere twin house-service cable, £93. 19s.; Piggott & Co., pipe work, £130; W. Adams, wiring the cooking and laundry schools, &c.

The contract for the complete engine-house equipment for the power station of the Scottish Central Electric Co. has been let to Bruce Peebles & Co., and includes one 1,200 I.H.P. set, two 600 I.H.P. sets, two 150kw. sets, exciters, switch gear, &c. The amount of the contract is £15,500.

Aberdeen Corporation have accepted the tender of Messrs. R. & J. Shinnie for the supply and delivery of 20 top-deck tramcar covers. The Brush Company, Messrs G. C. Milnes, Voss & Co. and Messrs. Hurst, Nelson & Co. also tendered.

The Grand National Tramways Co. (Buenos Ayres) have placed an order with the General Electric Co. of New York, through their Buenos Ayres representatives, for 100 electric car equipments, each comprising two 40 H.P. motors, with controllers, &c.

For the supply and erection of steam, exhaust and circulating pipes for extensions at Burton-upon-Trent electricity station, seven tenders were received, and that of a local firm (Buxton & Thornley) was accepted at £624.

For wiring and fitting for the electric light of Newport-road school, Leyton, the District Council have accepted the tender of Marshall & Co. at £221. 4s. 6d. 23 tenders were received, ranging from £477 to £221. 4s. 6d.

Brighton Town Council have let to the British Westinghouse Co. the contract for altering and extending the engine room at Southwick power station at £5,285, and for erecting a switchboard gallery at North-road at £820.

Aston Corporation have accepted the tender of the General Electric Co. (London) for a steam generator for their electricity works at £1,529.

Wimbledon General Purposes committee have accepted the tender of J. Burges & Sons for carpenters' and joiners' material required for extensions of the electricity station at £257.

T. Sugden (Ltd.) have secured an order from Birmingham Corporation to instal 14 of their superheaters in connection with the Lancashire boilers at the municipal electricity works.

Coventry Corporation have accepted the tender of Siemens Brothers & Co. for a 600kw. alternator, and that of Kelly & Sons for engine house extensions.

High Wycombe Council have accepted the tender of Stuart & Moore for maintaining the electric fire calls for seven years at £14. 8s. per annum.

Halifax Guardians have accepted the tender of the Gath Electrical Engineering Co. for electrical fittings, &c.

Maidstone Council have accepted the tender of the British Westinghouse Co. for a balancer and switch gear at £405.

Lancaster Corporation have placed an order with Fenton & Co. for electric bells, &c., at the schools under their control.

BUSINESS NOTICES, &c.

Mr. A. C. Barfield has retired from the business hitherto carried on by him in partnership with Messrs. C. H. Offord and F. C. Wilson as electrical engineers at Woodcock-street, Birmingham. Debts by Messrs. Offord and Wilson.

Messrs. W. Fielder & F. H. Rees, electrical engineers, 13 and 15, Maidenhead-court, London, E.C., have dissolved partnership. Mr. Rees continues as Fielder & Rees.

Messrs. M. Sutherland & E. Marcuson, electrical engineers, 61, Chandos-street, London, W.C., have dissolved partnership. Debts by Mr. Marcuson.

BANKRUPTCIES, LIQUIDATIONS, &c.

A receiving order has been made against Hy. Coles, electrical engineer, 10, York-street, Swansea.

An application for the discharge in bankruptcy of Walter Baker (trading with R. Foster as R. Foster & Co., at Adlington-street, Burnley, and as the Nelson Electrical Engineering Co., at Stott-street, Nelson), will be heard on Nov. 10 at the Court House, Burnley.

Mr. Percy Mason, 64, Gresham-street, London, E.C., has been appointed liquidator of Shippey Bros. (Ltd.).

Claims against F. W. Parkes & E. Sadleir, electrical engineers and fitters, the Dingle, Colwyn Bay, and against the separate estate of F. W. Parkes must be sent by Oct. 18 to Mr. L. Hugh-Jones, Crypt-chambers, Eastgate-row, Chester.

The London Electrical Synd. (Ltd.) is being wound up voluntarily for the purpose of transferring the undertaking to a new company with the same name. Mr. Geo. Pearson, 196, Abbott-road, Poplar, London, E., is liquidator.

A meeting will be held on Nov. 5 at 12, St. John's-lane, Liverpool, to receive an account of the winding-up of the Renewable Electric Lamp Co. (Ltd.).

A meeting will be held at the Grand Hotel, Manchester, on Nov. 4 to receive an account of the winding-up of the Clayton Engineering & Electrical Construction Co. (Ltd.)

A meeting will be held on Nov. 5 at 12, St. John's lane, Liverpool, to receive an account of the winding-up of the Electric Extension Co. (Ltd.).

The Electrical Indicator Synd. (Ltd.) is to be wound up voluntarily. Mr. H. Breese, 75, Aberdeen-road, London, N., is liquidator.

Sales by Auction.—Messrs. Fuller, Horsey, Sons & Cassell will sell by auction at the works of Electric Lighting Boards, Ltd. (in liquidation), 80, York-road, King's Cross, London, N., on Thursday and Friday, Oct. 13 and 14, plant and machinery, electric lamps and fittings, and a large quantity of accessories, material and sundries, of which further particulars will be found set out in an advertisement elsewhere. Catalogues are obtainable from Messrs. Dolman & Pritchard, solicitors, 9 and 10, Cheapside, E.C., of Messrs. Golding & Hargrove, solicitors, 99, Cannon-street, E.C., and of the auctioneers, 11, Billiter-square, London, E.C.

Messrs. Fuller, Horsey, Sons & Cassell will include in their sale at York-road, King's Cross, London, N., on Friday next, Oct. 14, the stock of electric ignition batteries for motor cars and cycles and other electrical gear lying at Messrs. Fenner, James & Co.'s premises, 14, Bridle-lane, W. Further particulars are given in an advertisement. Catalogues from the liquidator (Mr. Sidney Field), 17, Shaftesbury-avenue, London, W.C., and of the auctioneers, 11, Billiter-square, London, E.C.

Plant for Sale.—A complete 700 H.P. power plant (now supplying direct current at 550 volts to the trains on the Harrow branch of the Metropolitan District Railway) is for sale. Delivery March, 1905. Particulars from Mr. H. B. Twyford, Hamilton House, Victoria Embankment, London, E.C. See advertisement.

Messrs. W. H. Allen, Son & Co., Queen's Engineering Works, Bedford, have for immediate delivery two 200kw. steam dynamos. See advertisement.

Plant Wanted.—A second-hand single-phase alternator (75kw., 50 periods) with exciter, direct-coupled to compound engine, is wanted. Particulars to Mr. J. Hetherington, A.M.I.C.E., Hayes, Middlesex.

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Premises to be Sold and Let.—The 40 years' lease of Crown Works, Bancroft-road, Mile End-road, London, E., is to be sold on Friday, 28th inst. There is 84,000ft. of working space on two floors, a yard, stables, offices, &c., with option of purchasing freehold. Particulars from the auctioneers (Messrs. George W. Dawes & Co.), 12, Basinghall-street, London, E.C. See advertisement.

Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., have for sale conveniently-situated riverside engineering freehold property, within 30 miles of London. Total area about 18 acres, shop area 48 000 sq. ft. There are capital offices and manager's residence, all in good repair. See also advertisement.

A warehouse or factory is to be let at Lewisham, close to main road and within 2 minutes of station. Floor area about 6,000 sq. ft. Applications to Mr. Wm. Jerrard, 40, Loampit-vale, Lewisham, London, S.E. See advertisement.

Shops to Let.—There are three fine shops, with basements, to let in the Strand, London, on a 21 years' lease. Particulars from the secretary's office, Room 41, West Block, Hotel Cecil, Strand, London, W.C. See advertisement.

Catalogues.—The subject of "Street Lighting" is dealt with in a well-got-up catalogue issued by the Reason Mfg. Co., Lewes-road, Brighton, England. In addition to a full illustrated description of a large number of items with which our readers will be familiar, there are numerous fittings and examples of apparatus of which particulars are furnished, and which have been brought together for the first time in the pamphlet under notice. The book is in handy form, and can be readily slipped into the coat pocket for reference as occasion may require. Amongst the items to which particular attention may be drawn is a new reflector fitting in the form of a glope type lantern of registered design, which can be supplied for either Nernst, incandescent or small arc lamp lighting, and with clear or frosted glass, practically airtight and dust proof. By a simple device, the interior of this fitting can be got at by unscrewing the top finial, making the cover removable. The main object of the introduction of this fitting is to enable electricity supply undertakings to compete with incandescent gas, and it is not offered as suitable for competition with arc lighting. We may add that, in designing these fittings, the Reason Mfg. Co. have specially in view an effective means of meeting the keen competition of incandescent gas in street lighting. The company's contribution to this desirable end will be welcomed by the electrical industry. We have not space here to mention many other pieces of apparatus for use in street work, but may say that contractors for street lighting work and others will welcome the appearance of a compact and well-arranged list of street lighting accessories.

Reason Co.'s New Globe Type Lantern, for Incandescent, Nernst or small Arc Lamps.

The Allgemeine Elektricitäts-Gesellschaft (Berlin) are issuing, through their London agents (the A.E.G., Foreign Department, 125, Charing Cross-road, W.C.), a number of sectional lists relating to the electrical machinery and apparatus manufactured by the company. These lists are contained in register-fashion in a strong and useful portfolio case, which ensures the very easy finding of any particular item. It is further facilitated by thumb indexes at right angles. Although the list is not yet complete, the matter dealt with in the present compilation is most comprehensive, including continuous-current and alternating-current generators and motors, transformers and accessories, ranging from the smallest to the largest types. Prices, weights, speeds, voltages and other technical particulars are given, besides much information of a general character. Of practical value are the annexed diagrams and the dimensioned sketches. The series of lists is followed by an exhaustive conversion table (metric system to English system, and vice versa) and by neatly-executed pamphlets, describing in a technical yet popular manner the use and advantages of electricity in weaving factories and rolling mills. Two further pamphlets elucidate in a detailed technical way the working and properties of high-speed polyphase induction motors and oil-cooled transformers. The high qualities of the latter were, by the way, referred to some time ago in an article and editorial note in *The Electrician*.

"Electrically-heated Apparatus" is the title of a new list sent out by Messrs. Isenthal & Co., 85, Mortimer-street, London, W. The list contains particulars and illustrations of a considerable range of heating, cooking, soldering, medical and general domestic and industrial apparatus designed for use on electrical circuits. We illustrate a few of these. Fig. A is a new large superheated steam steriliser, with waste-pipe, steam tap, &c., made of copper, tinned inside, nickel plated outside, and, as will be seen, fitted with water gauge and funnel. The application of these sterilisers is mainly in connection with hospital work. Height over all 70in., inside diameter 14in., inside height 34in., weight about 2½ cwt. The water at the bottom of the steriliser is converted by the evaporator into steam, which rises between the inner and outer cylinders and enters the boxes at a temperature of from 120°C. to 150°C. without raising the pressure in the steriliser itself. Fig. B is a hot-air dryer, made of strongly nickelled parts mounted on a 20in. ring with caster wheels. Height 4ft., weight 66lb. The hair tray shown is separately heated. Fig. C is a hot-air douche used in medical work, similarly mounted on castered ring and fitted with thermometer. This apparatus yields hot air up to 200°C. Height 50in., weight 55lb. There are numerous other novelties in this list,

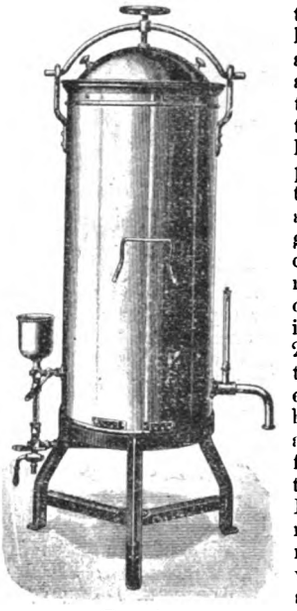

Fig. A.

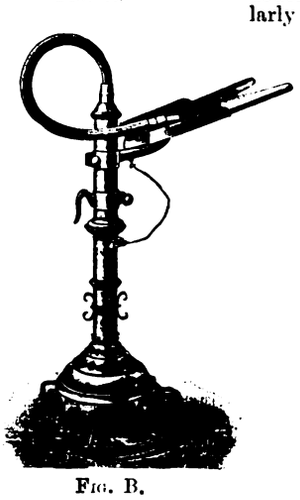

Fig. B.

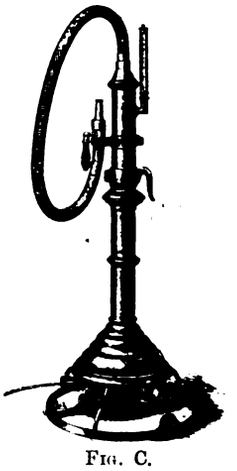

Fig. C.

We have received from the Gesellschaft für Drahtlose Telegraphie (system "Telefunken"), 3, Lindenstrasse, Berlin, S.W., a pamphlet fully illustrating and describing the company's system and giving interior views of the factory where the company's apparatus is manufactured and assembled, tested and completed for delivery. Interior views of the laboratories are also shown, as well as examples of the apparatus in detail. Exterior views show installations in operation in various parts of the world, and the illustrations include a number of examples of ship-and-shore installations. A list of the company's agents in all parts of the world is given, together with a specification and particulars of cost and upkeep of this system of wireless telegraphy.

Cunliffe & Croom, Broughton Ironworks, Manchester, have issued a supplementary list of brass finishers' machine tools. A number of these machines, which include universal lathes, disc grinders, &c., are installed in electrical engineering works.

The Sloan Electrical Co., 15, Fore-street-avenue, London, E.C., have ready a list of electric novelties of patented designs. These include pocket lamps, electric torches, hand or house lamps, electric candles, watch stands, clocks, &c. A separate list of Conradty carbons, for which the company are agents, is also ready.

The Linolite Co., 47, Victoria-street, Westminster, are circulating a report on "The Life and Candle-power of Linolite Lamps," by J. S. Dow. Copies can be obtained by those interested.

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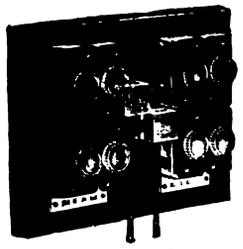
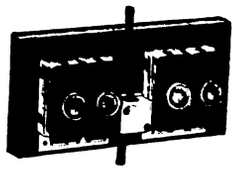
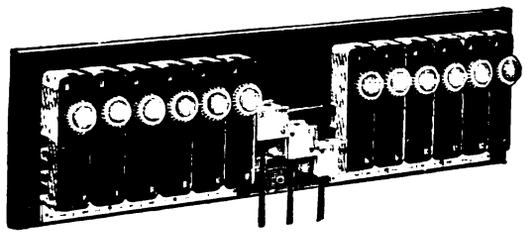
Siemens Electrical Appliances, 61–2, Watling-street, London, E.C., have ready a new list of uninterchangeable safety fuses. The illustrations show single and double-pole distributing boards with four branches and a double-pole distributing board for the three-wire system. The cartridge fuses described in the list under notice have been designed with the view of providing a small cheap fuse so constructed that it is mechanically impossible to replace a cartridge, either carelessly or by mistake, by one intended for a larger current, and so that, with the maximum voltage admissible, no permanent arc can be maintained even with a dead short. The poles are farther apart than in the case of the well-known "Edison" plug, which this resembles, and it has stronger walls and protected solder joints. The uninterchangeability of fuses from 0·5 ampere to 10 amperes has been effected simply by making the lower contacts of the cartridges in the form of a round pin, the diameter being different for different currents, and by providing the bases with gauge rings which fit the pins. The rings for the 250-volt cartridge cannot be used in the 500-volt fuses, the 500-volt cartridges being provided with stepped pins and rings with raised rims which do not fit the pins of the 250-volt cartridges even sufficiently to make a temporary contact. The rings are easily inserted in the bases and their feet bent over to prevent unauthorised removal.



Double-pole Board, Four Branches.



Single-pole Board, Four Branches.

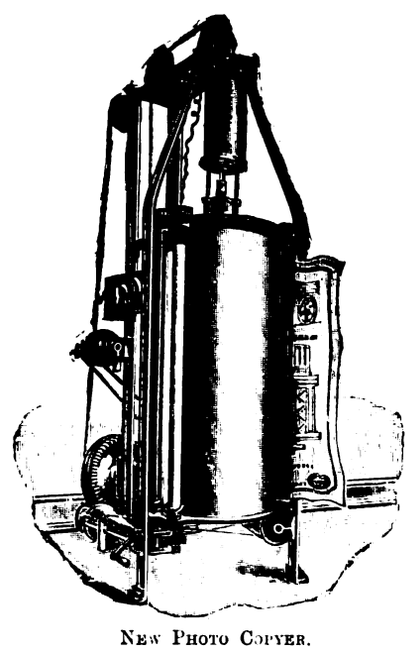


Double-pole Board for Three-wire System.

Ernest F. Moy (Ltd) issue a sheet of illustrated particulars and prices of stage arc lamps.

The International Steam Pump Co., Liberty-street, New York, describe in a circular just issued an electrically-driven system of permanent stationary fire-fighting apparatus installed in the City of Philadelphia. It is claimed for this system that it is specially designed for installation wherever public electricicity supply is available.

Automatic Blue-printing Machine.—We illustrate an automatic blue-printing machine, or photo copyer, for making copies from tracings by electric light. It is designed to overcome the difficulty of making very long prints such as required for railway plans, designs for bridges, and other constructional work. By this machine it is claimed that prints may be made in a continuous piece up to any desired length, while the feeding of the paper and the tracing, the traversing of the lamp across them, and the securing of the necessary contact between them, is effected automatically. The machine is also suitable for printing short lengths, which are fed in one after another. The machine is being put on the market by Mr. Leonard Shaw, 39, Victoria-street, London, S.W.



New Photo Copyer.

Forthcoming Books.—Messrs. Harper & Bros., are about to issue "The Testing of Continuous-current Machines," by Mr. Charles Kinzbrunner, A.M.I.E.E., Manchester School of Technology.

"Traction and Transmission."—We are informed that the proprietors have decided to discontinue the publication of this monthly supplement to "Engineering" after the October number, which completes the 10th volume.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Sept. 28 to Oct. 4, with the ports of destination:—

Africa—Cape Town, £75 (telegraph material); Durban, £979 (including £130 telegraph material); East London, £920; Port Elizabeth, £73; Port Said, £88; Suez, £38. *Argentina*—Buenos Ayres, £665 (including £220 telegraph apparatus); Zarate, £170. *Australasia*—Adelaide, £162; Melbourne, £120; Perth, £1,069; Sydney, £512; Wellington, £1,605 (including £728 telegraph material). *Belgium*—Antwerp, £252. *Brazil*—Rio Janeiro, £4,055. *British Guiana*—Demerara, £133 (telegraph material). *Burma*—Rangoon, £10. *Chili*—Santiago, £41. *Germany*—Bremen, £35; Hamburg, £294 (including £200 telegraph material). *Gibraltar*, £355. *Holland*—Amsterdam, £87; Rotterdam, £17. *India*—Bombay, £317; Calcutta, £1,776. *Japan*—Kobe, £930; Moji, £16; Nagasaki, £571; Yokohama, £541. *Malta*, £2,950. *Portugal*, Lisbon, £49 (telegraph instruments). *Russia*—St. Petersburg, £104. *Siam*—Bangkok, £13. *Straits Settlements*—Penang, £156; Singapore, £1,622 (including £1,341 telegraph material). *Sweden*—Gothenburg, £65. *West Indies*—Jamaica, £87; Trinidad, £86. Total, £21,038, against £16,058 in the corresponding week last year (Sept. 30 to Oct. 6.)

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

August 13, 1904.

17,620 J. Bennett and H. G. Crompton. Preston. Trolley poles for changing from one wire to another.
17,621 Veritys Limited and F. S. Worsley. Birmingham. Arc lamps.
17,627 P. C. de Azenedo. Regulation or graduation of the light of an incandescent lamp.
17,632 N. Norris. Manchester. Operating points of electric tramways and also overhead points or trolley switches and devices therefor.
17,639 W. Thomson. Manchester. Electrolytic cells.
17,650 M. Büttner. Electrolytic rectifier. (Date applied for, Aug. 13, 1903, date of application in Germany.)*
17,662 J. A. Sohneppe. Wedge chock for securing a door in a partly-open position and turning on electric light and bell*
17,672 G. C. Dymond (N. M. Watson and E. S. Wheeler, U.S.). Batteries.

August 15, 1904.

17,674 S. J. Port. Birmingham. Telephones.
17,675 Garnett Senior. Sunderland. Automatic protection for live rail on electric railways.
17,717 C. J. Klein. Switches.

August 16, 1904.

17,733 G. Davis. Suspension fitting for electric motors.
17,738 I. H. Parsons. Leicester. Switchboards.
17,741 W. Fairweather (Arnold Magnetic Clutch Co., U.S.). Alternating-current power transmitting apparatus.*
17,752 R. Ainsworth and P. R. Jackson & Co. (Ltd.). Manchester. Magnetic electric generator.
17,764 H. Hill. Byfleet. Regulating electric circuits.
17,768 E. A. Claremont and J. Stratton. Carriages for cable drums.*
17,784 E. A. Ashcroft. Improvements in or relating to electrolytic cells.
17,792 J. M. Canello. Manufacture of incandescent lamps. (Date applied for, Sept. 12, 1903, date of application in France.)*
17,805 T. H. M. Harvey. Conducting cords.
17,808 Evershed & Vignoles and S. Evershed. Electrical measuring instruments.
17,809 B.T.-H. Co. (G.E. Co., U.S.). Controllers.
17,810 E. A. Carolan. (G.E. Co., U.S.). Self-propelled vehicles.
17,811 B.T.-H. Co. (G.E. Co., U.S.). Automatic brakes.
17,812 B.T.-H Co. (G.E. Co., U.S.). Fuses.
17,813 B.T.H. Co. (G.E. Co., U.S.) Electric motor control.

August 17, 1904.

17,837 J. M. Richardson. Terminals for batteries.
17,841 W. J. Hawkins. Electric motors.
17,862 E. M. Ginders. Liverpool. Overhead conductors for electric tramways.
17,879 J. Schade, Jun. Spring terminal clips. (Date applied for Oct. 29, 1903, date of application in U.S.)*
17,939 J. Lauvernier. Berlin. Trolleys.*
17,975 J. S. Raworth. Control of electric vehicles.
17,978 G. B. Ellis (La Société A. Vedrine et Cie, France). Supporting electric motors or differential gear, or both, on motor vehicles.

August 19, 1904.

17,997 F. F. MacDonald. Sheffield. Switches.
18,020 J. R. Hill. Electrical driving mechanism for machinery.
18,021 L. Kitsee. Insulating conductors.*

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18,034 G. B. Ellis (La Société A. Vedrine et Cie., France). E'ectric automobiles.
18,042 O. Imray (Farbwerke vorm. Meister, Lucius & Brüning, Germany). Processes of oxidation and reduction effected in an electrolytic bath.

August 20, 1904.

18,046 J. F. Richert. Mobile contact.
18,054 J. Levin. Electric safety device against the unauthorised opening of door locks, windows, &c.
18,055 H. Mensforth. Bradford. Trolley heads.
18,060 G. D. A. Parr. Leeds. Electrical mechanical apparatus for automatically operating the rail and conductor points on electric tramways and railways from tram or train.
18,087 J. Kruyswijk. Transmission and distribution of electric power.
18,095 W. J. Burton and C. L. Burlingham. Telephone switchboard cords and like flexible electric conductors.*
18,098 G. C. Dymond (Gesellschaft für Drahtlose Telegraphie m.b.H., Germany). Liverpool. Wireless telegraphy and apparatus.*
18,101 W. C. Head. Converting alternating current for use with continuous-current measuring instruments.
18,105 M. Latour. Transformation of repulsion motors when running at speed into rotating field asynchronous motors. (Date applied for, Aug. 27, 1903, date of application in France.)*

August 22, 1904.

18,141 F. C. Robinson. Kingston-on-Thames. Electric block systems for railways. (Date applied for, Aug. 22, 1903, date of application in U.S.)*
18,144 J. Harris. Purification of air and generation of ozone.
18,162 and 18,163 J. P. F. Andrews. Arc lamps.
18,173 E. A. Carolan (G.E. Co., U.S.). Vapour electric apparatus.
18,181 W. J. Roussel and A. King. Telegraph transmitters.*
18,185 J. L. Routin. Controlling electric power distributing systems.*
18,199 C. C. Garrard. Controllers for electric circuits.
18,201 and 18,203 B.T.-H. Co. (G.E. Co, U.S.). Electric motor control systems.
18,202 B.T.-H. Co. (G.E. Co., U.S.). Electric motor control.
18,204 B.T.-H. Co. (G.E. Co., U.S.). Transformers for electric vehicles.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

22,910 Carolan (G.E. Co., U.S.). Bearings for measuring instruments.
23,192 Jones and Jandus Arc Lamp & Electric Co. Dynamo-electric generators and motors.
23,523 Zacharias and Lasker. Astatic magnet and process for making same.
23,546 Cruickshank. Telephone mouthpieces or receivers.
23,767 Halsey Electric Generator Co. (Halsey Electric Generator Co.) Galvanic batteries.

1904.

1,414 Gati. Telephone relay.
2,279 Hadfield. Trolley heads.
2,772A Fiddes and Watt. Fire alarms. Date applied for, Feb. 4, 1904.
3,211 Bradley and Bowen. Electric railway signalling systems.
3,560 Ingram and Phillips. Coin-freed apparatus for use with circuit controller.
3,882 Deutsch. Dynamos.
4,309 General Contracts Co. (Cook and Chipperfield). Switches.
7,823 Fairweather (American Electric Telephone Co.). Telephone transmitters.
7,825 Fairweather (Benjamin Electric Mfg. Co.). Twin sockets for incandescent lamps.
8,297 Hewitt. Systems of electrical distribution. (Date applied for, April 25, 1903.)
8,321 Moller. Receiving apparatus for wireless telegraphy.
8,903 Hyde. Electrically-driven fluid compressing pumps and pressure-controlled electric switches therefor.
8,992 Gleeson and Hamilton. Telephone systems. (Date applied for, May 1, 1903.)
9,226 Hoffmann. Continuous-burning arc lamp with amalgam electrodes
9,397 Dale. "Clusters" for incandescent lamps.
9,468 Neuburger and Minet. Heating charge of electric furnaces.
9,815 Kraft. Charging storage batteries without special apparatus.
9,914 Hauptmann. Magneto-electric igniting device.
9,951 Kandó. Driving mechanism for electric vehicles.
10,391 Neugebauer. Electric time switches for controlling barriers.
10,477 Lake (Submarine Signal Co.). Receiving submarine signals.
10,493 Lake (Submarine Signal Co.). Producing sound vibrations in water.
10,818 Barile. Winding clocks automatically by electric motor.
10,837 Render. Fuse heads for electric blasting.
10,896 Johnson (Elektrizitäts A.G. vorm. W. Lahmeyer & Co.). Electric motors.
10,906 Lichtenfels. Electrically stopping railway trains.
11,272 Mackenzie (Soc. Cousin & Cie.). Electrical safety signalling on railways.
13,379 Schwedler. Mercury current interrupters.
13,567 Weintraub. Envelopes for vapour electric conductors. (Date applied for, June 15, 1903.)
13,865 Weintraub. Transforming alternating currents. (Date applied for, June 18, 1903.)
14,020 Marchant and Worrall. Electrostatic apparatus for measuring potential differences.
14,350 Krause. Electric signalling and braking devices for trains.
14,148 Kruh. Vapour electric lamps or rectifiers. (Date applied for, June 22, 1903.)
14,160 Palmer. Electromotive apparatus for electric clocks and other mechanism.
14,231 La Force. Sparking plugs for internal combustion motors. (Date applied for, June 24, 1903.)
14,521 Lintern. Track sanders, brakes and controller handles.
14,543 and 14,544 Bristol. Thermo-electric couples.
14,545 Bristol. Thermo-electric couples.
14,553 Getto. Burglar and other electric alarms.
14,767 Hirst and Gunner. Nipple for conduit tubes and fittings.
14,814 Luby and Harris. Clip for binding trolley wires to fittings.
14,815 Luby and Harris. Section insulator for overhead wire systems.
14,911 Bellardent. Arc lamps. (Date applied for, Sept. 5, 1903.)
15,360 Kolling. Electrolytic circuit-breaker.
15,391 Brown. Surface-contact electric railway systems.
15,512 Clark and Hart Accumulator Co. Lid for acid-containing boxes.
15,561 Thompson (Gesellschaft für Drahtlose Telegraphie m.b.H.) Indicators for electric oscillations.
15,567 Cardonnelle. Electric or telephonic transmission.
15,637 Upton, Elliott and Pratt. Regulating mechanism for arc lamps.

COMPANIES' MEETINGS AND REPORTS.

Willans & Robinson (Ltd.)

The half-yearly meeting was held on Wednesday, Mr. Mark Robinson, M.Inst.C.E., presiding.

The SECRETARY (Mr. C. S. Essex) read the notice convening the meeting.

The CHAIRMAN said they must deplore the unfortunate results of the half-year's working and the small prospect there was of much immediate amendment in their position. In the previous accounts there was a profit at Rugby, small and disappointing, but it was a profit. This time the loss at Queen's Ferry was but supplementary to a smaller and more significant loss at Rugby. He considered the public was strangely unaware how very bad the engineering trade had become, yet it would be difficult to use language which could exaggerate the badness of business in this department. For themselves, they had a good many thousands of horse-power on order, but there was little profit in these orders. There had been times nearly as bad before, and they had passed through them unscathed. But then their speciality had a more distinct lead and a relatively higher name than it was possible for it to command now. They no longer had a monopoly of high-speed engine work; rivals have crept up closer, as was natural, and if they quoted lower prices they secured the orders. In preparing the accounts they had thought it right to show the worst. Depreciation had been written off on the same scale as usual, and reserves had been made for doubtful valuations with as much caution as they had ever used. On two points, which were discussed at their last meeting, they could reassure the shareholders. There was much criticism then because trade debtors stood for £186,000 owing to them. This time their debtors were only £153,000, and he regretted they had not more from such sound people as their former debtors had always proved to be. Another point was as to shares in other companies, taken in part payment for work done under contract. They had sold not all but a large proportion of these shares upon what they considered favourable terms—in fact, at precisely the valuation they had placed upon them. The directors had also gone in heartily for such reductions and economies as were possible on a drastic scale. Mr. Robinson continued: On the other side of the account, we are striving to add other and, perhaps, under present conditions, more remunerative branches to our business, and we have the strongest belief that after a time these combined efforts will bring back to our Rugby business much, if not all, its old prosperity. But this new business can bear no profit for some time, and must for the present be even a source of actual loss. Now, if the stress of bad times could play such havoc with an old and hitherto profitable business such as that at Rugby, you can realise how disastrous it has proved to the new business which we essayed to start at Queen's Ferry, but our manufacturing difficulties are over now. The heavy loss, however, in keeping the works open during the long and unproductive period has, as you know, crippled our resources, and we cannot get the extra capital required to properly complete the plant or to carry on the works upon other than the smallest scale. We are using every endeavour to dispose of the Queen's Ferry works, if we can obtain an acceptable offer. Negotiations are in progress to this end. The report will have informed you that the financial position of the company is already more satisfactory than at the date of our last meeting. This is the point of most supreme importance for us. Losses may be retrieved and profits restored, but only on condition that the company can not only carry on business, but carry it on with adequate resources and with the confidence of its customers. With regard to the salaries of the directors, these have been materially reduced in some cases, and the particular case of Mr. Lazenby, who has only been on the board for a comparatively short period, has, at his co-directors' request, been left for the shareholders' decision. I now move the adoption of the report and accounts.

Mr. F. W. CLARKE seconded the motion.

Mr. JAMES C. PEACHE, one of the new directors, gave some technical details of the company's manufactures, and added that much of the orders for Willans engines now being put through the shops had been taken at the ruinously low prices at present ruling. He could not suggest an early date for again earning profits. A bad time such as they were now passing through was the time in which to economise wherever

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possible, and to increase the efficiency of production wherever that could be done. This was the daily concern of the directors, and to that end they must and would devote their best attention.

Considerable discussion followed, in the course of which several shareholders criticised adversely the outlay incurred on the Queen's Ferry works, but the report was eventually adopted *nem. con.*

MILFORD-ON-SEA ELECTRIC SUPPLY CO. (LTD.)—At the meeting last week the directors reported that the company commenced business on Oct. 20, 1903, and the accounts were up to June 30, 1904. The revenue for the eight months had been £204. 18s. 3d., and the expenditure £120. 6s. 9d., leaving £84. 11s. 6d., out of which a dividend of 1½ per cent. per annum upon the fully-paid shares was recommended. One or two interruptions of supply occurred in consequence of defects in laying the mains. Those defects had, however, been localised and made good. The company commenced business with the equivalent of 1,406 8 c.p. lamps connected, and since then 334 had been added. To provide capital for additions to plant and mains, £2,000 4 per cent. first mortgage debentures of £50 each have been issued.

NORWICH ELECTRIC TRAMWAYS CO.—For the year ended June 30 the traffic receipts amounted to £34,719. 18s. 9d., against £33,516. 12s. in 1903. The gross profit was £10,768. 4s. 10d., to which have to be added £201. 0s. 11d., interest received, and £1,212. 17s. 11d. from last year. Duducting £2,640, being 4 per cent. interest on outstanding mortgage debentures, and £1,012. 9s. 9d. which has been placed to reserve, a profit of £8,529. 13s. 11d. remains. The directors recommend that a dividend of 3 per cent. be paid for the year, which would absorb £7,920, and that the balance (£609. 13s. 11d.) be carried forward. The gross receipts for the year showed an increase of £1,203 and the operating expenses an increase of £85. The average cost per car-mile was 5·24d., against 5·43d. in 1903 and the average receipts per car-mile were 7·74d., against 7·76d. The number of passengers carried was 7,461,718, and the number of car-miles run was 1,088,951.

NEW COMPANIES, LIENS REGISTERED, &c.

NEW COMPANY.

LONDON ELECTRICAL SYND. (LTD.) (82,137.)—Reg. Sept. 27, capital £10,000 in £1 shares (1,000 preference), to adopt agreement with London Electrical Synd., Ltd. (in liquidation), and its liquidator (Mr. G. Pearson), and to carry on the business of electricians, mechanical engineers, suppliers of electricity, &c. Subscribers are H. Anschel, F. G. Webster, G. Pearson, electrical engineer, L. S. Woolf, H. A. Tilcock, E. A. Lucas and I. Green. First directors, G. Pearson, H. Anschel and F. G. Webster.

MORTGAGES AND CHARGES.

BRITISH ELECTRIC CALIBRATED FUSE CO. (LTD.)—Issue on Sept. 22 of debenture for £50, part of series created Dec. 4, 1903, to secure £3,000, charged on company's undertaking and property, present and future, including uncalled capital. Holder, J. Lang, 137, Fenchurch-street, E.C. No trustees. Previously issued of same series, £2,700.

NEWMARKET ELECTRIC LIGHT CO. (LTD.)—Issue on Sept. 19 of debenture for £100, part of series created Oct. 16, 1900, to secure £15,000, charged on lands, buildings, machinery, &c., and company's undertaking and property, present and future, including uncalled capital. Trustees, G. H. Verrall and F. E. Gripper. Previously issued of same series, £14,100.

OTTO ELECTRICAL MFG. CO. (LTD.)—Issue on Sept. 1 of debenture for £500, part of series created June 22, 1904, to secure £5,000, charged on company's undertaking and property, present and future, including uncalled capital. Holder, J. Deakin. No trustees. Previously issued of same series, £1,500.

CITY NOTES.

MEMORANDA (Oct. 6).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26 1/16d. per oz. Consols 88⅝—88¾ for money, 88¾—88⅞ for account; 2½ per cent. annuities 87⅞—88⅛. Consols Pay Day, Nov. 4; Stocks and Shares Continuation Days, Oct. 11 and 25; Ticket Days, Oct. 12 and 26; Pay Days, Oct. 13 and 27; Mining Share Carry-over Days, Oct. 10 and 24.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The directors recommend a dividend at the rate of 5 per cent. per annum on the ordinary shares (tax free) for the half-year ended June 30.

DIRECT UNITED STATES CABLE CO. (LTD.)—The directors have resolved to pay an interim dividend of 3s. per share, tax free (at the rate of 3 per cent. per annum), for the quarter ended 30th ult., payable on 26th inst.

RAND CENTRAL ELECTRIC WORKS (LTD).—During September 845,000 units were generated, and the gross revenue was £7,900, compared with 711,000 units and £6,290 in the corresponding month of last year.

REUTER'S TELEGRAM CO. (LTD.)—An interim dividend at the rate of 5 per cent. per annum, tax free, has been declared for the half-year ended June 30.

SUBMARINE CABLES TRUST.—The coupon due Oct. 15 will be paid by Messrs. Glyn, Mills & Co., 67, Lombard-street, London, E.C.

WESTERN UNION TELEGRAPH CO.—Mr. T. Waldemar Goulding has been appointed general superintendent of this company in place of Mr. D. Le Rougetel. Mr. Goulding will have control over the company's service in Great Britain and the Continent, with headquarters in London.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Oct. 1	1,616	+ 310	18	29,186	+ 5,404
Airdrie	Sept. 13	216	...	33	6,609	...
Ayr Corporation	Oct. 1	325	+ 2	20	8,421	+ 472
Barnsley	Sept. 23	170	- 14	38	6,486	- 456
Barrow	,, 23	297	...	33	6,594	...
Bath Electric Trams, Ltd.	,, 23	721	...	39	25,365	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	Oct. 2	1,078	- 90	...	...	...
Birmingham Corporation	,, 1	341	...	39	11,950	...
Birmingham Tramways Co.	,, 1	5,755	+ 279	18	70,752	+ 2,968
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	Sept. 29	1,512	+ 399	26	88,213	+ 5,375
Blackpool and Fleetwood	Oct. 1	784	- 28	13	18,124	+ 149
Blackp'l, St. Anne's & Lytham	Sept. 29	550	+ 119	48	19,417	+ 7,231
Bolton Corporation	Oct. 2	1,844	- 28	27	51,224	+ 450
Bournemouth Corporation	Sept. 28	1,136	+ 16	‡26	31,769	+ 1,804
Bradford Corporation	Oct. 1	4,888	+ 943	26	125,872	+ 22,586
Brighton Corporation	,, 2	1,017	+ 69	26	29,647	+ 3,010
Brisbane Tramways	Aug. 17	3,126	+ 80	7	17,199	+ 52
Bristol Trams & Carriage	Sept. 30	5,017	- 203	8	102,474	+ 937
Buenos Ayres & Belgrano	...	...	...	...	...	...
Burnley Corporation	Oct. 1	1,124	+ 235	1	1,124	+ 235
Burton Corporation	,, 2	345	- 73	¶26	9,777	+ 1,839
Calcutta Tramways Co.	,, 1	₹38,502	+ ₹1,001	14	₹475,308	+ ₹46,811
Camborne-Redruth	,, 3	110	- 8	22	2,599	- 118
Cardiff Corporation	,, 1	2,065	- 8	26	56,193	+ 1,962
Carlisle Tramways Co.	,, 1	202	- 13	39	7,911	+ 274
Central London Railway	,, 1	6,473	+ 290	13	77,020	- 328
Chatham & Dist. Lt. Rys.	Sept. 29	591	+ 70	39	23,311	+ 2,138
City & South London Rly.	Oct. 2	2,515	- 29	14	33,442	- 1,131
Colchester Corporation	Sept. 29	230	...	9	3,168	...
Cork Electric Trams Co.	,, 29	512	- 49	39	18,522	- 2,408
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 23	548	+ 25	33	20,664	+ 3,323
Dover Corporation	Oct. 1	286	- 18	27	6,658	- 190
Dublin & Lucan Railway	Sept. 30	126	- 12	13	1,833	- 16
Dublin Southern District	,, 30	925	- 68	} 13	72,074	- 3,278
Dublin United	,, 30	3,928	- 192			
Dudley—Stourbridge	,, 23	974	- 9	38	33,676	+ 1,843
Dundee Corporation	,, 28	882	- 55	...	...	...
East Ham Council	Oct. 1	699	+ 121	26	20,319	+ 1,530
Gateshead & Dist. Trams	Sept. 28	932	+ 33	38	31,613	+ 1,497
Glasgow Corporation	Oct. 1	15,776	+ 109	†18	257,174	+ 14,915
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	Sept. 23	251	- 55	38	10,006	+ 694
Gt. Northern & City Rly.	Oct. 1	1,188	...	33	31,763	...
Greenock & Port Glasgow	Sept. 23	623	+ 76	38	22,279	+ 1,218
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 23	319	+ 16	38	11,493	+ 1,039
Huddersfield	Oct. 1	1,552	+ 323	26	36,779	+ 2,751
Hull Corporation	,, 1	2,131	+ 224	26	57,852	+ 7,736
Ilford District Council	,, 1	429	- 6	§26	13,302	+ 569
Ilkeston Corporation	Sept. 28	148	- 33	...	...	...
Ipswich Corporation	Oct. 1	481	...	26	14,360	...
Isle of Thanet Co.	Sept. 30	623	+ 228	52	34,980	+ 1,555
Kidderminster & District	,, 23	153	+ 2	38	5,126	+ 39
Kirkcaldy Corporation	,, 28	2 6	- 54	19	9 034	...
Lanarkshire Trams Co.	,, 29	759	+ 40	39	25.234	...
Leeds Corporation	Oct. 1	5,856	- 255	26	161,659	+ 9,947
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	Sept. 24	10,684	- 388	39	404,863	+ 12,214
Liverpool Overhead Rly.	Oct. 2	1,538	- 134	†14	23,112	- 865
*London County Council	Sept. 24	13,791	+ 2,737	§26	325,657	+ 67,764
Lowestoft	Oct. 1	212	- 19	...	...	...
Maidstone Corporation	Sept. 29	166	...	11	2,032	...
Manchester Corporation	Oct. 1	12,585	+ 448	26	327,562	+ 18,335
Mersey Railway	,, 1	1,478	+ 106	13	18,770	+ 1,351
Merthyr	Sept. 23	209	- 4	38	7,786	+ 117
Metropolitan Elec. Trams	,, 30	1,913	+ 572	13	25,651	+ 6,258
Middleton	,, 23	356	- 3	38	12,811	+ 188
Nelson Corporation	Oct. 1	123	+ 25	27	3,908	+ 1,081
Newcastle-on-Tyne Corp.	,, 1	3,940	+ 255	13	48,159	+ 2,825
Newport (Mon.)	,, 1	527	+ 54	26	13,991	+ 1,331
Oldham, Ashton & Hyde	Sept. 23	580	- 12	38	21,115	- 892
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams.	,, 30	1,194	+ 25	39	50,820	+ 6 028
Peterborough	,, 23	153	+ 3	38	5,923	- 121
Poole and District	,, 23	365	+ 9	38	11,962	- 23
Portsmouth Corporation	Oct. 1	1,933	+ 42	§26	57,915	+ 4,799
Potteries	Sept. 23	1,856	+ 51	38	65,028	+ 5,239
Reading Corporation	,, 29	639	+ 6	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 23	161	+ 35	38	6 2.5	- 53
Salford Corporation	Oct. 8	4,115	+ 31	26	111,013	+ 7,293
Sheerness	Sept. 21	75	- 4	38	2,498	- 478
Sheffield Corporation	Oct. 2	4,691	- 175	§27	128,616	+ 2,709
Southampton Corp'ation	Sept. 29	972	- 127	26	27,453	- 1 513
Southend Corporation	...	...	...	...	...	...
Southport Tramways	,, 23	333	+ 1	38	13,936	+ 599
S. Staffordshire Trams.	,, 23	840	- 227	38	23,388	- 5,034
Stockport Corporation	...	...	...	...	...	...
Sunderland Corporation	Oct. 2	1,216	+ 2	27	35,147	+ 390
Swansea Trams	Sept. 23	528	- 13	38	21,100	+ 998
Taunton Trams	,, 23	57	- 9	38	2,174	- 503
Tynemouth and District	,, 23	285	- 37	38	11,668	- 978
Tyneside Trams Co.	,, 28	543	+ 186	39	15,455	+ 2,585
Wallasey District Council	Oct. 1	744	+ 37	§26	21,196	+ 1,274
Walsall	,, 1	491	...	38	19,020	...
Warrington Corporation	Sept. 29	312	- 6	26	8,584	+ 321
West Ham Corporation	,, 29	1,140	...	31	28,389	...
Weston-super-Mare	,, 21	209	+ 46	38	5,613	+ 427
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 23	461	+ 66	38	15,083	- 17
Worcester	,, 23	361	+ 200	33	10,812	+ 5,186
Wrexham	,, 23	116	- 59	38	4,317	- 652
Yorkshire Woollen District	,, 23	647	+ 149	38	22,983	+ 8,729

(a) These comparisons are with the corresponding period last year.

* Partly electrical † Minus 8 days. ‡ Minus 2 days § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Oct. 5.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS WEEK TO OCT. 5. High est.	BUSINESS WEEK TO OCT. 5. Low est.
		ELECTRIC RAILWAYS, TRAM WAYS, &c		£ s. d.			
5	8/0	†Anglo-Argentine Ordinary Shares	£3/8–6¾	4 7 3	April, Oct	6¾	6½
5	2/6	† Do. 5% Cum. Pref.	£3/8–£4	4 8 10	..	6⅞	6⅝
St.	6%	Do. Permanent 6% Deb. Stock	139 –142	4 4 10	..	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	102 –104	4 17 6	..	103½	103½
10	6%	Barcelona Tramways Ord.	9 –10	3 0 0	..	9½	..
10	5/0	Do. 5% Cum. Pref.	9 –10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 –96	4 14 0	..	..	..
100	5%	Do. 5 per Cent. Debs.	98 –101	4 19 6	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	⅜ –½	..	..	..	..
1	..	Do. 5% Cum. Pref.	½–1	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1¾–2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½–4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96 –101	4 9 8	..	..	..
10	3½	Bristol Tramways and Carriage Ord.	19 –20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 –10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 –108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	97 –100	6 2 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	100 –103	4 18 0	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10½	4 15 3	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	104¾–106¾	4 6 7	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 –100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	9½–10	6 0 0	..	9⅛	9⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾–11½	5 6 7	Feb, Aug	11⅛	10⅝
St.	5/0	† Do. 5 per Cent. Perpetual Debs	115 –118	4 4 7	..	117	115½
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	94 –97	..	..	96	95
5	1/6	Buenos Ayres and Belgrano Ord.	3½–3¾	5 19 11	..	3⅛	3⅛
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5⅛–5¾	5 4 4	..	5¾	5⅝
5	3/0	Do. "B"	5¼–5¾	5 11 6	..	5¾	5⅝
St.	5%	Do. 5 per Cent. Debs.	105 –108	4 12 8	..	107½	107
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102 –105	4 16 3	..	..	..
St.	5%	Buenos Ayres Elec. Trams (.901) Ltd. 5% Deb. Stk.	96 –99	5 2 6	..	..	..
5	3 0	†Calcutta Tramways	7¼–7¾	4 2 9	..	7¼	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 –108	4 4 0	..	107	..
1	1/0	Cape Electric Tram Shares	1⅜–1¾	5 6 3	..	1⅛	..
St.	4%	Central London Ordinary Stock	87 –90	4 9 0	June, Dec	89	86½
St.	4%	Do. 4 per Cent. Pref. Stock	100 –102	3 18 3	..	..	..
St.	4%	Do. Deferred Stock	79 –81	4 18 9	..	80⅜	80½
100	4%	Do. 4 per Cent. Debs.	107 –110	3 13 4	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½–5	5 0 0	..	5	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	4 0 0	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	47 –49	4 10 10	Feb, Aug	48⅛	48
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 –125	4 0 3	Feb, Aug	..	..
St.	5%	Do. (1896)	117 –120	4 3 6	..	119	118
St.	5%	Do. (1901)	113 –117	4 6 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	105 –108	3 14 9	May, Nov	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	101 –104	4 18 0	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13 –14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	..	..
10	3 0½	Gt. Northern & City Rly. Prf. Ord. (4%)	5 –5½	..	..	..	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 –10	..	..	..	..
10	10%	‡ Imperial Tramways Ord.	19 –20	4 10 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½–14¾	4 1 4½	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109 –111	4 1 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 –91	4 7 11	..	..	..
10	1¾%	Liverpool Overhead Railway Ord	3⅜–3⅝	3 15 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 –10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10½–11	4 10 11	..	10⅛	10⅜
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 –105	3 16 4	..	104⅜	104½
St.	..	Madras Elec. Trams 5% Deb. Stk.	102 –105	..	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6 –9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 –15	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅝–¾	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	¾–1	5 0 0	..	⅞	⅝
St.	18/7	Do. 4½% Deb. Stock	99 –101	..	..	99⅜	99½
100	5%	Montreal St. Ry. St'g 5% Mrt. Dbs. (1908)	100 –103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 –105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1 –2	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	102 –105	4 16 6	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 –9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½–9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 –104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	86 –89	3 7 5	June, Dec	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	¾–1	5 14 2	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	¾–⅞	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5½–6	6 13 4	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¼–6	5 0 0	Jan, July	5⅛	5⅛
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 –104	4 6 7	..	..	..
St.	4½%	British Thom's'n-Houst'n 4½% 1st Mt. Db.	100 –102	4 8 6	..	..	..
5	3/0	British Westinghouse 6% Pref.	2⅝–3⅛	9 4 6	..	2⅝	2⅞
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	86 –89	4 10 9	..	..	..
2	..	Brush Electrical Engineering	½–¾	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1 –1½	8 0 0	Mar, Sept	1½	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	94 –97	4 12 10	Mar, Sept	93½	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	70 –75	6 0 9	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½–10½	5 14 3	Jan, July	9½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	101 –105	4 5 8	Nov, May	..	..
1	9¾d.	Castner-Kellner Alkali Co. (fully paid)	½–¾	5 6 8	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 –93	4 16 10	..	..	..
1	1/2½	Chadburn's (Ship) Telegraph Ord.	¾–1⅛	8 0 0	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½–2	3 15 0	Jan, July	1½	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	90 –95	5 6 5	Jan, July	..	..
5	10/0	†Dick, Kerr & Co. Ord.	7 –7½	6 13 4	Sept	..	..
5	3/0	† Do. 6% Cum. Pref.	5½–5¾	5 4 4	Sept	5⅝	5⅝
St.	4½%	Do. 4½% Deb. Stock	103–106	4 5 9	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½–¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 –2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 –82	4 18 1	June, Dec	..	..
St.	5%	† Do. 5 per Cent. 2nd Deb. Stock	78 –82	6 2 0	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6¼–6⅝	5 9 9	H'lf-yearly	6½	6⅜
5	3/0	Do. 6 per Cent. Cum. Pref.	6 –6½	4 16 0	..	6½	6⅜
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105 –108	4 3 10	..	106¼	..
2	1/7½	Electric Construction Co.	1 –1½	6 8 0	July	1½	1⅜
2	2/9½	Do. 7 per Cent. Cum. Pref.	2 –2½	5 12 0	July	..	..
St.	4%	Do 4 per Cent. 1st Mort. Deb. (red.)	96 –99	4 0 9	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 –9½	5 5 3	..	9⅛	..
St.	4%	† Do. 4 per Cent. 1st Mort. Debs.	91 –96	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½–11½	6 1 9	Feb, Aug	10½	..
[illegible]	2/3	Do. 4½ per Cent. Pref.	5 –5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 –111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	19 –20	5 0 0	Feb, Aug	19½	19
100	4%	† Do. 4 per Cent. 1st Mort. Deb (red.)	99 –102	3 18 5	Mar, Sept	100	99½
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½–11	4 10 11	Mar, Sept	..	..
15	12/0	Telegraph Construction & Mainten'ce.	85 –88	6 6 3	Mar, July	86½	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 –104	3 17 6	Jan, July	..	..
5	..	Willans and Robinson Ord.	1 –2	..	..	..	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Oct. 5.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS WEEK TO OCT. 5. High est.	BUSINESS WEEK TO OCT. 5. Low est.
		ELECTRICITY SUPPLY.		£ s. d.			
..	..	Blackheath & Greenwich Dist. El. Lt. See South Metropolitan Elec. Lt. & Power Co. below	..	..	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½–12½	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½–10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½–11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 –106	4 5 9	..	..	..
5	..	Bromley (Kent) El. Lt. & Power Shares	5½–5¾	..	..	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 8 3	..	103½	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½–11½	4 8 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10½–10¾	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7½–8	4 7 6	..	7⅛	7⅛
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	107 –110	3 13 8	..	..	..
10	4/0	Charing Cross & Strand Electric Sup.	8½–8¾	4 11 6	Feb, Aug	8¾	8½
5	2/3	Do. 4½ per Cent. Pref.	5¼–6½	4 1 10	Feb, Aug	6½	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½–5	4 10 0	..	..	..
5	2/3	Do. Do. (1903)	4½–5	..	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103 –105	3 17 3	..	104	103½
5	2/3	Chelsea Electric Supply Ord.	6½–7	4 2 2	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108 –111	4 1 9	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10½–10⅝	4 13 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	120 –125	4 0 0	Jn, Dec ..	124	123½
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103 –106	4 5 9	..	105	104½
10	4/0	County of London Elec. Supply Ord.	8 –9	4 8 11	..	8⅜	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12	5 0 0	Mar, Sept	11⅝	11½
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	105 –108	4 3 6	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	102 –105	4 7 5	..	102⅜	102
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 –93	5 7 6	..	..	..
5	2 0	†Folkestone Electricity Supply Co. Ord.	5½–6	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 –104	4 7 6	..	..	..
10	..	Havana Electricity Co. Shares	9½–10½	..	..	..	..
5	5 0	Hove Electric Lighting Ord.	7⅜–8¼	5 0 0	..	8	..
St.	4½%	I of W. Elec. Lt. & Power 4½% Db. St (red.)	101 –103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	1/16–⅛	..	..	..	..
5	5/0	Kensingtn & Knghtsbdge Ord.	12 –13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6¼–7	4 5 9	Jan, July	..	..
St	4%	†Kensingtn. & Knghtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	100 –103	3 17 9	..	..	..
3	..	London Electric Supply Ord.	1¾–2¼	..	..	..	..
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 9 1	..	5½	5⅛
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	97 –100	4 1 0	Mr, Jn, S, D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	15½–16½	5 10 8	April, Oct	16⅛	15¾
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅛–5⅜	4 0 0	Jan. July	5⅜	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	112 –117	3 18 0	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 –99	3 10 6	..	97	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93 –96	4 13 9	..	..	..
10	6/0	Notting Hill Electric Ord.	14½–15½	3 17 6	March	..	..
100	4%	† Do. 4 per Cent. 1st Mt. Debs.	99 –102	3 18 6	..	..	..
5	2/6	Oxford Electric Ord.	5⅜–6½	5 4 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99 –102	3 19 2	..	..	..
1	..	Rand Electric	1/16–1/8	..	..	..	..
100	4½%	*†Royal Elec., Montreal 4½% 1st Mt. Deb	98 –101	4 9 0	April, Oct	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	14½–15½	4 13 7	Feb, Aug	15	14⅞
5	3/6	Do. 7 per Cent. Pref.	8 –9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 –101	3 10 0	..	100½	100
5	4/0	Smithfield Markets Electric Sup. Ord.	2⅜–3½	6 3 1	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 –87	4 12 6	..	..	..
5	3/0	South London Electric Supply Ord.	4½–4⅝	3 3 1	..	4⅝	4⅞
1	..	South Metrop'n Elec. Lt. & Power Ord.	¾–1	..	..	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅛–1½	4 13 4	..	..	..
St.	4½%	† Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	104 –108	4 3 3	..	107⅛	105½
5	2/6	†Urban Electric Supply Ord.	4⅜–5	5 0 0	..	4⅝	4⅜
5	2/6	† Do. 5% Cum. Pref.	4⅝–5	5 0 0	..	4⅝	..
5	6/6	Westminster Electric Supply Ord.	12½–13½	5 0 0	Mar, Sept	13½	12⅞
5	2/6	Do. 5 per Cent. Cum. Pref.	6 –6½	3 16 11	..	..	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	98 –102	3 19 0	Jan, July	..	..
10	..	Amazon Telegraph	2¾–3½	..	Jn, Dec ..	..	..
St.	12/6	Anglo-American	50 –53	5 5 9	F, My, Ag, N	52	51½
St.	25/0	Do. Preferred	96 –98	5 12 8	F, My, Ag, N	97½	96½
St.	2/0	Do. Deferred	8½–8¾	1 2 8	F, My Ag, N	8⅞	8½
100	£2	†Commercial Cable Capital Stock	170 –190	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	93 –96	4 3 6	Jn Ap, Jy, O	96	94
10	5/0	Cuba Submarine Ord.	7 –8	7 10 0	Feb, Aug	7⅞	..
10	10/0	Do. Preference 10 per Cent.	15 –16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½–3½	5 14 4	April, Oct	..	..
10	5/0	† Do. 10 per Cent. Cum. Pref.	7 –8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅞–101⅞	4 9 2	Jan, July	..	..
20	3/0	Direct United States Cable	10½–10¾	5 11 3	Ja, Ap, Jy, O	10⅝	10⅜
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 –101	4 9 2	Jn, Dec ..	..	..
St.	65/0	Eastern Ordinary	130 –135	5 3 9	Ja, Ap, Jy, O	134	131½
St.	17/6	Do. 8% per Cent. Pref. Stock	87 –90	3 18 6	Ja Ap, Jy, O	89	88½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106 –109	3 14 3	May, Nov	107	..
10	2/6	Eastern Extension	12½–13	5 7 9	Ja, Ap, Jy, O	12⅞	12⅝
St.	4%	Do. 4 per Cent. Deb. Stock	105 –108	3 14 3	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	99 –102	3 18 9	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100⅞–103⅞	3 18 6	May, Nov	..	..
10	5/0	Gt. Nrthn. (of Copenhagen)	29 –30	5 0 0	Jan, July	29½	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 –101	4 9 2	June, Dec	..	..
25	37/6	Indo-European	44 –47	5 6 4	May, Nov	46	45
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 –100	4 0 0	June, Dec	..	..
10	6/0	West African Telegraph Shares	6 –7	5 14 3	..	..	..
100	4%	West Coast of America	1/16–⅛	..	..	..	..
		Do. 4 per Cent. Debs.	97 –100	4 0 6	Jan, July	..	..
10		West India and Panama	⅜–½	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6¼–7	8 11 5	May, Nov	6⅜	6⅛
10	..	Do. 6 per Cent. 2nd Pref.	5 –6	..	May, Nov	5⅛	..
100	5%	* Do. 5 per Cent. Debs.	100 –103	4 17 10	Jan, July	..	..
10	3/0	Western Telegraph	12½–13	5 7 9	Mr, Jn, O, D	12⅝	12½
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 –104	4 16 3	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 –104	3 17 6	..	..	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5 –5½	6 7 3	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	1/16–⅛	..	..	..	..
St.	6%	National Co. Pref. Stock	104 –106	5 13 9	..	105½	104
St.	5%	Do. Def. Stock	92 –94	5 6 5	..	13½	91
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 –14	4 5 8	Feb, Aug	18⅛	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 –13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅛–5⅝	4 13 0	Feb, Aug	..	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 –99	3 10 8	June, Dec	98	97½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104 –106	3 15 9	..	104½	..
..	5/0	Do. Do. Prov. Certs. 35% to be pd.	67 –69	..	..	67½	..
1	0/8½	Oriental	1⅛–1 1/16	6 6 8	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼–1⅜	4 16 0	..	..	..
5	5/0	United River Plate	6 –6½	6 8 3	July	6⅝	6½
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅝–5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 –106	4 14 4	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾–5¼	5 14 4	..	9½	9⅜
10	2/0	Globe Telegraph and Trust	9¼–9½	5 12 8	Jn Ap, Jy O	16	15⅞
10	3/0	Do. 6 per Cent. Pref.	13½–14½	4 4 2	Ja Ap, Jy, O	..	..
		[illegible]			April, Oct		

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THE ELECTRICIAN:

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NOTES.

THOSE of our readers who have failed to make practical application of the contents of Mr. OLIVER HEAVISIDE'S "Electromagnetic Theory" will have been interested by the important papers we conclude this week on "The Duplex Balancing of Telegraph Cables." In these Mr. GAYE has not only shown the application of HEAVISIDE'S methods to the general problem of a long cable duplex balance, but has extended them to include the case which had been omitted in the mathematical work both of HEAVISIDE and of HOCKIN, partly, no doubt, on account of the very lengthy formulæ to which it leads. The infinite series representing the curves of current and pressure entering a cable through a terminal resistance or terminal capacity had been considered separately, whilst the case in which both the resistance and the capacity are present together remained to be dealt with. It is precisely this problem which is the practical one, for in the condenser bridge duplex system it has always been the practice to introduce a differentially adjustable rheostat between the key and condensers. Mr. GAYE has fully investigated this standard system, as well as that of the plain resistance bridge.

IT is, however, the obstacles arising from the want of true similarity between the artificial line and cable which constitute the difficulty of duplexing a long submarine circuit. Although, as Mr. GAYE shows, the difference between the resistance operators $\sqrt{R/S}$ and $\sqrt{R_1/S_1}$ is balanced by the ratio of the bridge arms, there remain a number of factors in which the cable may not be exactly imitated; and these cannot also be compensated by the ratio arms, but have to be allowed for by alterations in the artificial line. The number and distribution of these artificial line adjustments further complicate the problem of balancing. As an instance of one of the applications of mathematical theory which would require to be included in a complete study of the subject, may be mentioned the reflection of the wave at changes of the $\sqrt{R/S}$ constant, or again from the remote end of the line, unless earthed through a critical resistance; factors which are dealt with in the remarkable treatment, both of possible and impossible cables, in Vol. II. of "Electromagnetic Theory."

MR. GAYE'S curves form a valuable contribution to the graphics of submarine cables; for whilst the pressure curves illustrate the points to be attended to in duplex balancing, those of the current bring out very clearly the influence of the various factors upon signalling amplitude. One of the most useful of them is the curve of maximum pressure, from which may be readily ascertained the greatest stress to which the dielectric of a cable is subjected under a given combination of battery resistance, condenser capacity, and core ratio. The want of an expression for this has long existed, and to the average mathematician the solution of the problem appeared by no means easy. Alike in the simple formula he has arrived at for this maximum pressure, and in his development and handling of the laborious and cumbrous expansions from which the curves had to be traced, Mr. GAYE has rendered good service to telegraph engineers.

PROF. SILVANUS P. THOMPSON can hardly have paused to consider the damage which he might do to the electrical engineering profession when he indited his letter, published in last Saturday's *Times*. "For it was not an enemy that reproached me; then I could have borne it: neither was it he that hated me that did magnify himself against me; then I would have hid myself from him. But it was thou, a man mine equal, my guide, and mine acquaintance." Re-reading and considering the letter does not diminish our feeling that Prof. THOMPSON'S action is unfortunate and serves no public interest commensurate to the damage it may do. The Professor makes the blunt assertion that the "live rail" is an "obsolete device"

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and an "engineering blunder"; and he appeals to "public opinion in some effective form, such as a departmental inquiry, to step in and prevent the railway engineers of England from committing our railway systems any further to this dangerous and unnecessary device."

WE hold no brief for the live rail, and have, indeed, consistently suggested that its use on railways is necessarily limited to lines on which the traffic is of the suburbs-to-city class. This limitation is essentially economic, and needs no assistance from public opinion or departmental inquiries. There is not the slightest reason to anticipate that the live rail will find general application on English main lines. Prof. THOMPSON should know that; other experts do; the readers of *The Times* do not. The machinery of departmental inquiry has its uses: for example, in the case of the Metropolitan and District electrification, where it removed a deadlock caused by a conflict of opinion between equally interested parties, each supported by some of the most eminent electrical engineers of this and other countries. We doubt whether Prof. THOMPSON was pleased with the result in that case. Moreover, we would suggest to him that the assistance he invokes often obstructs advance by its natural tendency to approve only what is well tried, and while intending only to hedge with safeguards, often builds barriers across the road of progress.

THE Professor's ostensible motive is humanitarian, and his good faith being absolutely above suspicion, we can but express our surprise that he has seen fit to step into the market place and publicly denounce the railway engineers (and—by inference—their electrically-trained advisers) as adherents to obsolete, dangerous, and unnecessary devices. Disregard for life and limb is not a marked characteristic of English engineers, and if they sin in ignorance it would seem to be the Professor's duty rather to teach and reason with these men who cannot disregard his teaching *ex cathedrâ*, but will hardly be convinced by mere assertions in *The Times*. The task is to convince the railway engineers and boards that there is available to-day an overhead system commercially practicable and applicable to railways carrying frequent and heavy traffic. If there is, we agree that the live rail is for the future unnecessary, and its days are certainly numbered. We should hail the demonstration with delight, but we doubt whether there is to-day an overhead system applicable to, say, the Liverpool Overhead or the City and South London Railways without serious detriment to their service. On these lines the live rail has done excellent service for many years with very few accidents to its debit and an immense sum of public convenience to its credit. It has not merited the Professor's denunciation.

THE Paper read by M. NODON, before the St. Louis International Electrical Congress, on electrolytic rectifiers or "valves" to convert alternating into continuous current contains several points of interest. It appears from the researches carried out by the author that the apparatus works fairly well until a temperature of 30°C. is reached, when leakage occurs, and, as a matter of fact, we believe this is borne out in practical working. In order to prevent any occurrences of this kind, it is necessary to resort to artificial cooling by means of electric fans. Other points of interest in M. NODON'S Paper relate to the composition of the cathode and electrolyte. He finds, for instance, that the best results are obtained when the cathode used is of lead, capable of formation, and having a larger surface than the anode. A concentrated solution of neutral ammonium phosphate is the most suitable electrolyte, this being important, as the wave-form of the rectified current depends largely on the nature of the electrolyte. Considerable improvement is still necessary before the Pollak-Nodon rectifier becomes a commercial piece of apparatus, and we trust that M. NODON will continue his investigations.

AN interesting case under the Workmen's Compensation Act is reported in another column of this issue. The facts are as follows:—A labourer was at work at a trench for laying cables in connection with the Newbury electric light system. A horse took fright at the cable drum, ran away and fell in the trench on top of the man, with the result that the man's leg was broken. He claimed 10s. a week damages, this being half the rate of wages he was earning at the time. Had the accident occurred in an engineering works there could be no dispute, but as the workman had necessarily to contend that the trench was in point of law an engineering works, as it was part of the work carried out under the Newbury Provisional Order, which included the erection of electricity works, the claim was naturally contested. An award in this sense was made, notwithstanding the fact that the trench was at the time separated from the works by two lengths of unlaid road, each 250yds. long, in which no cables had yet been laid. The facts were not disputed, so that the case resolved itself into a question of law and is an important precedent. We trust, therefore, that there will be an appeal. It is a peculiar construction of the Act that a man working in the street a quarter of a mile distant from the works shall be considered "in, on or about" a factory. The case is a particularly hard one, for the fact that there is no negligence on the part of the employer has to be considered as irrelevant; it is merely necessary for a man to prove that he was injured during the course of his employment in, on or about a factory, for him to be able to recover damages.

ONE of the most valuable Papers of Section F (Electric Transportation) of the International Congress of St. Louis was that by Mr. LEWIS B. STILLWELL, containing a detailed description of the electrically-operated Wilkesbarre and Hazleton Railway. The line traverses a very mountainous district with various cross ranges, but in spite of this the length of track is but 26·2 miles—*i.e.*, only 25 per cent. more than the straight distance between the two towns at the termini. On the other hand, the two steam railways which connect the same places are nearly 2½ times as long as the intervening distance. In view of the attention which is now given in this country to the protection of the third-rail, the construction of the protective device on the Wilkesbarre–Hazleton line merits careful attention, as it appears to have fulfilled its function for some 18 months (therefore, both in winter and summer) with entire success, and to be preferable

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in some respects to the forms employed hitherto. The guard plank is a single sloping board, supported by short wooden posts, spaced at regular intervals. This design has the advantage over the present form of guard planks in that occasional accumulations of autumn leaves, snow, &c., are, in Mr. STILLWELL's experience, swept away automatically by side winds. A special form of collector shoe was needed to work satisfactorily with this type of protection, and the pattern adopted seems to fulfil all requirements. The principle of restricting the point of breakage —if such were to occur—to a given place by making this place weaker mechanically than all the other parts of the device is, of course, not new. It has been applied, for instance, to the De Laval turbine for minimising the damage done if ever the turbine wheel should increase in speed so as to burst. Another feature of this electric railway is the sub-station on wheels, which may be shifted along the line so as to meet abnormal requirements at any point.

THE wireless telegraph patent granted to Mr. J. NEVIL MASKELYNE, which we reprint in another column, covers a principle which has, for some considerable time, been used in the De Forest system. We refer to the "loop" or "closed circuit" constituting the aerial wire or antenna. Last December this same method of sending and receiving by a loop instead of a single vertical wire was employed by Dr. DE FOREST in his experiments across the Irish Channel from Holyhead to Howth (*The Electrician*, Vol. LII., p. 240). But Mr. MASKELYNE filed his provisional specification on July 21, 1903, and although Dr. DE FOREST made use of the principle he had been unaware that it was due to Mr. MASKELYNE. Doubtless the fact that Mr. MASKELYNE held such a patent facilitated the recent successful negotiations towards the amalgamation of the two systems. Another interesting feature of the patent is the exceedingly ingenious instrument termed a "conjunctor." This device was tried at the Holyhead–Howth trials, and worked most successfully.

University College, London.—Sir William Ramsay will begin a special course of lectures on "Radio-activity" at University College, Gower-street, London, on Tuesday next, at 5:30 p.m.

The Metric System.—At Tuesday's meeting of the French Academy of Sciences, M. Berthelot announced that the metric system is to be adopted in New Zealand in accordance with a decision of the parliament of that Colony.

Röntgen Ray Congress.—A congress for the purpose of discussing the production and application of Röntgen rays will be held in Berlin on April 30, 1905. The occasion is the tenth anniversary of the discovery, and Prof. Röngten will be present as the guest of honour.

Faraday Society.—Beginning with November the Faraday Society will publish its own *Proceedings* instead of their being incorporated with the *Electro-Chemist and Metallurgist*. The Society's publications will consist of quarterly *Transactions* and monthly *Proceedings*.

Institution of Mechanical Engineers.—The first monthly meeting of the Institution of Mechanical Engineers of the coming session will be held on Friday next at 8 p.m. at Storey's Gate. The Paper to be read and discussed is "A Scientific Investigation into the Possibilities of Gas Turbines," by R. M. Neilson.

Opening of the Keighley Electric Tramways.—This system was inspected by the Board of Trade and formally opened on Wednesday. A provisional order was obtained by the Corporation in 1903, and the lines were laid down under the supervision of Mr. W. H. Hopkinson, the borough surveyor. Current is obtained from the Corporation power station. The length of the track is 3¼ miles and the gauge 4ft.

Cable Interruptions.	Date of Interruption.
Cayenne—Pinheiros	Aug. 13, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Cayenne—Paramaribo	July 13, 1904
Cap Haitien—Mole St. Nicholas	Aug. 20, 1904
Bundaberg—Gomen (New Caledonia)	Aug. 30, 1904
Cap Haitien—Puerto Plata	Sept. 26, 1904
Dominica—Martinique	Oct. 1, 1904
St. Lucia—Martinique	Oct. 1, 1904
Trinidad—Demerara	Oct. 11, 1904

Wireless Telegraph Notes.—It is reported that the United States Navy Department has selected 82 sites, on the coast, for wireless telegraph stations; 20 of these are, however, already equipped. The Department has, as yet, come to no decision regarding the system which they will adopt officially.

A Reuter telegram affirms that a wireless telegraph station was opened last Friday at Ushant. This station will be employed for communicating with ships at sea and, it is said, will receive messages from France, Algeria, Tunis, Monaco and Andorra.

Institution of Electrical Engineers.—No. 169 of the *Journal*, forming the last number of Vol. XXXIII., has now been issued. It contains three Papers read before local sections in March and April, an original communication on "Eddy Currents in Solid and Laminated Iron Masses" by M. B. Field, and two students' Papers—viz.: "Armature Reactions in Alternators with some Notes on the Running of Synchronous Motors," by H. W. Taylor; and "Alternating-current Commutator Motors," by F. Creedy. The index to Vol. XXXIII. has been prepared in a more detailed and useful manner than hitherto. Members who have contributed to the McMillan Memorial Fund received with the *Journal* a fine photogravure of the late secretary. It is an excellent portrait of Mr. McMillan, and as a picture is a most artistic production.

New Central Station at Brussels.—According to *L'Industrie Electrique*, the municipal authorities have accorded the contract for the new central station of Brussels to the Allgemeine Electricitäts-Gesellschaft, who have agreed to carry out the work for 1,285,000fr. (£51,400). The company also guaranteed that for 10 years the cost of production (including capital charges) per kilowatt-hour, measured at the entrance of the high-tension three-phase line into the sub-stations, was not to exceed 10c. (0·96d.), and that the corresponding figure for the continuous current after leaving the switchboard of the sub-stations was not to be more than 18·5c. (1·78d.). These guarantees refer to a minimum annual consumption of 6,467,000kw.-hours on the three-phase side and to an output of not less than 5,250,000kw.-hours on the continuous-current side.

Municipal Electricity Works at Loughborough —The new electricity works at Loughborough are now practically completed, and it is anticipated that supply will be commenced to-morrow (Saturday). A provisional order was secured by the Town Council in 1898, and Mr. C. H. Gadsby was appointed consulting engineer. The steam-raising plant consists of two dry-back boilers, by Messrs. Danks & Co., working at a pressure of 180lb. per square inch and fitted with superheaters for raising the temperature of the steam 250°F. There are two steam-driven feed pumps, a storage tank capable of holding 15,000 gallons of water, and a 200-tube economiser. Steam will be delivered to two Brush turbine sets, each of 250kw. capacity, and the engine room also contains a Siemens balancer booster. The battery consists of 260 cells having a capacity of 500 ampere-hours at the 10-hour rate. Canal water will be used for condensing.

Personal.—Mr. W. Gowland, professor of metallurgy at the Royal College of Science, has been appointed a member of the examination board of the Department of Technology of the City and Guilds of London Institute, in room of the late Sir C. Le Neve Foster, F.R.S.

Dr. Walter Reichel, having resigned his position of chief electrical engineer to Messrs. Siemens and Halske, com-

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menced his duties as professor of electrical engineering at the Charlottenburg Technical College on October 1st. Dr. Reichel, who is 37 years of age, has been with the firm of Siemens and Halske since 1889. He is responsible for the design of the sliding-bow collector for electric tramways, and various types of motors, motor cars, &c., and for the building of a number of electric tramways and railways including those at Genoa, Lichterfelde, the first Dresden tramway, and the Berlin underground and overground railway. His name was also prominently before the engineering public in connection with the Gross-Lichterfelde high-tension experiments, which resulted in the construction of the Marienfelde-Zossen railway and afterwards the high-speed trials there, all of which was carried ont under Dr. Reichel's direction.

The Proposed Higher Technical College for London.—Although nearly 18 months have passed since Lord Rosebery propounded his excellent scheme of a post-graduate technical college for London, on the lines of the famous Charlottenburg Hochschule, little more has been heard of the proposal, and it has been rumoured more than once that the scheme had been abandoned. The *Daily News* having made inquiries with regard to the matter, is able to state that there is some difficulty in finding the necessary money at the present time, but that the matter is under the consideration of a Government Departmental Committee, including representatives of the London County Council and the London University. It is possible that the Government may furnish a site, free of charge, at South Kensington, and that the Royal College of Science and the School of Mines may form the nucleus of the new institute.

Radio-activity and London Clay.—Prof. S. Skinner, writing to *Nature*, states that samples of London clay taken from such different points as Hyde Park Corner, Brompton-road and Haverstock Hill have been tested in the physical laboratory of the South-Western Polytechnic for the presence of a radio-active gas by Mr. H. Cottam, who has been unable to detect with his apparatus any marked quantity of active gas from the clays. With the same apparatus he has detected quite easily the radio-active gas from the water of a deep well belonging to Messrs. Eastman, Latimer-road, W., which goes below the clay to the greensand. The experimenters have, therefore, come to the conclusion that the London clay forms a floor through which the radio-active gas does not penetrate, or it may be said that the radio-active substance only travels when the water with which it is associated can travel. This, Mr. Skinner points out, is an argument in support of Prof. J. J. Thomson's view that the radio-active gas, which he found in deep well waters, arises from the splitting up of a trace of soluble radium salt which comes up with the water.

The Glasgow Technical College Scientific Society.—The opening meeting of the session will be held in the large hall, 38, Bath-street, Glasgow, on Saturday, October 15th, at 7:30 p.m., when the president, Mr. R. D. Munro, will deliver his presidential address. The following is the list of Papers which will be read during the session: October 29th—"The Law of Workmen's Compensation," by W. Boyd Anderson. November 12th—"The Diesel Internal Combustion Engine, as applied to Electrical Generation," by A. J. Lawson. November 26th—"The Electrical Drive of Large Reversing Engines Working Intermittently," by Maurice Georgi. December 3rd—"Symposium." December 10th—"Electro metallurgy: Some Notes on its Present Position," by John D. Mackenzie. December 17th—Thirteenth Anniversary Dinner. January 21st—"Notes on Tool-room Organisation and Practice," by George Blair. February 4th—"Cathode Rays and Allied Phenomena," by Professor Blyth. February 18th—"High-speed Tool Steels from the Users' Point of View," by Edward H. Robertson. March 4th—"Steam Generators and their Failures," by George Ness. March 18th—"Independent Condensing Plant," by Charles Day. April 1st—Annual General Meeting.

2,000kw. Rotary Converters.—The New York Edison Co. will, in the near future, put into service at the Duane-street power house the first of four new 25-cycle, six-phase, 270-volt, 2,000kw. rotary converters, built according to the specifications of the Edison Company's engineering staff. It is asserted by the *Western Electrician* of Chicago that these converters are the largest ever made by the General Electric Co. and are the largest ever installed by the Edison Company. The total height of each machine is nearly 17ft., and the base measures about 13ft. by 17ft., occupying about 225 sq. ft. of floor space. The armature is 12ft. 9in. in diameter and weighs 75,000lb., the weight of the entire machine being 176,000lb. (88 tons). One machine is now in position ready for operating; a second is well advanced, and active preparations are being made to instal the third. All these are for the Duane-street power house, the fourth being for the Twenty-sixth-street station. The shafts are so long that it is necessary to ship them apart from the armatures. The bases are made in two sections, jointed in a line parallel with the shaft, and the pillar blocks are also composed of two portions. With each converter there are three air-cooled 800kw. transformers. The induction regulator at the low-tension side of the transformer, between the transformer and the rotary collector rings, is of 300kw. capacity. It is operated by a small three-phase induction motor controlled by the station regulator from the operating board. The machines will be used for the regular lighting circuits, and are being put in in anticipation of a heavy demand during the coming winter months. Each converter has an overload capacity of 25 per cent. for two hours and 100 per cent. momentarily.

Electric Traction in Russia.—A recent issue of *Engineering* state that two rather ambitious schemes for electric traction on a large scale have recently been brought before the Electrotechnical Association of St. Petersburg. The first is no less than the electrification of the trans-Siberian Railway, a project considered by Count A. F. Lubienski as not only desirable, but necessary. The transportation of passengers and goods on this railway, apart from the traffic due to the war, has developed to such an extent that it will soon become necessary to increase the number of trains. Owing to several circumstances, particularly the lightness of the rails and the insufficiency of water, the existing trains are said to have reached their practical limit of speed; and though the water difficulty might be met by canalisation or other means, the relaying of the track would entail an enormous expenditure of money and time. The Count maintains that the most rational and economical way of meeting the case is by the introduction of electric traction on some parts of the line at least. The existing track would be made use of, and the many sharp curves and heavy gradients would not limit the speed of a multiple-unit electric train to the same extent as in the case of a train drawn by a steam locomotive. It is proposed to make use of the rivers and waterfalls along the course of the line for the supply of electric energy, which would be generated at power stations from 100km. to 200km. apart and distributed in both directions to transformer sub-stations at a pressure of 100,000 volts. The second project was brought forward by Mr. G. O. Graftis. He proposes the electrification of the Caucasian railways on the grounds that electric traction is particularly adapted to a mountainous country, and that abundance of power is at hand in the waterfalls of the Caucasus. The large number of rivers and mountain torrents watering the district through which the railway runs, and supplying up to 80 cubic metres of water per second, constitute an ideal source of power, which could be turned to account with little difficulty. As to the expense of constructing a line along the rocky coast of the Black Sea, the speaker adduced figures showing the cost of the Italian Lecco-Sondrio-Chiavenna electric railway and the Vladikavkase steam railway. He estimated that the establishment of central stations and sub-stations equipped with plant for producing three-phase current at 30,000 volts would entail an expense of £1,000,000 above the cost of a steam service. On the other hand, the working expenses of the electric service with the same amount of passengers and goods carried would show an annual saving of £800 per mile as compared with steam. It is also claimed that, as the electric service would admit of heavier gradients, the construction of the permanent way would be cheapened. After the meeting, in consequence of the importance of schemes of this nature to a district well supplied with water power, the Electrotechnical Association appointed a committee to make an exhaustive investigation of the subject.

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THE AMERICAN TOUR OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

BY OUR SPECIAL CORRESPONDENT.

(*Concluded from p. 980.*)

Sunday, September 11th.

Sunday morning witnessed our arrival in the pleasant country town of Springfield, capital of Illinois, and famous for its association with the name of Abraham Lincoln. After breakfast at the Leland Hotel, a short trolley ride brought us to the cemetery, in the middle of which, on a beautiful wooded knoll, stands the tomb of Lincoln and the national monument erected to his memory. The structure, with its imposing groups of statuary and its fine surroundings, is worthy of its great object.

Shortly after our arrival, the Governor of the State, His Excellency R. Yates, honoured the gathering with his presence, and made a powerful speech on Lincoln's influence on the growth of the American Commonwealth, referring gracefully to electrical engineers as men who can influence the world by their knowledge and activity. The respective presidents of the American, British and Italian Institutions made replies, Prof. Ascoli dwelling particularly on the similarity in character of the struggle through which the young Italian nation had passed, a struggle which also produced a man befitting the time—Garibaldi.

The party then returned to the train and in the early afternoon reached St. Louis. This was one of the few journeys we made by daylight, and the opportunity was welcomed by many of seeing the fertile corn land and natural scenery of the Mississippi Valley.

At St. Louis accommodation was found in the Jefferson Hotel for the whole international party, now swollen to considerable numbers by the influx of engineers and delegates from the Eastern States, many of whom had never before penetrated so far west. An informal reception was held on Sunday evening at the hotel to enable the members to make each other's acquaintance, but it was not till Monday morning that the actual programme of the Congress was begun.

Monday, September 11th, to Saturday, September 17th.

The first meeting was in the great hall of the Coliseum, close to the hotel, in the various rooms of which the different sections subsequently met. President Francis, of the Exhibition, was in the chair, and during his address of welcome to the delegates he made some interesting forecasts as to the improbability of such another gigantic World's Fair as the present, pointing out, however, that any future exhibition would more likely be illustrative of the development of some specialised industry. Prof. Elihu Thomson, as president, then addressed the meeting, stating the objects of the Congress. The appointment of honorary vice-presidents and advisory committees was proceeded with, immediately after which the different sections began the work of reading and discussing their Papers. The sectional meetings, despite their variety and number, and the harassing feeling that one might be missing an important speech from some world-renowned authority in the next room, were well attended, but the Papers were by no means fully discussed. Indeed, this was hardly possible when the ordinary programme in each section often included the reading of four or five Papers in three hours. The chairmen, with stop-watch in view, had to exercise considerable self-restraint in curtailing interesting discussions; nevertheless, much valuable information on American practice was contributed by many of the experts on the various subjects. Among the English speakers, Col. Crompton figured largely, his experience in pioneer work and his views on the more modern developments being received with great attention.

The business of the Congress at the Coliseum building occupied the whole forenoon of each day, while for the most part the afternoons were utilised in visiting the Exhibition, which, being 6 miles off, necessitated a trolley ride of 40 or 50 minutes.

The grounds and buildings, covering as they do 1,250 acres, rendered it scarcely possible for visitors to do more than examine those sections in which they were specially interested, and naturally most of the electrical men gravitated towards the Palace of Electricity, in which they spent the bulk of their time. The intramural railway, with fast electric cars and frequent stops, is of great assistance in obtaining a general view of the Exhibition and in passing from one building to another.

The St. Louis reception committee were just as active as the others in their efforts to give us a hearty welcome, and during our week's stay they had arranged many social events in our honour. The first of these was a reception on Monday evening at the New York State Building to the delegates and members of the Congress. The next was the exchange of international courtesies between the Italian members and those of the other countries, who were invited on Tuesday afternoon to the Italian Pavilion. On Wednesday the electrical exhibitors entertained the whole of the visitors at lunch, and in the evening gave a reception, in connection with which some remarkable lighting displays were introduced, both in the buildings and the adjoining courts and spaces. On Friday afternoon the British Commissioner held a reception in the British Pavilion, which was largely attended. The proceedings were enlivened by the presence of the Grenadier Guards' Band, which lent a touch of national colour to the garden of the English country house which the Pavilion represents.

The social aspect of the St. Louis visit culminated on Friday evening in a banquet given by the committee in the German National Pavilion, which was one of the most enjoyable functions of the tour. The speeches were not too numerous, but they were above the average after-dinner standard, due in a great measure to the witty example of the toastmaster, Mr. F. W. Lehmann, one of the directors of the Exhibition. By a happy reference to the paternal and grandpaternal progenitors and the lawgivers of the American people, he successively called upon Mr. R. K. Gray to reply for England, Dr. Lewald for Germany, and Prof. Ascoli for Italy. He then commented on the facility with which "Colonel" and other titles of honour were accorded and accepted in America, and following that custom called on "the Hon. Prof. Hammond," who rose to the occasion with a clever and amusing speech.

At the close of the banquet Prof. Goldsborough, chief of the electrical section of the Exhibition, intimated that he had arranged a demonstration with the 500,000-volt transformer, which had been constructed under his direction, and though the time was now the "wee sma' hours" he would be disappointed if it were not seen. Most of the party then walked down to the courtyard in which the transformer and apparatus were installed. The transformation ratio was from 120 to 500,000 volts in one step. The high-pressure secondary was led from the terminals over considerable lengths of insulated wire, suspended on wooden poles. The insulation of the circuit was most carefully effected, using the largest porcelain insulators, supported on long pieces of bitumen conduit, while the distance between the wires was nowhere less than 8ft. (for a more detailed description of the transformer see *The Electrician* of Sept. 16, p. 858). On closing the primary an arc was at once started with a loud crack between the two terminals, placed 4ft. apart, and was maintained for nearly a minute, absorbing about 70kw. The luminosity of the whole of the overhead wiring and the intense glare of the arc produced a very fine effect; even although some were sceptical of the actual existence of 500,000 volts pressure, the voltage must have been approximately of this amount.

On Saturday morning the Congress held its last formal meeting in the Festival Hall of the Exhibition. This day was also marked by the hospitality of President Gray to several of the members of the English and American parties, whom he invited to lunch at the New York State House. Mr. Gray took this opportunity of formally thanking the American Institute, and especially President Arnold, for their magnificent welcome, and asked their acceptance, in recognition of this, of the painting of "Gilbert Exhibiting his Experiments to Queen Elizabeth," the original of which was last year presented by the British Institution to the Borough of Colchester.

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In taking leave of the Exhibition, it may not be out of place to record a few of the more obvious impressions it in general produces. To begin with, it covers too large an area, and in spite of intramural railway, automobiles and other means of communication, it makes the business of studying the exhibits most laborious. One can easily understand the truth of President Francis' remarks as to the inadvisability of repeating an exhibition on a similar scale, as in practice each visitor will probably only wish to inspect the one or two sections in which he is interested.

The size of the grounds and buildings afforded an opportunity to the designer and architect for producing an imposing general effect, and this was fully taken advantage of, the central vista leading up to the Festival Hall and cascades being particularly fine. At night the illumination of the buildings and cascades was brilliant and not too glaring, incandescent and Nernst lamps only being employed. One noticeable general feature was that, save in the neighbourhood of the principal entrances, the 300,000 visitors who were frequently present were practically lost in the great extent of the grounds.

The exhibitors' day in nearly every department finishes at six o'clock, everyone closing his stall and going home or spending the evening in the amusements of the "Pike." This is the local name for the street devoted to side shows, which are here in disproportionate number and variety. It was the only spot in the Exhibition which might be called crowded. As far as one could judge most of these shows were of the usual dull and dreary description, but all were characterised by much megaphone shouting and big-drum thumping.

Whatever our views were on the World's Fair in general we took our departure on Saturday night for Pittsburg in the now familiar special in which we left New York. Our journey occupied the whole night and most of next day, it being seven o'clock before we began to pass through the oil country in the neighbourhood of Pittsburg. The party on arrival put up at the Schenley Hotel, overlooking the park in the residential district of the town.

Monday, September 19th.

Next day there was quite an *embarras de choix* in the selection of the works to be visited, practically every manufacturer of note throwing open his establishment. Those interested in railways could see the air-brake works of the Westinghouse Company and the Union Switch and Signal Factory, while for other specialists there were the Nernst Lamp Co. and the R. D. Nuttall Machine Co.'s works. Almost everyone took advantage of the occasion to see the great steel works at Homestead and Bessemer in the morning, devoting the afternoon to a rapid survey of the Westinghouse Company's manufactures.

To electrical engineers the Westinghouse establishment is always a source of interest and admiration. Quite different from the General Electric Co.'s works at Schenectady, which are distributed over many buildings, it concentrates all its operations under one vast roof, the raw material being supplied at one end and the finished products ready for shipment being delivered at the other. The two principal aisles are 1,600ft. and 1,200ft. long respectively, these being divided into sections through which the different classes of work methodically advance. The study of the series-alternating motor with commutator has made wonderful progress under Mr. Lamme, and perhaps the development in this direction received the greatest attention from the visitors. A standard railway truck had been equipped with 200 H.P. motors and all the necessary controller and brake apparatus for experimental work. As distinct from the G.E. Co. method the control is effected entirely by the variation of pressure of the supply. This is done by a variable induction type of transformer in which the secondary is moved through various angles, so as to give five or six distinct steps before full voltage is reached. In the motor itself the chief feature is a careful lamination of the pole-pieces and armature, with a distributed winding on the former to compensate for armature reaction. With this construction and a periodicity of 20 and a voltage not exceeding 250 the motor answers its purpose most satisfactorily. An experimental track about 2 miles long, with a trolley-wire voltage of 3,000, is being used to test the various designs, and some are now commercially available.

Two or three hundred motors are on order for alternating supply only, but one or two are also designed to run at intervals on direct-current tracks. Several large motors were being run at full load in the test room of the works, the efficiency reaching as high as 87 per cent. without abnormal heating or sparking.

The closing of the works at six o'clock came all to early, and soon afterwards the straggling members assembled for dinner, at the invitation of the company. The dining hall was extemporised from one of the new machine rooms, and was illuminated by Cooper-Hewitt and Bremer lamps, two of the company's specialitities. Mr. George Westinghouse presided and gave a short address of welcome, which was responded to by the respective presidents. Long speeches were obviated by the fact that our train for Washington left the station in the works at 9:30. Some enthusiasts sat up in the observation car to see the Horse-shoe bend, but to most it was manifested as merely an extra grinding of wheels on the track that disturbed their well-deserved sleep.

Tuesday, September 20th.

On arriving at Washington we proceeded to the New Willard Hotel, and after breakfast set out to see the city, on this occasion more after the manner of the ordinary tourist than as high-souled seekers after technical wisdom. There was one item a possible exception to this—our visit to the National Bureau of Standards—but as the buildings were only half-finished and the greater part of the apparatus and the whole of the work of standardisation had been transferred to the St. Louis Exhibition, we saw but little. The laboratories are situated in a secluded part of a natural park, and have just that air of abstraction and quietude that make for accuracy in physical measurements. Such apparatus and arrangements as were visible in the photometric and thermostatic rooms indicated partly, at least, the high order of work the institute will undertake.

Amongst the public buildings visited were the Capitol, Congress Library, White House, the Treasury and other national offices. Some conscientious members went down to the Navy Yard to investigate the applications of electricity there, but it was generally understood their visit was disappointing. This city, seen so shortly after the dingy buildings and acid laden atmosphere of Pittsburg, was considered by all to be the finest we had hitherto been in. The character and design of the buildings and their green surroundings makes a capital city the Americans are justly proud of. Its appearance compares favourably with such views as those in the Vienna Ringstrasse.

From Washington we hastened on in the evening to Philadelphia, passing through Baltimore on the way. The Philadelphia engineers had in our honour engaged rooms in the fine new hotel the Bellevue-Stratford, which had only been opened that day. The confusion natural to such an event, when 1,100 bedrooms have to be allocated by a new staff, led to some amusing incidents, but by 2 a.m. everyone had secured some sort of accommodation.

Wednesday, September 21st.

The time at our disposal in the city was only a few hours, but most of us were able to drive round and have at least a glimpse of the electricity station, the Baldwin Locomotive Works and the United States Mint. The electricity works are on much the same lines as the latest Edison stations in Boston, Chicago, &c., and the 5,000kw. Curtis turbine will become the standard unit for the future. The Baldwin shops are remarkable for their situation in the very heart of the city, and were they not so large it would be an obvious economy to at once remove them to some industrial suburb. The U.S. Mint belongs to that class of things that one is "bound to see." The genial guide explained in the usual way, with much pride, that they were the biggest and best equipped establishment of the kind in the world—at least there is no doubt they turn out more silver dollars than any other.

The lunch at which we were entertained by the local engineers, presided over by Mr. J. B. M'Call, the president

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of the Philadelphia Edison Company, was the last public function in which all the members took part. Our train for New York left in the afternoon, and before nightfall we had reached the city and left our official programme as a thing of the past.

Thursday, September 22nd.

On the following day, however, a special visit was organised to Edison's laboratory in Orange, N.J., at which most men endeavoured to be present. Mr. Edison, with his family, personally received us in the library, and after showing us his establishment invited us to afternoon tea. The great inventor is still as keen and active as ever, and showed us with considerable pride his private laboratory where his researches on his new battery were made. Some of these are now being manufactured in the works, but the greater part of the space is devoted to the manufacture of gramaphones and their records. In the evening a farewell supper was given at the Waldorf-Astoria, to which were invited those officers of the American Institute who were in New York. Amongst those present were Mr. Arnold, Mr. T. C. Martin, Mr. Samuel Insull, Mr. Coffin, Mr. R. W. Pope and Mr. Muller, and to these Mr. Gray again conveyed the thanks and appreciation of the British Institution for the hospitality and kindness shown to them.

Friday, September 23rd.

The last scene of all on American soil took place the following afternoon, when the majority of the English visitors set sail in the White Star liner "Arabic" for Liverpool. Those who stayed behind and many of the American hosts came down to say good-bye and to give a farewell cheer.

Many of those who remained for a week longer inspected, in greater detail, some of the factories in the Eastern States and near New York, and under those conditions learned a great deal more of manufacturing and organisation than when they were "with the crowd," but they certainly missed the genial company, hearty good-fellowship and magnificent hospitality, which will always be remembered by those who took part in the great circular tour.

THE DUPLEX BALANCING OF TELEGRAPH CABLES.

BY W. GAYE.

(Concluded from page 996.)

A diagram of the simplest connections for balancing one cable against another on the "double-block" principle is given in Fig. 14. In practice, the circuit of the receiving instrument through which the beginnings of the cables are connected would probably contain a condenser also, or, to adopt a more modern practice, the instrument would be in parallel with a magnetic shunt. For the present, however—as indeed it is in practice when balancing a cable for the first time—it will be well to short-circuit the condenser or disconnect the shunt. ρ represents the sum of the resistances in the battery circuit—viz., that of the battery itself and anything more it may contain. Let V be the potential at the junction of r and r_1, and v, v_1 those respectively at the beginning of the upper and lower cables. Then fundamentally we have

$$v=\frac{V}{\left(\frac{Sp}{R}\right)^{\frac{1}{2}}\left(r+\frac{1}{sp}\right)+1}$$

and

$$v_1=\frac{V}{\left(\frac{S_1p}{R_1}\right)^{\frac{1}{2}}\left(r_1+\frac{1}{s_1p}\right)+1}.$$

But that no current shall pass through the instrument connecting the points at which these potentials exist, it is necessary that $v=v_1$ or that

$$\left(\frac{S_1}{R_1}\right)^{\frac{1}{2}}\left(r_1+\frac{1}{s_1p}\right)=\left(\frac{S}{R}\right)^{\frac{1}{2}}\left(r+\frac{1}{sp}\right),$$

an equation that will be satisfied when $r/r_1=(RS_1/SR_1)^{\frac{1}{2}}$ and $s/s_1=(SR_1/RS_1)^{\frac{1}{2}}$, or when $rs=r_1s_1$. Expressing v in terms of e, we have now, when a balance has been obtained,

$$v=\frac{e}{\rho\left(1+\frac{r}{r_1}\right)+r+\frac{1}{sp}+\left(\frac{R}{Sp}\right)^{\frac{1}{2}}}.$$

When the lower cable and r_1 are disconnected the expression is, of course,

$$v=\frac{e}{\rho+r+\frac{1}{sp}+\left(\frac{R}{Sp}\right)^{\frac{1}{2}}}.$$

So that their connection to the circuit in the manner shown has the same effect upon the course of events with respect to the upper cable as a simple increase of the resistance ρ to $\rho\left(1+\frac{r}{r_1}\right)$, or $\rho\left(1+\frac{s}{s_1}\right)$, would have when they are disconnected.

If both cables are of the finite lengths l and l_1, and have their distant ends insulated, the final potential values at their beginnings as well as elsewhere in their lengths, instead of falling to 0, cannot be less than $\frac{e}{1+\frac{Sl}{s}}$ and $\frac{e}{1+\frac{S_1l_1}{s_1}}$.

But that the balance shall be maintained these must equal each other, and it must accordingly be arranged that

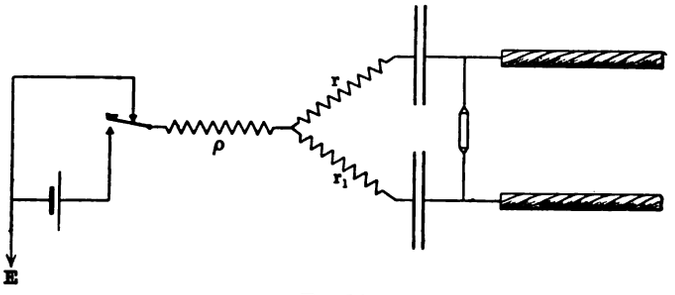

Fig. 14.

$s/s_1=Sl/S_1l_1$. There are, therefore, three conditions attaching to a perfect balance—viz.,

$$r/r_1=(RS_1/SR_1)^{\frac{1}{2}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

which is called for especially at the very outset of affairs and at the intermediate stage to some extent also.

$$s/s_1=(SR_1/S_1R)^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

required for the somewhat later and intermediate periods. And

$$s/s_1=Sl/S_1l_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

necessitated as the potentials v and v_1 approach their final values. Of these three, (1) takes, perhaps, the first rank in importance. Attention has been already directed to the fact that the resistance r not only delays and limits the rise of potential, but is responsible for some retardation in its fall also. This is more clearly exhibited in Fig. 15, which illustrates the crests of the potential waves, an arbitrary case in which, owing to r_1 being in excess of what it should be, a balance has not been obtained. Curve 1 represents the potential at the beginning of the upper cable and curve 2 that at that of the lower—or as it would most probably be—artificial line. It is observed that while the values on the cable side are at first higher, they ultimately fall below those on the artificial line side. The current through the receiving instrument arising out of this want of balance is consequently first in one direction and then in the other. As the change in the direction (under ordinary practical conditions) occurs at an enormous speed, the first effect upon the instrument when the want of balance is slight may be small, but is, under any circumstances, extremely rapid, the mechanical result being that of a "jar."

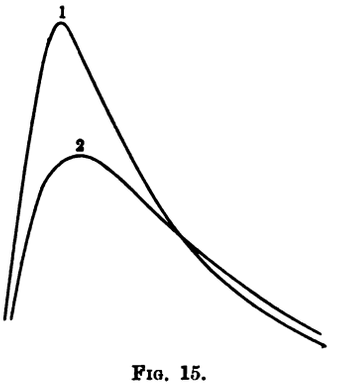

Fig. 15.

From the expressions for v and v_1 it is evident that the resistances r and r_1 may be theoretically short-circuited and

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the balance remain undisturbed. Of a necessity for their presence in practice there is no doubt. It arises in part from the fact that the various connecting wires themselves possess a small resistance, and, as it would be difficult to ensure that of those on the cable and artificial line sides being otherwise suitably proportioned, it is desirable to furnish some means of compensating for this, which these resistances provide. It is probable, also, that they play some part with respect to the balancing of the complex function that we are ignoring—viz., the inductance, not only of the cable but that also of the connecting wires.

Second in importance is the condition (2) which must also be exactly satisfied, although its want of observance creates a difference of potential in one direction only. The close satisfaction of the third condition is of less moment in practice, owing to the fact that a relatively long time elapses after the battery is applied before it becomes prominently called for; the long, slow disturbance or current wave which results from the want of it does not, in signalling also, materially interfere with the more abrupt impulses caused by the signals from the other end. Where this "double-block" system of balancing is employed, the receiving instrument might—for reasons to do with the signals from the other station—be in series with a condenser, as has been said. The disturbance to the receiving instrument caused by a want of balance is then more complex, since it is no longer the outcome of a simple difference of potential, but is caused by the time-rate-of-change in this difference. Under these circumstances, while the demand for an exact fulfilment of the first and second conditions remains, that of the third is of still less practical significance.

It is to be remembered that the current through the instrument is the product of the capacity of the condenser and the time-rate-of-change in the difference of potential. So that if the latter be small, the instrument may not be sensibly affected, even though the final potential values of the artificial line and cable differ. We may even arrange that one final value may be zero by putting the end on that side to earth, while the other remains finite, without occasioning any disturbance of sufficient amplitude to prohibit signalling, or to be even noticeable. These observations hold equally good if, instead of a condenser in series with it, the instrument have in parallel a magnetic shunt, with the difference that the disturbance to the balance becomes again a consequence of the simple difference of potential. By the time that an exact satisfaction of condition (3) begins to be theoretically demanded, the effective resistance of the magnetic shunt will have become almost entirely ohmic, and, as this is usually small relatively to that of the instrument, by far the greater part of any current arising from a want of balance in this respect will pass through it, leaving the instrument unaffected to any serious extent.

In referring to the practical balancing of a cable on the resistance "bridge" plan (Fig. 4), it was pointed out that something beyond the simple theoretical conditions given as necessary was required. It was suggested that the need arose from the cable possessing inductance. As will have been anticipated, in balancing on the "double-block" principle, it is also found necessary to either expedite and increase the rise of potential on the artificial line side of the instrument, or to delay and limit it on that of the cable. These objects being attained in the manner there described—viz., by, respectively, the insertion of a resistance on the artificial line side or by the connection of a condenser in parallel with the cable.

While for various reasons the falling short of it may sometimes with the usual receiving instrument be difficult to detect, a perfect balance is not and cannot be produced by the adoption of either the one or the other of these expedients. Their shortcomings are manifested, of course, at the very outset by a disturbance, minute perhaps, but exceedingly abrupt.

It is to be borne in mind that all that has foregone has reference to cables the insulation of which is perfect, and their core ratios unchanged throughout their lengths. A want of homogenity in this latter respect will affect the potential curve more or less according to, first, its situation in the length, and, secondly, its extent.

Thus, the substitution of the length of a knot or even less of a different core ratio at, or near, the beginning of a cable, or a corresponding change in the artificial line, will cause the potential on that side to rise either more abruptly or slowly, according to the nature of the difference, and so produce a sudden and marked disturbance of the duplex balance, necessitating an alteration of the conditions for its restoration. If the extent be only that mentioned—viz., a knot or so—as its situation is removed further and further from the beginning, the disturbance of the balance will become less and less marked, soon eventually disappearing so far as to be practically indiscernible. Indeed, in the latter part of cables, or the artificial lines employed in connection with them, very great changes in extent and situation may be made without occasioning any appreciable disturbance of the balance. Where the double-block system is employed—*i.e.*, on long cables—we may, as has been pointed out, even put the end of cable or artificial line to earth, and so make the core ratio there = 0, the effect, provided a good balance existed with the end insulated, may not be appreciable, and in any case will be but the cause of a sluggish disturbance of small amplitude.

In this connection it may be mentioned that where, in consequence of a somewhat insufficient length of artificial line, the potentials at the later stages become on that side too high and are so the cause of a disturbance that, while it is slow, is of inconveniently large amplitude, the defect may be remedied by an arrangement of one or more suitably proportioned "leaks" at, and towards, the end of the line. In cases where a sufficient length of line is more markedly absent, a better plan is to add on some condensers to the end of the line.

When a cable develops a fault, the balance becomes, of course, upset, though, if the fault be steady—*i.e.*, one of unvarying resistance—it may be restored by the insertion of a "leak" of proportional resistance in the corresponding position of the artificial line. Under most circumstances, however, the capriciousness of the fault prohibits this being done. Even then the resulting disturbance is not without its utility, since it affords a rough guide as to the position of the fault. Thus it is at the end nearer the fault that the greatest disturbance is experienced; indeed, at the other end, especially if the cable be a long one, and the fault of high resistance, none at all may be appreciable.

The maintenance of a balance on long cables (where the receiving instrument has a high figure of merit) calls generally for daily and, in some cases, for hourly attention. The cause of this is the variation of temperature, and the factor commonly and most affected by this is the core ratio of the artificial line. It is interesting to note that as a probable consequence of the line's material bulk, there is a considerable time lag in this respect. Thus, a sudden rise or fall in the temperature immediately surrounding the artificial line is not followed by a change in the balance conditions for some hours.

Although it is exceptional, evidence is not wanting that the core ratio of the cable is occasionally affected from the same cause. An instance within the experience of the writer existed in which the daily alteration of the balance conditions did not, during a certain season of the year, follow the variations of temperature surrounding the artificial line. The reason became manifest from the tests of a second short cable running in comparatively shallow water close to, and parallel with, the first for a distance of 100 miles or so. These indicated at that time of year a change in the total resistance of the cable amounting, at its maximum, to about 3 per cent.

In drawing these notes to a conclusion, expression may be given to the hope that they may be regarded rather in the light of suggestion than as containing any definite assertion. The student should also be warned that in comparing any practically existing duplex balance conditions with those quoted as theoretically necessary, he must not expect to find that they agree. It is suggested that the discrepancy may be accounted for in the neglect in what has foregone of the property of inductance. If this is the case, and it seems reasonable to suppose that it may be, the comparison referred will afford striking evidence of the potency of this factor at the beginning of a cable. In any case it may encourage an embarkation on a more thorough investigation of the theory of the duplex balance in which, in common with its co-associates resistance and capacity inductance is taken into account.

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ELECTRICITY SUPPLY IN WILLESDEN.

In our issues of September 23rd and 30th we described in detail the Willesden power house of the North Metropolitan Electric Power Supply Co., from which energy is supplied "in bulk" to the Willesden Urban District Council. Part of the current is supplied directly at low pressure to the 2 × 240-volt three-wire network near the generating station, and the major part of the energy is conveyed at high pressure to the sub-station in Salusbury-road, Kilburn, where it is converted. Fig. 1 is a map of the district, showing the positions of the station and sub-station and the various mains, feeding points, &c. The shaded portions show the more thickly-populated parts of the area, where the greatest demand now exists, but, owing to the exigencies of space, only those streets can

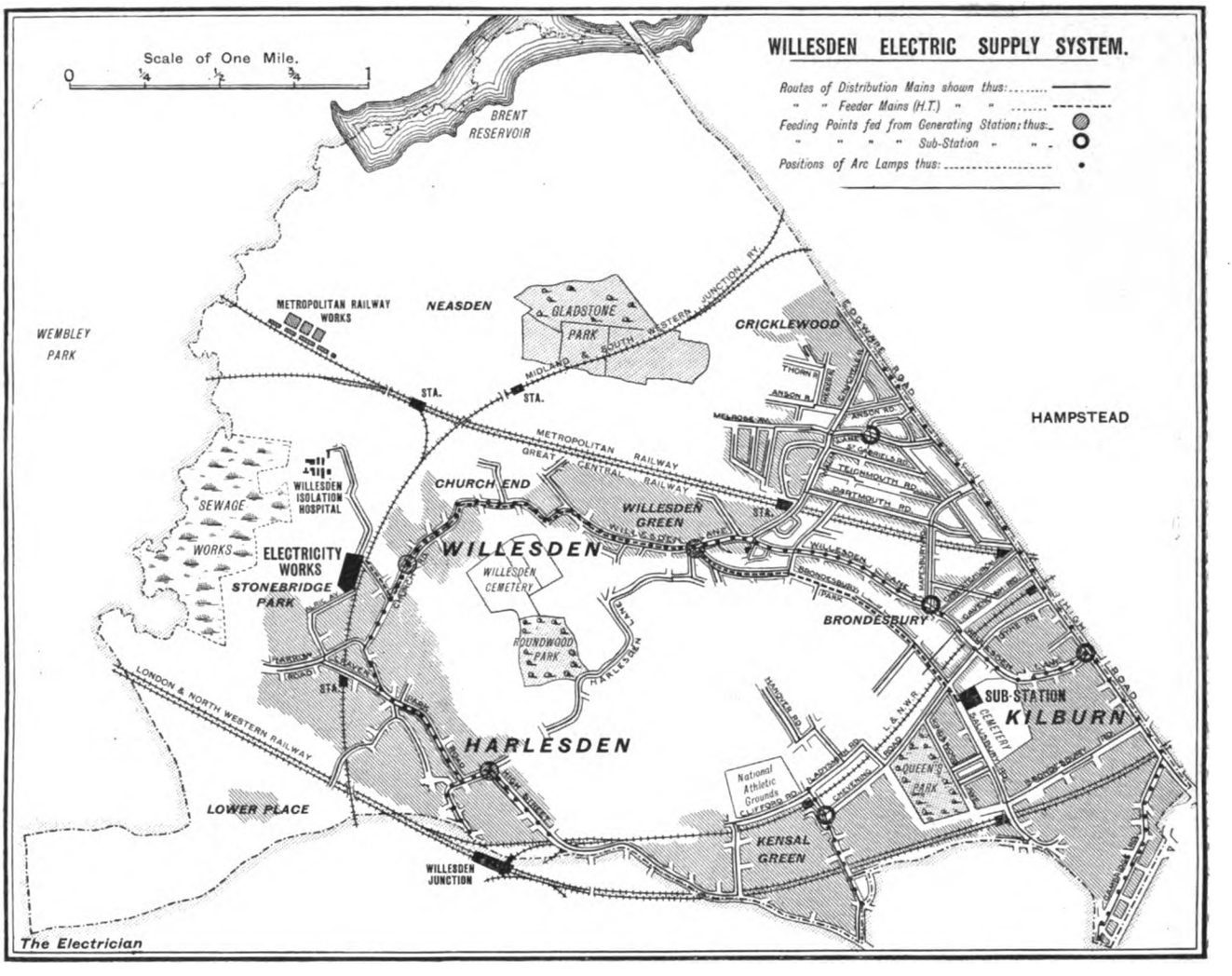

FIG. 1.—MAP OF DISTRICT, SHOWING POSITIONS OF MAINS AND ARC LAMPS.

be shown in which distributing mains are laid. The reason for the adoption of a "double-current" supply system were explained in our previous article, and these will be readily appreciated by a glance at the map.

The high-tension feeders from the generating station to the sub-station are 0·125 sq. in., lead-covered three-core cables, insulated for 3,000 volts between phases. They are of the British Insulated and Helsby manufacture, and are laid "solid" in iron troughs. Two cables have been laid up to the present. These cables come directly to a high-tension board at the sub-station, this board being of the standard Ferranti pattern and similar to the high-tension board at the generating station. The board has three sets of three feeder panels, connecting the feeders to the 'bus bars and four sets of three transformer panels, connecting the transformers to the 'bus bars. There are fuses on all the panels, but ammeters on two phases only of the feeders and one phase only of the transformer circuits. Two ordinary synchronisers are provided, each fitted with phase lamps, paralleling voltmeter and two high-tension voltmeters, one for the 'bus bars and one for the in-coming machine. There is also an Everett-Edgcumbe synchroscope. The board carries no regulating switches, these being placed by the converters, as will be explained.

The sub-station building adjoins the offices of the electricity department. The converter room (Fig. 2) and the battery room are on the ground floor, and the transformer room in the basement. On the first floor are the testing rooms, stores, &c. The converters do not stand on independent foundations, but are simply bolted to the floor, which is supported by iron columns—a system which, it will be remembered, was also followed in the sub-stations for the London County Council tramways. Each group of transformers is placed immediately below its rotary converter, and the low-tension leads run straight up to the slip-rings of the rotaries without passing through the switchboard. The transformers are mesh-connected on the high-tension side and star-connected on the low-tension side, the middle point of the star being connected to the third wire of the three-wire network.

Regulation is done by varying the number of turns of the primary in the case of two of the three phases, the "Hartford" regulator being placed by the converter, as seen in Figs. 2 and 3. The regulator is to the right of the converter in Fig. 3, the square box on the left being the starting switch. Fig. 4 is a diagram of the connections of the regulator. This consists of a circular box containing two 15-contact circular switches placed back to back with a ratchet arrangement between them. The switches are rotated by means of the handle at the top of the regulator. A forward motion of the handle moves the

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switch on one phase and the following backward motion the other switch. This is doubtless in order to avoid the discontinuity which would occur in the two transformer circuits if both switches were moved simultaneously, for such a discontinuity, although only momentary, might suffice to put the rotaries out of step. There is an index on the handle, and for raising the E.M.F. the handle is turned with the index forward and pointing to the words "Raise E.M.F." on the case. By turning back the handle, before pumping with it, through about 60deg. to "Lower E.M.F.," the ratchets are reversed and moving the handle turns the switches in the reverse direction. Although there are only 15 contacts, 30 adjustments can be made, for when the switch has been round once, say for lowering the E.M.F., the whole section of the winding between the points 1 and 2 is switched out, and this is equivalent to 15 of the smaller sections. It is only necessary to vary the turns on two of the windings, for, the three transformers being connected in mesh, the third one adjusts its pressure automatically when the number of windings of the other two is varied. All three transformers are identical, however, so that one "spare" suffices for all three. There are two sets of three 40kw. transformers and two sets of three 100kw. transformers. They are oil-cooled and of the ordinary Westinghouse pattern.

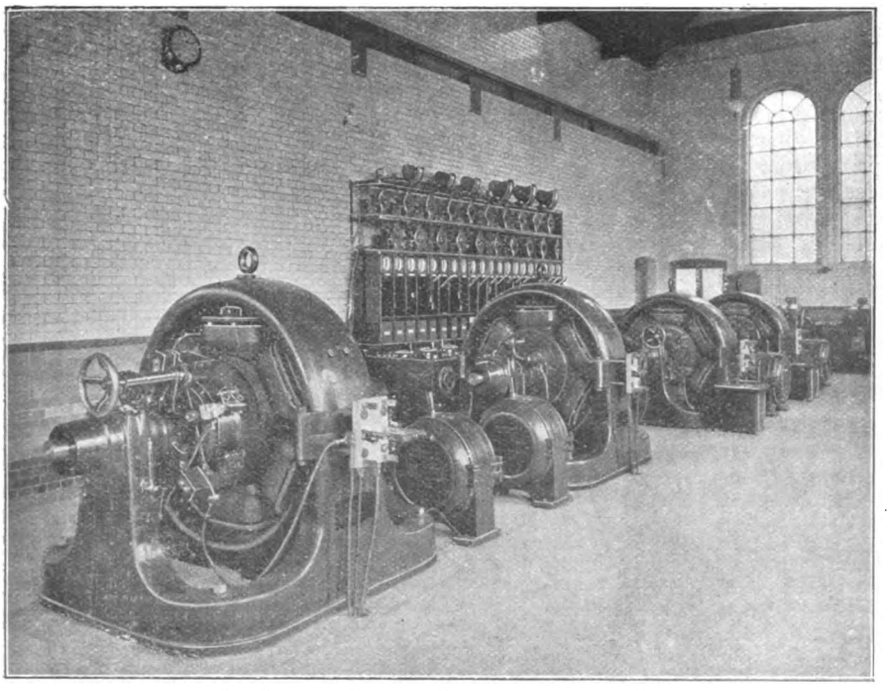

Fig. 2.—General View of Converter Room in Sub-station.

The rotaries (there are four at present, with space for twelve) are of the same make, and are standard 6-pole machines, with a frequency of 25 ~ per second, and, therefore, a speed of 500 revs. per min. Two are rated at 100kw. each, and two at 250kw. each. The machines have the usual damping coils on the field poles. They are compound wound, but at present only the shunt fields are employed; the usual throwover switch connecting up the compound winding and the equaliser bar is placed on the machine itself, as seen in Fig. 3. The machines can supply a pressure of from 480 to 680 volts on the continuous-current side, with a current of 455 amperes. They are started by the starting switch off the continuous-current 'bus bars, and are run up to voltage and synchronised at the high-tension board. The regulation by the "Hartford" regulator covers a range corresponding to 250 volts on the continuous-current side.

We now come to the low-tension board, which is almost exactly similar to the one at the generating station, the chief difference being that there is a panel and main switch for each pole of the machines. As at the generating station, there are four 'bus bars with "selector" switches, so that the feeders can be run at four different pressures and from separate machines if desired, while on the other hand two, three or four 'bus bars can be joined together by paralleling plugs. At present two different feeder pressures have to be used every evening. We give an elevation of the board (Fig. 5) and a diagram of the connections (Fig. 6). From these figures it will be seen that each pair of machine panels (on the left) has two main switches with excess-current tripping coils, an ammeter and a pair of selector switches, while the feeder panels (on the right) are similar but are fitted with fuses instead of tripping coils. The three 'bus bar voltmeters are on sliding rails as at Taylor's-lane, and can be pulled over by cords to make contact with either of the four 'bus bars. In addition there is a booster voltmeter and two pilot voltmeters. The main battery balancer panels are in the middle, and the various auxiliary switches are on the regulating table in front. These latter are again similar to those at the generating station. The booster fields, which are separately excited from the 'bus bars, can be reversed for boosting up or down, there being no regulator cells on the battery. The boosters are used for charging the cells in the ordinary way, but they can be discharged through, and can be connected in parallel

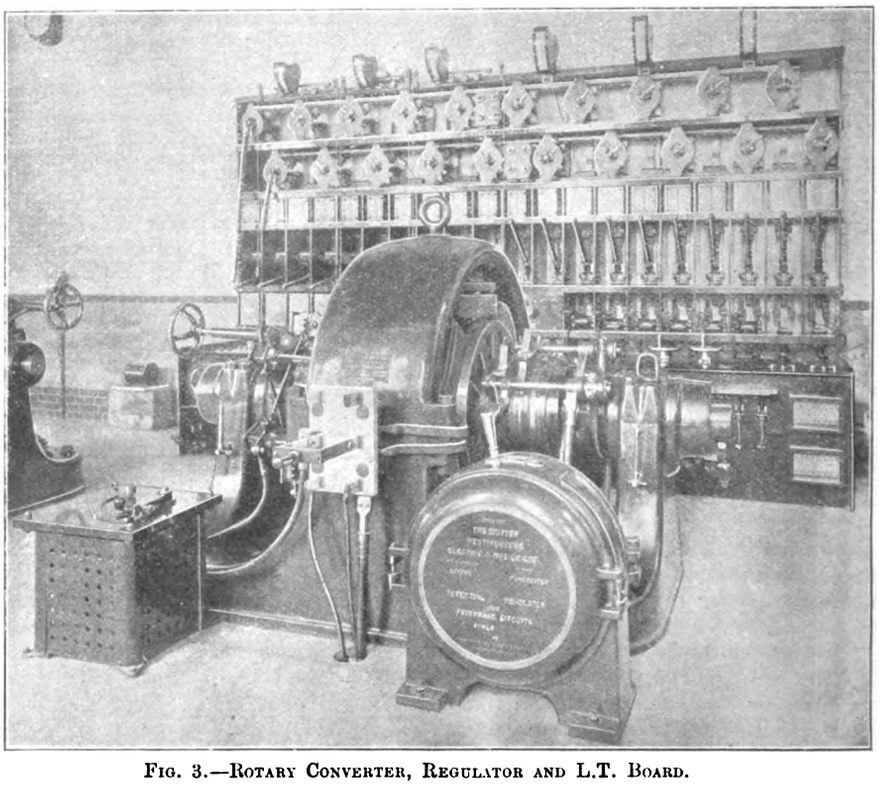

Fig. 3.—Rotary Converter, Regulator and L.T. Board.

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between the middle wire and the middle 'bus bar by means of the switch marked "booster 2-way switch." Provision is also made for separate excitation of the converters, if desired, from the 'bus bars. The two halves of the battery may be interchanged by means of the coupled switch below the battery

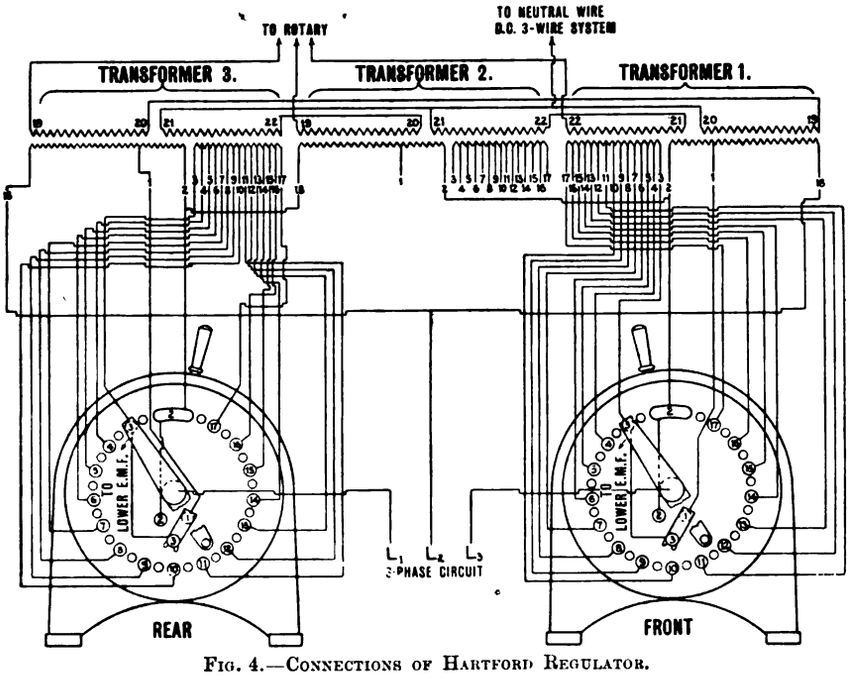

FIG. 4.—CONNECTIONS OF HARTFORD REGULATOR.

panels. By the field switches of the rotaries are four knife switches, for connecting the middle points of the transformer secondaries to the neutral wire of the three-wire system. Messrs. Ferranti have supplied and erected the switchboards, and these are fitted with Nalder Bros. and Thompson instruments. The boosters and balancers are 33kw. machines, all mounted on one shaft with three bearings, as at the generating station.

By this machine are the starting switches and also a separate panel for testing the mains and burning out faults. Normally, a recording ammeter, reading from 0 to 40 amperes on either side of zero, is connected between the middle wire and earth through the coil of an automatic switch. This switch can be adjusted to trip at any current between 10 and 70 amperes, and when it drops it connects a bank of lamps between the ammeter and earth, the number of lamps in parallel being only sufficient to allow 4 amperes to pass at 240 volts. Two of the lamps are on the board, so that their brightness is a rough gauge of the badness of the fault, and in addition there is a red lamp which is connected between one of the outers and the middle wire when the switch drops. A two-way switch with a central "off" contact is provided by which either outer main can be earthed through a water resistance when the middle wire is disconnected from earth, this being for the purpose of burning out faults. When this is done, the ammeter is short-circuited by a plug provided for the purpose. A third switch is provided for testing the network with an earthed two cell battery; it can connect the middle wire to the battery, and can reverse the poles of the battery as a check. The recording ammeter is then in circuit, and readings are taken from its dial.

The converter room is well lighted by windows on three sides of the building, and the walls are faced with white glazed bricks with green dado, as in the engine room at Taylor's-lane. Two enclosed arc lamps in series off the 240-volt mains light it at night. An 8-ton hand-travelling crane by the Chatteris Engineering Works Co. was found serviceable during erection of the machines. The battery room contains two sets of Tudor cells with a capacity of 840 ampere-hours at a 10-hour discharge rate.

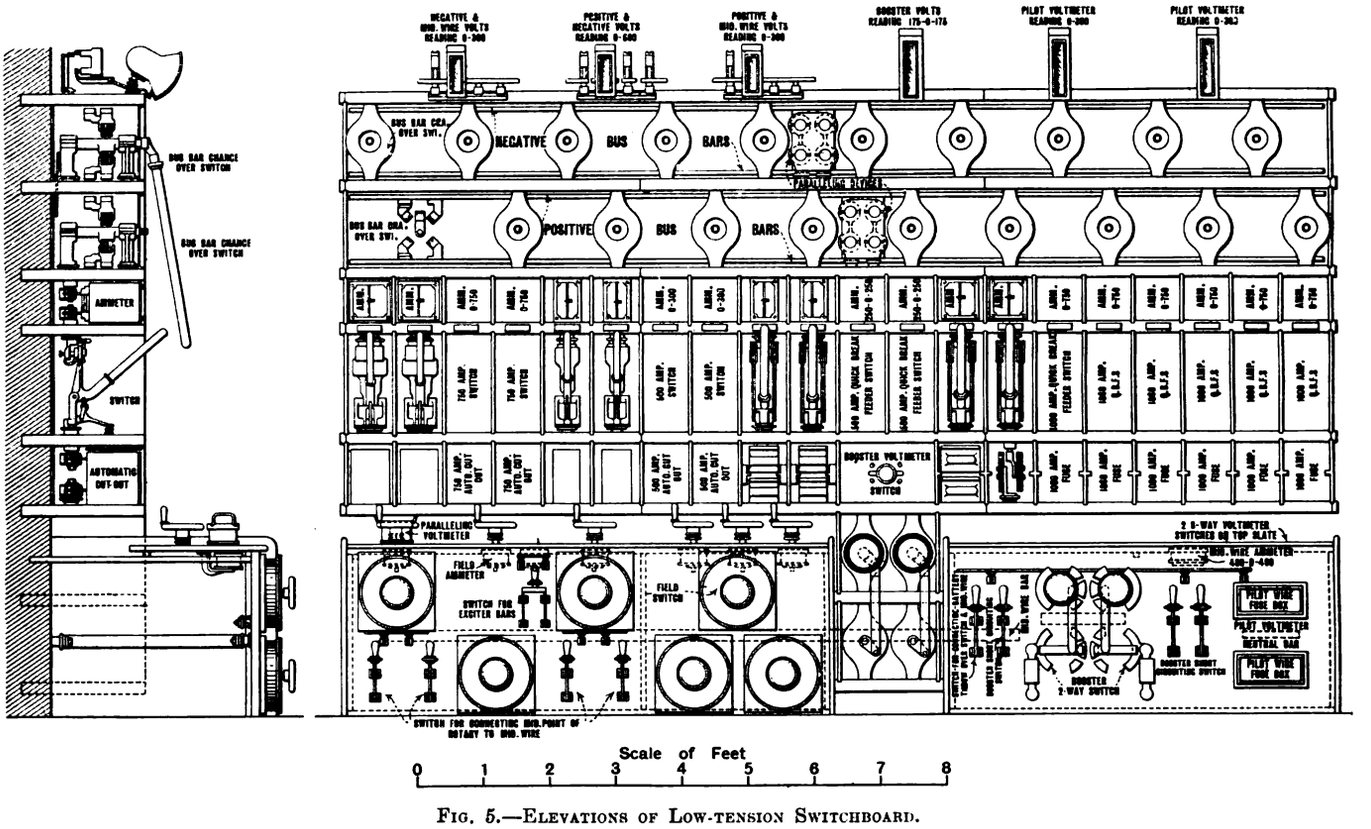

FIG. 5.—ELEVATIONS OF LOW-TENSION SWITCHBOARD.

At present there are four feeders from the sub-station. These, as all the cables, are paper-insulated and lead-covered, are laid "solid," the British Insulated and Helsby Cables Co. having supplied and laid them. The U-shaped supporting

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straps designed by Mr. Ruthven-Murray and described in *The Electrician*, Vol. LII., p. 786, are used on the more recent extensions. The feeders are 0·6 sq. in. concentric cables and are laid in iron troughs. To the Taylor's-lane network there are three feeders, two 0·6 sq. in. and the other 0·25 sq. in., while the Salusbury-road network is fed by 0·4 and 0·6 concentric feeders. The middle wire of the distributing system is connected both to the sub-station and to the electricity works through a 0·3 sq. in. feeder, the mid wire being earthed at the sub-station only. Five sizes of distributors are employed—0·3, 0·25, 0·2, 0·1 and 0·15 sq. in.; they are three-core cables, the third wire being in all cases half the section of the other two. The distributors are all laid in wood troughs with brick covers. "Wiped" glands are employed on all the network boxes (which are filled with solid links instead of fuses), but the service boxes are simply filled with compound. The latter are bonded to the cables and are placed in wooden boxes also filled with compound. The feeding boxes are all above ground, forming short pillars of rectangular section about 2ft. 6in. × 2ft, and 4ft. high. At these points, the cables terminate in boxes where they are jointed to rubber cables which lead into the feeder pillars. At the point where the Taylor's-lane distributing network meets the sub-station network, the two are connected together, through fuses, on the outers, and by a solid link on the middle wire.

The positions of the arc lamps are shown in the map (Fig. 1). There are in all 140 lamps, 40 of which burn all night, and 100 half the night. The pillars of the latter carry two incandescent lamps which come in when the arcs go out. In addition, some experimental incandescent lighting is in progress in one street. All the arcs are of the Gilbert double-carbon 10-ampere type, burning 32 hours. They are connected 10 in series on the 480-volt mains. A brief description of the arc lighting appeared in *The Electrician*, Vol. LII. p. 88, but we may add a few particulars. On switching on a group of 10 lamps, the switch first connects up nine lamps in series with the substitutional resistance of the tenth. When the lamps have started burning steadily, the tenth lamp is switched in by a further movement of the switch. This saves a heavy rush of current at starting. The usual cut-out is provided in every lamp pillar for cutting in the substitutional resistance when the arc is out. In connection with the automatic switch for switching in the incandescents in place of the half-night arcs, there is an ingenious device for switching off. The coil of the switch is in series with the arc in the usual way and the armature which makes the contacts for the circuit of the incandescents is

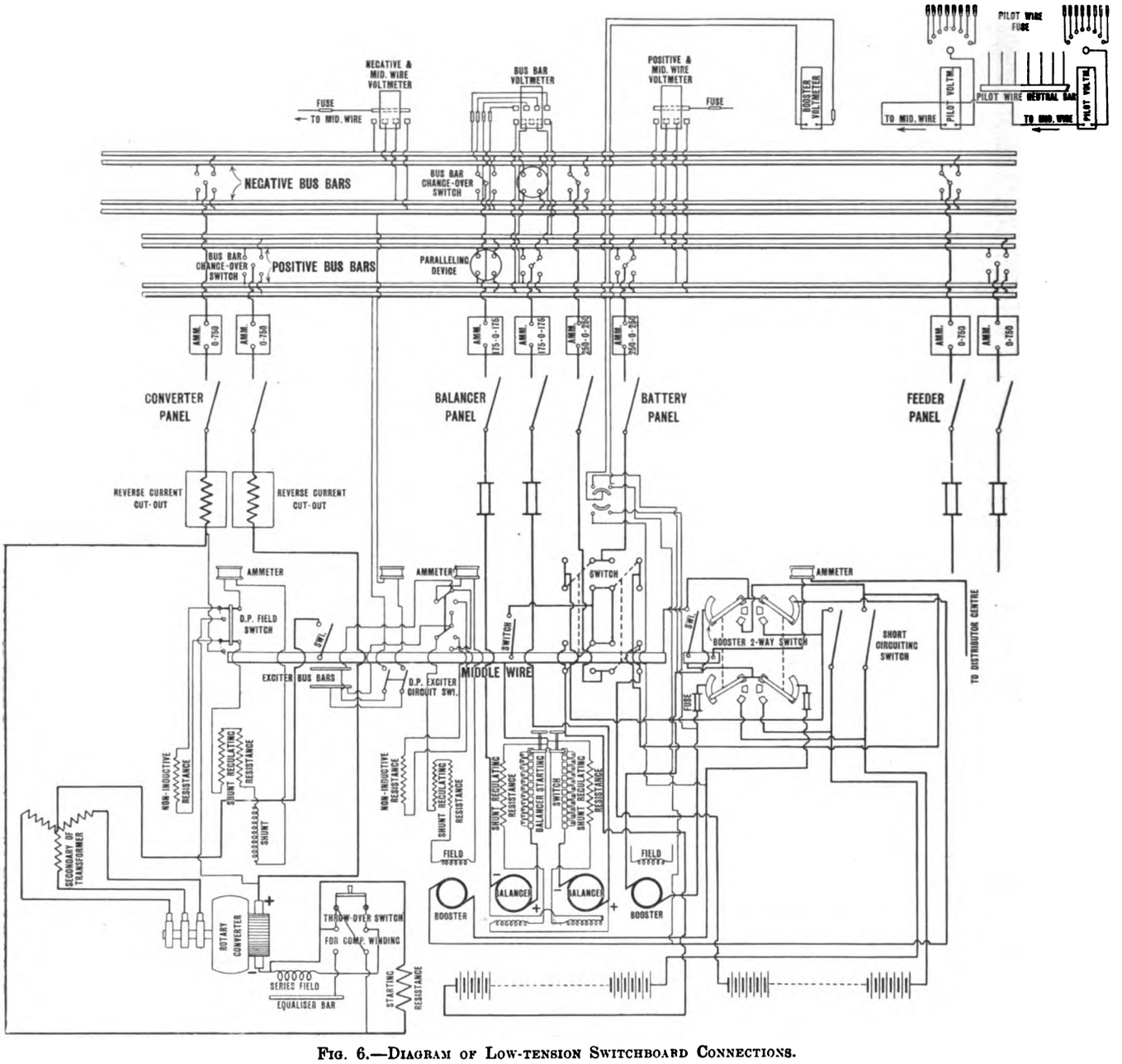

FIG. 6.—DIAGRAM OF LOW-TENSION SWITCHBOARD CONNECTIONS.

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lifted when the arc is burning. Attached to the centre of the armature is a helical spring, the bottom of which is attached to a dash-pot. The centre of the dash-pot is slightly out of plumb with the centre of the armature, so that for a few seconds after the armature is lifted against the tension of the spring—*i.e.*, until the dash-pot has risen to its full extent—the armature is tilted slightly. If the lamp is switched off again within this period, a weight attached to the armature catches on a projection from the case of the switch, and the armature does not drop. Thus, to switch out the incandescent lamps in the morning, all that is necessary is to switch the arcs in momentarily and switch off again, for then the armature of the automatic switch is lifted, but does not drop into the incandescent lamp contacts. It is, however, still in position for switching on the arcs again in the evening, for which purpose only the usual switch is necessary.

In preparing this article as well as our previous one, we owe much to the help of Mr. Ruthven-Murray, the consulting engineer to the Willesden Urban District Council, and the Council's staff (Mr. C. H. Smyth, the mains superintendent, and Mr. A. H. Ellis, who is in charge of the sub-station). We also desire to thank Mr. R. Poole for lending us the photographs from which some of the illustrations in this article were prepared.

A RECENT WIRELESS TELEGRAPH PATENT.

A recent patent, No. 16,113 of 1903, issued to Mr. J. Nevil Maskelyne, relates to an "Improved Mode of and Apparatus for Producing and Detecting Hertzian Oscillations."

In both transmitter and receiver the active oscillations are set up in a "closed" circuit or loop, instead of the usual vertical wires forming an "open" circuit. In each case, means are provided to ensure the bringing of the points where the highest P.D.s are found (anti-nodes) into the positions where their influence can be most efficiently exerted. The main circuit or loop is formed of a well-insulated wire or a number of wires connected in parallel. It is vertically supported from its central point by a mast or in any other convenient manner. The two ends are brought into the instrument room through suitable insulators capable of withstanding the high potentials used in transmitting. The same main circuit or loop serves either for transmitting or receiving.

Referring then to Fig. 1 k is a Morse key lever mounted on a pivot, the arm being hinged at h to allow a certain amount of movement from right to left. On the opposite side of the pivot extends a tail lever g, which is joined by a vulcanite connecting rod u to a lever working a rotating switch l. This switch consists of a central pivot surrounded by contact studs 1 to 8. Mounted on the pivot are three insulated arms carrying metal segments s, s_1, s_2, which serve to connect pairs of the contact studs. The particular studs joined up will depend upon the position to which the lever is moved. Normally, the connecting rod u is drawn to one side, say to the right, by a spring w, and the metal segments s, s_1, s_2 connect the studs 1, 6, which represent the ends of the main circuit, with the studs 2, 7, which represent the ends of the receiver circuit. Further, the key lever also acts as a switch for preventing the accidental working of the transmitter, while the receiver is in circuit, the key contact k_1 being carried out of contact with its fellow k_2. Normally, the studs 1, 6 are connected by the segments s, s_1 to the studs 2, 7. When it is required to use the transmitter, the operator moves the Morse key lever k to the right and retains it by a gentle pressure while working. This movement brings the Morse key contacts k_1, k_2 into juxtaposition and at the same time, through the connecting rod u, rotates the switch l, thus throwing the receiver out of contact and connecting the studs 1, 6, which represent the ends of the main circuit or loop, by means of the metal segments to the studs 8, 5, which represent the ends of the transmitter circuit. At the same time the third segment s_2 completes a circuit between studs 3, 4, the purpose of which will appear later. The contact studs and segments are preferably immersed in oil to ensure immunity from any danger of sparking across when the transmitter is in use. The Morse key contacts should also be bridged by a condenser for the purpose of reducing sparking between them when transmitting.

c is the sensitive detector or conjunctor (see Fig. 5), whereby the received impulses are caused to effect the working of the apparatus. This conjunctor consists of a short glass tube, c, on the ends of which metal caps, 9, are cemented. Through these caps 9 are passed plug pieces 10, with rounded ends projecting inwards. The rounded ends are ground truly spherical and brought to a mirror polish. When in position, the spherical surfaces are separated by a distance of about 5mm. and the space between the spherical surfaces is bridged by a hollow cylinder 11, whose internal diameter is less than the diameter of the spheres which support it. The ends of the cylinder are bevelled and accurately ground to a knife edge and both the inside and ends of the cylinder are brought to a mirror polish. The length of the cylinder 11 is so adjusted that, when the plugs are screwed in, the cylinder will not be clamped, but will have a small amount of play. The plugs and cylinders are preferably made of hardened steel and will act as a conductor of electricity. In order to render the conjunctor normally non-conductive and in a condition in which it will become conductive only, when acted upon by electric surgings or oscillations, the cylinder and plugs are put into a closed platinum crucible and carefully heated until they become coated with a pale yellow film of oxide. They are then allowed to cool and mounted in the glass tube, the plugs being cemented into the caps to render the whole airtight. One of the plugs is provided with a cavity, z, for containing a small quantity of anhydrous calcium chloride or similar substance, for the purpose of absorbing any slight moisture that the air in the tube may hold, thus ensuring that the enclosed air should be quite dry. The plugs are extended outwardly to form two pins 12, which fit into clips provided for the purpose on the receiver. This construction of conjunctor may be modified—for example, the connecting cylinder may have spherical ends, filling into knife-edged cups on the plugs supporting it. Or, instead of spherical surfaces, truncated cones may be employed, but spherical surfaces are preferable on account of the ease with which they may be accurately formed and polished. The contact surfaces, when oxidised in the manner above described, become practically non-conductive to currents of low potential, but when subjected to the action of any slight electrical disturbance, they become almost perfectly conductive. To destroy their conductivity the surfaces have to be separated by mechanical means, and this is preferably accomplished by a slight upward movement which throws the cylinder off its spherical supports and restores the arrangement to its normal condition. This throwing-up movement is obtained by mounting the device upon the armature d_1 of an electromagnet, a, which is caused to act whenever a current passes through the conjunctor, as will be more readily seen by reference to Figs. 6 and 7, which will be more fully described. It is preferred to describe the detector as a "conjunctor," in order to distinguish it from the irregular and heterogeneous point-and-surface contacts, known as "coherers." In this form of conjunctor all the components are mechanically accurate and thus are capable of exact reproduction in any quantity. The mechanical accuracy of the conjunctor is reflected in its extremely regular action in practical use.

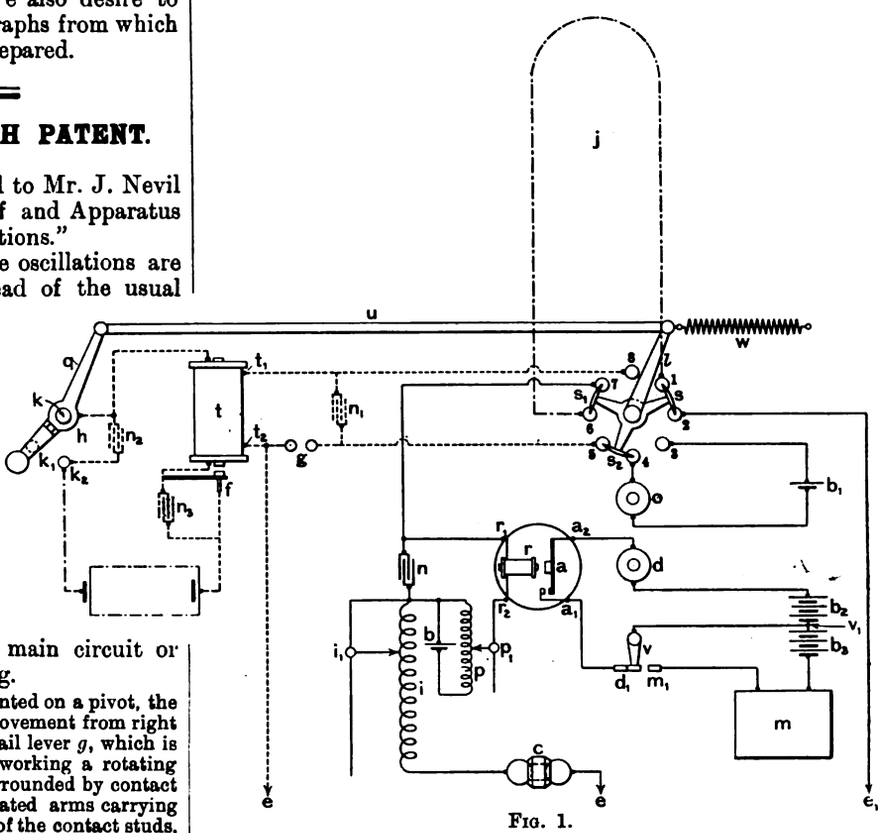

FIG. 1.

In the apparatus as arranged for receiving, one end of the main circuit is led to an earth connection, e_1, through the studs 1, 2, the other end being connected to one plate of a condenser, n, through the studs 6, 7, by means of the segments s and s_1 respectively. The opposite side of the condenser n is joined to one end of a variable self-induction coil, i, the other end of the coil being connected directly to one side of the conjunctor, the other side of the conjunctor being connected to earth at e, thus forming a complete circuit. The arrangement consisting of the condenser n and adjustable inductance i is termed an "integrator," and its object is to integrate the successive oscillations received and cause them to act cumulatively upon the conjunctor. The impulses

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radiated by the transmitter will have a certain definite period of oscillation depending upon the physical conditions involved, and the receiving circuit, as above described, will also have a very distinct natural period of its own, therefore, in order to produce integration of the received oscillations, it will be obviously necessary that the two systems shall have their respective periods "tuned" or brought into harmony, otherwise the oscillations first received will act in opposition to those that follow and defeat the end in view. It is for this reason that the self-induction coil i is made adjustable. It is preferably constructed of uninsulated copper wire wound upon an insulating cylinder. A slider, i_1, short-circuits those turns of the coil which lie between it and the condenser n, thus, by moving the slider towards one end or the other of the coil, the path of the oscillations may be lengthened or shortened at will and the period correspondingly altered. By moving the slider to its fullest extent, the whole coil will be short-circuited and the integrator practically cut out. Besides determining the positions of the anti-nodes or points of maximum potential, the condenser n provides a point at which the conductors forming the circuit are not actually joined. This virtual gap is bridged by a relay, r, and a battery cell, b. Then, so long as the conjunctor is in its normal state, no current passes through the relay, but, when under the influence of electric surgings, the conjunctor makes contact, a current from the cell b will pass around the circuit through the relay r, causing its armature a to move and close the local circuits. There are two local circuits operated by this relay r, one which operates the magnet of a restoring device or "disjunctor" d—that is to say, which separates the sensitive contacts of the conjunctor—and the other, which simultaneously excites the magnet of a Morse recording instrument, m.

The connections and operation of these local circuits are as follows:—Two batteries, b_2, b_3, are joined in series and from the junction v_1 between them a wire leads to a rocking arm, v, actuated by the disjunctor armature. At its free end, this rocking arm v carries a contact stud, which moves between two loose pivotted contact studs d_1 and m_1. Light springs tend to press these loose pivotted contact studs towards the contact stud on the rocking arm v. Their movement, however, is restricted by stops, so that they have not as much play as the rocking arm. The loosely pivotted contact stud d_1 is connected in series with the armature a of the relay, the other, m_1, being connected in series with the Morse recording instrument m. When, therefore, the rocking arm v has moved to its full extent in either direction, it will break contact with the stud d_1 or m_1 from which it has moved. Normally, it rests against the stud d_1 in series with the relay armature, being drawn in that direction by a suitable spring. When the relay r makes contact, a current passes from v_1 between the batteries b_2, b_3, to the rocking arm v, through the contact stud d_1 in series with the relay armature a to the disjunctor d, and thence back to the battery b_2. The disjunctor magnet thus excited attracts its armature, which, in turn, rocks the rocking arm v. Directly the rocking arm begins to move it comes in contact with the stud m_1 in series with the Morse recording instrument m, and a current then passes from v_1, through the rocking arm v and the stud m_1, to the Morse recording instrument and back to the battery b_3, thus actuating the said Morse recorder, On the completion of its stroke, the rocking arm v breaks contact with the stud d_1 in series with the relay armature a, and at the same instant the contact surfaces of the conjunctor are thrown apart, and all the parts automatically return to their normal positions, ready to repeat their movements on receipt of another impulse. As drawn, the movements are much exaggerated for the sake of clearness and emphasis, but in practice the movements of the apparatus are slight and extremely rapid, so that with a continuous stream of impulses the ink wheel of the Morse recording instrument never leaves the paper. Dots and dashes, therefore, are signalled by sending streams of impulses for short and longer periods, as required. The sending current acting through the conjunctor is not of the full potential of the relay battery cell b, and the conjunctor may and should be made sufficiently sensitive to become conductive when its contacts have a P.D. of from 1·5 to 2 volts. Therefore, if the relay battery b consists merely of a single dry cell, its full potential will be too great. To remedy this, I join up the poles of the battery b with an adjustable rheostat p, with a slider p_1. The sending current is taken directly from the battery terminal on one side and from the slider p_1 of the rheostat p on the other side. By suitably adjusting the latter, the potential of the sending current may be altered at will.

The last point relating to the receiver is in reference to the third segment s_2 on the rotating switch l. The conjunctor c being so sensitive that it responds to a potential of 1 or 2 volts, cannot be expected to suffer no damage if submitted to the near action of the transmitter, whose oscillations may have a potential of hundreds of thousands of volts. It is, therefore, advisable that, during transmission, the conjunctor should be disconnected from everything that may convey to it an excess of energy. For this reason its support is made of ebonite or other insulating material, and contact with it is made by two rocking arms, c_1, c_2, mounted upon a pivotted insulating shaft, c_3, see Figs. 6 and 7. This shaft also carries an armature, c_4, which, when attached by a magnet o, draws the rocking arms away from the two ends of the conjunctor c. Normally, the arms are pressed into contact by a spring, c_5. When the rotating switch l is rotated to the position for transmitting, the third segment s_2 joins with contact studs 3, 4, and completes the circuit of the battery b_1 through the magnet o, which instantly disconnects the conjunctor c. On releasing the transmitting key contact between these studs 3, 4 is broken and the current from battery b_1 will be interrupted, the arms again making contact with the conjunctor. In the receiving apparatus each magnet bobbin should be bridged by a non-inductive shunt, whose resistance is preferably about double that of the bobbin itself. It is preferred to keep the resistance low and use a comparatively large current of low potential. In this way local circuits are prevented from reacting upon the conjunctor c and the necessity for shunting contacts with condensers or resistances is obviated. The method of using high resistances requiring high potentials to reduce the current leads to infinite trouble, as the after spark, which occurs whenever a contact is broken, has so high a potential that it is difficult to eliminate, and reaction upon the sensitive detector or conjunctor difficult to prevent.

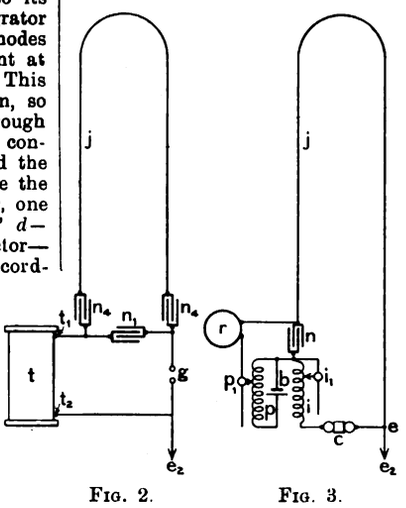


FIG. 2.

FIG. 3.

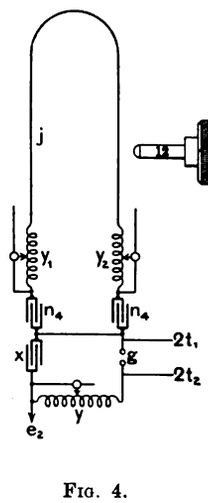


FIG. 4.

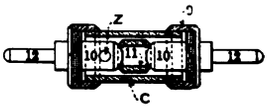
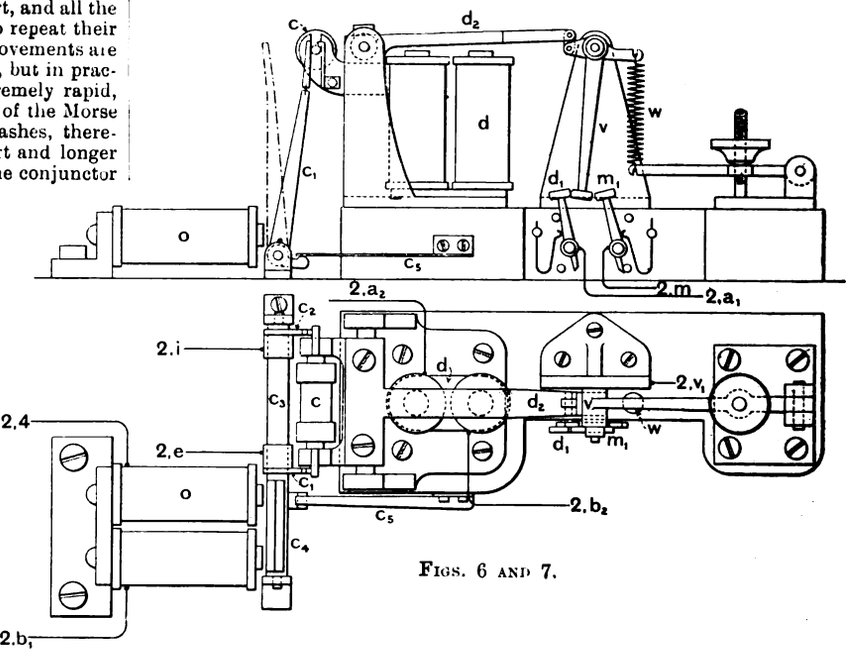


FIG. 5.

But with currents of low potential, however large they may be, local disturbances are easily prevented, as it is potential alone that affects the conjunctor. Beyond the amount necessary to charge the contact surfaces current-density may be increased indefinitely without affecting the conjunctor in the least.

Referring now to Fig. 2, which refers to the transmitting arrangement, energy is supplied from an induction coil or transformer, t, provided with condenser n_1 and contact breaker in the usual manner. One secondary terminal, t_1, of the induction coil t is connected to one end of the main circuit or loop, j, the other end of the main circuit passing to one side of a spark-gap, g. The opposite side of the gap g is connected to the other secondary terminal t_2 of the coil and also to earth at e_2. The lower ends of the main circuit j are, in this case, bridged by a condenser, n_1, situated near the coil, the object of which is to produce an anti-node at the highest point of the main circuit. Without this arrangement, the anti-node would be at the secondary terminal t_1 of the induction coil, where, obviously, radiation would be absolutely inefficient, as will be apparent to those conversant with the subject of electrical oscillations. It is also found convenient to insert condensers, n_4, in the main circuit or loop j in order that the current oscillating therein shall not be at the full potential given by the transformer terminals before the oscillations



FIGS. 6 AND 7.

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are established, thus tending to avoid undue leakage from the main circuit or loop j. This arrangement of transmitter is, for general purposes, to be preferred on the score of economy, as it will transmit signals as far as they can be sent with the power employed and under the conditions imposed. But for cases in which economy is not the chief consideration, when energy may be wasted, in order to fulfil some special requirement, such as when a transmitter must be able to communicate with any single station of a number which are within speaking distance, the integrators at the communicating station must be adjusted to periods as diverse as possible, the transmitters must be made adjustable to suit the various periods adopted, and the oscillations radiated must be individually too weak to affect the nearest receiving station. This being arranged, it will only be the particular receiver which integrates the impulses sent out that responds to the transmitter. The transmitter, instead of sending out a few powerful waves at each impulse, sends out many feeble ones, thus causing the waste of energy above referred to. At each oscillation there will be a definite loss of a certain percentage of the total energy by leakage, by conversion into heat at the spark-gap, by overcoming resistance and self-induction, and the more the oscillation is prolonged the greater must be the total loss of efficiency.

Various methods of altering the frequency and percentage of radiation at the transmitting station may be employed. For example, an adjustable self-induction coil y, see Fig. 4, may be inserted between the ends of the main circuit j, while other adjustable coils, y_1, y_2, may be placed in the circuit with a condenser n_4 for each. A third adjustable condenser, x, is also employed, while e_4 indicates earth and g the spark-gap. By widely separating the plates of this adjustable condenser x, both it and its inductance can be rendered inoperative. Thus the period may be altered by varying the inductance at the end of the main circuit. The percentage of radiation may be varied for prolonging or curtailing the oscillation by adjusting the adjustable condenser for capacity and tuning its inductance to the same period as the main circuit. Obviously, the more energy is retained in the system containing the adjustable condenser and the inductance, the less will be radiated from the system containing the main circuit and its inductances, and the longer the oscillations will continue, for the reason that the former does not radiate anything but the latter does. The sparks producing the radiated oscillations are the result of interruptions of the primary current by the contact-breaker f (see Fig. 1) bridged by the condenser n_3, thus the part played by f is a very important one. The defects connected with a simple make-and-break vibrator are so marked that many devices are employed to take the place of f. The object is to increase the rapidity of action while reducing the sparking at the contacts. For this purpose I may use a motor-driven commutator of any convenient construction.

In Figs. 6 and 7 the leads to the various parts are indicated by the reference letters $2a_1$, $2m$ in Fig. 6, and $2a_2$, $2r_1$, $2b_2$, $2i$, $2e$, 2 4 and $2b_1$, and in Fig. 4 by the letters $2t^1$, $2t^2$. The transmitter connections are shown on the drawing Fig. 1 by dotted lines, the receiver connections by full lines and the common connection by dot and dash lines.

NOTES ON EQUIPMENT OF THE WILKESBARRE AND HAZLETON RAILWAY.*

BY LEWIS B. STILLWELL.

The equipment of the Wilkesbarre and Hazleton Railway, which was completed in the spring of 1903, has been referred to in some detail in technical publications, but it is thought that a brief description of certain features, novel in whole or in part particularly the covered third-rail and the special form of collecting shoe employed, should be recorded in the proceedings of this Congress. The fact that this was the first railway of any considerable length in America to be equipped for commercial use with a protected third-rail, and that for the last 18 months it has been in highly successful operation, may make the following descriptive notes relative to construction and to performance of some value to engineers who may be called upon to deal with similar equipment problems.

The more important features of this railway and its equipment are:—1. The use of a contact rail covered by a plank guard to protect it against snow and sleet, and to prevent accidental contact by people crossing the track or walking near it. 2. The elimination of all grade crossings. 3. The fact that it traverses a rugged and mountainous country, level stretches of roadbed being practically insignificant, while there are several stretches of 3 per cent. grade not less than 4 miles in length. 4. The use of cars weighing 42 tons net, without passenger load, and equipped with four motors of 125 H.P. (one hour rating) each. 5. Brake equipment so designed that no one accident to any part of the rigging can render all brakes inoperative. 6. The use of a portable converter station in the form of a car carrying transformers, converters and necessary switch gear. 7. The use of a soldered—not riveted—rail bond.

The railway is 26·2 miles long, has a single track and connects the cities of Wilkesbarre and Hazleton in north-western Pennsylvania. It competes with two steam railways, the Lehigh Valley and a branch of the Pennsylvania, both of which were in operation long before their electrically-equipped competitor was projected. The maximum grades used by the steam railways approximate 2 per cent., and the distance between their respective terminals in the two cities is 50·4 miles in the case of the Pennsylvania and 49·6 miles in the case of the Lehigh Valley. The country between Wilkesbarre and Hazleton is mountainous, the new railway being compelled to cross not less than three ranges. The terminus of the line in Hazleton is nearly 1,200ft. above the Wilkesbarre terminus. One of the striking advantages of electric traction is illustrated by the fact that the adoption of a practically uniform gradient of 3 per cent. has made it possible to locate and construct a line but 26·2 miles in length, connecting, through so exceptionally mountainous a country, termini which are 21 miles apart as the crow flies. In accomplishing this result, one tunnel is used; this pierces the Penobscot range, and is 2,684ft. in length The passenger traffic of the road is chiefly through service, the country between the two cities being sparsely populated. A considerable freight business in delivery of supplies to the inhabitants of the intervening country and in hauling farm produce to market as well as a moderate express business has been developed since the service of this road was inaugurated.

The railway is constructed upon a private right of way 60ft. wide fenced on both sides throughout its entire length. Grade crossings are entirely eliminated, a feature of construction which may well be copied wherever and whenever possible, the resultant increase in speed compensating in a large degree if not wholly for the increased cost of construction. There are 33 bridges crossing highways and streams; the majority of these structures have concrete abutments and steel girders. There is one three-arch bridge of granite masonry, and one bridge using steel girders supported upon high masonry piers. The track rail weighs 95lb. to the yard, and is supported upon 8ft. ties spaced to 24in. centres. Every fifth tie is 9ft. long, the extended ends of these ties carrying the insulators which support the contact-rail. The ties are laid upon a bed of anthracite coal cinders topped with a dressing of broken stone. All curves are carefully compounded, and the outer rail properly elevated with reference to high-speed service.

The contact rails are 60ft. in length and weigh 80lb. per yard. The specified composition of the contact rail is as follows:—Carbon not to exceed 0·10 per cent.; manganese, 0·55 per cent.; phosphorus, 0·08 per cent.; sulphur, 0·10 per cent.; silicon, 0·03 per cent. Its conductivity is equivalent to pure copper, having about one eighth its cross-section. The centre line of the contact-rail is 28in. from gauge line of the track, and its upper face is 5in. above the track rail, this location being selected to permit operation of steam locomotives over the track without disturbance of the contact-rail or its guard. Fig. 1 shows relative position of the track rails, contact rail, the rail guard and collecting shoe.

Each 60ft. length of the contract rail is anchored at its middle by a projection of the malleable iron casting at the top of the insulator, which projection engages with a slot in the base of the rail. To allow for expansion, adjacent rails are separated by a distance of $\frac{1}{4}$in. when temperature of the rail is 60°F. To permit free expansion and contraction, the fish plates are left sufficiently loose. Contact rail and track rails are electrically connected throughout their respective lengths by copper bonds which are soldered to the rails. These bonds are fastened under the base of the rail. The rail guard is a 2in. pine plank, 6in. in width, supported directly over the rail by oak posts at intervals of 8ft., these posts in turn being supported by the contact rail to which they are attached by means of malleable iron castings and hook bolts, as shown in Fig. 1.

The schedule provided for in the equipment of the road contemplated an hourly express service and a local service upon headway of 90 minutes. The rolling stock equipment comprises six combination coaches, each having a passenger compartment, a baggage compartment and a toilet room. The passenger compartment provides 38 seats of standard Pennsylvania passenger car size—*i.e.*, 40in. long—while eight seats are provided in the baggage compartment, which is also used as a smoking compartment. The general dimensions of the car are:—Length over end panels, 43ft.; over platform, 51ft.—width over outside sheathing, 9ft. 6in.; height from bottom of sill over roof 9ft. 8$\frac{1}{2}$in. Double sliding doors are used at the passenger end of the cars and single sliding doors at the opposite end. Loading steps are used at only one side of each platform, and the side of the platform opposite these steps is used for the motorman's cab. At each side of the baggage compartment is a sliding door 42in. wide; the vestibule side doors are hinged to the vestibule post next the car body, and when closed are locked by the trap door which is lowered to complete the floor of the vestibule and cover the steps when the door is closed. Automatic air sand boxes are used. "Cow-catchers" attached to the trucks are placed at each end of the car and are set back a sufficient distance to avoid interference with the couplings.

Brill No. 27-E-2 trucks are used; the wheel base is 7ft. 6in., and the wheels are 36in. in diameter. A General Electric No. 66 motor is attached to each of the four axles. The control system is the Sprague multiple unit automatic control, using contactors instead of control cylinders. The total weight of the car equipped, without

* Abstract of a Paper read before Section F of the International Congress of St. Louis.

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passengers, is 84,000lb. A railway using cars of this weight and operating over gradients of 3 per cent., ranging from 3 to 5 miles in length, requires a reliable brake equipment. In the case described in this Paper, both outside and inside brake shoes are provided, the outside brakes being operated by two independent means—viz., Westinghouse automatic air apparatus and a vertical hand-wheel located in the motorman's cab. The inside brakes are operated by a vertical wheel in the vestibule through mechanical connection absolutely independent of that which operates the outside shoes.

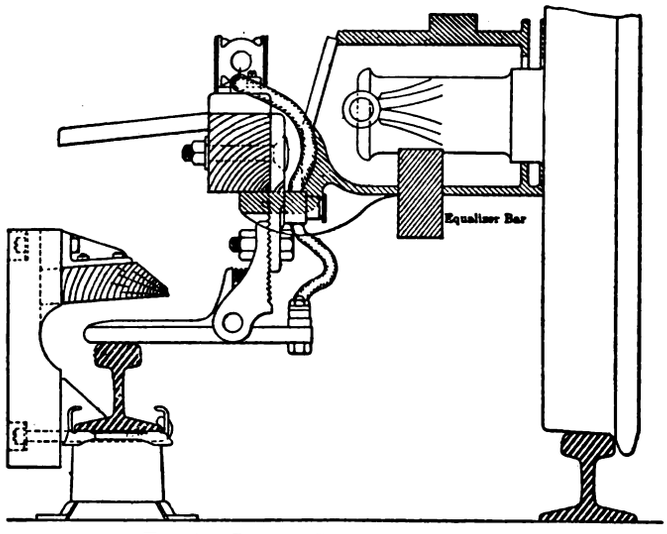

FIG. 1.—CONTACT SHOE AND GUARD-RAIL.

The failure of no one element in the brake equipment, therefore, can deprive the train crew of effective means for checking the speed of the car. In the arrangement of the inside brake equipment, provision is also made for the Newell magnetic track brake, which, however, has not yet been developed for cars equipped with motors of so large a size as are used in this instance.

The Westinghouse air-brake apparatus is so arranged as to permit use of the "straight air system," and also of the automatic system. The former, by which air admitted by opening the engineer's valve operates directly upon the piston of the brake cylinder, is generally used for the reason that it readily permits graduated application of the brakes. At the same time, the automatic is available and is brought into service at any time by reduction of the train-line pressure The cars are arranged for operation singly or in trains, the multiple-unit control system being adopted with special reference to possible ultimate operation of trains comprising two or more cars each.

The construction of the contact or collecting shoe is shown in Fig. 2. This design is due to Mr. W. B. Potter, chief engineer of he railway department of the General Electric Co.

The cars are equipped with trolley poles for use in passing over portions of the city traction systems, and the switch which controls the connection to trolley and shoe is arranged to permit change from trolley to third-rail supply or vice versa without losing contact.

The power plant is located about 8·4 miles from the Hazleton end of the line upon Nescopeck creek. The electrical equipment comprises three 400kw. three-phase alternators of ths revolving-field type, direct connected to three single-expansion twin engines, operating at 150 revs. per min. The alternators deliver three-phase currents at 390 volts. A 400kw. converter, located in the power house, receives alternating current from the generator 'bus bars, and delivers continuous current at about 625 volts to contact-rail where the line passes the power house. Two groups, each comprising three transformers of 150kw. each, connected in delta, deliver to the transmission circuits energy at 15,000 volts potential. The transformers are of the oil-insulated self-cooling type.

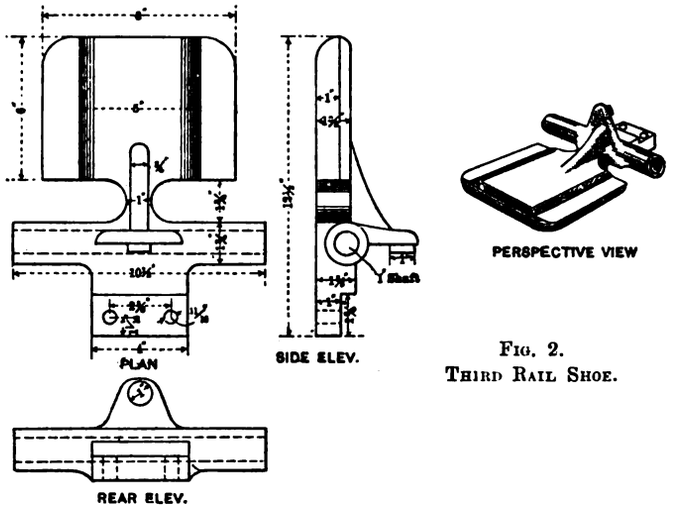

FIG. 2.
THIRD RAIL SHOE.

At a distance of 11 miles from the power house, in the direction of Wilkesbarre, a sub-station, comprising three step-down transformers and one 400kw. converter, is located. The contact rail, from this point to the Wilkesbarre terminus, is supplied from this sub-station, while between the sub-station and power house it is supplied at each end from the converters located at these points. At the Hazleton end of the line, which is 8·4 miles from the power house, the contact rail is supplied in part from the power house of the Lehigh Traction Co., the direct-current compound-wound generators in the plant of that company operating in parallel with the rotary converter at the power house of the Wilkesbarre and Hazleton Railway.

The alternating-current transmission line comprises three bare copper wires, No. 4 B. & S. gauge, forming an equilateral triangle

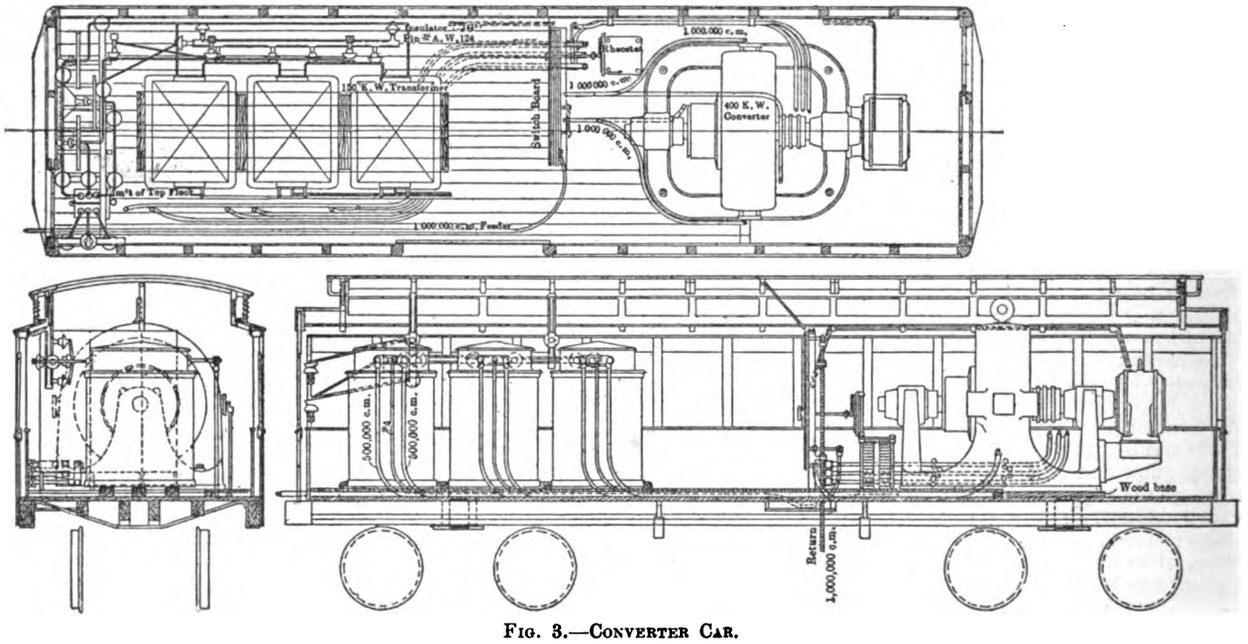

FIG. 3.—CONVERTER CAR.

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30in. on each side. Double-petticoat glass insulators, 7in. in diameter, are used. The poles are spaced 100ft. on curves and 125ft. on tangents. Locust pins, 7in. long and 2in. in diameter, where they enter the cross arm, are used. Two of the pins are carried by the cross arm, and the third is inserted in the top of the pole, which is clamped with 7in. iron bands. The yellow-pine cross-arms are 6in. by 4½in. in section and 34in. long. They are secured to the pole by two §in. bolts. The transmission circuit is transposed twice, each transposition making one-third of a turn. The transmission circuit is carried to a distance of 14 miles from the power house in the direction of Wilkesbarre—*i.e.*, about 3 miles beyond the fixed sub-station at Nuangola. This is done to permit the supply of alternating current to the portable sub-station, which is sometimes located at the end of the transmission circuit.

The portable sub-station comprises a car 36ft. long and 9ft. 6in. wide, carrying a complete sub-station equipment of electrical apparatus, comprising three 150kw. transformers, one 400kw. converter and a complete outfit of alternating-current and continuous-current switching apparatus. It is also equipped with lightning arresters and reactance ceils. Fig. 3 illustrate the arrangements of the apparatus inside the car. The total weight of the equipment is about 51,000lb. The car is not equipped with motors, but, when necessary, is attached to a regular passenger car and hauled to any part of the line where it may be needed. In the operation of the line it serves the double purpose of providing a reserve for the transforming and converting equipment of the power house and sub-station, and of supplying an additional sub-station, which may be located near the top of the long grade at the Wilkesbarre end of the line when traffic on that part of the system is particularly heavy, as may happen in case of special excursions from the city.

In operation of the road the guard has repeatedly demonstrated its value in protecting the contact rail against sleet and thereby preventing interruptions of service, which in the severe winter climate of these Pennsylvania mountains would otherwise have been comparatively frequent and serious. During the winter of 1903-4 cars were operated from 6 a.m. until midnight upon headway which at no time was less than one hour, and notwithstanding this infrequent service and the fact that no cars were running between midnight and 6 a.m., there were but two instances in which any serious delay occurred by reason of the formation of sleet on the contact rail. Upon one occasion a car was delayed one hour and 50 minutes, and at another time a car lost, during the round trip, 28 minutes. The trouble occurred on a stretch of track where the line is particularly exposed to the sweep of the wind over the mountains. Partial formation of sleet on top of the contact rail which occurred in these cases would have been greatly reduced, if not eliminated, had the guard been even 2in. wider. In cases where it is not necessary to consider the possibility of occasional operation of steam rolling stock experience on this road seems to show that effective protection against sleet can be secured by employing a horizontal plank guard substantially as shown in Fig. 1, but extended in each direction—*i.e.*, toward the track and away from it—1in. farther than the guard adopted in this instance. Where possible operation of steam rolling stock will not permit such extension in the direction of the track, the guard should be widened at least 1in. in the other direction—*i.e.*, away from the track.

The addition of a vertical plank attached to the posts which carry the top guard would secure effective protection against sleet coming from that side of the track, but on the other hand it would tend to cause the accumulation of snow around and upon the contact rail. Mr. C. H. B. Houck, superintendent of motive power of the Wilkesbarre and Hazleton Railway, to whose courtesy I am indebted for many particulars regarding operation, attributes the success of the guard in large degree to the fact that it is open front and back, so permitting the wind to drive snow through the space between contact rail and the guard.

The use of a horizontal guard above the contact rail implies necessarily the adoption of a collecting device differing from the familiar link type generally employed in connection with systems of third-rail supply. On the whole, experience in operation of the shoe illustrated in Fig. 1 has been very satisfactory, and in the opinion of the writer has demonstrated the essential superiority of a shoe of this type, particularly at high speeds. Some trouble has resulted from failure to maintain accurate alignment of contact rail and track rails, as a consequence of which shoes have been broken by striking against the posts which support the guard, and in order to make sure that when the shoe strikes these posts the break shall occur at a predetermined point and not carry away the supporting casting as well as the shoe, it has been deemed advisable to reduce the section of the shoe casting at the weakest point to the dimensions shown in Fig. 2, which, in this respect, are considerably modified as compared with the original design. At high speeds the shoe has less tendency to jump than the link type shoe, the moving parts being comparatively light, and the spring pressure—about 15lb.—proving more effective than gravity in maintaining contact of shoe and rail. The design of this shoe can with advantage be materially modified in respect to details; in type, however, it is excellent and very satisfactory.

Its ability to collect heavy currents satisfactorily was well demonstrated by a test carried out for the purpose of determining the ability of the electrical equipment of the Wilkesbarre and Hazleton cars to draw a heavy trail car up the mountain grades. In this test a motor car was coupled to a passenger coach weighing 70,000lb. The total weight of the two-car train, including train crews and observers reading the measuring instruments, was 156,000lb. Simultaneous readings of current and E.M.F. were taken at 30-second intervals at the power house and at the permanent sub-station, and similar readings were taken at 15-second intervals on the motor car. At times the speed was determined with a fair degree of accuracy by counting rail joints, although at the higher speeds the results thus obtained are hardly reliable.

The start was made at the Wilkesbarre terminal at 1 a.m., and the run to the Hazleton end of the line was accomplished in 68 minutes, the average speed being 22 miles per hour. During this run the current per motor cars in climbing the long 3 per cent. grades exceeded 400 amperes per shoe. The only sparking noted occurred at irregular intervals, averaging perhaps distances of something over a quarter of a mile, and due doubtless to slight differences in elevation of adjacent rail ends. The night was dark, and the slightest spark under the shoe was easily detected. At the end of the run the shoes were found to be in good order and not excessively heated.

Where both inside and outside brake shoes are used it is found advantageous in descending heavy grades to apply one set or the other to the point of actual contact with the wheel, leave this set thus adjusted and use the other set for such additional braking as may be necessary. This method is particularly advantageous where axles and trucks are light in construction, or where from long usage or inadequate maintenance there may be lack of rigidity, and where, consequently, if but one set of brake shoes be applied the braking may become ineffective. The partial application of one set—*e.g.*, the inside shoes—holds the wheels firmly in place, and increases the promptness and effectiveness of results attained in applying the other set of brakes. In the operation of the Wilkesbarre and Hazleton Railway, when a car reaches the top of one of the long grades the conductor takes his place in the vestibule and applies the inside brakes by hand, tightening them just sufficiently to take up the lost motion and bring the shoes into firm contact with the wheels. The motorman then holds the train, usually by applying the air-brake as may be necessary, and in case any part of the brake rigging of the air-brake apparatus should fail, the car can be held by using the inside brakes, which, being already in contact with the wheels, can be promptly applied.

Novel American Power Scheme.—According to the *Electrical World* of New York, a scheme possessing novel features is contemplated in Colorado for obtaining water power for electrical purposes. The site of this project is 24 miles from Silverton. The Animas Company, which is carrying out the scheme, has acquired water rights in a drainage area of 400 sq. miles in San Juan and La Plata counties. This drainage area is enclosed towards the centre, where flows the Animas river. The river between Silverton and Durango has a gradual fall of nearly 3,000ft., most of it within 20 miles. The problem was to use a portion of this fall. At a point 10 miles below Silverton the river is dammed and nearly all of its water is diverted to a canal, which is composed mostly of a box flume, 6ft. deep and 8ft. wide. This canal follows the line of the river in a south-westerly direction about 3 miles and then gradually leaves it. For 5 more miles it proceeds, and then it is joined by another canal, 3 miles long, which carries the water of Lime Creek from the north. After the junction the canal is carried 2 miles to what is called Cascade Reservoir. This reservoir is a natural basin, 3 miles long and about three-quarters of a mile wide, extending north and south. In addition to being fed by the Animas river and Lime Creek it receives another supply from a canal which brings the water of Cascade Creek. This canal is about 5 miles long. At the southern end of the reservoir is another dam, and over this the water is poured into what is called a power canal, which proceeds south-easterly for 2 miles and ends in a feed reservoir. This is close by the top of a cliff 1,000ft. high. At its base flows what is left of the Animas river. From the feed reservoir down the face of the cliff a riveted steel pipe, 4ft. in diameter, is being extended. It will withstand the enormous pressure of 900lb. to the square inch. Through this the water will drop to the power house. Ultimately, the power house is to have a capacity of 40,000 H.P.

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WIRELESS TELEGRAPHY ACT, 1904.

In response to requests which we have received, we give below the text of the Wireless Telegraph Act, 1904, as finally revised and amended. The original Bill, the debates upon it, and the amendments will be found in *The Electrician* of July 22, Aug. 12 and 19.

1.—(1) A person shall not establish any wireless telegraph station, or instal or work any apparatus for wireless telegraphy, in any place or on board any British ship except under and in accordance with a licence granted in that behalf by the Postmaster-General.

(2) Every such licence shall be in such form and for such period as the Postmaster-General may determine, and shall contain the terms, conditions and restrictions on and subject to which the licence is granted, and any such licence may include two or more stations, places or ships.

(3) If any person establishes a wireless telegraph station without a licence in that behalf, or instals or works any apparatus for wireless telegraphy without a licence in that behalf, he shall be guilty of a misdemeanour, and be liable, on conviction under the Summary Jurisdiction Acts, to a penalty not exceeding £10, and on conviction on indictment to a fine not exceeding £100, or to imprisonment, with or without hard labour, for a term not exceeding 12 months, and in either case be liable to forfeit any apparatus for wireless telegraphy installed or worked without a licence, but no proceedings shall be taken against any person under this Act except by order of the Postmaster-General, the Admiralty, the Army Council or the Board of Trade.

(4) If a justice of the peace is satisfied by information on oath that there is reasonable ground for supposing that a wireless telegraph station has been established without a licence in that behalf, or that any apparatus for wireless telegraphy has been installed or worked in any place or on board any ship within his jurisdiction without a licence in that behalf, he may grant a search warrant to any police officer or any officer appointed in that behalf by the Postmaster-General, the Admiralty, the Army Council or the Board of Trade, and named in the warrant, and a warrant so granted shall authorise the officer named therein to enter and inspect the station, place or ship, and to seize any apparatus which appears to him to be used, or intended to be used, for wireless telegraphy therein.

(5) Secs. 684, 685 and 686 of the Merchant Shipping Act, 1894 (which relate to the jurisdiction of courts and justices), and sec. 693 of the same Act (which relates to distress for sums ordered to be paid by masters and owners of ships), shall apply to the jurisdiction of courts and justices in respect of ships, and to distress under this Act.

(6) The Postmaster-General may make regulations for prescribing the form and manner in which applications for licences under this Act are to be made, and, with the consent of the Treasury, the fees payable on the grant of any such licence.

(7) The expression "wireless telegraphy" means any system of communication by telegraph as defined in the Telegraph Acts, 1863 to 1904, without the aid of any wire connecting the points from and at which the messages or other communications are sent and received. Provided that nothing in this Act shall prevent any person from making or using electrical apparatus for actuating machinery or for any purpose other than the transmission of messages.

2.—(1) Where the applicant for a licence proves to the satisfaction of the Postmaster-General that the sole object of obtaining the licence is to enable him to conduct experiments in wireless telegraphy, a licence for that purpose shall be granted, subject to such special terms, conditions and restrictions as the Postmaster-General may think proper, but shall not be subject to any rent or royalty.

(2) Where an applicant for a licence satisfies the Postmaster-General that a wireless telegraph station is to be used solely for the transmission of telegrams which are within the first or second exception from the exclusive privilege of transmitting telegrams conferred upon the Postmaster-General by the Telegraph Act, 1869, a licence for that purpose, if granted, shall not be subject to any rent or royalty.

(3) It shall be lawful for the Postmaster-General, due regard being had to the maintenance and exercise of effective control over wireless telegraphy, to grant special licences at reduced terms for the establishment and working of wireless telegraph stations to be used exclusively for the transmission within the United Kingdom of news to public registered newspapers. A schedule of all reduced rents or royalties imposed by any special licences shall be laid before both Houses of Parliament within 14 days of the commencement of the session next succeeding the grant of any such licences.

3.—(1) This Act may be cited as the Wireless Telegraphy Act, 1904, and may be cited with the Telegraph Acts, 1863 to 1904.

(2) This Act shall extend to the whole of the British Islands and to all British ships in the territorial waters abutting on the coast of the British Islands, and the Royal Courts of the Channel Islands shall register this Act accordingly.

(3) His Majesty in Council may order that this Act shall, subject to any conditions, exceptions and qualifications contained in the order, apply during the continuance of the order to British ships whilst on the high seas.

(4) A person shall not work any apparatus for wireless telegraphy installed on a foreign ship whilst that ship is in territorial waters otherwise than in accordance with regulations made in that behalf by the Postmaster-General, and the Postmaster-General may by any such regulations impose penalties recoverable summarily for the breach of any such regulations not exceeding £10 for each offence, and may provide for the forfeiture on any such breach of any apparatus for wireless telegraphy installed or worked on such ship. Save as aforesaid, nothing in this act shall apply to the working of apparatus for wireless telegraphy installed on any foreign ship.

4. In the application of this Act to Scotland the expression "misdemeanour" means crime and offence.

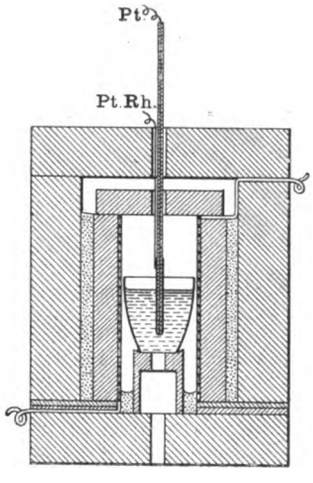
5. In the application of this Act to the Channel Islands and the Isle of Man: (1) The lieutenant-governor of the island of Jersey or the island of Guernsey, and the governor, lieutenant-governor or deputy governor of the Isle of Man, as the case may require, shall be substituted for the Board of Trade; (2) Offences may be prosecuted, fines recovered, proceedings taken and search warrants issued in such courts and in such manner as may for the time being be provided in the Channel Islands and the Isle of Man by law, or, if no express provision is made, then in and before the courts and in the manner in which the like offences, fines, proceedings and warrants may be prosecuted, recovered, taken or issued therein by law, or as near thereto as circumstances admit, and the bailiff or his lieutenant, or any jurat of the Royal Court in the island of Jersey or the island of Guernsey, and the judge or any jurat of the Court of Alderney, and the high bailiff or two justices of the peace in the Isle of Man shall respectively be substituted for a justice of the peace.

6. This Act shall continue in force until July 31, 1906, and no longer, unless Parliament otherwise determines.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

High Temperature Standard Scale.—A. L. Day and E. T. Allen announce that they have succeeded in reproducing the Reichsanstalt high temperature scale at Washington by means of thermo-couples and melting points. The gas thermometer scale thus made available in the United States extends from 250 to 1,150deg. The thermo-couples reproduce the scale with a maximum error of 1deg., which is about the same as that of the gas thermometer itself. The authors obtained from Dr. Heraeus, of Hanau, a set of four thermo-elements cut successively from the same roll of wire, which, when joined together, gave identical readings. These were taken to the Reichsanstalt and measured in the original melting-point furnace with the same elements in terms of which the gas thermometer scale had been expressed. Five comparisons were made, at the melting points respectively of cadmium (in air), zinc (in air), antimony (reducing atmosphere), silver (reducing atmosphere) and copper (in air). The elements were then conveyed by messenger to the Geological Survey at Washington, and again compared in a special electric furnace, whose construction is shown in the diagram. The coil was wound on the inside of the oven instead of the outside. It required about 3,000 watts to maintain a constant temperature of 1,600deg. The furnace was carried at times on a 110-volt direct-current street main, but accurately constant temperatures could not be depended upon without a storage battery. Although the constants in the measuring apparatus—thermo-elements, resistances, standard cells, metals, &c.—had all been changed in the transfer, the aggregate error nowhere exceeded 1deg. The form of thermo-couple employed had the platinum wire embedded in a Marquardt porcelain tube, provided with a cap of platinum-rhodium alloy. The melting points used as points of reference were cadmium 321·7, zinc 419·0, silver 961·5 and copper 1,064·9. Antimony was used to fill the gap between zinc and silver, but it can only be had in sufficient purity from Kahlbaum, Berlin.



[DAY and ALLEN, *Physical Review*, September, 1904.]

Transformation of Radium into Helium.—F. Himstedt and G. Meyer have undertaken series of careful experiments with the object of proving that the helium found in the spectrum of radium emanation after a certain time is in it from the beginning. The result of the experiments has turned out entirely the reverse, and the authors have no doubt now that the transformation of the element radium into the element

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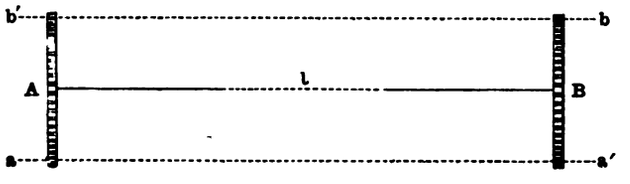
helium does actually take place, and that, therefore, we are bound to considerably modify our views as to the constitution of atoms and elements. The authors used 50 milligrammes of purest radium bromide prepared by Giesel. This was enclosed in a U-tube and attached to another U-tube with a capillary connection at the bottom, which was provided with aluminium electrodes and served for the spectrum analysis of the emanation. The whole arrangement was evacuated and dipped into liquid air. The two electrodes were both joined to another at −4,000 volts. Then pure hydrogen was conducted for three days over the radium bromide and through the spectrum tube. The two tubes were then fused off and separated. To judge by its intense luminosity in the dark, the spectrum tube must have contained a great deal of the radium emanation. The spectrum showed the primary and secondary H-series and the CO bands. Nothing could be seen of the helium lines, either with a Heele prism or with a Steinheil grating spectrograph. After eight weeks a photograph was taken of the spectrum with a Rowland grating and an exposure of 39 hours. Again no helium lines. The tube was fused off on December 12th. In the middle of May the red, yellow, green and blue helium lines made their appearance. That they appeared five months after the emanation and not in five days, as in Ramsay and Soddy's experiments, may be due to the fact that the authors had nothing colder than liquid air at their disposal, and could, therefore, not reach Ramsay and Soddy's degree of vacuum. The authors attach importance to the fact that they neither heated nor dissolved the radium bromide, but extracted the emanation by hydrogen at atmospheric pressure.

[HIMSTEDT and MEYER, *Annalen der Physik*, No. 11, 1904.]

Relative Motion of the Earth and Ether.—Following upon the plan he submitted to the British Association at Cambridge, W. Wien puts forward another, based, not upon Foucault's, but upon Fizeau's method, which offers fewer mechanical difficulties. Let two identical toothed wheels, A and B (see diagram), be mounted paralled to each other at a great distance apart. Let a and b be two equal sources of light, whose rays proceed through the gaps between the teeth. Let, now,



both wheels be set in rapid rotation at the same rate and in the same direction. The average light reaching a' and b' will again be equal if the ether does not move relatively to the earth. The equality of the two velocities of rotation can be controlled by the constancy of the light received at either observing station, since it will flicker if there is a slight difference in the period. Now, if the line l joining the two wheels is in the direction of the earth's motion—*i.e.*, east and west at midday or midnight, and the ether does not move with the earth, the arrival of one of the rays will be accelerated and the other retarded, and there will, in general, be a difference in the luminosity at a' and b'. To obtain a decisive result, it would be necessary to determine the velocity of light to within one part in 5,000, and this has already been accomplished. The only formidable problem lies in the synchronism of the two wheels, which might be secured by a stroboscopic method. The synchronism need not last long, and no absolute measurement is required, only an observation of a possible difference in the intensity of the two rays. The chief attraction of the method lies in the fact of its being independent of any measurement of length, and, therefore, free from the error pointed out by Fitzgerald.

[W. WIEN, *Physikalische Zeitschrift*, October 1, 1904.]

Time Variation of Gravitation.—A somewhat startling speculation is advanced by K. R. Koch on the basis of a comparison of measurements of the gravitational force at Stuttgart and Karlsruhe. He shows the great probabiliiy of the statement that between June, 1900, and March, 1904, the value of g at Stuttgart increased from 980·915 to 980·918, the difference being about four times the mean error. This assumes that the value at Karlsruhe was constant during the same period, so that the increase would only be a comparative one, and the actual increase or decrease might have been different. The author claims to have taken into account all the possible sources of error affecting the pendulum used for the measurements. He surmises that possibly there may be a variation of the direction as well as the intensity of the force of gravity. Such a variation of direction is indicated by certain observations with the horizontal pendulum. But there may also be a connection or analogy with the proved variation of the altitude of the pole, and as that is periodic, the author expects that the time variation of gravitation will also turn out to be periodic.

[K. R. KOCH, *Annalen der Physik*, No. 11, 1904.]

Electric Insulation in a Vacuum.—Lord Kelvin makes some interesting calculations of the force necessary to pull an electron (or "electrion," as he calls it) out of its atom into a space filled with nothing but the luminiferous ether. To begin with, he points out that this absolute vacuum must be a perfect conductor of electricity, in the sense of offering no resistance to the free motion of an electron, and therefore producing no joulean waste. But the fact that no current passes through a vacuum from one conductor to another, which gave rise to the myth of the resistivity of the ether, is due rather to the force which binds the electron to its atom, and prevents its being pulled out of the metal unless it is subject to a similar attraction outside. The author endeavours to get an idea of the magnitude of that force by calculations based upon the E.M.F. necessary to produce a discharge in the highest vacua now attainable, ranging from one-millionth to one two-hundred-millionth of an atmosphere. Suppose the vacuum so high that no current, nor torrent of sparks, passes between two blunt electrodes $\frac{1}{4}$mm. asunder, when the difference of potential between them is raised to 200,000 volts the electrostatic force will amount to 96 million volts per centimetre, or 320,000 C.G.S. units. Taking $e = 3{\cdot}4 \times 10^{-10}$, we find 109×10^{-6} dyne as the force which a single electron would experience in the electrostatic field between the electrodes. Assuming $2{\cdot}2 \times 10^{-8}$ for the diameter of an atom, an electrostatic force about four times the above would break down the insulation by pulling electrons out of the front atoms. The outward attraction experienced by the surface of the electrode with that force would be about 66·4 tons per square centimetre. The breaking strength of the strongest steel wire scarcely amounts to 20 tons per square centimetre. Hence the wire would be broken rather than have its electrons extracted singly. But practically matters are complicated by the fact that a perfect vacuum cannot be attained. The author suggests making careful measurements of the greatest steady difference of potential that can be maintained with or without any measurable current between two metals separated by a very short length of the highest vacuum attainable.

[Lord KELVIN, *Philosophical Magazine*, October, 1904.]

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"The Testing of Continuous-current Machines in Laboratories and Test Rooms." By C. Kinzbrunner. (London: Harper & Bros.) 6s.

"Journal of the Institution of Electrical Engineers," September: Vol. XXXIII., Part 6, No. 169. (London: E. & F. N. Spon). 4s.

"Smoke Prevention and Fuel Economy." By W. H. Booth and J. B. C. Kershaw. (London: Archibald Constable & Co.). 6s.

"Electric Furnaces and their Industrial Applications." By J. Wright. (London: Archibald Constable & Co.). 8s. 6d.

"List of Officers and Members of the Institution of Electrical Engineers." Corrected to Aug. 31, 1904. (London: E. & F. N. Spon.)

"Lois Fondamentales de l'Électrochimie." By P.-Th. Muller. (Paris: Gauthier-Villars.) 2fr. 50c.

"Transactions of the American Institute of Electrical Engineers." Vol. XXI. No. 7. September, 1904. (New York: The Institute.) 50c.

"Electric Lighting for the Inexperienced." By Hubert Walter. (London: Edward Arnold). 2s.

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THE ST. LOUIS CONGRESS.

From reports which have reached us from various sources it can scarcely be said that the St. Louis Electrical Congress was an unqualified success as an international electrical engineering conference. So far as the number of Papers and the diversity of subjects are concerned nothing was wanting, but in these very features rested the chief weakness of the undertaking. Considering the amount of time at the disposal of the various sections, far too much was attempted, and it must be confessed that much of this all too-valuable time was wasted on Papers that need never have been brought before the consideration of such engineers and electricians as attended the Congress. About 160 Papers were presented before the eight sections sitting simultaneously, and it is safe to say that 50 per cent. contained no fresh information. The result was that some of the Papers possessing real merit, were dismissed with little more than casual consideration, while the discussion on others was nothing more than the repetition of oft-expressed opinions and canons of belief. Only six morning sessions were devoted to the reading of Papers and the discussions upon them, and time had first to be found for presidential addresses and the customary exchange of courtesies between the American and foreign delegates. Hence, members had to draw out a programme beforehand, and select only those sections and Papers to which their time permitted them to attend. Much time must also have been wasted in getting from one section to another; and not only were members prevented, by lack of time, from listening to discussions of great interest, but leaders of the profession whose views would be considered authoritative on the subjects discussed in several sections had their range of actions confined. Perhaps it is hardly fair, however, to look for solid results from a meeting that was merely regarded as a pleasant social function by a large proportion of those who attended it, and it is only fair to say that much credit is due to those who organised the Congress, as the direction of such a gathering could have been no light or easy task. In membership the Congress created a record, no fewer than 2,100 names being on the list, and of these some 400 were foreigners. The average attendance was, however, only about 700.

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As we have said, the Congress was divided up into eight sections. The Papers before Sections A and B (General Theory and General Application) embraced subjects connected with almost every branch of electrical engineering and electrical science. There were many excellent Papers (which we hope to publish at an early date), but practically all of them dealt with specific subjects—some of them with what might almost be called personal subjects—rather than with general theory or applications. Section C (Electro-chemistry) included three Papers on electrical standards, one of which is a proposal to employ the lead voltameter for current determinations. The Edison storage battery, Mr. SWINBURNE'S chlorine smelting process, the electrical extraction of nitrogen from the air, and the perpetual problem of a carbon-consuming battery were also dealt with, the remaining Papers being mostly of a theoretical nature. Nearly all the Papers before Section D (Electric Power Transmission) dealt with the construction, operation and maintenance of extra high-tension three-phase transmission lines, particular attention being given to the most approved forms of line insulators. Pole construction, determination of the voltages to be adopted, and details of transformer connections and switches were also considered. One Paper reviewed the possibilities of single-phase long-distance transmission for railway work. The list of Papers submitted to Section E (Electric Light and Distribution) was the longest of all, many dealing with broad questions in a general way with the obvious intention of promoting discussion. Perhaps it was only reasonable that these should have received, in most cases, more attention than the interesting Papers on single technical matters of a higher order. More might certainly be learned by discussing "Insulating Materials in High-tension Cables" or "Single-phase Motors" than a comparison of systems of charging for electricity supply or a debate on the well-worn theme of rotary converters *versus* motor generators; but probably the latter subjects are more suited to the holiday tone prevailing in an international exhibition congress. Only a few Papers were read in Section F (Electric Transportation) but they covered wide ground, ranging from a historic sketch of the development of electric railways, by Mr. FRANK T. SPRAGUE, the electric traction veteran, to the description of a recent electric railway, built on the most up-to-date lines, by Mr. L. B. STILLWELL. Alternating *versus* continuous-current as applied to traction was exhaustively dealt with by another writer, and the best designs of air-brakes for heavy and fast electric trains was discussed in a short Paper. An unexpectedly large number of contributions on telegraphy and telephony were submitted to Section G (Electric Communication), and the programme before Section H (Electro-therapeutics) showed that medical men in America are not so reticent on this subject as their colleagues in Great Britain.

Many of our readers, however, will be more interested in the result of the deliberations of the official "Chamber of Delegates," which are of the utmost importance. This Chamber consisted of electrical engineers of high standing, who were appointed by the Governments of their respective countries to meet and discuss the vexed question of electrical units. The representatives of Great Britain were Col. CROMPTON, Dr. GLAZEBROOK and Prof. PERRY. We have already criticised the American proposals in our columns, and it is reasonable to suppose that objections to them were raised by several of the delegates from Europe, although the Chamber held its meetings *in camera* during the week of the Congress and only presented their report on the last day. It appears that the consideration of specific subjects was relegated to two separate Committees, one on "International Electromagnetic Units" and the other on "International Standardisation of Electrical Apparatus and Machinery." The former expressed the opinion that the discrepancies between the laws relating to electric units, or their interpretations, in the various countries represented, required consideration with a view to securing practical uniformity. Other questions bearing on nomenclature and the determination of units and standards were also raised, and on these also the Chamber reported that it was desirable to have international agreement. In order to attain the desired end, it was recommended that these and similar questions could best be dealt with by an international commission representing the Governments concerned. Such a commission might, it was further suggested, be appointed, in the first instance, by those countries in which legislation on electric units has already been adopted, and it might consist of two members from each country. Provision should be made for securing the adherence of other countries prepared to adopt the conclusions of the commission. In bringing this report of their Committee before the Congress, the Chamber of Delegates expressed the hope that the proposed commission might eventually become a permanent one. Finally, it was recommended that the delegates should report the resolution of the Chamber as to electric units to their respective Governments. The second Committee had naturally propositions of a different nature to make, as it could not be expected that Governments would concern themselves in the least degree with the standardisation of electrical machinery and apparatus. They recommended that steps should be taken to secure the co-operation of the technical societies of the world by the appointment of a representative commission to consider the question of the standardisation of the nomenclature and ratings of electrical apparatus and machinery. It was suggested that much of the work could be accomplished by correspondence in the first instance, and by the appointment of a general secretary to preserve the records and crystallise the points of disagreement which might arise between the methods in vogue in the different countries interested. Delegates were asked to report this resolution of the Chamber to their respective technical societies, with the request that the societies take such action as might seem best to give effect to it. The replies of such societies are to be forwarded to Col. CROMPTON in England, and to the President of the American Institute of Electrical Engineers in America.

OBITUARY.

GEORGE BENHAM STACEY.

We regret to record the death, at Bath, on 5th inst., of Mr. George Benham Stacey, who was one of the very few surviving pioneers of telegraph and submarine cable working, with which he had been officially connected for over half a century. Born in 1839, he joined the Electric Telegraph Co. in 1851, and on the laying of the first cable to Holland in 1853 he was transferred to the Hague. Two years later he was sent to the Prussian Government telegraph office in Berlin, and 12 months afterwards was transferred to the Foreign Gallery in London. From 1857 to 1859 Mr. Stacey was with the Egyptian Transit Administration, and during the following 12 months was in service at Messrs. Glass, Elliott & Co.'s cable works, now the Telegraph Construction and Maintenance Co.

On the laying of the Malta–Alexandria cable, Mr. Stacey was appointed to Benghazi in 1861. From 1863 to 1867 he served at Benghazi as superintendent, after which he was transferred to Malta. In 1868 he became superintendent of the Anglo-Mediterranean Telegraph Co.'s Susa–Modica landline through Italy, and also agent to the Italian Government.

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In 1869 he was promoted to be general superintendent of the British India Submarine Telegraph Co., and on its amalgamation with three other companies into the Eastern Telegraph Co., in 1872, he was appointed manager at Bombay. In striking contrast to the rapidity of previous changes he remained there for the long period of 28 years. He was then placed in charge of the Cape Town station of the Eastern and South African Telegraph Co., being there during the period of the Boer War, and completely satisfying the necessarily exacting conditions of the censorship, as testified by letters recording warm appreciation of his services. He was afterwards for a short time in charge of the Tangier station, retiring from active service in 1902, at his own desire and on a well-earned pension.

The funeral took place at Bath on the 8th inst. Mr. Stacey leaves a widow as well as two sons and two daughters.

Mr. Stacey was an ideal representative of the great cable service, possessing high ability and administrative skill. He won golden opinions in every position which he filled, and no man in the service has ever been more universally respected alike by the staff and the directors of the companies in which he was engaged.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Electric Motors. Continuous-current Motors and Induction Motors: Their Theory and Construction. By HENRY HOBART, B.Sc., M.I.E.E., Mem.A.I.E.E. (London: Whittaker & Co.) 1904. 12s. 6d. net.

Mr. Hobart writes as an expert to experts; and no one engaged in this particular branch of electrical design will care to miss taking advantage of the information and help that Mr. Hobart so freely offers from his wide and successful experience. The present work is, we are told in the preface, based on a series of articles published in our contemporary *Traction and Transmission*, and to this fact no doubt is due its somewhat disjointed character. It need hardly, however, be said that Mr. Hobart has not given us an undigested collection of data from his notebooks, such as often passes for technical literature; but neither has he produced a series of easily-read essays on motor design. With its scores of instructive curves and diagrams, and elaborate detailed calculations of the data of actual machines or of trial designs, it is a book for careful study. The reader will note down as he proceeds the points where his own experience is supplemented or contradicted by the author's, or where an old problem receives new light from being treated from a different standpoint to his own; or he will, perhaps, carefully compare step by step with one of his own designs, the data and calculations as here given of some other well-tried make. If he is prepared to undertake this, he will probably not much mind the extra trouble of converting to English units: Mr. Hobart boldly uses metrics throughout the book, for which course there is much to be said, even though it be a little ahead of current practice.

About half the book is given to the continuous-current motor, for whose future Mr. Hobart has no qualms, in spite of the ever-increasing attention that is being given to its alternate-current rivals.

> The present tendency seems to be to reconsider the merits of the continuous-current motor. . . . The best motors of to-day are characterised by a complete absence of sparking at the commutator, while the collection of the current with fixed brush position at all loads is in all respects as satisfactory as can be obtained at the slip-rings of induction motors.

And how is this perfect commutation to be obtained? Not by any winding devices nor pole-piece arrangements. In a later chapter we read:—

> In the author's opinion, the best way of designing motors with a certainty of satisfactory commutation is altogether to abandon dependence upon electromagnetic assistance in reversing the current in the coil undergoing commutation under the brush, and to rely upon having such proportions that the reactance voltage in the short-circuited coil has, at full load, such a low value as to itself ensure freedom from sparking.

Whilst Mr. Hobart entirely believes in the ultimate triumph of the continuous-current motor, he admits that its alternate-current rival has sometimes the advantage, and expects, too, that

> The wide interest now taken in the numerous large power distribution plants at present being constructed in England will inevitably be accompanied by a temporary increase in the use of induction motors in the districts supplied by these plants.

But whilst admitting the advantages of the polyphase system for generation and transmission at high voltages, our author's ideal would be, wherever possible, to transform with motor-generators, generally to continuous-current; but even if alternate-current motors are to be used, he would prefer to use a motor-generator. The motor would be of the synchronous type, the frequency of the generator would be made to suit the type of prime mover employed, and the distribution system could be regulated independently of pressure variations on the transmission line.

> The decision as to whether the secondary generator at the sub-station should be a continuous-current or polyphase dynamo would depend on the special requirements of the work. Thus, if much of the work was required to be done at varying speeds, continuous-current motors would generally be used. When other considerations should not definitely determine the choice, one should by no means overlook the point already referred to—viz., that continuous-current motors are far better suited for low speeds, and polyphase motors for high speeds. A clear realisation of the importance of this point, which, unfortunately, is seldom obtained except by the designers of the motors, would often show it to be worthy of receiving consideration in the arrangement of a distribution system. The high-speed, low-frequency induction motor may economically be so designed as to be characterised by high power-factor (even at considerably less than full load), low current when running light, high overload capacity and greater economy of material and labour in construction.

We have quoted Mr. Hobart's views at some length on this old controversy, because they will be of general interest to electrical engineers, and the matter must more and more be looked at from the point of view of the motor designer. But the book is not mainly devoted to such subjects, and, having had his say in favour of the continuous-current motor, Mr. Hobart deals with its rival in no grudging spirit and with the same evidence of masterly knowledge that is displayed in the former part of the book. In reading these later chapters one cannot help feeling how much further the design of the induction motor is from finality than is that of the continuous-current motor—a fact which is not surprising in view of the long start that the latter has had, and which suggests that in the future the former will improve more rapidly than the continuous-current motor can now be expected to do, perhaps soon overtaking its rival in some of the qualities in which it is now deficient.

In addition to the numerous diagrams in the text, the book is illustrated with a large number of plates, consisting of photographs of motors and parts of them and sectional drawings, which add considerably to the merits of what we have no hesitation in describing as a valuable addition to our technical literature.

The Theory of the Lead Accumulator. By Dr. FRIEDRICH DOLEZALEK. Translated from the German by CARL L. VON ENDE. (London: Chapman and Hall.) 10s. 6d.

This work, although only published in 1900, has already gained a considerable and well-deserved reputation abroad, and its translation will be welcome to many both here and in America to whom it has hitherto perforce been an altogether sealed book or whose knowledge of the German language was scarcely sufficient for a complete understanding of its abstruser portions. It may at once be said, however, that the primary appeal of the book is not so much to those who are practically or theoretically interested in the lead accumulator because it is an important technical appliance, as to the student of the latest developments of physical chemistry, who will find that the large fund of knowledge and data that has grown up around the storage battery enables the author to employ it for a concrete demonstration of many of the deductions and calculations that the newer theories involve. This point of view determines the whole character of the book, both in its strength and its weakness. It is a series of "splendid" confirmations and verifications, but the enthusiasm is all for the law illustrated and little for the certainty added to our knowledge of the lead cell. Also, such original work as was carried out by the author himself is confined to filling in gaps left by previous investigators, and so making more complete his comparisons between observed and calculated results.

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Taken as a whole, the most important achievement of the book is the indirect but none the less conclusive establishment of the correctness of the double sulphation theory of the cell's reactions. It opens with an enunciation of the equation

$$PbO_2 + Pb + 2H_2SO_4 \rightleftarrows 2PbSO_4 + 2H_2O$$

as originally propounded by Gladstone and Tribe, and proceeds in the two first chapters to an examination of the direct theoretical and experimental evidence in its favour and against the alternatives championed by Darriens and by Elbs. This basis forms the starting point for the calculations in every following chapter, and by the agreement shown between theory and experiment corroboration is supplied from so many diverse points of view as to seem irresistible in its total effect. If, in spite of it all, the double sulphation theory is incorrect, then not only must nearly every page of this book be re-written, but the whole science of physical chemistry must be revised.

The bulk of the book is occupied with an elaborate theoretical and quantitative demonstration of the already known facts as to the relationship between the strength of the electrolyte and the various properties of the lead accumulator. Chapters are devoted to a consideration of the dependence of the E.M.F., both of the complete cell and of the separate electrodes, upon acid concentration, and the large part it plays in determining the P.D. of charge and discharge as well as the output and efficiency is fully considered. As might rather be expected from the author's standpoint, he seeks a solution of every problem on these lines, and the effects of inequalities of acid strength due to imperfect diffusion are made to explain far more than they legitimately can, even after every consideration has been given to their immense importance. Thus the influence of gaseous polarisation or the charging P.D. is practically ignored, and the effects and nature of the chemical and physical changes in the active materials receive but scant attention. The fact is, these and several other matters are not suitable for attack with the mathematical tools which are wielded so effectively upon the electrolyte, with the result that no fresh light is thrown upon the real outstanding difficulties in the way of a complete understanding of the action of the lead cell.

There is an interesting chapter on the temperature coefficient which the author was the first to investigate thoroughly. He confirms the long-accepted fact that with working strengths of acid it has a positive value so small in amount as to be practically negligible; but finds that as the acid strength is reduced it sinks to zero at a specific gravity of 1·044, and then becomes negative and attains quite large values when the merest trace of acid is present. The latter, then, is the only condition under which a lead cell could act as a heat engine and so quite impracticable. At the time the book was written the most recent investigations showing such large changes of output with temperature had not been made, but the author, as might be expected, clearly recognised that this springs from entirely different causes to the one just mentioned.

The mathematics is rather aggressive throughout the book, and in some instances pages of it might be more simply expressed in as many sentences. The empirical formulæ for the variation of output with rate of discharge given in Chapter XII. are a good example of mathematics gone mad, for they obviously have no theoretical meaning, and in practice their constants would be as much trouble to obtain and far less reliable than a direct determination of the complete curve. The author is, however, not responsible for these; he has only collected together the figures of Peukert and others. It is, indeed, one of the merits of this little work that it forms an excellent summary of most of the investigations into the theory of the lead accumulator that have been made abroad.

Radium, and other Radio-active Elements. By Leonard A. Levy and Herbert G. Willis. (London: Percival Marshall & Co.) 1904. 2s. 6d.

This is one of the semi-popular books hurriedly prepared when radium had achieved daily-paper popularity. Unfortunately, the subject of radio-activity is difficult to treat in a semi-popular manner. The result in this case has been a production which will be largely unintelligible to the layman, while, on the other hand, it cannot rank as a scientific text-book.

Enroulements d'induits à courant continu. By E. J. Brunswick and M. Aliamet. (Paris: Gauthier-Villars.) fr.2.50.

The authors of this little work have succeeded in explaining in a clear and concise manner the internal action and structure of continuous-current armatures. After a short opening chapter, in which the principal laws governing the production of E.M.F.s in conductors are passed in review, the various forms of armature windings are at once dealt with, first in a general way, and then in a more definite and numerical manner on the lines first adopted by Prof. Arnold. All the usual windings are mentioned, and a few pages are devoted to equalising connections. Numerous winding diagrams, tables and examples are given. It may be stated, as the title is somewhat indefinite on this point, that the book treats of the principles only of armature windings, and does not discuss questions relating to the workshop. It may be recommended, on account of its clearness, to the student who wishes to become familiar with the subject, but also to the more advanced electrician, who desires to have the rules and formulæ relating to all kinds of windings compiled in concise form.

Propriétés et Essais des Matériaux de l'Electrotechnique. By F. de Poncharra. (Paris: Gauthier-Villars.) fr.2.50.

The contents of this clearly-written and practical booklet are descriptive of the origin, properties, treatment and tests of most materials used in the electric industry. Simple formulæ are occasionally made use of and a number of sketches, diagrams and tables help to render the subject quite clear and practical. Insulating materials of the solid, liquid and gaseous form are first dealt with, this part being followed by a treatise on electric conductors (including resistance material and carbon). The third and last part deals with magnetic material. The book may be recommended to practical men who desire a general, technical survey of the subject in French.

THE PRESENT STATUS OF THE EDISON STORAGE BATTERY.*

BY A. E. KENNELLY AND S. E. WHITING.

The Edison cell is of the oxygen-lift type. That is to say, the process of charging consists in driving oxygen electrolytically from the negative to the positive plate. During discharge the oxygen leaves the positive plate and enters the negative plate. The chemical actions in the cell have not, as yet, been completely investigated.† The following conditions may, however, be accepted provisionally as forming a working theory:—

Condition.	Positive plate.	Electrolyte.	Negative plate.
Charged	NiO_2 / NiO_2	KOH / H_2O / KOH	Fe
Discharging	NiO_2 K + H_2O	HO —	Fe
,,	NiO_2 K + Ni_2O_3 KOH KOH	HO — H_2O	FeO
Discharged	Ni_2O_3	KOH / H_2O / KOH	FeO

The cycle represented in the above table shows that during discharge the electrolyte divides into potassium cations and hydroxyl anions, the former being directed toward the positive plate and the latter toward the negative plate. On arriving at these plates the ions give up their respective charges. At the positive plate the potassium robs the nickel oxide of a portion of its oxygen and, in combination with the water present, forms new molecules of potassium hydrate, the original electrolyte. At the negative plate the hydroxyl ions deliver oxygen to the ion and form water. Thus the electrolyte tends to become concentrated in the pores of the positive plate, and attenuated in the pores of the negative plate. Diffusion ultimately destroys this difference of concentration and leaves the electrolyte in its original condition, since at any instant

* Abstract of a Paper read before Section C (Electrochemistry) of the St. Louis International Electrical Congress.

† E. F. Roeber, *Transactions* A.E.S., Vol. I., 1902; M. V. Schoop, *Electrochemical Industry*, July and August, 1904.

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the total quantity of water and of potassium hydroxide (including the pores of both plates) remains the same.

It would appear from the form of E.M.F. curve during complete discharge that, after the cell has become almost entirely discharged, other stages of oxidisation develop, and further investigation may show that the outline of the chemical cycle above presented is very incomplete. Whatever the complete cycle may be, it is, in all probability, however, of the type indicated.

It would seem that neither the plates of nickeled steel nor the active materials within them are subject to local or chemical corrosion or solution in the electrolyte of potassium hydroxide. For this reason the cell is chemically stable either in the charged, discharged or any intermediate condition.

It has been observed, both by the authors and by other experimenters, that the internal resistance of an Edison type E cell is substantially constant during the main working portion of the discharge. Thus, in the E-18 cell, the internal resistance at ordinary temperatures is about 0·0022 ohm. This would correspond to 0·0278 ohm in a type E similar cell weighing 1lb., or to 0·0126 ohm in a cell weighing 1 kg. The internal resistance is slightly less at the beginning of the discharge, but becomes considerably greater near the end of the discharge. Since, however, this rise in resistance occurs only during a small portion near the end of the delivery, its effect in the total discharge may be neglected for most practical purposes. The internal resistance does not vary greatly with the discharge rate within the usual working limits of 0 – 150 amperes. In other words, the drop of pressure in the cell is approximately proportional to the discharging current strength.

The maximum amount of power obtainable in the external circuit of any cell is $e^2/4r$ watts; where e is the actual E.M.F. and r the actual internal resistance of the cell. Under these conditions the cell will work at 50 per cent. efficiency, with equal internal and external resistance. In other words, it is impossible to obtain from any cell a greater amount of external power than corresponds to the above expression, which represents the maximum power of the cell. Taking the mean E.M.F. of the Edison type E-18 cell as 1·3 volts and the internal resistance as 0·0022 ohm, the maximum power is 192 watts, or about ¼ H.P. or 15·15 watts per pound (33·4 watts per kilogramme) at a current strength of 296 amperes, corresponding to a discharge time of less than half-an-hour. We have taken a current averaging 250 amperes from such a cell on approximate short circuit (through heavy leads and an ammeter) for a period of 30 minutes. The practical rate of power delivery at 150 amperes is $\{1{\cdot}3-(150\times0{\cdot}0022)\}\ 150=145{\cdot}5$ watts, or 11·5 watts per pound (25·4 watts per kilogramme). This is on a par with the full-load output of good dynamo machines.

The energy liberated in an Edison E-18 cell is 1·3 volts × 141 ampere-hours = 183·3 watt-hours = 14·48 watt-hours per pound (31·9 watt-hours per kilogramme) and this liberation of energy is constant to a first approximation for all rates of discharge within the working limits. The amount of this liberated energy which is delivered in the external circuit depends only on the electrical efficiency of the circuit, or on the drop of pressure in the cell. Thus, at 90 per cent. electrical efficiency, or 10 per cent. internal drop (corresponding to about 60 amperes in the E-18 cell), the externally delivered energy would be $183{\cdot}3\times0{\cdot}9=165$ watt-hours.

It can be shown that if any Edison type E battery, in any grouping of cells, be discharged at the rate of p watts per unit mass, reckoned at the mean voltage of discharge, the electrical efficiency, η, of the battery circuit will be $\eta=\dfrac{1+\sqrt{1-n}}{2}$, where $n=\dfrac{p}{\mathrm{P}}$ and P is the maximum power per unit mass or $e^2/4mr$, where m is the mass of a cell.

Thus, if a battery of 68 Edison type E-18 cells be discharged at 120 amperes or 124·3 average external watts, the total external power will be $68\times124{\cdot}3=8{,}454$ watts, and the total weight being 861lb., the power rate per pound taken from the battery is 9·83 watts. The maximum power rate is, however, 15·15 watts per pound, as above; so that the ratio $n=9{\cdot}85/15{\cdot}15=0{\cdot}65$. The electrical efficiency of the battery circuit is, therefore,

$$\eta=\frac{1+\sqrt{1-0{\cdot}65}}{2}=0{\cdot}796,$$

or 79·6 per cent. The delivery per pound of battery will, therefore, be $14{\cdot}5\times0{\cdot}796=11{\cdot}5$ watt-hours per pound, and the entire battery will deliver 9,900 watt-hours to the external circuit when discharged to 0·75 volt P.D. per cell.

Since the mean E.M.F. of discharge is approximately 1·3 volts, and the mean E.M.F. of charge approximately 1·67 volts, it follows that the superior limit of watt-hour efficiency in an Edison cell is 1·3 1·67, or 78 per cent. In practice it is always less than this, due to internal drop. The efficiency may be best examined, first, in relation to the voltage of charge and discharge, and, second, in relation to the electric quantity charged and discharged.

1. If there were no drop of pressure due to internal resistance, either in charging or discharging, and all the electricity charged in the cell (as expressed in coulombs or ampere-hours) were discharged, the ampere-hour efficiency of the cell being thus 100 per cent., the watt-hour efficiency would be 78 per cent. or thereabouts. This figure can, in fact, be approached by employing very low rates of charging and discharging—*i.e.*, by taking many hours to each process. On the other hand, the more rapid the charge and discharge the greater the IR drop in the cell and the less the efficiency, even on the assumption of 100 per cent. ampere-hour efficiency. Thus at 60-amperes charging and discharging rates, the P.D. in charge would average about 1·8 volts in the E-18 cell and the P.D. in discharge would average about 1·17 volts to the 0·75-volt limit, representing a watt-hour efficiency of 65 per cent., with 100 per cent. ampere-hour efficiency.

2. The Edison cell would manifestly possess an ampere-hour efficiency of 100 per cent. if no gases or irreversible substances were generated in its cycle of chemical action. Thus, if a certain number of grammes of iron were reduced and a certain number of grammes of nickel were oxidised by one ampere-hour of charging current, and no other action took place, then on discharge the reconversion of these masses of active material would develop the complete ampere-hour of electricity. On the other hand, every gramme of hydrogen (or the equivalent mass of oxygen) liberated and discharged from the negative plate during charge absorbs 26·8 ampere-hours of electricity, which is not returned to the circuit during discharge. The ampere-hour efficiency of the Edison cell is, therefore, determined by the amount of gas escaping during the charge. This, in turn, depends upon the rate of charge or charging-current strength, since the greater this strength the greater the drop in internal resistance, and the sooner the plates are brought to that difference of potential at which the water is rapidly decomposed. At high rates of charge, then, the watt-hour efficiency of the cell must fall off, not only because of the voltage drop, but also on account of the reduction of ampere-hour efficiency in gasification. Nevertheless, in many cases, and particularly in automobile work, this sacrifice of energy is amply warranted by the convenience and saving of time effected by rapid charge. The normal charging time of Edison E cells is about four hours. In cyclical charges and discharges of four hours each the ampere-hour efficiency is about 75 per cent. and the voltage ratio 70 per cent., so that the watt-hour efficiency may be taken in round numbers as 50 per cent. ($0{\cdot}75\times0{\cdot}7=0{\cdot}525$). It is possible, at a still greater sacrifice of efficiency, to charge the cell at fully double the above normal rate.

Mr. H. M. Wilson, of the Boston Edison Illuminating Co., reported some observations on an Edison automobile battery of 68 D-28 cells regularly employed in a single-seat service waggon of the Boston Company carrying two persons. The weight of the battery was 1,260lb. (570kg.). In four rows of 17 cells each it occupied a space (including trays and lugs) of about 6ft. by 2ft., and was about 1½ft. high, thus having an over-all volume of 16 cubic ft. (0·45 cubic metre). The weight of the vehicle complete was about 3,150lb. (1,425kg.). During 22 working days of regular urban service in October and November, 1903, the battery received 1,380 ampere-hours at 110 volts, or 151·4kw.-hours, and delivered at terminals 68·85kw.-hours at an average P.D. of 85 volts. The ampere-hour efficiency was 58 per cent., the volt efficiency 77 per cent., and the watt-hour efficiency 45 per cent. The distance run was 324 miles, or 14·7 miles daily, and the energy consumed per mile was 0·47kw.-hour. These results are not only much surpassed by similar batteries of type E, but they are also stated to be exceeded by later batteries of the type D. Consequently, they may be regarded as conservative.

It would seem that the Edison cell is so durable that no electrical depreciation is discernible in the cells during the three years' total experience of the practical construction of the battery. No mechanical corrosion of the plates or pockets has been discernible during that time, and no depreciation seems to have yet occurred in the active material, judging from the capacity tests of cells, which are stated to be as great at the present time as they were when the cells were first constructed. The authors have recently confirmed this observation in the case of type D cells that have run nearly 3,000 miles in an automobile of the Edison Company in Boston. The capacity of these cells was found to be equal to that of new cells of the same type. Two of these cells were opened for examination and the sediment in them collected and dried. The dry sediment weighed 3·9 and 7·1 grammes respectively, probably less than one-third of 1 per cent. of the active material in the grids. In fact, a new cell freshly set up will show about this quantity of material washed by the solution from the external surface of the plates. No signs of depreciation or corrosion appeared on any of the plates or connections.

According to observations at the factory Edison cells lose 15 per cent. of their ampere-hour charge in eight weeks of idleness. Another test showed 11 per cent. of loss by standing one week. A test of the authors on four type E-18 cells gave, after 26 days' idleness, 100 ampere-hours per cell. This represents a loss of 9 per cent. of the normal rated capacity of the cells, or 28·6 per cent. of the maximum rated capacity. At a corresponding charge the delivery within 24 hours would have been about 140 ampere-hours.

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ELECTROLYTIC RECTIFIERS: AN EXPERIMENTAL RESEARCH.*

BY ALBERT NODON.

Buff discovered in 1856 the property which is possessed by aluminum, when dipped in a salt solution, of allowing a free flow of current in one direction, but of stopping the flow when in the opposite direction; Ducretet utilised this property in 1876 for constructing an alternating-current rectifier; Le Gratz studied a particular method of setting up the apparatus; Carl Liebenon investigated the electrolyte; Pollak made a number of investigations upon the valves and obtained the first results of industrial value. In 1899 the present writer reviewed what had previously been done and conducted a series of researches at the Sorbonne and the Collège de France, with a view to throwing light upon a problem as yet but little understood. These investigations constitute the subject of the present Paper.

The valve effect is in general one obtained by means of any metal dipped in an electrolyte and subjected to a definite difference of potential. The phenomena of double layers appear to be associated with the valve effects. The value of the electric charge that may be obtained by means of the valve effect is greater as the molecular weight of the metal which constitutes the anode is smaller. Magnesium and aluminum admit of the valve effect being obtained under a high difference of potential; metals of large atomic weight, such as lead or mercury, on the other hand, produce the valve effect only under a low difference of potential. This effect thus produced bears the name of double layer. In theory, the nature of the cathode is without influence upon the valve effect, if its relative surface be sufficient. In practice, lead or polished steel are principally used as cathodes. For any definite metal constituting the anode and dipped in an electrolyte at fixed temperature under known difference of potential, the magnitude of the charge that it is capable of acquiring during unit of time under the valve effect depends upon the current density at the anode surface. This charge depends also upon the effective surface of the anode and the disposal of this surface relative to the cathode. The nature of a metallic alloy, when employed as anode, plays also an important part in this phenomenon. The valve effect may be obtained with ordinary water. In practice, however, the choice of electrolyte is important in the operation of the valves as a result of the more or less destructive nature of the secondary products of the electrolytic reactions. With magnesium, the best results are obtained by means of a saturated solution of alkaline fluorides. With aluminum, the most perfect action is secured by means of neutral ammonium phosphate. The phosphates of potassium and sodium give rise to free potassium and sodium which attack the electrodes and produce an imperfect action of the valves.

In the following table are given results which were obtained by the aid of anodes made of different metals in electrolytes of various composition. The cathodes were of graphite and the experimental conditions were the same in all determinations. The measurements were made while cool, with the assistance of a constant temperature apparatus of Chauvin and Arnoux. The current was furnished from a storage battery capable of maintaining a difference of potential of 85 volts. In the table the letters at the head of the columns have the following signification:—S = nature of the solution. M = nature of the metal anode. U = E.M.F. in volts between the two electrodes of the valve, which are connected with the voltmeter. U′ = P.D. in volts between the valve electrodes at the instant of changing the direction of the continuous current by means of a commutator. I′ = current in amperes escaping in valve from metal to graphite. I = strength of direct current, in amperes, from graphite to the cathode metal.

S.	M.	U.	U′.	I′.	I.
Potassium fluoride	Aluminum	85	20·0	2·9	3·7
	Cadmium	85	17·0	4·0	4·0
	Bismuth	85	16·0	4·0	4·1
	Antimony	85	16·0	4·0	4·1
Ammonium fluoride	Magnesium	16	19·0	0·1	3·9
	Aluminum	20	26·0	0·1	3·8
Ammonium fluorsilicate	Aluminum	54	1·2	3·4	..
	Magnesium	54	1·2	3·4	..
	Bismuth	No valve effect.			
Ammonium carbonate	Aluminum	15	42·0	0	3·8
	Bismuth	64	20·0	0·10	..
	Antimony	64	20·0	0·10	..
	Magnesium	No valve effect.			
Ammonium oxalate	Aluminum	4	56·0	0	1·7
	Bismuth	45	..	0·2	2·65
	Antimony	75	..	0·5	..
	Cadmium	68	..	0·2	..
Ammonium phosphate	Aluminum	4	50·0	0	2·1
	Bismuth	20	38·0	0·1	2·85
	Antimony, Cadmium, Magnesium	No valve effect.			
Double phosphate of ammonium and potassium / Potassium phosphate	Aluminum	8	25·0	0	3·25
	Anodes attacked	..	..	..	..

The following facts may be deduced from the table:—(1) Magnesium, cadmium, bismuth and antimony do not give rise to the valve effect. (2) Aluminum alone does this. (3) Anodes are attacked when potassium or sodium salts are employed. A precipitate of alumina is produced with aluminum anodes. (4) Only the carbonate, oxalate or phosphate of ammonium produce the desired result. (5) An increase of the internal resistance of the valve is demonstrated upon opening the circuit and at the instant of reversing the current.

The following measurements have been made by means of valves whose electrodes have been constructed of different materials and whose electrolytes have been different ammonium salt solutions. The column headings have the following significance:—A = metal from which the anode is constructed. C = nature of the cathode. D = nature of the electrolyte. N = character of the current; dc for continuous, ac for alternating. R = resistance of the valve in ohms per cm.³ at closed circuit. r = resistance of the valve in ohms per cm.³ at open circuit.

A.	C.	D.	N.	R.	r.
Lead	Lead	Double phosphate of potassium and ammonium	dc	6·29	..
,,	Aluminum		dc	..	18·9
Al+5% Ni	Al+5% Ni		dc	12·11	..
Lead	Lead		ac	8·39	..
Al+5% Ni	Al+5% Ni		ac	6·91	..
Aluminum	Lead		ac	60·00	..
Lead	,,	Ammonium carbonate	dc	8·84	..
,,	Aluminum		dc	18·9	..
,,	Al+5% Ni		dc	8·84	..
Al+5% Ni	,, ,,		dc	15·00	..
Lead	,, ,,		dc	12·47	..
,,	Lead	Ammonium carbonate	ac	10·62	..
Al+5% Ni	,,		ac	61·50	..
Bismuth	,,		ac	10·62	..
Antimony	,,		ac	12·17	..
Aluminum	Graphite		ac	28·00	..
,,	Lead		ac	30·00	..

From the above table the following deductions may be drawn:—(1) The specific resistances of saturated solutions of double phosphate of potassium and ammonium, of neutral phosphate of ammonium and of carbonate of ammonium are about equally large—that is, from 6 to 9 ohms per cm.³. (2) Lead gives a special resistance of 2 ohms owing to the formation of a layer of lead oxide. (3) The resistance manifested between aluminum and the passive cathode at the moment of reversal of the valve is about three times as great as that of the electrolyte. The resistance of the film about the anode then increases up to the maximum limit. The resistance of the electrolyte then becomes practically negligible compared with that of the film. (4) The resistance of the valves connected in series is proportional to the number of valves.

The value of the electrolytic hysteresis in the valves is the ratio of the time required for the formation of the valve to that required for its destruction. The action of the valves is affected, under good conditions, only with a hysteresis value equal or inferior to unity. The lowest hysteresis value with aluminum is given by ammonium phosphate; for magnesium and ammonium fluoride this value is lower than unity. If the surface of an aluminum anode of a valve in operation be examined with a microscope, no sensible modification of the surface can be observed. The formation of the film is too thin to be noted. The writer has measured the electrostatic capacity of a valve whose surface had but one-tenth of a square millimetre extent, and which was charged to a difference of potential of 2 volts during a period of less than one-hundredth of a second. The capacity found was 7 to 10 microfarads. These capacities correspond to values of 700,000 to 1,000,000 microfarads per square decimetre. With surfaces of aluminum a decimetre square the observed capacities are no more than a farad for 10 sq. metres; that is to say, 1,000 times less than the preceding. For a given surface the capacity diminishes very rapidly with the time of charge, as a result of the proportional augmentation of the thickness of the film. The charging of the condenser continues during an appreciable time varying from one-tenth to one second. In the case of the largest capacity observed, the thickness of the dielectric is of the order 10^{-7}; that is to say, of molecular magnitude. A condenser of large capacity and instantaneous effect can be obtained by using broad sheets of aluminum in a solution of ammonium phosphate. The surfaces of the aluminum should undergo a long preliminary formation.

One of the principal applications of the valves consists in the rectification of alternating currents. The writer will review here

* Abstract of a Paper read before Section B (General Applications) of the St. Louis International Congress.

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the investigation he has made of this subject. Consider the influence of an electrolyte upon the constants of a valve in the following table, where U = effective E.M.F. of the alternating current measured with a thermic voltmeter, U_u = effective E.M.F. of the rectified current, U_c = E.M.F. measured with a voltmeter of the magnetic or d'Arsonval type, I = alternating-current strength with a thermic ammeter, I_e = rectified current strength, T = temperature in degrees C.

Influence of Electrolyte.

Electrolyte.	Alternating.			Rectified.		T.
	U.	I.	U_c.	U_u.	I_e.	
Biphosphate of ammonium	105	6·3	38·0	42	5·6	35
	103	6·7	37·0	43	5·6	75
Neutral phosphate of ammonium	103	6·1	37·0	41	5·45	23
	104	6·7	38·5	43	5 7	70
Double phosphate of sodium and ammonium	111	7·5	39·0	48	5·8	22
	109	7·6	41·5	47	6·3	60
Double phosphate of potassium and ammonium	103	6·1	36·0	40	5·2	35
	107	7·2	39·7	45	5·9	87
Phosphate of ammonium and zinc	104	6·7	3·8	43	5·0	25
	104	7·3	3·6	45	5·4	60
Biphosphate of sodium	106	8·2	31·0	52	4·6	25
	103	11·7	16·0	73	2·6	69
Neutral chromate of ammonium	106	7·5	36·5	48	5·3	25
	110	8·7	35·0	55	5 3	52
Double chromate of ammonium and aluminum	110	93·0	33·0	57	5·0	23
	108	102·0	31·0	62	4·7	85

The following may be deduced from this table:—(1) The rectification is complete up to about 30°C. The leakage increases thereafter up to the boiling point. (2) Ammonium salts give the best results. (3) The addition of another salt to the ammonium salts diminishes the valve effect. (4) Neutral ammonium phosphate of all the ammonium salts is that which gives the most complete results.

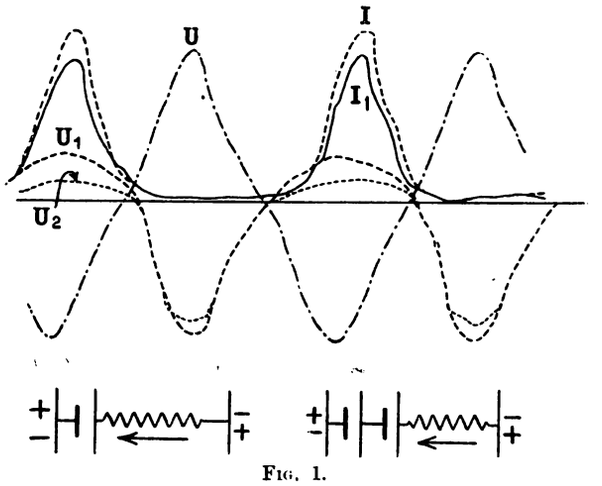

Fig. 1.

From the results noted above it is to be concluded that the best practical arrangement for an electric valve consists of:—(1) An anode of aluminum alloyed with a small proportion of a foreign metal. (2) A cathode of lead of larger surface than the anode and capable of formation. (3) A concentrated solution of neutral ammonium phosphate.

A valve containing a concentrated solution of double ammonium and sodium phosphate was investigated by means of an ondograph. The curves are plotted in Fig. 1, in which U = alternating current whose effective E.M.F. = 100 volts at a frequency of 42 cycles, U′ = E.M.F. at the two outside terminals of the valve = 82 volts, U_2 = effective E.M.F. between the terminals of a single valve = 73 volts, I = strength of current with one valve = 3 amperes, I′ = strength of current with two valves in series = 2·6 amperes. An examination of these figures shows: (1) The direct current is manifested only during each half-cycle of the alternating current. (2) The E.M.F. and the current are dephased with reference to the alternating potential difference. (3) The current strength is weaker with two valves in series than with one. (4) The rectification in the particular case above (double ammonium and sodium phosphate) is rendered more pertect by the use of two valves in series. An examination of a large number of tables results in the conclusion that the form of the curve of the E.M.F. varies with the nature of the electrolyte, that the dephasing of the rectified current varies according to the inductance of the exterior circuit.

Fig. 2 shows the phase displacement of the current with reference to the potential difference. The valve is made of an anode of magnesium, a cathode of graphite, and an electrolyte of ammonium fluoride. Fig. 3 is obtained with a valve made with an anode of pure aluminum, a cathode of surface about 100 times as great, formed of aluminum alloyed with 10 per cent. copper, and with an electrolyte of ammonium carbonate. V′ = difference of potential between terminals of valve on open circuit = 69 volts, U = difference of potential in operation = 89 volts, I = strength of rectified current = 1·3 amperes.

Graphite used for the cathode disintegrates slowly. Iron becomes coated with an adherent coating of iron phosphate and alumina, which increases the resistance. A sheet of polished steel is but

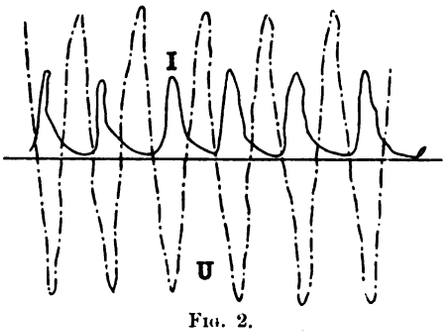

Fig. 2.

slightly attacked. Lead becomes covered with lead peroxide which protects the metal. The alloys of aluminum containing from 8 to 10 per cent. copper and 5 per cent. nickel suffer no sensible attack, but the output is less than with lead or steel. In a single valve of aluminum the electrolytic hysteresis has a value higher than unity with the alternating current. The persistence of the film of dielectric, during a portion of the inverse half-cycle, results in very noticeably augmenting the internal resistance of the cell. It may be demonstrated that the effective current I_{eff} of an

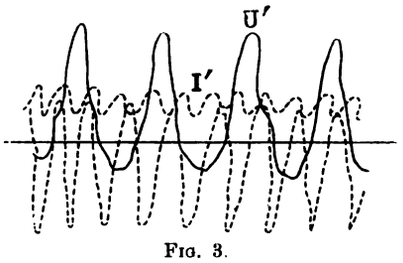

Fig. 3.

alternating current must be equal to the ratio existing between the potential difference V_{eff} between the plates of a condenser and the ohmic resistance R of the exterior circuit $I_{eff} = V_{eff}$. In this particular case when this effect is obtained, the angle of dephasage between current and voltage is zero, and the phenomena occur as if there were neither condenser nor self-inductance. If a valve, the capacity of which is known, be connected in series with a corresponding self-inductance, the graph indicates that more dephasing is necessary. This result is readily obtained with small outputs.

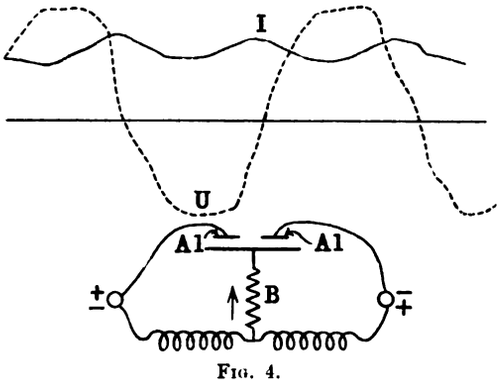

Fig. 4.

The current from a single valve, when fed to one winding of a transformer, causes the latter to furnish an alternating current from the other winding. Pulsating rectified current given by a single valve produces considerable induction results in series or in shunt excited motors, from which there results a poor mechanical output, a rapid heating and sparking at the commutator. The operation of magnets is much more satisfactory.

In the arrangement of apparatus indicated in Fig 4, the cathode is connected with the exterior resistance A which itself is in circuit

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with two resistances of self-inductances, S and S', equal and opposed. Two anodes, A_1 A_1, of aluminum placed in the valve with the cathode are connected with the two terminals of the alternating source. The rectified current in the operating circuit is slightly undulating, its strength I=10 amperes, its E.M.F. U=55 volts. The alternating potential difference=110 volts.

In order to use both half-cycles of the alternating current, four valves may be employed connected as in a Wheatstone bridge. An examination of this arrangement shows that each half-cycle of the current will always traverse two valves connected in series and that the two successive half-cycles are rectified in one direction and that they add their effects upon an exterior circuit. The regulation of the output is effected by means of reactances of variable self-inductance and the output of the valves is limited by the cut-out fuses. The loss of energy effected in the valves is manifested in the form of heat. The apparatus grows warm, and it is necessary to maintain it at a constant temperature of between 30°C. and 40°C. by means of external refrigeration. According to the output of the valves there may be utilised for this refrigeration external radiation, a cold current of air or a cold current of water. In the latter case the four valves are to be carefully insulated from the water. The model of the valve most in use is that constructed by Mors & Co. of Paris.

This valve is composed in its essentials of a prismatic vase of lead, of plate form, constituting the cathode. The vase is surrounded by sheet iron forming its support. The anode is an aluminum alloy assuming the form of thin plate laminated at the edges, upon which is fixed a rod of aluminum forming the lead for the current. This rod is insulated by means of a tube of rubber.

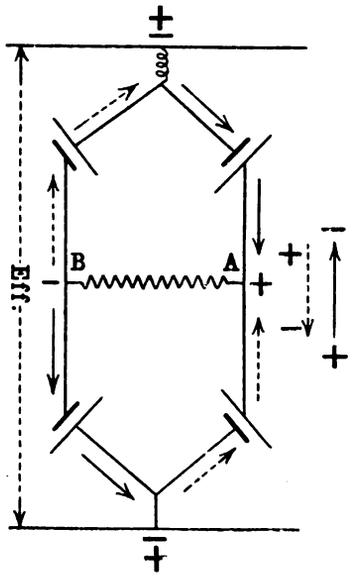

FIG. 5.

The valves contain a saturated solution of neutral ammonium phosphate. Cooling is accomplished by means of a lateral electric ventilator. The Mors Company constructs standard sizes between 1 and 100 amperes at 110 volts, whose operation is regular and constant. The guaranteed industrial efficiency of these valves varies between 65 and 75 per cent.

Two-phase or three-phase currents can be rectified by means of the valves. By an arrangement of apparatus similar to that of the Wheatstone bridge, but using six valves, a practically continuous current may be obtained. A special arrangement can also be used which consists of a single cathode and of two or three anodes dipped in a solution of ammonium phosphate. The rectified current pulsations, which correspond to the successive half-cycles, are then utilised in charging a battery of small capacity and low internal resistance. The current obtained at the terminals of the battery is practically rectilinear. Induction coils will operate with current which has been rectified by means of four valves. A rotary interrupter is then employed. Rochefort has investigated a special model which uses a single valve, of variable capacity and internal resistance, connected to a rapid interrupter. The induced currents obtained by means of these devices can be advantageously employed for radiography or for wireless telegraphy. When a valve is used with small anode surface and a strong current it operates in a manner analogous to the Wehnelt interrupter. The result obtained is the same as with continuous currents. It seems probable that the Wehnelt effect is an effect of electrolytic capacity analogous to that of the valves. The energy efficiency of the Nodon valve varies from 65 to 75 per cent., according to the operating conditions.

LEGAL INTELLIGENCE.

Poole & District Electric Traction Co. v. Bournemouth Corporation.

ARBITRATION.

The proceedings in connection with this arbitration were resumed yesterday at the Surveyors' Institution, Westminster. It is an arbitration arising out of an agreement between the Poole & District Electric Traction Co. and the Bournemouth Corporation, whereby the latter body is purchasing the undertaking of the company. The agreement, which was confirmed by the Bournemouth Corporation Act of 1903, contained no purchase price, but failing an amicable arrangement, it was to be ascertained by arbitration. Hence these proceedings. We have reported the earlier stages fully in our issues for June 3, 10, and 24 and July 1. The case for the company was opened on Friday, May 27, and disposed of on Saturday, June 18, after 4½ days' sittings. The case for the Corporation was opened on Saturday, June 18, and was continued on Monday, June 20 and Friday, June 24, when, for the convenience of the parties, an indefinite adjournment was made. Very little evidence then remained to be called. The umpires are Mr. William Eve (for the Corporation) and Mr. Leslie Vigers (for the company), with Mr. A. T. Lawrance, K.C., (since appointed to the Bench) as umpire. The counsel engaged in the case are Mr. Balfour Browne, K.C., Mr. C. A. Cripps, K.C., and Mr. C. C. Hutchinson for the company, and Mr. H. Lloyd, K.C., Mr. Williams and Mr. Jeeves for the Corporation. It may be remembered that the witnesses for the company placed their value of the undertaking at figures averaging about £400,000, whereas the Corporation evidence was to the effect that the company's tramways were only worth about £60,000.

Mr. J. B. HAMILTON, general manager of the Leeds Corporation Tramways, examined by Mr. H. LLOYD, K.C., said he did not consider the Stringer method of construction adopted on the permanent way was one likely to give good results. He had nothing to say against the overhead equipment and rolling stock. The road maintenance, however, had not been efficiently maintained, and having regard to the conditions obtaining to-day on the line, sufficient had not been spent on maintenance and repairs. It would need considerably more than had been spent upon it to maintain the road in proper order, and as time went on this would increase. In arriving at a valuation of the undertaking he had taken the profit shown in the balance-sheet for the nine months of 1901, and, on the basis of working expenses aggregating 8·19d. per car-mile, he had calculated that, for the twelvemonths, there was a profit of £3,685. 10s. 5d., which on a 16⅝ years' purchase amounted to £61,425. 6s. 11d. He had also made another valuation, based upon the 1903 balance-sheet. During that year 338,500 car-miles were run, and in order to allow for possible increase of traffic due to increased population and the running powers, he had increased this to 350,000 car-miles, as the utmost which the line could ever deal with. Taking the working expenses at 7·03d., the same as before but minus 1·16d. for renewals, and a revenue of 11d. per car-mile, he arrived at a profit of £4,209. 11s. 8d. From this he deducted depreciation at £1,700 per annum for three years, as he considered this sum should have been set aside from the commencement of the undertaking. On this basis, with 16¾ years' purchase, he arrived at a total valuation of £65,559. 14s. 5d. This he considered was the total value of the undertaking at its best. Dealing with the authorised and proposed extensions, he said there was bound to be a loss on the Christchurch line. The proposed extension to Poole Harbour could not pay, in his opinion, even supposing all the difficulties were overcome and the line authorised. The authorised Parkstone extension was bound to be a competitor with the existing line. This had been a very general experience. They certainly had a tendency to relieve the other lines, but, as a rule, they increased the working expenses without any other result. The Canford Cliffs line would not pay even if the land were given without cost. At Leeds there was a parcel service, but the revenue from it was only about £117-£120 per annum, although it had been in existence for many years.

Cross-examined by Mr. BALFOUR BROWNE, K.C.: With regard to the Christchurch line he would not care to put money into the new route proposed by the Corporation, but at the same time it was a more likely route than the original one. On the question of the renewal fund, or redemption, he maintained that the volume of street traffic was not an important factor in the amount to be set aside. It was a question of speed of service, for the wear and tear would be less with heavy street traffic and slow tramway speed than with less street traffic and high speed. At Leeds the policy of the Tramways committee was to set aside for rolling stock 10 per cent. of the cost. Last year £19,086. 11s. 4d. was put aside, This worked out at 0·63d. per car-mile. The permanent way was maintained out of revenue.

Mr. BALFOUR BROWNE: But you have put down in your estimate 1·16d. for redemption?—Yes.

Therefore, you get a fictitious result by introducing figures which were not in the 1901 balance-sheet, and this balance-sheet was agreed to be the basis of this arbitration.

Continued cross-examination: On the question of running powers, so far as the Newcastle lines were concerned he had been informed by the officials of the Corporation that they had not benefitted by the through running to a very small extent. There would have to be a large number of transfers on every system, in his opinion. It was a fact that the Leeds Corporation were negotiating with the Wakefield & District Tramways Co. for through running, because the company had offered terms which he was of the opinion the Corporation should consider. Personally, however, he was of the opinion that the Corporation would benefit only to a very

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small extent, but as a public facility some good would be done. The present heads of agreement between the Leeds Corporation and the Wakefield Company were that the arrangements should only last in the first instance for three months. The stringer method of construction adopted by the Poole Compony was not a good one, although the Corporation had also a few miles constructed in a similar manner.

Re-examined: In arriving at his valuation, he had adopted those figures in the 1901 balance-sheet which appeared to him normal, and had rectified those figures which seemed inadequate. As a matter of fact, however, the Company's witnesses had agreed that 7d. per car-mile for working expenses was a fair figure. Therefore, there was only a difference of 0·03d. between the parties on that point. On the question of depreciation, he had taken 1·16d. per car-mile, whilst Mr. Hammond, for the company, had taken 1·09d. per car-mile, making a difference of 0.07d. per car-mile, so that the total difference between the two parties was 0·10d. He did not know that Swindon Corporation had recently been proposing the stringer method of construction, and that the Board of Trade had refused to allow it.

Mr. A. L. RYDE, surveyor, of Great George-street, London, senior partner of the firm of Ryde & Sons, said there were three points to consider in this matter—viz. (1) Amount of annual net profit, (2) security or otherwise of the net profit, (3) number of years' purchase, having regard to this. The first point he had left in the hands of the engineers, whose evidence he accepted. There had always been a great deal of difference of opinion with regard to the life of the various portions of a tramway undertaking, but it was common ground that generally the life was a very short one, and in no concern was an adequate depreciation fund more necessary than in an electric tramway undertaking. With regard to the security of the net profit as shown, he said there was no proper competition at present between the L. & S.W. Railway Co. and the tramway company. But there was a possibility and a probability of this in the future. Up to the present time the L. & S.W. Railway Co. had made no effort to capture the local traffic about Bournemouth. But railway companies were making experiments with single-motor coaches to see if they could not do something to compete with local tramways. Experiments were now being actually made, and it was possible that such cars would be run from Christchurch on the east to Wimborne on the west of Bournemouth. In addition to this, there were the improvements in road traction to be taken into consideration. So much for the security or otherwise of the profit. With regard to number of years' purchase, he pointed out that Consols were 36 years' purchase, Bournemouth Corporation stock 29 years' and that the British Electric Traction Co.'s preference and ordinary shares could be purchased half-and-half to pay 6 per cent., which was 16¾ years' purchase, and the ordinary stock alone was 14·3 years' purchase. Therefore, he preferred to take the Poole Company as a 6 per cent. undertaking, which was a 16⅔ years' purchase. The claims of the company for the other lines not yet constructed or authorised, he considered would have no marketable value.

Cross-examined by Mr. HUTCHINSON: He had considered the matter from the point of view of a person wishing to invest, quite apart from the existence of the agreement. This he considered fair market value.

This concluded the evidence on behalf of the Corporation.

Mr. H. LLOYD, K.C., then addressed the tribunal on behalf of the Bournemouth Corporation. He said he did so with some diffidence because this was a matter of great importance and some novelty, and it was also likely to become of very great importance in the future. The great point was that it was only in comparatively recent times that the change had taken place from the basis of the terms of purchase contained in the Tramways Act of 1870 by reason of the passing of the Light Railways Act of 1896. The natural result had been that as yet there had not been much, if any, experience of the application of the new principle. Therefore, the tribunal were asked to ascertain the value of the whole of a tramway undertaking under the new principle. It had been hinted that one of the difficulties in the way of obtaining money for tramway purposes had been the damper on the concern by reason of the local authority having the right to purchase as "old iron," and that this being so, Parliament, it had been suggested, had endeavoured to give some impetus to enterprise by proposing a new basis. But he ventured to think that if the company were successful in persuading the arbitrators to accede to their demands they would be doing the cruellest injustice to tramway undertakings in the future that could be imagined. In acceding to the company's claims the tribunal would be defeating the very object which the tramway industry, as a whole, suggested was the thing which was going to favour tramway enterprise in the future, for if tramway companies were to be able to get a valuation of this description acceded to, Parliament would be very slow in altering the old condition of things at present existing under the Tramways Act. As a matter of fact, the price asked by the company, if paid by the Corporation, would land the whole undertaking in bankruptcy, but he ventured to think that the claim could not be made good. He could not help thinking that the thing which was running through the minds of the claimants was this: They were under the impression that they had the Corporation of Bournemouth in a cleft state, and that they could screw the Corporation to accept any terms they chose to put forward. They were also under the impression that the agreement placed the parties in this position—viz., that the Corporation had no option but to pay a freehold value of one particular figure in a balance-sheet, and that the tribunal had no option but to award it. Heaven help them if the arbitrators came to that conclusion! The question of the construction of the wording in the agreement as to the balance-sheet of 1901 he had dealt with at an earlier stage, and he was content to accept the remarks of the umpire on that occasion that the Corporation were free to go beyond the actual profit shown there, and to analyse the methods by which such profit was arrived at. He would, therefore, endeavour to show from the evidence of the claimants' own witnesses that the figure of profit there shown was not a solid one. For instance, a willing buyer had a right to know if the figure for working expenses there shown could be maintained. In 1901 this amounted to 47·4 per cent. of the total revenue, in 1902 it was 67·3 per cent., and in 1903 it was 61·4 per cent. The car-miles in 1901 were 219,289, and the working expenses per car-mile were 5·61d. In 1903 the car-miles were 338,500, and the working expenses were 6·8d. per car-mile. Then let them take the evidence of the witnesses for the company as to what could be looked upon as a normal figure for working expenses. Several of their witnesses put the fair receipts at 11d. per car-mile with working expenses at 7d., which was 63·6 per cent. All this demonstrated that the company were seeking to get some advantage at the hands of the tribunal in asking that the profit shown in the balance-sheet of 1901 should be regarded as a fixed figure. Then as regards the question of depreciation, both Mr. Sellon and Mr. Hammond had admitted that this should be allowed for after 1901, again demonstrating that the claimants were of the opinion that they had some advantage in taking the balance-sheet of 1901 as the basis. Therefore, by taking their revenue for 1901, and deducting 60 per cent. for working expenses this left £5,496 profit for 1901. Then there was the question of depreciation to be considered. Mr. Hammond said £1,351 per annum ought to be allowed, and on this basis the net result would be £4,145, as against over £7,000 claimed. If depreciation were deducted upon the basis of any of the company's witnesses, the net result would be in the neighbourhood of £4,000 profit for 1901, and this, he claimed, would be about as near as it was possible to get to the real value of the undertaking. Assuming this, the next question was, "How many years' purchase should be taken?" In taking the evidence on this point into consideration, he appealed to the tribunal to bear in mind that the company had obviously thought that this was a matter where engineers might be well assisted by the mature experience of a surveyor who had been accustomed to value all classes of property, and therefore throughout the earlier part of these proceedings he had observed that Mr. Daniel Watney, the surveyor, was in attendance on behalf of the company. But after hearing Mr. Sellon's views on the question of the number of years, Mr. Daniel Watney no longer was present. On the other hand, Mr. Ryde had heard Mr. Sellon's evidence, and had had no compunction, with his experience of all sorts of undertakings, in coming before the tribunal and giving quite opposite views. Mr. Daniel Watney, on the other hand, did not give evidence to support Mr. Sellon. Practically speaking, the company were asking for 30 years' purchase of the present profits plus an amount for every other possible increase of profit, some of them at 28 years' purchase. On the other hand, the Corporation claimed that 16⅔ years' purchase covered all possible increments, and was based on the basis of the maximum service the company could give and the district could stand. Dealing then with the evidence more in detail, counsel put before the arbitrators a tabular statement of the traffic receipts for every week from the commencement of the undertaking up to the end of September last, and the thing which this table demonstrated he said was that in no year did the traffic receipts of the first three months equal one-third that of the remaining nine months of the year. Yet all the witnesses for the company had added one-third to the profit for the nine months of 1901 in order to arrive at the whole year's working. Then, again, the increase of population was dealt with in very various ways by the witnesses for the company, and it looked very much as if it was like an indiarubber ball, to be squeezed about anyhow. One witness even allowed no depreciation in respect of the increased traffic due to increased population. Except as regards this one witness, they had the principle of depreciation admitted, which emphasised his earlier remarks on this matter. Then, as regards running powers, he wondered why, in view of the value placed upon the continuation of the Poole line into Bournemouth, the company had not claimed something for their running powers from Christchurch into the east of Bournemouth. Either they were valued at nothing or were included in the £5,500 which it was agreed should be paid by the Corporation to the company for certain other things included in the agreement, and with which this arbitration had nothing whatever to do. With regard to the running powers at the western boundary of Bournemouth, counsel commented upon the various methods employed and the divergent results arrived at by the various witnesses for the company. On the question of the Parkstone loop, there was a broad issue between the parties, because the Corporation had suggested that, if a second line was laid through practically the same country in a district such as this, and at a distance at no point of more than one-third of a mile, it was, in effect, providing two lines to accommodate the same traffic. And in addition to this he contended that the method of calculating the possible traffic was monstrous, for many of the pedestrians counted on a particular day by Mr. Sellon he ventured to think were already served by the existing line. The estimates of the value of the Parkstone loop demonstrated the absolutely iniquitous and unfair results arrived at by taking the balance-sheet figure of 1901 as the basis, for Mr. Hammond got a value of between £90,000 and £100,000 for this small line, not yet constructed; nearly double that given by Mr. Sellon, and against some £40,000 given by Mr. Dickinson. The Christchurch line produced a very curious state of affairs, because the Corporation got powers for another route to the one proposed by the company owing to the totally different character of the two routes and their disbelief in the financial poossibilities of the latter. In addition, the Corporation would have been only too pleased not to construct any line to Christchurch at all, the reason for its construction being an obligation to the Christchurch Corporation. In connection with the Canford Cliffs line, it was a *sine quâ non* to the company that the land upon which it was built should be given without charge, and then Mr. Sellon, on oath, said he had not considered whether it would pay or not, he only knew that it would act as a feeder to the other line, and upon which he put a certain value. Then, as regards the Poole

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Harbour line, he failed to see that the company had put forward any material evidence in favour of their claim. At one time the line had been applied for and rejected, another application had been withdrawn, and no effort had since been made to get the powers. On the question of parcels, he thought the least said the better. Except Mr. Sellon and Mr. Anderson, no witness for the company had put any value upon this, and the evidence of his witness (Mr. Hamilton) that morning showed that in Leeds, which was a pretty go-ahead place, the parcel service was worse than worthless. In conclusion, he had a word to say as to the total estimates of the company's witnesses. Mr. Sellon had asked for £420,089, and, in addition, there would have to be spent upon the undertaking, according to him, £144,857. In other words, the undertaking would cost the Bournemouth Corporation £564,946. Assuming that Mr. Sellon's figure of £6,250 profit for 1901 were dealt with in the manner he had suggested, the Corporation would pay 90⅛ years' purchase. If, on the other hand, the profit would only be about £4,000, as the Corporation alleged, the sum to be paid the company would be equal to 144 years' purchase. On Mr. Hammond's figures the results would be 100¼ and 157 years respectively. Assuming that the company's 30 years' purchase was taken, it would mean that he would have to earn a profit of £18,830 per annum, whilst if the Corporation claim of 16⅝ years was correct, then, to earn the sum claimed by the company there would have to be a profit of £38,896 per annum. He only wished that he could express in language his view of the claim. He could not. His clients regarded it as grossly exaggerated and extravagant, and he could not help thinking that it was put forward in order to arrive at that wretched result called "splitting the difference," and so give to the company a sum which in their most sanguine mood they could not expect by arbitration. He hoped and prayed that the award would not be anything like the figure put forward.

The proceedings will be concluded to-day (Friday).

Ferranti Limited.

On Wednesday Mr. Justice Warrington considered the petition of the company for the sanction of the Court to a scheme of reconstruction.

Mr. Jessel, who appeared for contributories opposing the scheme, suggested there was the possibility of some concession on both sides if the petition were allowed to stand over, and it was agreed the petition should stand over until the 25th inst., when a petition for the compulsory winding-up of the company is down for hearing, both petitions to come on together.

National Telephone Co. v. Jenkins.

In the Lord Mayor's Court (London) on Tuesday plaintiffs sued Mr. A. C. M. Jenkins to recover £18. 5s., a year's subscription claimed to be due under two contracts for hire and rental of telephone apparatus. Plaintiffs said defendant had entered into agreements for the use of telephone instruments for five years at an annual subscription of £17, payable in advance, but had declined to pay the subscription due Oct. 15, 1903, on the ground that between Sept 28 and Nov. 30, 1903, the company did not maintain the telephone line and instruments in good working order, with the result that it was useless. One of the conditions of the agreement provided that the company should not be held responsible or liable to the subscriber for any delay provided they used every reasonable endeavour to restore communication as speedily as possible.

Mr. H. Blandford, inspector in the company's employ, said he visited defendant's premises and examined the telephone on several occasions. The faults found were put right. These visits were paid between Oct. 12 and Nov. 9.

Defendant said he had been a subscriber to the company's service since 1899, paying his subscriptions in advance up to Oct. 15 last. After September he had trouble with his instrument. One day it was in proper working order, and the next it was completely out of gear. On Sept. 28 he wrote stating that he was constantly receiving complaints. During the whole of October the service was altogether intermittent, he being unable to get on with his customers, and they being unable to communicate with him. The company sent a man to look at the instrument which at one period was being attended to for fully 10 days in succession. His difficulties continued until the end of November, when the instrument was put into working order. On Dec. 9 plaintiffs disconnected his machine. Previously he had been discussing the matter of an allowance being made for the period during which the machine was useless, and he suggested subsequently that he should pay a nine months' subscription. He had always been willing to pay, provided an allowance was made for the time the instrument could not be used.

The jury found that the telephone was not in condition for use, and found for defendant. Judgment was entered for defendant on the claim, and also on a counterclaim that had been raised for the agreement with plaintiffs to be delivered up and cancelled. Leave to appeal was refused.

Workmen's Compensation.

At Rotherham County Court recently a novel point in the construction of the Workmen's Compensation Acts was raised. An oiler claimed compensation at the rate of 15s. 3d. a week for total permanent incapacity caused by injuries received while engaged in work, but it was pleaded in defence that plaintiff was guilty of serious and wilful misconduct in oiling the machinery while it was in motion. It was admitted that a notice had been posted to the effect that "enginemen must not themselves or allow other persons to oil or clean dangerous parts of machinery when in motion." Evidence was, however, given to show that the practice was contrary to the rule and that the breach of the rule was known to the responsible officials. It was stated that when the machinery was stopped for lubrication there was official grumbling.

The JUDGE held that the notice was ambiguous, and that the claimant had not broken any clear and well-defined rule. He was therefore entitled to compensation, and an award was made in his favour, with costs.

Arbitration proceedings took place at Newbury County Court last week in connection with the claim of a workman named Brown for compensation from the Urban Electrical Supply Co. and Edmundson's Electricity Corpn. for injuries sustained through the loss of his leg while in the employ of Callender's Cable & Construction Co., the contractors for laying cables for the companies in the district. A third party was introduced in Col. Marshall, whose horse fell on the injured man in a trench.

Mr. WALSH, for applicant, said he was engaged by Callender's Company. The two respondent companies had the same offices and the same secretary, but were separate legal entities. Machinery had been established at Greenham for pumping and lighting. Brown was at work at Newtown-road, about a mile from the mill, and a horse owned by Col. Marshall became frightened at one of the cable drums and ran away. It fell into the trench on the top of Brown, the result being that his leg had to be amputated. He was earning £1 a week, and the claim was for 10s. a week. The injury was, it was urged, caused by and arose out of his employment, as he was digging in the trench when the accident happened.

Mr. HILL, for the two companies, said the works were owned by the Urban Company, Edmundson's Company were putting down the plant at Greenham Mills and Callender's Company had the contract to lay the mains.

Mr. WALSH argued that the injury came under the section of the act dealing with engineering work, which included any work in connection with machinery driven by steam, water or other power; or it might come under the factory section of the act, as Greenham Mills was a factory. That the works were engineering works did not necessarily mean that there should be actual physical contact, it was enough that they were all part of one scheme which, if not actually in connection with, would be joined to, the works at Greenham, where machinery was situated.

An employé of Callender's Company said the trench in which the man was working was disconnected from the mill by two lengths of unlaid road of 250yds. each. They would, of course, have to be connected before supply of electric current could be given.

Mr. WALSH again argued that the break in the cable made no difference. Trench digging was part of an engineering work, because eventually it would be connected with the supply station where the power was generated.

Mr. HILL argued against this view, and

His HONOUR, in giving judgment, said it was difficult to decide cases under the complex 1897 Act, but he had come to the conclusion that the accident had arisen in the course of the man's employment. He agreed that it was clearly an engineering work, and that compensation must be given by Edmundsons' Company. There was no dispute as to the amount to be paid, and he made an award for 10s. a week, with costs on the higher scale.

Overcrowding Electric Tramcars.

A conductor of one of the West Ham Corporation electric tramcars was summoned last week for carrying 20 excess passengers.

A police-inspector said the conductor could have had policemen to help to evict the excess passengers if necessary.

For the defence it was pointed out that the act under which defendant was summoned was passed in 1842, long before electric cars were thought of.

The summons was dismissed.

Obstruction of Tramcars.

At Leigh Police Court on Monday, Mr. G. Shaw (managing director of the Leigh Brewery Co.) and four of his carters were again charged with wilfully obstructing a tramcar of the South Lancashire Tramway Co. between Leigh and Lowton on March 11, 1903. The case had been remitted to the Leigh magistrates from the King's Bench, with a direction that there was no absolute right on the part of a vehicle to keep the left-hand side of a road, but on a tramcar and a vehicle meeting they should act reasonably towards each other.

Evidence was now given that a tramcar running from Leigh to Lowton was going up Pennington railway station bridge when it met one of defendant's lurries. The driver of the lurry refused to leave his own or left-hand side, and the tramcar driver refused to back to the loop 30yds. away, and the lurry and car stood facing each other for 50 minutes, causing a general dislocation of the tramway traffic.

After a long hearing, the chairman said the Bench were equally divided, and, as he would not give a casting vote, no decision would be given.

Theft of Electricity.

At Weston-super-Mare Petty Sessions on Friday last, Wm. Coombes was convicted of fraudulently abstracting electricity on Sept. 26 from the mains of the Weston-super-Mare & District Electric Supply Co.

It was stated that defendant had dabbled a little in electrical matters and had done a few local jobs. He was also caretaker of the Royal Arcades and had access to the empty shops there.

A jointer (named Harris), in the employ of the company, had observed a light in a shop in September. He knew there was no electricity meter there, and so reported the matter to the manager (Mr. Leech) and a watch was kept on the premises. On Sept. 26 the jointer called on defendant and told him he wanted to inspect the fuse boxes in No. 76. Defendant replied that he had not got the key but he subsequently produced it and they entered the premises. As Coombes was unlocking the door he said "I am charging an accumulator upstairs." The accumulator was such as might be used for driving the motor bicycle which defendant rode. A twisted lead (produced) was connected with the free end of a cable projecting from one of the company's fuse

boxes, and another lead was twisted round a steel bradawl, the point of which was inserted in the company's main just below the other fuse.

Defendant pleaded guilty, and it was ingenuously urged on his behalf that "the apparatus was a very ordinary one for stealing electricity, and, unfortunately, there was no denying that the unhappy young man did steal a small quantity." Defendant was only 20 years of age, and had hitherto had a very good character.

The Bench imposed a fine of £6, or in default one month's imprisonment.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An assistant electrical engineer is required by Erith District Council. Applicants must have had good mechanical training, and preference will be given to one with practical experience in the working of a three-phase system. Salary £150 per annum. Applications to the clerk (Mr. Chas. H. Fry), Council Offices, Bexley-road, Erith, by 10 a.m. Oct. 24. See also advertisement.

A junior engineer is required at the West Ham electricity department to take charge of an 8-hour shift. Salary £2 2s. per week. Forms of application, &c., from borough electrical engineer, electricity generating station, Tucker-street, Canning Town, London, E. See advertisement.

Wolverhampton Lighting committee require a canvassing engineer, competent to prepare specifications and estimates for light and motor power installations. Particulars from the borough electrical engineer (Mr. C. E. C. Shawfield). Applications to the town clerk (Mr. Horatio Brevitt) by noon Oct. 31. See also advertisement.

Second-class engineers (aged 22-24) and second-class technical officer (24-30) are required for the engineer-in-chief's department, General Post Office. Applications, on forms to be obtained from the secretary, Civil Service Commission, Burlington-gardens, London, W., by Oct. 20. See also advertisement.

An engine driver is wanted for shift work in generating stations. Applications to city electrical engineer (Mr. H. Faraday Proctor), Temple Back, Bristol. See advertisement.

A designing engineer, accustomed to D.C. motors, boosters, &c., is required by a leading firm of manufacturers in the North of England. See advertisement.

Woolwich (London) Council require a station engineer. Applications by 17th inst.

An armature winder is required by Ferranti Limited, Hollinwood, Lancs.

Bermondsey (London) Council require a chief assistant electrical engineer. Applications by noon 18th inst.

Applications are invited for the position of lecturer and demonstrator in electrical engineering at the school of engineering, electricity and technical science, Canterbury College, University of New Zealand. Salary £300 per annum, with saloon passage to New Zealand. Particulars of qualifications and forms of application from the Agent-General for New Zealand, 13, Victoria-street, London, S.W., to whom applications by Oct. 29.

EDUCATIONAL.

Technical Education in London.—The final report of the Technical Education Board of London County Council states that there has been a great advance in the volume and character of evening instruction in science and technology.

Ten years ago instruction in electricity was given in only five centres, but there are now 23 centres. Trade classes have also increased. Artisan students in polytechnics in 1903 numbered 7,181, an increase of nearly 38 per cent. in two years. The students worked over 400,000 hours. The number of polytechnics and technical institutes has increased from nine to 26 in 10 years. This success has not been attained at the expense of other institutions. The total volume of instruction in mechanical and electrical engineering, carpentry and joinery, plumbing, building trade classes, experimental physics, chemistry and mathematics shows an increase from 118,732 student hours in the first year of the board's operation to 454,363 student hours for the session 1900-1. In 1903 the number of students enrolled at the five London County Council schools and institutes was 2,053. Since 1894 the board has equipped in secondary schools 17 chemical laboratories, 18 workshops for manual instruction and 25 science lecture rooms. During the past year a total of £305,212. 12s. 5d. was expended by the board.

Afghanistan.—It is again reported that Kabul, the capital city, is to be lighted electrically.

Alleged "Electric" Fire.—As we announced in our last issue, a fire recently occurred at St. Chrysostom's Church, Manchester, and, as usual in cases where there is no direct evidence as to the cause, it was attributed to a defect in the electric wiring. Fortunately, Mr. E. T. Steinthal, hon. secretary of the Manchester and District Association of Electric Lighting and Power Contractors, promptly took the question up and wrote to the local Press protesting against the assumption that the cause of the fire was an electric one. The Emergency committee of the Association was summoned, and, after full investigation of the matter, issued a report to the effect that the fire did not arise from any electrical cause. A report was also prepared by the chief engineer of the Corporation electricity department (Mr. S. L. Pearce) which is to the same effect. These reports were presented to the Electricity committee of the Corporation on Saturday.

In Mr. Pearce's report it is stated that the service to the church was a new one, completed on the Friday previous to the outbreak of fire, the lights being switched on for the first time on Saturday. The wiring was carried out by a competent firm of contractors, and prior to the current being switched on careful tests were made by the electricity department's inspector. The tests were entirely satisfactory, an insulation of 5 megohms being obtained between any two wires, the whole installation to earth testing out at 2·5 megohms.

A close investigation into the occurrence had elicited that at 6:45 p.m. one of the double-pole switches was switched off altogether by the contractor's foreman, and through the second double-pole switch a supply to two fittings only in the choir was being given. Four hours after the supply had been switched off the fire was discovered. The Corporation inspector who connected up and tested the installation reports that there was a large fire in the vestry burning all the rubbish which had accumulated during the alterations and a gas ring was in use at the back of the organ for hot-water purposes. After careful consideration Mr. Pearce came to the conclusion that the outbreak of fire could not be put down in any way to the new electrical installation and that other causes must be looked for.

The report of the Emergency committee of the Contractors' Association is as follows:—

The electrical installation was carried out on satisfactory lines, the circuit wiring being in continuous steel tubing to the switchboard, and all circuits controlled by single-pole switches on the outer wires of the three-wire service. The lighting for electroliers, which were wired in the roof, was controlled completely by double-pole switches. Previous to the time of the fire all circuit wiring from the switchboard onwards was absolutely cut off from the supply. The mains from the point of supply to the place where they rise through the floor to the switchboard are intact at the present time, showing that no fault occurred there. The contractor personally tested the installation on the day previous to the fire, and took the insulation between poles of the wiring (not less than 8 megohms) and also the insulation of each pole to earth (none less than 5 megohms), and, further, the total combined insulation to earth (2 megohms). . . . There seems to be no doubt that the fire originated in the immediate neighbourhood of the organ chamber. There is distinct evidence of an escape of gas in the organ chamber, which was only slight so long as any through draught existed, but which accumulated to an unpleasant extent after all doors had been closed throughout the night. The escape was vouched for by the rector and verger, and by the contractor and his staff. A gas ring burner had been in use throughout the day in the organ chamber, but the cleaners state that that was cleaned and put away on the Saturday, and that the gas jet in the organ chamber was turned off. The gas had not been turned off at the main, however. The committee is of opinion that the fire did not arise from any electrical cause, and that the escape of gas suggests a possible source of danger, though there is not sufficient evidence to show the actual source of ignition.

Argentina.—The "Review of the River Plate" says that the Buenos Ayres Corporation's second invitation of tenders for the construction and working of an electric tramway to serve the western suburbs has, like the first, not resulted in the receipt of any offer.

Buenos Ayres Municipality have granted a 55 years' concession to Messrs. Sawyer & Lacaze for an electric tramway for the western suburbs.

Mr. H. H. Fisher seeks a 60 years' concession for electricity supply in Flores, Belgrano, &c., from Buenos Ayres Corporation, and proposes to supply current for private lighting at 9c. gold per unit and for power at 6c. To the Municipality the charge for incandescent lighting would be 6½c. gold per unit and for power 4½c. For arc lighting the Council would have the option of paying $17 m. n. per 800 c.p. lamp per annum, or 4c. gold per unit.

The Tres Arroyas Electric Light Co. has been formed with an authorised capital of $90,000 m.n.

The La Plata National Tramway, owned by Mr. L. Monteverde, is about to be converted to electric traction.

The General Electric Co. (London) have appointed Messrs. Colson, Brookhouse & Pyne their agents at Buenos Ayres.

The public lighting department of Buenos Ayres Municipality have come to the conclusion that the Compañia Alemana Transatlantica de Electricidad can amortize their capital in 25 years, and in the meantime pay dividends of 5 per cent. if their charges are from 5c. to 7c. gold per unit (a reduction of 72 per cent. on the maximum charge).

Aston.—The Council last week decided to contribute £5,760 towards the cost of rebuilding the L. & N.W. Railway Co.'s Aston Station-street bridge, to permit of the construction of the City of Birmingham Tramway Co.'s line at that spot as a double track.

Battersea (London).—On Wednesday the Council resolved to fit, at an estimated cost of £125, the meter-testing room at the generating station so that the works of repair, which at present are carried out by meter makers, can be effected there.

The public lighting mains are to be extended and Nernst lamps provided at an estimated cost of £942. The charge for supply of current to and maintenance of Nernst lamps has been fixed at £6 each per annum.

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Barrow-in-Furness.—An inquiry was held here on Friday for sanction to a loan of £35,000 for the extension of generating plant at the electricity station, mains, &c. Already four extensions have been authorised, and there are nearly 1,400 consumers.

Biddulph.—The Council have opened negotiations with the North Western Electricity & Power Gas Co. for a supply of electricity.

Birmingham.—A special meeting of the Corporation will be held on the 31st inst. to consider the proposed tramways bill.

Bradford.—The Board of Trade inspection of the Undercliffe-Greengates and the Allerton-Stoney-lane extensions of the electric tramways (1¾ miles and one-third of a mile in length respectively) took place on Wednesday, the shorter line being at once opened for traffic. The opening of the Greengates line is deferred for a few days.

Brighton.—Last week the Council sanctioned the proposal to wire and fit up for the electric light the diphtheria pavilion at the Sanatorium, and also approved recommendations of the consulting engineer (Mr. Arthur Wright) regarding alterations at Southwick power station. Tenders were let to the British Westinghouse Co., as set out in our last issue.

Councillor SONE moved a resolution that Mr. May, borough engineer and surveyor, be given three months' notice to leave the service of the Corporation.

The MAYOR intervened and appealed to Mr. Sone not to proceed with his motion on the ground that it would be highly prejudicial to the success of their appeal against the decision in Macartney *v.* Brighton Corporation if the discussion continued.

Councillor SONE, however, desired to press the matter, and the Mayor then left the chair.

Eventually Ald. Carden was voted to the chair and suggested the postponement of the meeting for a fortnight in the hope that some arrangement might be come to.

Ald. Stafford, Councillors Butt-Thompson, McClean and others joined in the appeal, it being generally thought that Mr. May should be heard before the Council took action.

Eventually the meeting was adjourned until Monday last, when the Council went into committee under the presidency of Ald. Sendall.

The borough surveyor (Mr. MAY) had an interview with the Council and read a written statement which dealt with the thorny subject of the tramway litigation in detail. He indignantly protested against any suggestion that he had done anything to forfeit the confidence of the Council, and claimed that, throughout the whole of his service he had ever had the best interests of the town at heart, and that he merited a continuance of the trust hitherto reposed in him by the Corporation.

The CHAIRMAN appealed to Councillor Sone to withdraw his motion, and this he agreed to do.

On the motion of Councillor PANKHURST it was resolved to instruct the General Purposes committee to report as to the desirability of appointing an independent auditor to audit all the Corporation accounts.

Burton-on-Trent.—The borough electrical engineer and tramways manager (Mr. P. J. Pringle) has recommended certain alterations in the charges for electrical energy. These have been approved by the Gas and Electricity committee, and if the Council endorse the recommendation, the new scale will come into operation as from the beginning of the present quarter.

The present charges for current are on the maximum demand system—6d. per unit for the first 1½ hours and 3d. after. Owing to the large proportion of shops and offices at present connected, it is found that about two-thirds of the total consumers get no rebate, the mean price to all consumers being 5¼d. per unit. Of two methods of reduction reported upon by Mr. Pringle, the committee recommend that which gives a flat rate of 5d. per unit, with the present maximum demand system as an alternative, rebates to be given quarterly instead of half-yearly. The reduction in revenue is estimated at about £430. Meter rents, which at present vary from 3s. 6d. per quarter for 5-ampere size, up to 9s. per quarter for the 300-ampere size, are all recommended to be reduced by 1s. 6d.

Last autumn the Tramways sub-committee, in conjunction with the borough electrical engineer and tramways manager inspected several types of car-top covers, but it was decided to postpone decision in order to ascertain from other towns whether there is any disadvantage from the use of these covers during summer months. This has been found not to be so in practically all cases, and an order has been placed with Messrs. G. C. Milnes, Voss & Co. for three top covers with Magrini sides and canopy roofs, extending the whole length of the cars, at £82 each. These will be in operation shortly, and if experience with them is satisfactory extensions will be made for the winter.

Bury Tramways.—Ramsbottom District Council have suggested that Bury Corporation's tramways should be extended to Ramsbottom and that a further extension from the latter place through Walmersley, to join another of the Corporation's lines at Limefield, may ultimately be advisable. Representatives of the two Councils discussed the subject last (Thursday) evening.

Chelsea (London).—It was reported to the Council on Wednesday that the initial outlay on the electric lighting of the baths and town hall would be £2,600 if independent plant were put down, and that the cost of current if taken from the local electric lighting company would be £650 per annum. Current generated by an independent plant would cost £226 per annum, plus £313 for interest and sinking fund charges. The matter was referred to the Finance committee.

Companies Struck off the Register.—The following have been removed from the Register of Joint Stock Companies:—

British & Foreign Tramways Co.	Electro Stannus Co.
Carbon Co.	Gramme's Magneto-Electric Co.
East Suffolk Tramways Co.	Kew, Richmond & Kingston Trams. Co.

Dewsbury.—The charge for electric current for lighting has been reduced from 6d. to 5½d. per unit for the first hour's maximum demand, and 3d. after. For motive power the reduction is from 4d. to 3d. per unit for the first hour and 1d. after. Rental for meters up to 50 amperes will be 7s. per year and 10s. per annum for all sizes above 50 amperes.

East Barnet.—At the meeting of East Barnet Valley Council last week, a deputation of ratepayers, headed by Mr. J. B. Braithwaite, jun., urged the postponement of the Council's projected electric lighting scheme.

Mr. BRAITHWAITE thought that before finally committing ratepayers to a large expenditure full details should be supplied, and that ratepayers should have an opportunity of expressing their opinion on the scheme.

Councillor BOWDEN moved that the deputation be informed that ample time would be given for holding a public meeting for considering the Council's scheme.

This was carried by four votes to three.

East Ham.—The Public Libraries committee have been empowered to accept a tender for the wiring of the Carnegie Library at Manor Park.

Electric Club for Birmingham.—We referred in our last issue (p. 1001) to the proposed formation of an electric club for the Birmingham district to serve as a social centre for workers in the electrical industries. The preliminary meeting announced to take place on Saturday last in connection with this proposal was duly held.

Mr. J. W. Innis, who presided over a representative gathering, stated that for some time a feeling had existed amongst the allied workers in the electrical trades that a club or institute should be formed the membership of which, it was proposed, should be confined to those engaged in the manufacture and use of electrical apparatus and machinery. The basic principle would be mutual, social and intellectual help to its members. Several speakers expressed the opinion that the social side should be developed to it fullest extent, and that the subscription should not be prohibitive to the ordinary worker. A committee of seven was appointed to consider the advisability of promoting the club, and to present a report at a subsequent meeting. Messrs. J. W. Innis (consulting electrical engineer), W. H. Whitehouse and W. Smith (municipal technical school), E. R. Wood (electrical engineer), H. W. Dipple (National Telephone Co.), M. G. Waggott (Post Office telegraphs), and W. Dalby (Midland Railway telegraphs) were appointed as the committee.

Electric Light in the Theatre.—There passed away on Monday, at the age of 78, Mr. John Hollingshead, a noted figure in London theatrical life, and for many years manager of the Gaiety Theatre from its opening in the late sixties. Mr. Hollingshead was the first manager to introduce the electric light for theatres, and, in fact, claimed to have been the first to introduce the electric arc light on a commercial basis into England.

Electric Pumping in Mine Drainage.—In a report presented to the Mines Drainage Commissioners at Dudley last week Mr. E. B. Marten stated that direct-current electric motors and pumps have been installed at Hopyards, Bentley, New Priestfield, Bailey's East, Bailey's West, Ocker Hill, Ghost, Leabrook and Berkeley Wood pits. Current is supplied by the Midland Electric Corpn. for Power Distribution. There are now 10 electrically-driven pumps installed, and the expenditure on surface works during the past year included £1,200 for electric pumps.

Electricity in Mining.—Additional electric pumping machinery has been recently installed by the Cosmopolitan Proprietary Co. at their Kookynie mine, North-East Coolgardie, Western Australia. The three sets of Blake & Knowles pumps and a duplex Deane pump are driven by Westinghouse motors, and electrical energy is supplied by a 160 H.P. Hall-Belliss generating set.

At the meeting of the Sudan Goldfield (Ltd.), the chairman announced that it was proposed to erect an electric power station at the central shaft, from whence power would be transmitted to each of the three principal shafts. Provision was also being made for supplying power for the proposed two new vertical shafts.

Exhibitions.—There is being held at the large Baths of the Shoreditch (London) Borough Council in Pitfield-street, Hoxton, throughout next week and up to and including Oct. 22, a very interesting and complete exhibition of electrical plant, apparatus, fittings, accessories and the numerous sundries which are utilised in the application of electricity to practical purposes. The exhibition has been organised for the special purpose of bringing to the notice of the inhabitants of this large and important industrial district the latest improvements in electrical apparatus, and is intended especially to demonstrate the value of electric motors as an economic power for the many manufacturing branches of woodworking, furniture manufacture, cabinet making and upholstery with which this compact area abounds. The borough electrical engineer (Mr.

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C. Newton Russell) and the members of the Lighting and Exhibition committee, who are responsible for the organisation of the exhibition, have provided a show of a really high-class and most comprehensive character. Perhaps the most noticeable feature of the exhibition is the demonstration by actual working of the utility and profit-earning powers of the electric motor when employed upon such work as forms the staple trade of the Shoreditch district. In this direction a very effective display has been provided, and the exhibition has been well patronised by the workers of the district, who with their wives have flocked to see the latest improvements in electrical science and industry, especially as bearing upon their particular branches of work. For the wives of the Shoreditch workers are, many of them, as directly interested as their husbands in the developments of electrical methods, as they are themselves employed in one or other branch of the local industries, where women can be so employed, and in these branches light-running machinery is operated to a very large extent by power. In a district like Shoreditch, therefore, men and women, married and single, are naturally attracted to an exhibition where so much can be learned that is likely to prove of everyday service, and where the advantages of electric driving are so attractively presented. A well-illustrated catalogue of about 80 pages is available at the popular price of 1d., and the musical programme and catering facilities which have been provided make the exhibition attractive from many points of view. The exhibitors include a considerable number of manufacturing and supply firms, and we may select the following as making instructive exhibits:—Babcock & Wilcox, British Prometheus Co., Brockie-Pell Arc Lamp (Ltd.), whose works are in the Shoreditch district; Crompton & Co., Crypto Electrical Co., J. Defries & Sons, Electric Construction Co., Electrical Welding Co., Electromotor & Dynamo Co., General Electric Co, W. T. Glover & Co., J. S. Henry (Ltd.), a local firm of electric fittings makers (to whose fittings we refer on another page of this issue), Humpage, Jacques & Pedersen, H. F. Joel, Marryatt & Place, Nalder Bros. & Thompson, A. W. Penrose & Co., Phœnix Dynamo Mfg. Co., Pinching & Walton, F. W. Potter & Co., a local firm, Reason Mfg. Co., Reed's Electrical Engineering & Supply Co., Robertson Lamp Co. (a very popular stand this), Royce (Ltd.), and a good show by the Simplex Steel Conduit Co. The exhibits all display goods of a thoroughly practical character, many of the motors at work being employed to drive machinery which is largely used in the manufactures of the borough. It would be impossible, in the space at our disposal, to do justice to the efforts made by the exhibitors to make the Exhibition a really useful one, but we can say that their efforts have been eminently successful. As we have said, the exhibition remains open to the evening of Oct. 22, and as there are stands showing machinery in motion driving wood-working, printing, boot-making and sewing machines, the exhibition offers attractions for others beside those employed in the Shoreditch industries, and, pending the holding of such exhibitions in other parts of London, it would be well if those engaged in the London manufacturing industries generally were to organise visits of workmen and workwomen to Pitfield-street to intelligently inspect the many interesting exhibits there. In almost all cases where electrical exhibitions of this kind have been held they have proved direct incentives to trade, and must have an excellent educational effect. Similar shows would prove attractive in many other London districts, and we can commend the example of Shoreditch as well worthy of being followed.

An international automobile exhibition is to be held in Berlin from Feb. 4 to 19, 1905, under the auspices of the German Automobile Club and the Association of German Motor Car Manufacturers. Full particulars from Baron von Brandenstein, 4A, Sommerstrasse, Berlin, N.W.

Farnham.—The Public Works committee are considering whether the Council should sanction the application of the Farnham & District Electric Supply Co. for a provisional electric lighting order.

Finchley.—The salary of the electrical engineer (Mr. E. Calvert) has been increased from £300 to £350 per annum, with a further increase of £50 in 12 months.

An additional feeder has been laid to provide for increased demand for current in the Ballards-lane and Long-lane district. At present the equivalent of 14,100 8 c.p. lamps is connected to the mains.

Last week the chairman of the Electric Lighting committee, in submitting the half-yearly estimates, said that the anticipated receipts were put at £2,715 and the expenditure at £2,718. 19s. 11d.

Glasgow.—In presenting the Tramway minutes at the meeting of the Corporation on Thursday last, the convener (Mr. Paton) referred to the resignation of the general manager (Mr. John Young) and said:—

They would all agree with the committee in their high appreciation of the services of Mr. Young, and their regret at losing him to London. He had known Mr. Young for the last 12 years, since the tramways were municipalised, and during all that time had watched with the greatest care and with the greatest appreciation the devoted services which Mr. Young had given to the Corporation. To a large extent they owed the present successful position of the tramways in Glasgow to the services of Mr. Young, and they wished him every success in the position which he was about to fill. The Council would agree that the committee had done the very wisest thing in the appointment of Mr. Dalrymple as Mr. Young's successor. After Mr. Young, Mr. Dalrymple was one of the first officers appointed to the tramway department. During 10 years he had done splendid service, not only in his position as accountant, but also as deputy-manager, to which he was recently appointed.

On the recommendation of the Tramways committee, it was decided to apply for Parliamentary powers to construct nine additional tramway routes.

A discussion followed as to the revenue on the routes outside the city. In a report by Mr. John Young it was stated that by taking the earnings for the 12 months to Aug. 20 last on those routes which had one or both termini outside the city boundaries, it was found that the average revenue worked out at 10·74d. per car-mile, and by taking the earnings on those routes which might be termed city routes the average revenue for the year worked out at 10·51d. per car-mile. A motion that a further statement be prepared was negatived.

Official inspection of the permanent way of several extensions of the Corporation's electric tramways took place last week.

Government Contracts.—In a return recently issued particulars are given of contracts made in the United Kingdom for manufactured articles by Government departments for the year ended March 31, 1904, with contractors outside the United Kingdom or with contractors or agents who obtained the goods from abroad.

Admiralty: Carbons £402, electric drills £21, lubricating oil £12,782.

War Office: Ammeters £67, electric light carbons £922, wireless telegraph equipment £1,656, electric motors £3,241, screw-cutting tools, &c., £369.

Post Office: Telegraph apparatus, protectors and heating coils £574. 3s. 4d., telephone apparatus £69,802. 11s. 9d., electric light apparatus and fittings £207. 7s. 5d., cable grips £56. 5s., special insulators £40, electric light and other carbons £568. 12s., copper wire (silk covered) £47. 2s. 7d., telegraph papers £535. 12s. 11d., ebonite goods £1,655. 0s. 8d.

It is explained that the goods in this list are only those which it would be possible to obtain in the United Kingdom. Specialities and patented articles are omitted from the list.

Greenock.—The capital expenditure on the electricity department during the year ended June last was £5,968. 11s. 6d., bringing the total to £86,175. £90,000 has been borrowed, and £9,833. 6s. 8d. repaid. The deficit is attributed to the result of the arbitration proceedings.

The total receipts were £12,120. 5s. Working expenses came to £8,979. 5s. The arbitration proceedings between the Corporation and the tramways company reduced the amount claimed by the former by £1,669. Expenses of arbitration and other items caused an addition of £2,180 to the year's expenditure, leaving £3,140. 19s. 11d. gross profit. Interest amounted to £1,931. 12s. 5d., and redemption of loans to £5,252. 19s. 1d., leaving a deficit of £2,111. 19s. 2d. 1,585,206 units were generated, 71,120 supplied to public lamps, 806,457 to the tramways and 536,206 to private consumers. The total maximum supply demanded was 794kw. (against 710kw. last year).

Hackney (London).—The Electricity committee are about to invite tenders from certain firms for 1,000 demand indicators (estimated cost 30s. each) and for arc lamps for four thoroughfares. Main extensions estimated to cost £141. 5s. were authorised at last meeting. A third meter reader and a temporary draughtsman are to be appointed.

Hebden Bridge.—The electricity works were formally inaugurated on Thursday last.

Heywood (Lancs.).—On Friday last the Council decided to seal the conveyance of the undertaking of the Bury, Rochdale & Oldham Tramways Co. to the local authorities concerned.

The arbitrator's award was for £160,000, and the money had to be paid by Saturday, or it will bear 5 per cent. interest. Councillor Popple stated that a cheque for the amount would be refused by the company unless the costs of the arbitration, which could not be immediately ascertained, were paid at the same time.

Holyhead.—The District Council have decided to light Queen's Park electrically. The generating plant at the station is to be insured for £4,250.

Hull.—Ald. Larard, chairman of the Electric Tramways committee, has been selected as mayor for the ensuing year.

Indian Telegraphs.—It is announced that a scheme for the reorganisation of the Telegraph Department has been decided upon, the idea being to work on the lines of the Public Works Department. "Circles" will be created with a view to relieving headquarters of much local work, which, under present arrangements, has to be dealt with at Calcutta.

Leith.—On Tuesday the Council formally approved the recommendation of the Tramways committee to adopt the overhead system of traction on the lines recently acquired from the local tramways company, and the consulting engineer (Mr. More) has been instructed to proceed with the preparation of specifications, &c. Mr. Wilson has been appointed interim manager of the horse tramways, which the Council take over on 22nd inst.

Liverpool.—An inquiry will be held on 20th inst. into an application of the Corporation for sanction to a further loan of £400,000 for extensions of their electricity undertaking.

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Light Railways.—The Board of Trade have, after modification, confirmed the Southend and Colchester Light Railways Order, 1904.

The British Electric Traction Co. are applying for an extension of time (until November, 1907) for completing the Mitcham light railways.

The County of Durham Electric Power Supply Co. have secured an extension of 12 months for complying with the terms of the Durham and District Light Railways Order authorising the construction of the Durham to Brandon light railway.

London County Council.—At Tuesday's meeting it was agreed to lend £23,960 to Stepney for electric lighting installation and meters.

Greenwich Tunnel.—The offer of the London Electric Supply Corpn. to supply current for lighting at the Tunnel at 2d. per unit, and for power for working the lifts, &c., at 1½d. per unit was accepted.

Tramways.—It was agreed that expenditure of £3,500 on capital account be sanctioned for additional plant and electrical equipment in connection with the temporary arrangements made with the City of London Electric Lighting Co. for the electrical working of portions of the London County Council tramways, and that the Highways committee be authorised to take steps for the purchase of the plant, &c., required.

It was also agreed that the estimate of £2,700, submitted by the Finance committee, be approved; that expenditure, on capital account, of sums not exceeding that amount be sanctioned for a temporary supply of electricity, for power purposes, during the erection and equipment of the Greenwich electricity generating station; that the Highways committee be authorised to take all necessary steps in connection with the purchase and installation of the electrical plant required; that the offer of the South Metropolitan Electric Light & Power Co. to supply electric current on the terms offered by the company be accepted.

It was further agreed that expenditure on capital account of sums not exceeding £3,000 be sanctioned in connection with the wiring and fitting for electric lighting of the Greenwich electricity generating station, and that the work be carried out by the electrical staff of the tramways department.

It was reported by the Highways committee that 12 summonses had been issued for wilful obstruction of the Council's tramcars, and that fines had been imposed in each case where apologies had not been tendered and the Council's costs paid by the persons summoned.

Chairman's Address.—In the course of his annual address to the Council the chairman referred to the work of the Highways committee, who, he said, now worked for the Council over 40 miles of tramways in the south of London. These only constituted a third of London's tramways, but during the year 133 millions of passengers were carried over these lines, and over £500,000 was received in fares; 50 millions of these passengers were carried at ½d. fares in beautiful and swift electric cars. The work of electrification had been progressing. In 1903 the Greenwich and Tooting sections of the lines were electrified. The work of reconstructing the southern lines had been one of great difficulty, but the trying period of reconstruction had almost passed, and the Council's service in the south of London, under Mr. Baker's chairmanship, had given great satisfaction. The people of the north of London were naturally desirous of securing a like service, and he was sure the Council would assist them so far as it had powers. During the year the below-street or shallow tramway between Theobald's-road and the Embankment had been steadily progressing. On its completion he believed it would revolutionise the ideas of dealing with the traffic of London.

Lowestoft.—At Tuesday's meeting of the Council the electrical engineer (Mr. G. A. Bruce) reported that another cable under the harbour had broken.

Originally there were 20 cables, of which 16 had broken, and of the remainder two were in a bad state. Mr. Bruce recommended that six cables be laid across the harbour in a steel tube, as was done for the tramways, at a cost of about £1,200 inclusive, and it was resolved that this should be done.

There are now connected to the mains 546 consumers, representing 27,348 8 c.p. lamps.

Manchester.—A special meeting of the Electricity committee was held on Wednesday to consider the report of the chief engineer (Mr. S. L. Pearce) on the experiments which have been made in street lighting.

All the old types of lamp have been exchanged for the Gilbert enclosed type. The illuminating power of the new lamps is between 1,300 and 2,000 candles.

Marylebone (London).—At the meeting last evening the report of the Finance committee concerning the principal loan for the electricity supply undertaking was discussed, and a recommendation "That the Council's seal should be affixed to the mortgage of the general rate of the borough in favour of the London County Council to secure within a period of 35 years the repayment of £1,415,000, with interest thereon at a rate to be hereafter determined, for purposes connected with the purchase of the St. Marylebone electric lighting undertaking," was adopted.

London County Council give notice that tenders will be received at the Bank of England to-day (Friday), at 1 p.m., for London County bills sufficient to produce £1,415,000, required for the loan to Marylebone Borough Council in connection with their electric lighting undertaking.

Mr. F. A. Wilkinson, the newly-appointed resident electrical engineer, is to partially commence his duties at once, and is to be paid half salary until his notice of resignation with Walthamstow Council expires.

Mexico.—On Sept. 1 a newly-formed company took over the electric lighting of Mazatlan. This company contemplates considerable extensions. Manufacturers and contractors might communicate with Señor José H. Rico, Mazatlan, Sinolia, Mexico.

Mid-Sussex.—The Electric Supply Co. are negotiating with Cuckfield and Haywards Heath Councils for sanction to the company's application for provisional electric lighting orders.

Mombasa.—A telephone system has been installed in this town.

Municipal Telephony.—On the presentation of the minutes of the Telephone committee at Brighton Corporation meeting last week Councillor SONE objected to the committee's decision that the expenses of canvassers should be charged to capital account during the current year, remarking that it tended to produce a fallacious balance-sheet at the end of the year. He moved an amendment accordingly.

Ald. REEVES contended that the committee were justified in charging to capital account salaries paid in procuring new customers, especially in the first few years of the undertaking.

Ald. CARDEN, replying, said the practice of the telephone world was to do as the committee recommended, and it was good sound finance. Glasgow, Portsmouth, Swansea and the National Telephone Co. all did so. In committee they compromised matters by agreeing that after the first year it should go against revenue, but this year, on financial grounds, they were fully justified in charging the expenditure to capital.

The amendment was lost by 18 votes to 19.

In a letter on the above subject Mr. W. E. L. Gaine replies to Ald. Carden as follows:—

The statement made by Ald. Carden that "the practice of the telephone world was to do as the committee recommended, and it was good sound finance. Glasgow, Portsmouth, Swansea and the National Telephone Co. all did so," is inaccurate. Ald. Carden is entirely wrong. It is not the practice to charge these expenses to capital, it is not good and sound finance, and it is not the practice, and never has been the practice, of the National Telephone Co. to do so. That it may be the practice of the municipalities in this country who are running telephone systems to do so I am not prepared to deny.

At the meeting of Portsmouth Council on Monday the Telephone committee recommended

That they be authorised to complete the 120 spares of cable running to Southsea at an estimated cost of £635. 8s. 5d., and that application be made for sanction to borrow this amount.

Councillor DITTMAN moved the adoption of the recommendation, and desired to add to the £635. 8s. 5d. an additional sum of £1,200 to complete the lines. They had a surplus of £1,250 on the undertaking last year, and if the Local Government Board persisted in refusing to grant the money they would have sufficient in hand at the end of the present year to meet this expenditure.

The MAYOR: Do you ask that the extra £1,200 should be passed now before it has gone to the Finance committee?

Councillor DITTMAN: Yes. I know it is unusual, but in consequence of the urgency of the matter we ask it. If it is objected to, however, I will bring it up at the next meeting.

The MAYOR: Perhaps you will bring up the extra £1,200 when the proposed loan of £20,000 is brought forward.

Councillor DITTMAN: Yes, but the £635 should be passed now.

This was agreed to, and the recommendation of the committee was adopted.

A communication has been received by Portsmouth Telephone committee from the Postmaster-General enclosing the draft of the proposed deed for the extension of the Corporation telephone area, so as to include Rowland's Castle, and it was resolved at the last meeting that it be approved.

Neath.—An inquiry was held here on Friday into the application of the Council for power to borrow £20,000 for electricity supply. It is proposed to take electricity in bulk from the South Wales Electrical Power Distribution Co. Technical particulars were supplied by the consulting engineer (Mr. H. T. Sully), and evidence was also given by Mr. Swann, of the South Wales Co. There was no opposition.

Patent Amendment.—Mr. Harold Hawthorn (late of 16, St. Helen's-place, Bishopsgate-street Within, E.C., and now of 7, Leinster-square, Hyde Park, W., London) seeks leave to amend specification of letters patent No. 12,379, 1903, for "improvements in and relating to electric fire alarms and thermo-indicators." Particulars of the proposed amendment are set out in the "Illustrated Official Journal" (Patents) of Sept. 28, and notice of opposition must be given within one calendar month from that date.

Perth.—The salary of the burgh electrical engineer (Mr. J. Lambert) has been increased from £250 to £275 per annum.

Perth (Western Australia).—Perth Electric Tramways (Ltd.) are extending their lines, and have ordered a 250 H.P. boiler and a 300 H.P. steam generating set. It is proposed to enlarge the car shed and erect a 70ft. cooling tower and a chimney stack 150ft. in height and 7ft. in diameter.

Prison Lighting.—Electric lighting is to be adopted at Holloway Castle Gaol (London), where about 400 cells are to be wired.

Reading.—Increases of salary have been granted by the Council to the assistant tramways engineer (Mr. A. G. Shearer) and the chief officer of the department (Mr. R. J. Fardell).

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Retford.—Mr. A. B. Mountain advises the Council to establish municipal electricity works at an initial cost of £5,070. Mr. Mountain anticipates a surplus after three years.

St. Pancras (London).—The Council agreed on Wednesday to acquire for £500 the leasehold interest in 96, Great College-street, as the occupier complained of vibration, noise, &c., from the electricity works.

It was resolved to support the proposed application of the London County Council to Parliament for powers to enable local authorities to wire consumers' premises and to obtain loans for that purpose.

Seattle-Alaska Cable.—It is announced that telegraphic communication has been established between Seattle and all parts of Alaska, the cable between Valdez and Sitka having been completed on Thursday last week. 46 telegraph stations have now been established in Alaska.

Siam.—A concession for the construction and working of a new tramway in Bangkok has been granted to H.R.H. Prince Naradhip, and the Siamese Tramway Co. (Ltd.) has been formed to work the concession, the tender of a British firm having been accepted for the construction and equipment. The length of the line is about 13½ miles.

The reorganisation of the Siamese Telegraph Department has been demanded for some time past, and recently a combined memorandum from the bankers and merchants of Siam has been submitted to the Government, and, it is hoped, will bear fruit.

Electrical apparatus, accessories and materials to the value of £13,044 were imported into Siam in 1903, compared with £8,806 in 1902.

South Africa.—The "British and South African Export Gazette" announces that the Pietermaritzburg Corporation tramway extensions scheme is likely to be proceeded with, in which case much work should be found for manufacturers. A sum of money has been voted for the survey of possible routes, and a bill authorising the construction of the first 2 miles of the proposed lines has been prepared for presentation to the Natal Parliament.

As a result of further information regarding the Port Elizabeth electricity supply scheme having been supplied by the borough electrical engineer (Mr. R. Pape) to the consulting engineers (Messrs. R. Hammond & Son), the latter have withdrawn their objection to Mr. Pape's proposal to adopt a low-tension system, and specifications for plant and material are being prepared. The plant will include three 400kw. steam turbine generators. Arc lamps will be used for main street lighting and Nernsts for the smaller thoroughfares.

Amongst other electrical schemes projected or in progress are those at Kimberley, where it has now been decided to take current from the De Beers Company; a proposed extension to the cantonments of the Middelburg municipal electric light undertaking; an extension of the King Electric Power Co.'s King William's Town electric lighting plant; the Vryheid Local Board's scheme, for which tenders are under consideration; the Greytown municipal works, which are now running; and the Heilbron and Bethlehem schemes, for which Harris, Lee & Co. have secured concessions, the works in the former case being nearly ready for giving a supply of current.

The borrowing of £13,000 for the Johannesburg municipal telephone project has been sanctioned by the Transvaal Government. The exchange is to be planned for 10,000 subscribers, and Ericsson instruments are to be used.

Swansea.—The contractors for the tramways have laid over 7½ miles of track out of the 10¾ miles provided for by their contract.

The Tramways and Electric Lighting committee are inviting tenders for the removal of an engine and dynamo from Strand station to the destructor works, &c. This advertisement appears in another column.

The engineer (Mr. C. A. L. Prusmann) has been requested to report on the advisability of adopting a flat rate of charge for electricity supply.

Tramway and Railway Competition.—Sowerby Council recently decided that, so far as they legally could, they would, in return for the proposed extension by Halifax Corporation of tramways to Sowerby, exempt the Corporation from rates in respect of such tramways. The Lancashire & Yorkshire Railway Co., as ratepayers in the district, notify both authorities of their intention to oppose this arrangement as being illegal and contrary to the Public Health Acts.

Trunk Line Telephony.—Holyhead District Council have been informed by the Postmaster-General that Holyhead will be connected with the trunk system almost immediately.

Urmston.—The Board of Trade have sanctioned the borrowing of £1,600, the township's share of promoting the Manchester Southern Tramways Act. The local authorities obtained the option of taking over the powers and Davyhulme has already done so. After construction the lines will be leased to Manchester Corporation.

Village Lighting.—Datchet is now lighted electrically, current being supplied by the Windsor Electrical Installation Co.

Derby County Council have expressed approval of the proposal of Whitwell Parish Council to borrow £2,000 for electricity supply.

West Bromwich.—The agreement between the Corporation and the British Electric Traction Co. provides for payment by the latter of a rent of £6,979. 2s. 10d. per annum. The Corporation have power to use the tramways at night for the removal of night soil, for carrying road material and for watering the streets, the charges for current supplied by the Corporation to the company to be 2d. per unit up to 400,000 units per annum and 1½d. per unit after.

Whitby.—The Lighting committee recommend the Council to reduce the charge for electric current to a flat rate of 5d., with discounts of 10 per cent. to payers within 14 days.

Winchester.—As an experiment in public electric lighting, the Winchester Electric Light Co. has been instructed by the City Council to erect and maintain four arc lamps in City-road and two in the Broadway, and some Nernst lamps at the North Walls.

Wolverhampton.—On the recommendation of the Lighting committee it has been decided to reduce the charges for electric energy.

The chairman of the Lighting committee (Mr. Gough Allen) said the committee had to face keen competition, and the only way to meet it was by a drastic reduction in prices. The suggested reduction on the present year's working meant a decrease in revenue of about £3,000, or the conversion of a profit of £2,775 into a loss of £225. The committee anticipated a largely increased output, which meant lower production cost.

Worsley.—The District Council propose to take electricity in bulk from Lancashire Electric Power Co.

Yarmouth.—The half-yearly estimates of the Electric Light committee put the anticipated profit on the electricity undertaking at £1,018.

The Council have resolved to purchase the Gorleston tramway undertaking and to convert the same to electric traction.

Electro-Harmonic Society.—Our readers are reminded that the first smoking concert of the season takes place this (Friday) evening in the King's Hall, Holborn Restaurant, London, at eight o'clock. The chair will be taken by Mr. John S. Raworth, and an exceptionally interesting programme will be given.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Tottenham District Council invite offers (based upon certain arrangements, particulars of which are set out in the form of tender) for the exercise of the Council's powers under their provisional electric lighting order, 1902. Particulars, on and after Oct. 7, from the clerk (Mr. E. Crowne), 712, High-road, Tottenham, Middlesex, to whom tenders by noon Oct. 21. See also advertisement.

Tamworth Corporation are prepared to consider offers for the construction and maintenance of electricity works. Particulars from the town clerk. See advertisement.

Swansea Corporation invite tenders for the removal, alteration and re-erection at a new station of one 450 I.H.P. modern type triple expansion engine and of a 225kw. continuous-current dynamo; also the supply and erection of an 8-ton travelling crane. Specifications from the borough electrical engineer (Mr. C. A. L. Prusmann), Strand, Swansea, after 20th inst. Tenders to the town clerk (Mr. John Thomas), by noon Nov. 12. See also advertisement.

Shanghai Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlements of Shanghai. Alternative proposals are desired for single-trolley and double-trolley lines. Copies of pro forma contract, &c., from the Council's agents, Messrs. John Pook & Co., 63, Leadenhall-street, London, E.C., or from Messrs. Fearon, Daniel & Co., 90, Wall-street, New York, from whom further information may be obtained. Tenders to the secretary, Municipal Council, Shanghai, by March 31, 1905. An advertisement contains additional information.

The directors of the *Great Western Railway Co.* invite tenders for supply of various stores for the year ending Nov. 30, 1905, including telegraph instruments, apparatus (insulators, &c.), ironwork, tools and drysalteries, electric wire and cables, carbons, incandescent lamps, &c., &c. Specifications, &c., from stores department, Swindon. Tenders to the secretary (Mr. G. K. Mills), Paddington Station, London, W., by Oct. 17.

The Visitors committee of *Cumberland and Westmorland Lunatic Asylum*, Garlands, Carlisle, invite tenders for two Lancashire boilers, feed pumps, steam exhaust and water pipes and valves; two 50kw. and one 30kw. steam dynamos, and a 5-ton travelling crane; economiser; underground bitumenised cables and boxes; wiring of buildings, switchboards, motors, fans, &c. Specifications from and tenders to Mr. C. W. Allan Hodgson, The Courts, Carlisle, by Nov. 1.

Sunderland Corporation invite tenders for two 300kw. three-phase generators (5,500 volts) to couple to existing Belliss engines, and two 300kw. synchronous three-phase motors (5,000 volts) to be coupled to existing multipolar Silvertown dynamos. Tenders

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(addressed chairman of Electricity and Lighting committee) to the town clerk (Mr. Fras. M. Bowey), Town Hall (Sunderland, by noon 28th inst.

Tenders are required for six months' stores, including electric lamps and fittings, &c., by *Glasgow* Parish Council and Lunacy District Board. Forms of tender, &c., from 266, George-street, Glasgow, until 21st inst.

Wandsworth (London) Council invite tenders for the installation of electric lighting at the Council House, and the provision and fixing of an electric fan for the Council Chamber. Tenders to the Council House, Wandsworth, S.W., by Oct. 18.

London County Council invite tenders for 12 months' supply of stores, including electric fittings, cables, engineers' goods, &c. Tenders by 24th inst.

Ipswich Corporation require tenders for continuous-current meters for the ensuing 12 months. Specifications from the chief engineer and manager, Mr. Frank Ayton. Tenders by 24th inst.

Fulham (London) Borough Council invite tenders for a 3,000-volt main generator switchboard. Tenders to the town clerk, Mr. R. M. Prescott, Town Hall, Fulham, S.W., by noon Oct. 19.

Rugby District Council invite tenders (until Oct. 25) for about 440yds. of 0·15 three-core low-tension paper-insulated and lead-covered cable.

Tenders are invited for the erection of an electricity generating station at *Newquay*. Tenders to Messrs. Cowell & Cowell, Central-chambers, Newquay, by noon 19th inst.

Aberdeen City Parish Council invite tenders for electric lighting plant for their new poorhouse at Oldmill. Tenders to Mr. C. B. Williams, 20, Union-terrace, Aberdeen, by noon Oct. 19.

Dublin Lighting committee require tenders by noon 24th inst. for cast-iron troughing and covers.

Richmond (Surrey) Guardians require tenders by 4 p.m. 27th inst for electric telephones at the workhouse.

West Ham Corporation want tenders by 4 p.m. Nov. 11 for 35 double-deck tramcars with electrical equipment.

The "Commonwealth Gazette" of Sept. 3 announces that tenders will be received at *Brisbane* up to noon of Dec. 12 for the supply at Thursday Island of 100 tubular wrought-iron telegraph poles; also, at the cable tanks, Thursday Island, of 3 nauts of submarine cable to specification. Tenders must state the time required for delivery, and must be sent to the office of the deputy Postmaster-General, Brisbane. Specifications, &c., can be had at the General Post Offices at Sydney, Melbourne, Brisbane, Adelaide and Perth.

Tenders are invited for steam-heating apparatus at the municipal telephone offices, *Amsterdam*. Adjudication will be made on Oct. 24. Particulars from the State Printing Establishment, Amsterdam, price 5s.

A *Swiss* brewery company require tenders for the supply of a motor dray 4·50 metres long, body 1·50 metres long (available space for carrying merchandise). The dray must be of sufficient power to haul about 6 tons along any kind of road at a speed of 12km. per hour. Particulars from Le Brasserie du Lion de Beau-Séjour, Nyon, Vaud, Switzerland.

The issues of the "Madrid Gazette" for Oct. 4, 5 and 6, contain particulars of various requirements for electric lighting and electric tramway material, &c., for Liria, Madrid and Gijon.

TENDERS RECEIVED AND ACCEPTED.

In our issue of Aug. 19 we announced that an important cable contract had been let to Messrs. W. T. Glover & Co. by Johannesburg Municipality, and the "British and South African Export Gazette" now states that the Corporation have placed contracts in connection with their electricity supply and tramway scheme as follows:—

W. T. Glover & Co. for sections A and B (lighting cables) at £100,038 and for section C (tramway cables) at £6,339; British Insulated & Helsby Cables (Ltd.) for section D (bare copper wire and cables for lighting and tramways) at £10,789. The latter company also tendered for sections A and B at £107,448, and the St. Helens Cable Co. tendered for section C at £6,498. W. T. Glover & Co. tendered for section D at £11,269.

Watford District Council have accepted the tender of Clifford & Gough for the erection of additions to the electricity station buildings at £3,745, that of Babcock & Wilcox for main steam pipework and steam connections and water separator at £629, that of Wm. Boby for exhaust steam pipework and connections between condensing plant and cooling pond at £170. 10s., that of C. A. Parsons & Co. for force pump and connections from air pump to exhaust hot well at £60, and that of the Brush Co. for a new engine in exchange for an old engine and a payment of £130.

London County Council have accepted the tender of J. E. Spagnoletti & Co., at £150, for installing the electric light at Sydenham Technical Institute, and that of A. H. Marshall & Co. for wiring and fittings for an electric lighting installation at the Eltham fire station at £139. 10s. In the latter case there were ten tenders, varying from £139. 10s. to £184. 13s.

West Ham Corporation have accepted the following tenders in connection with the electrification of the tramways in High-street, Leytonstone road and Romford-road:—

P. & W. McLellan, for about 870 tons of British steel rails and fish plates.
Edgar Allen & Co. (Askham Brothers & Wilson), for the whole of the points, crossings and special work at junctions.
W. Griffiths & Co., for 4,000 to 5,000 tons Guernsey granite pitchers.

For transforming plant required at Greenwich electricity generating station the following tenders were received by London County Council:—

Electric Construction Co. (*accepted*)	£860	Lancs. Dynamo & Motor Co.	£1,034
British Westinghouse Co. ..	1,083	British Electric Plant Co. ..	940
		Johnson & Phillips	860

The contract is to be completed in 14 weeks.

East Ham Council have accepted the tender of Dick, Kerr & Co., for tramrails at £6. 10s. per ton, fishplates at £7. 15s., tie-bars at £11, bolts and nuts at £14. 10s., 29 30ft. lengths and six 35ft. lengths of special heavy rails for curves at £7 per ton, and for top covers for six cars at £85 per car.

The Lancashire Dynamo & Motor Co. (Ltd.), Trafford Park, Manchester, have secured the order from the Admiralty for the whole of the electrical equipment for Sheerness Dockyard in accordance with the specification of the consulting engineers, Messrs. Preece & Cardew.

The Union Electric Co., 151, Queen Victoria-street, London, E.C., have received an order for the supply of all the arc lamps for the illumination of the Newcastle Industrial Exhibition, and the "Excello" intense flame arc lamp has been adopted as being the most suitable for this work.

Battersea (London) Council have placed an order with the British Thomson-Houston Co. for 70 prepayment electricity meters for workmen's dwellings at £5 each. The company will replace, free of further charge, with meters of the latest improved type those previously supplied.

Colchester Corporation have accepted the tender of J. G. White & Co. for permanent way materials, &c., at £1,132. 13s. 3d., and that of Boulton & Paul for covered ways at North Station Approach at £592. 9s. 6d.

Salford Council have accepted the tender of Goddard, Massey & Warner for a feed pump for Wilburn-street depot at £20, and that of F. Leroy & Co. for covering the boilers and steam pipes at 5d. per square foot.

Stepney (London) Council have accepted the tender of H. Allen to remove refuse from the electricity works at 1s. 8d. per load for clinker and ashes. Flue dust is to be removed free of cost.

Brighton Corporation have accepted the tender of W. & T. Garrett for alterations and additions to the municipal telephone exchange at £88.

Bury (Lancs.) Guardians have accepted the tender of Blackburn & Co. for wiring the hospital.

Dewsbury Electricity committee have placed an order with Callender's Co. for distributing cables.

Hereford Town Council have placed an order with the India Rubber Co. for service cables, &c.

Exeter City Council have accepted the tender of W. E. Blake for the erection of a tramcar shed at £4,265.

King's Lynn Town Council have ordered 50 electricity meters from Chamberlain & Hookham.

Wrexham Town Council have placed an order with the St. Helens Cable Co. for cables.

BUSINESS NOTICES, &c.

Intimation is made by Messrs. Browett, Lindley & Co. (Ltd.), Patricroft, near Manchester, that Mr. Fred. C. Gibbons, M.I.E.E., who was formerly one of the joint managing directors, has returned, and now occupies the position of sole managing director of the company. Mr. T. E. Kay, secretary of Browett, Lindley & Co., in making this notification, points out that it was during Mr. Gibbons' former association with the company that their standing as manufacturers of the double-acting forced-lubrication enclosed-type engines was secured. There are a large number of these engines installed, not only in electric generating stations of municipal corporations and companies, but also in private installations.

The Linolite Co. have removed from 47 to 25, Victoria-street, London, S.W.

The offices of the Civil and Mechanical Engineers' Society have been changed to 25, Victoria-street, London, S.W.

BANKRUPTCIES, LIQUIDATIONS, &c.

The first meeting of the creditors of Charles Bunyan Ward, late of the South London Telegraph and Commercial College, Brixton, took place last week. Debtor had carried on the college for 10 years up to Sept. 1 last, when he sold it. He attributed his failure to com-

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petition by the L.C.C. colleges, decline in telegraph and cable business, &c. Liabilities £310, assets £143.

A meeting will be held on Nov. 17 at 140, Leadenhall-street, London, E.C., to receive an account of the winding-up of the Stewart Electrical Synd. (Ltd.).

A meeting will be held on Nov. 15 at 4, Pembroke-street, London, N., to receive an account of the winding-up of the Electrical Indicator Synd. (Ltd.).

Plant for Sale.—A complete 700 H.P. power plant (now supplying direct current at 550 volts to the trains on the Harrow branch of the Metropolitan District Railway) is for sale. Delivery March, 1905. Particulars from Mr. H. B. Twyford, Hamilton House, Victoria Embankment, London, E.C. See advertisement.

A complete second-hand electric lighting plant, suitable for installation of 200 lamps, is for sale. Full particulars from Mr. W. P. Adams, M.I.E.E., 28, Victoria-street, Westminster, S.W. See advertisement.

The liquidator (Mr. H. J. Allen) in the voluntary liquidation of Barnaby & Co. (Ltd.), electrical contractors, Rotherham, is offering for sale as a going concern the stock, fixtures and tools, &c. Further particulars from Mr. Allen. See also an advertisement.

A quantity of electric fittings, slightly damaged by fire, is advertised for sale at 188, Walton-street, London, S.W.

Stores for Sale.—Messrs. Horne & Co., 8, Delahay-street, Storey's-gate, Westminster, will sell by auction at the Royal Arsenal, Woolwich, on Oct. 20 (by order of the Secretary of State), at 11 a.m., a quantity of obsolete and unserviceable stores, including some electrical stores and cable, copper, brass, aluminium and other metals, tools, &c. May be viewed at the Royal Arsenal on days previous to, and on the morning of, sale. Catalogues at the War Office, Pall Mall; at the Ordnance Office, Tower; and at the Ordnance Office, Royal Arsenal, Woolwich. See also advertisement.

Premises to be Sold and Let.—The 40 years' lease of Crown Works, Bancroft-road, Mile End-road, London, E., is to be sold on Friday, 28th inst. There is 34,000ft. of working space on two floors, a yard, stables, offices, &c., with option of purchasing freehold. Particulars from the auctioneers (Messrs. George W. Dawes & Co.), 12, Basinghall-street, London, E.C. See advertisement.

A warehouse or factory is to be let at Lewisham, close to main road and within 2 minutes of station. Floor area about 6,000 sq. ft. Applications to Mr. Wm. Jerrard, 40, Loampit-vale, Lewisham, London, S.E. See advertisement.

There are three fine shops, with basements, to let in the Strand, London, on a 21 years' lease. Particulars from the secretary's office, Room 41, West Block, Hotel Cecil, Strand, London, W.C. See advertisement.

A New Dynamo Brush.—It has been often proposed to better the commutating qualities of dynamo brushes by making them up of alternate layers of a good electrical conductor and resistance material. Amongst the number of such composite brushes which have made their appearance from time to time is the one shown in the adjoined illustration. Messrs. J. Defries & Sons, of 146 and 147, Houndsditch, London, E.C., who are placing the brush on the market in this country, state that it is extensively used in the United States of America. The illustration shows the brush one-third full size. It consists of laminations of copper and high resistance metal alloy, soldered together at the top. We are informed that these brushes are capable of collecting about 200 amperes per square inch of contact area. It will be understood, of course, that this brush is not intended to replace carbon brushes in machines which have been designed to work with carbon brushes, but it is suited to replace copper brushes where these may give trouble. The brush is clamped to the brush-holder in usual manner.

Cramps.—Edward G. Herbert (Ltd.), Rosamund-street East, Manchester, are placing on the market a novel form of cramp, which has been named the "Combination" cramp. This can be used as an end cramp, and combines the qualities of the hexagon and side cramps manufactured by this company for use on planing, shaping and other machines.

"D.P." Storage Batteries.—An exhaustive price list of storage batteries has been prepared and issued by the D.P. Battery Co., 11, Victoria-street, Westminster, S.W., and contains complete details of the manufacture and construction of these batteries for lighting, traction and general installation work. Several types of this company's batteries are now styled the "Lumford," after the works at Bakewell, Derbyshire, where they are manufactured. The illustrations accompanying the new list effectively show a number of installations of batteries in double and single tiers. One of the latest introductions is the "Lumford" heavy type cell, of which we illustrate a section of the positive plate in Fig. 1. The complete positive plate weighs 18½lb. and the negative plate 9lb., and there is nearly 4in. clearance between the plates and the bottom of the box. In the "Lumford Station" type cell, with the positive plate weighing 28lb. and the negative plate 21lb., there is a 6in. clearance. Our illustration (Fig. 2) shows this clearance, and an improved arrangement of the glass tubes, which overcomes the objection that used sometimes to be made that these tubes work out of place at the lower corners of the plates. It will be seen that by running horizontally three couples of glass tubes (A) the rigidity of the vertical tubes is assured. It is claimed that these plates are the heaviest on the market, and contain more pure metallic lead. They are made in accordance with the latest Continental practice, and are in no way experimental cells, as the makers have satisfied themselves that this type of plate has proved its value during a number of years' practical experience in actual use. A distinctive feature of this list, and one which will appeal to installers, is a very complete set of detailed drawings of every type of cell supplied by the company, made to scale. In this way installation contractors are enabled to

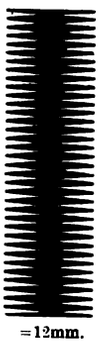

FIG. 1.—Section of Positive Plate, "Lumford" Heavy Type Cell.

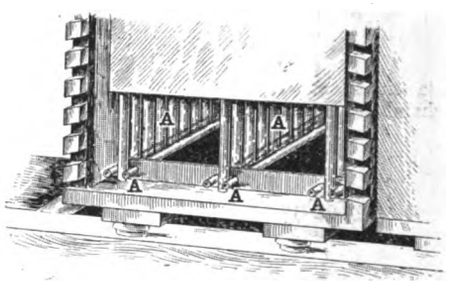

FIG. 2.—Showing arrangement of Glass Tubes (A) to secure rigidity.

calculate, straight away, the exact space required and all other essential particulars concerning their erection. Complete instructions for erecting and starting these accumulators and general working instructions accompany the list. Numerous testimonials go to make up a useful catalogue of electrical accumulators. We must not omit to mention that the D.P. Battery Co. have essayed to meet the maintenance difficulty by giving a two to three years' guarantee with all batteries supplied, from date of first charge, against any defects in material or workmanship, provided the cells are erected by the company, and that their working instructions are strictly carried out in all particulars.

Catalogues, &c.—An illustrated pamphlet of electric radiators has been issued by the General Electric Co., and several new designs are shown. The luminous or "glow" pattern are fitted with polished aluminium reflectors requiring a minimum of attention to keep them in perfect condition. The heat lamps can be instantly fixed. An improved form of holder is supplied with these radiators

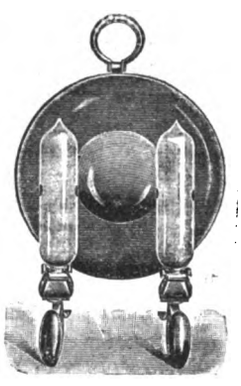

FIG. 1.

FIG. 2.

FIG. 3.

ensuring perfect connection. The "Shield" form of radiator, which we illustrate (Fig. 1), is designed for small rooms and offices where only little heat is required from time to time. It is made up of iron feet and handle, lacquered copper reflector as shown, is fitted with two lamps, but without switches. This is a very cheap form of radiator. Fig. 2 is the "Mercury" form of radiator, constructed of polished brass and copper and fitted with four lamps and two flush switches. The ornamental "Diaper" pattern radiator (Fig. 3) is a form of radiating apparatus, wired on the enamel system, of the non-luminous type and designed for heating small offices and rooms. A heating pad is also shown and described in the list. This takes the place of the popular hot water bottle, and where electric current

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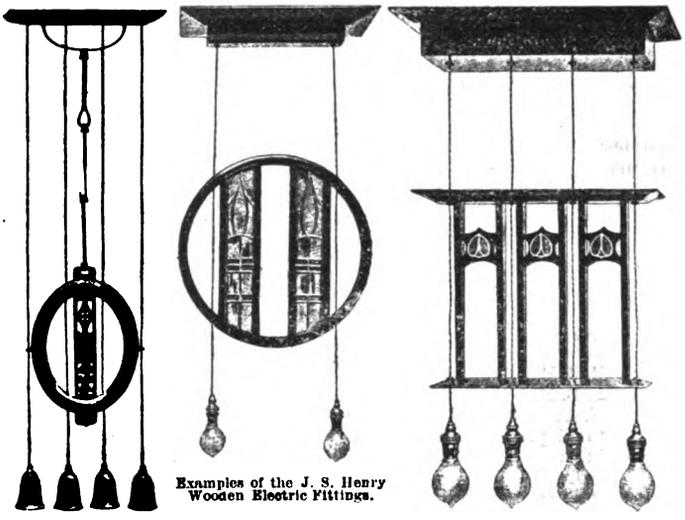
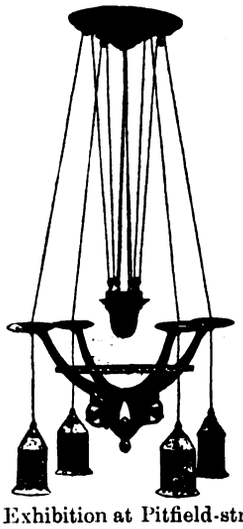
is available is ready for use at a moment's notice. Current consumption is low. The pads have the appearance of a block of lamb's wool, and are free from the many objectionable features of hot-water bottles, poultices or other heated appliances for the body.

J. S. Henry (Ltd.), 287-291, Old-street, London, E.C., have prepared for publication a set of five books dealing with various classes



Examples of the J. S. Henry Wooden Electric Fittings.

of wooden electric fittings. The complete set of these lists should be in the hands of every installation contractor, as an infinite variety of fittings are described and effectively illustrated. We have selected a few of the fittings for illustration as examples of a large number of unique designs, suitable, in particular, for situations where the taste of the client is in the quaintly artistic or antique direction. As an example of what can be done with the electric light in such surroundings, the fittings will assist both the architect and the contractor for electric lighting work. An important factor in connection with the introduction of wooden fittings is, of course, their acceptance by the fire insurance companies. We understand that the Phœnix and other offices have approved Messrs. Henry's fittings. We may add that some good samples are on show at the Electrical Exhibition at Pitfield-street, Hoxton, London, now being held.



We have received an advance copy of a new catalogue of continuous-current motors now being issued by Messrs. Crompton & Co., and which deals very fully with the subject of the construction and working of these machines, which have been fully standardised and are now manufactured by the company in very large quantities. In order to be able to supply these machines at the prices listed, Messrs. Crompton have to adhere rigidly to their standard designs, but as the driving conditions with these machines vary so largely considerable modifications in the mechanical parts have to be introduced to meet these conditions from time to time. On this subject it is clearly pointed out that foreign competitors have always adhered more rigidly to their standard designs than have the English manufacturers. Messrs. Crompton have, therefore, endeavoured to take a middle course. They have reduced the price of their standard motors to the lowest figure, and have decided that where a customer requires special modifications of the designs these can be made, but at his cost. In this way the customer who is satisfied with, or whose requirements will allow of his accepting, the standard machines made by Messrs. Crompton & Co. will reap the full benefit of the reduction in cost due to standardisation. It is very properly pointed out that, at first sight, it may appear a simple and inexpensive matter to modify the mechanical designs of a motor, but where machines are manufactured to standard patterns in large quantities, thereby ensuring economy in manufacture, any alteration in the design may involve the building of a special armature or of some other portion of the machine, entailing sometimes large additional expenditure for which there is practically nothing to show. In the list now published a plain motor is taken as the basis of charge, and the list gives particulars of a large variety of machines, with all necessary details as to dimensions, weights, measurements, &c. In the geared-motor section, three different speed ratios have been standardised for large machines. A section of the list is devoted to starters, reference being made to the difficulty of dealing with this question owing to the numerous different types required by the various supply and insurance companies. There is, however, a considerable amount of information in the list on this subject in handy form, and relating to (1) light load starters, (2) half-load starters, and (3) full load starters. Much care has been taken in preparing the list and in compressing the particulars given.

A fine list of steel and wrought-iron bridges, roofs, tanks, columns and general construction work, cast-iron stanchions, &c., power-gas plants (Wilson patent), Temperley patent transporters for all classes of work, &c., is to hand from the Horsehay Co. (Ltd.), of Horsehay, Shropshire. The list is notable for a well-executed set of photographs of the company's shops, for some fine examples of bridge work for India, South America, South Africa, and other parts of the world, and for some excellent photographs of cast-iron column work and tanks of large capacity, all work executed by the company at Horsehay. The gas-power plant on the Wilson principle which is erected at the company's works is also shown, as is another complete plant of a maximum working load of 150 B.H.P. for use in New Zealand. A 1,000-ton haulabout engine is also illustrated, as are several high and low platform examples of Temperley transporters. The list gives a good idea of the company's facilities for handling large contracts.

The Electrical Co., 121-125, Charing Cross-road, London, W.C., forward leaflet No. 33, which deals with small motors, and No. 44 dealing with polishing motors for continuous, three-phase and single-phase currents. Both lists give in compact form all necessary particulars. Further reference is given in a separate sheet to a waterproof motor erected in the open air in April, 1903, and which is still (Oct. 1, 1904) in proper working order and can be inspected at any time. There is also issued by the same company a reference list of dynamos and motors supplied by the company up to July 1, 1904. These machines number 2,321 for continuous current, 212 for single-phase alternating current from 100 to 220 volts, and 445 three-phase current from 200 to 6,500 volts. With sundry small motors, the total machines sold in this country up to July 1, 1904, is 3,988, of a total horse-power of 140,693·25. The location of these various machines is set out in the list.

Messrs. John Davis & Son, Derby, have ready a new catalogue of drawing-office requisites, &c.

The Mirrlees Watson Co., of Glasgow, issue a circular describing a large jet condensing and cooling plant recently installed at the Scottish Co-operative Wholesale Society's premises.

Two and three-phase induction motors and apparatus therefor are illustrated, described and priced in pamphlet No. 175, issued by the British Thomson-Houston Co., Rugby.

"Under-fed Stokers" is the subject of a pamphlet issued by Erith's Engineering Co., 70, Gracechurch-street, London, E.C. A number of these machines are illustrated and described as applied to different classes of boilers.

The "Journal."—Part 169 of the "Journal" of the Institution of Electrical Engineers is now ready, price 4s. Particulars of the contents are given in an advertisement.

Forthcoming Books.—Messrs. A. Constable & Co. will publish shortly a new work on electric traction by Messrs. F. H. Parshall and H. M. Hobart.

Imports.—The following are official values of imports of electrical machinery, material and apparatus into this country during September :—

Electrical machinery, £51,007 (an increase of £12,526 compared with September, 1903); telegraph cables and apparatus, £9,370 (increase £6,702); other electrical goods £63,699 (decrease £21,977). The total imports of the three classes during the nine months ended 30th ult. were respectively £423,928 (decrease £6,090), £33,036 (decrease £11,744) and £565,964 (decrease £19,519).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Oct. 5 to 11, with the ports of destination :—

Africa—Alexandria, £117; Beira, £15; Cape Town, £4,492 (including £2,207 telegraph material); Durban, £1,407 (including £439 telegraph material); East London, £369; Mombasa, £273 (including £250 telegraph material); Port Elizabeth, £118 *Australasia*—Brisbane, £34; Perth, £675; Sydney, £431. *Brazil*—Pernambuco, £31; Rio Janeiro, £665 (including £165 telegraph material). *Canada*—Toronto, £90. *Ceylon*—Colombo, £57. *France*—Bordeaux, £44; Le Treport, £45. *Germany*—Hamburg, £176. *Gibraltar*, £631. *Holland*—Amsterdam, £57; Rotterdam, £51. *Hong Kong*, £13. *India*—Bombay, £370 (including £250 telegraph material); Calcutta, £777 (including £162 telegraph material). *Japan*—Tokyo, £544; Yokohama, £319. *Malta*, £28 (telegraph material). *Siam*—Bangkok, £28. *Spain*—Malaga, £20. *Straits Settlements*—Singapore, £232 (including £201 telegraph material). *Turkey*—Constantinople, £50. *Uruguay*—Monte Video, £78. *Zanzibar*, £19. Total, 12,256, against £11,086 in the corresponding week last year (Oct. 7 to 13).

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PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

August 23, 1904.

18,208 J. YOUNG. Effecting telephonic intercommunication.
18,252 O. HENN. Hamburg, Germany. Automatic electric telegraphic transmitters.*
18,255 Hon. C. A. PARSONS and G. G. STONEY. Parallel running of dynamos.
18,280 F. R. SIMMS. Magneto-electric machines.
18,293 W. H. SCOTT. Controllers for electric capstans.

August 24, 1904.

18,306 J. CULSHAW. Manchester. Electric advertising.
18,316 K. EDGCUMBE and E. I. EVERETT. Electrical measuring instruments.
18,317 J. A. KENNEDY MCGREGOR and H. WREN. Birmingham. Switches.
18,322 H. PIEPER and G. L'HOEST. Birmingham. Electric lighting for railway trains.*
18,342 and 18,343 W. J. PHELPS. Incandescent lamps, connections and switch mechanism therefor.*
18,356 F. L. BARTETT. Electrolysers.
18,358 B.T.-H. Co. (G.E. Co., U.S.). Electric measuring instruments.
18,359 B.T.-H. Co. (G.E. Co., U.S.). Incandescent lamp sockets.
18,360 WARWICK MACHINERY CO. (G.E. Co., U.S.). Elastic fluid turbines.
18,361 B.T.-H. Co. (G.E. Co., U.S.). Resistances for electrical apparatus.
18,369 G. R. ROBSON. Trolleys for electric cars.
18,378 B. S. HORNBY. Combined electric switches and fuses.
18,383 R. HOENICKE. Indicating device for electrical fire alarms.*

August 25, 1904.

18,403 C. P. TOWNSEND. Electrolytic process and apparatus therefor.*
18,429 H. I. HAWKHURST. Selective telephone call mechanism.*
18,434 J. P. L. DONLEVY. Apparatus for transmitting and receiving messages.
18,439 R. S. MCLAREN. Charging of accumulators.
18,446, 18,447 and 18,448 E. A. CAROLAN (G.E. Co., U.S.). Vapour electric apparatus.

August 26, 1904.

18,464 J. T. CHERRY and E. H. CLIVE. Plymouth. Trolley heads, with wire-finding apparatus attached.
18,469 J. E. BENTLEY. Manchester. Trolleys for electric tramways and railways.
18,496 J. G. GARQUHAR. Switch for electric circuits.
18,499 J. S. WOOD, W. S. WOOD and J. R. WOOD. North Shields. System of cable connections with electrified railways.
18,501 G. WALLACE and WALLACE J. L. SANDY. Primary batteries.
18,520 F. J. BEAUMONT. Coin-freed electricity meters.
18,523 J. CARPENTIER. Interrupters for ignition coils of internal combustion engines. (Date applied for, Aug. 29, 1903, date of application in France.)*
18,538 G. C. DYMOND (Ges. für Drahtlose Telegraphie m.b.H., Germany). Liverpool. Wireless signalling systems.*

August 27, 1904.

18,546 M. BYNG and W. J. CRAWSHAW. Incandescent lamps, whereby two or more lamps are governed by one central connecting cap.
18,561 J. LINKLETER. Tynemouth. Live rail protections for electric railways.
18,592 E. A. CAROLAN (G.E. Co., U.S.). Electric railways.
18,594 L. FIEDLER and F. J. GERARD. Galvanic batteries.
18,598 G. WESTPHAL. Automatic fire alarm.*

August 29, 1904.

18,628 G. B. STERN and A. C. GREENE. Electric lamp holder.
18,635 D. COOK. Method of generating electricity.
18,642 H. MANDERS. Production and application of electrical resonance.
18,645 H. OPPENHEIMER (A.G. Mix & Genest, Germany). Movable arms for microphone carriers.
18,654 T. F. RENE. Sparking plugs for internal combustion engines*
18,683 B.T.-H. Co. (G.E.Co., U.S.). Control of alternating-current motors.

August 30, 1904.

18,704 ELECTRIC & ORDNANCE ACCESSORIES CO. and R. F. HALL. Birmingham. Circuit-breakers and automatic switches.

August 31, 1904.

18,792 J. GRAHAM and R. KENDAL. Stockton-on-Tees. Controlling the flow of electricity into operative rails for vehicular or other traffic, said means being also available for signalling purposes.
18,801 R. FALSHAW. Harrogate. A mechanical electric governor.
18,811 C. B. CHESSHIRE and D. D. ESSON. Apparatus actuated by radium or its compounds.
18,813 J. TAYLOR. Switches and the like.
18,823 C. M. JACOBS. Apparatus for enabling telegraphic and telephonic messages to be received simultaneously over the same line wire.
13,827 C. KLOPFENSTEIN and G. KLOPFSTEIN. Thermostatic electric-circuit controller.*
18,831 W. K. KISE. Kingston-on-Thames. Telegraphic and like circuits.
18,840 B.T.-H. Co. (G.E. Co., U.S.). Electro-deposition.
18,841 B.T.-H. Co. (G.E. Co., U.S.). Transformers.
18,842 B.T.-H. Co. (G.E. Co., U.S.). Polarity indicators.

September 1, 1904.

18,855 R. GREEN. Birmingham. Conductors for electric vehicles.
18,882 E. T. KERBAKER. Light regulator for electric railway cars.
18,908 M. KELLY. Electric time-recording mechanism and apparatus.*
18,910 L. B. PEMBERTON. Electrical heaters. (Date applied for, Jan. 4, 1904, date of application in U.S.)*
18,919 W. MIDDLETON and J. Y. MIDDLETON. Coupling for cables.
18,920 H. H. LAKE (Société Anonyme Matthey & Co., Switzerland). Manufacture of electrical insulating and non-heat conducting compositions.

September 2, 1904.

18,937 J. HARGREAVES. Widnes, Lancs. Appliances for operating electrolytic cells.
18,942 R. T. SIMCOCK. Birmingham. Advertising on electric tramcars.
18,949 G. D. SALE. Glasgow. A safety guard for conductor or live rails.*
18,959 O. D. LUCAS. Electric lamps.
18,971 H. S. ANDERSON. Magnetic mechanical movement.
18,979 R. S. CLOUSTON. Electric traction.
18,987 P. H. THOMAS. Systems of electrical distribution. (Date applied for, Sept. 4, 1903, date of application in U.S.)*
18,989 R. MULLER. Liverpool. Insulating substance and method of making same.
18,991 P. HOLBROOK THOMAS. Systems of electrical distribution. (Date applied for, Sept. 4, 1903, date of application in U.S.)*

September 3, 1904.

19,000 F. S. PORAH and S. G. LIVETT. Rectifying alternating current.
19,034 J. B. HAYNES and J. HINCHCLIFFE. Wall plugs.
19,061 H. T. HINCKS. Liverpool. Instruments for calculating conductors and problems generally where all but any specific one of the members of a simple algebraic formula are known, as, for instance, Ohm's formula $C=v/r$.

September 5, 1904.

19,109 F. PUNGA. Single-phase commutator motors.
19,113 J. A. S. ARNOLD. Wireless telephony.
19,125 B. G. LAMME. Brush holders. (Date applied for, Sept. 16, 1903, date of application in U.S.)*
19,126 W. H. FOOT. Dynamo-electric machines. (Date applied for, Sept. 16, 1903, date of application in U.S.)*
19,139 W. SEDLBAUER. Arc lamps for medical purposes.
19,160 ERNST G. SIEVERT. Telephone cord.*
19,168 W. P. THOMPSON (Berliner Maschinenbau A.G. vorm. L. Schwartzkopff, Germany). Alternating-current and electrical machinery.*

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1903.

11,828 MUIRHEAD. Electric telegraphy.
11,828A MUIRHEAD. Electric telegraphy. (Date applied for, May 23, 1903.)
11,921 DE FERRANTI. Electric welding of turbine blades.
17,851 WESTINGHOUSE. Electric railways.
18,237 REGENBOGEN (Rund). Igniter mechanism for internal combustion engines.
18,318 WALLACE. Incandescent lamp.
18,354 WILDE. Electromagnetic rail brakes.
18,624 BASTIAN and SALISBURY. Electric vapour lamps.
18,581 LEITNER and LUCAS. Electric lighting of railway trains.
18,745 ATKINSON. Excess current indicators.
19,172 SIEMENS BROTHERS & Co. and RYDALL. Controlling electric cars.
19,454 WEINTRAUB. Operating vapour electric lamps from an alternating-current source. (Date applied for, Oct. 18, 1902.)
19,657 STEWART. Working of points and plough guides on electric or cable tramways or railways.
20,645 UPTON, ELLIOTT and PRATT. Arc lamps.
20,834 O'BRIEN and ROTTANZI. Incandescent lamp casing and reflectors.
22,008 BOYDEN. Multipolar generators and motors.
22,497 MAKIN. Electrical switch.
22,634 DE VEVLLE. Terminals for stranded wires.
22,907 CAROLAN (G.E. Co., U.S.). Controlling devices for electric vehicles.
22,981 HARMATTA. Welding by electricity and apparatus therefor.
23,443 CROMPTON & Co. and PRICE. Electrometers.
23,712 NEHMER. Dry batteries.
24,626 THOMPSON (Pflüger Accumulatorem Werke Act.-Ges.). Plates for secondary batteries.
25,199 SANGSTER. Switches for the electrical ignition systems of motor cycles, &c.
27,736 JOHNSON (Elektricitäts Act.-Ges. vorm. W. Lahmeyer & Co.). Electrical means for starting prime movers for electric generators.

1904.

5,663 HENNING. Annunciators for electric bells.
8,912 WALLOCH. Line selectors of intercommunication telephone apparatus. (Date applied for, Sept. 25, 1903.)
8,965 SIEMENS BROTHERS & Co. (Simpson & Wheat). Section insulators for overhead trolley wires.
9,307 MORCK. Alternating current meters on Ferrarl's principle.
12,187 RITTER. Telephone and telegraph systems.
12,691 TURCHI. Apparatus for the simultaneous transmission of telegraphic and telephonic or other currents over the same line.
13,427 FAIRWEATHER (Brown Hoisting Machinery Co.). Brake and means for suspension for overhead electrically-driven locomotives.
13,468 SCOTT. Switches. (Date applied for, July 31, 1903.)
14,066 GOURNAY. High-voltage galvanic battery.
14,230 LAKE (Submarine Signal Co.). Submarine signalling and apparatus therefor.

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NEW COMPANIES REGISTERED.

CITY OF BUENOS AYRES TRAMWAYS CO. (1904), LTD. (82,214.)—Reg. Oct. 6, capital £1,240,000 in £5 shares, to acquire certain assets of and adopt agreement with City of Buenos Ayres Tramways Co., Ltd. (in voluntary liquidation), to receive payment from Anglo-Argentine Company of certain annual sums, and to hold same on certain trusts, to farm, or let out for farming, building or other purposes, and generally to deal with and turn to account the lands of the company, to acquire or construct, maintain, work and control any tramways, railways, telegraphs, telephones, electric lighting or power works, factories, &c., to promote any other company for acquiring all or part of the assets and liabilities of the company or otherwise, &c. First directors, J. Heaton, E. Clapham, W. Hutchinson, S. Rostron and E. H. Woods. Reg. office, 1, Great Winchester-street, London, E.C.

MARKS & HODGKINSON (LTD.) (82,205.)—Reg. Oct. 5, capital £5,000 in £1 shares, to acquire and carry on the business of electricians and electrical engineers carried on by J. Marks and H. Clarkson, and to carry on the business of manufacturers of and dealers in electric lighting plant, apparatus and fittings, civil, mechanical and general engineers and contractors, &c. First directors, J. Marks, W. B. Hodgkinson and W. L. Hodgkinson (chairman).

SCOTTISH ELECTRIC TRACTION CO. (LTD.) (5,705.)—Reg. in Edinburgh Oct. 6, capital £500 in 1s. shares, to promote, assist and establish companies, syndicates and associations for carrying on any business or adventures of any description, whether relating to electrical enterprise or not, &c.

CITY NOTES.

MEMORANDA (Oct. 13).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26 9/16d. per oz. Consols 88 1/4—88 3/8 for money, 88 5/16—88 7/16 for account; 2½ per cent. annuities 87 1/4—87 3/8. Consols Pay Day, Nov. 4; Stocks and Shares Continuation Days, Oct. 25 and Nov. 9; Ticket Days, Oct. 26 and Nov. 10; Pay Day, Oct. 27; Mining Share Carry-over Days, Oct. 24 and Nov. 8.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The directors, after placing £5,000 to credit of renewal fund, have declared an interim dividend for the quarter ended Sept. 30 of 12s. 6d. per cent. on the ordinary, and £1. 5s. per cent. on the preferred stock (less tax), payable Nov. 1.

BROWETT, LINDLEY & CO. (LTD.)—The directors announce that the trading results to June 30 do not justify them in declaring a dividend on the ordinary shares.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The tranfer books and register of holders of second debenture stock will be closed from 18th to 31st inst. inclusive, preparatory to payment of interest due Nov. 1.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The directors' report for the half-year to June 30 states that the total receipts were £18,715. 15s. 6d., and the expenses (including cost of attempted repair of the Cienfuegos-Santiago 1875 cable) £14,039. 12s. 9d., leaving a balance of £4,676. 2s. 9d., to which is added £6,970. 19s. 8d. brought forward, making £11,647. 2s. 5d. Preference dividend absorbs £3,000, leaving £8,647. 2s. 5d. The directors recommend the payment of an ordinary dividend at the rate of 5 per cent. per annum, tax free, the balance (£4,647. 2s. 5d.) being carried forward. The payments to June 30 on account of the Cienfuegos-Santiago new cable have been charged to reserve, which now stands at £144,982. 1s. The directors regret that the Cape Cruz-Santiago section of the Manzanillo-Santiago cable became interrupted on June 14. The West India & Panama Co.'s cs. "Henry Holmes" has been hired for the repair, and is now at work on the cable. This interruption accounts for the falling-off in receipts during June. The claim against the United States Government for payment of the claim for the cost of repairing the damage done to the cables during the Spanish-American War, and against the Cuban Government for payment of the subsidy for the coast cables, are still unsettled.

EDISON & SWAN UNITED ELECTRIC LIGHT CO. (LTD. & REDUCED)—The net revenue for the year ended June 30 was £42,603. 17s. 9d. Interest absorbed £18,760. 18s. 4d.; £11,000 has been set aside as depreciation on freehold and leasehold property, plant, machinery and tools; £1,442. 13s. 11d. has been applied in writing down values of stocks; and £1,508. 8s. has been reserved on account of bad and doubtful debts. A further £1,000 has been added to reserve for future stock depreciation. After providing for the foregoing, the credit balance is £8,891. 17s. 6d. As a result of writing down the capital by £2. 10s. per share on each of 23,564 "B" shares a debit balance of £3,589. 14s. 7d. remained, and deducting this, the credit balance to be carried forward is £5,302. 2s. 11d. The cost of establishing the business, goodwill, &c. (£443,451. 8s. 1d.) and also the freehold and leasehold property, plant, machinery and tools, have been brought forward at the value stated in the last balance-sheet, with the addition of the amount expended to June 30, less depreciation charged in net revenue account. There has been expended on capital account during the year £1,029. 7s. The shares of Altrincham Electric Supply (Ltd.) have been taken at par. The indebtedness of the company has been reduced during the year by £1,466. 10s. 1d.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 5 per cent. per annum (tax free), payable Nov. 1. The transfer books will be closed from 18th to 31st inst. inclusive.

SOUTH LANCASHIRE ELECTRIC TRACTION & POWER CO. (LTD.)—At a meeting on Friday last, the directors' report and recommendation that the company be wound up for reconstruction purposes were approved.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
‡Aberdeen Corporation	Oct. 8	1,820	+ 180	19	30,451	+ 5,593
Airdrie	Sept. 30	228	...	34	6,832	...
Ayr Corporation	Oct. 8	214	- 3	21	3,635	+ 469
Barnsley	Sept. 30	170	- 20	39	6,656	- 476
Barrow	,, 30	206	...	34	6,799	...
Bath Electric Trams, Ltd.	Oct. 5	676	...	40	26,041	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 9	1,039	- 52	...	...	...
Birmingham Corporation	...	...	...	...	...	...
Birmingham Tramways Co.	,, 8	8,526	+ 218	14	76,278	+ 8,181
Blackburn Corporation	,, 7	957	+ 160	28	27,532	+ 2,817
Blackpool Corporation	,, 6	879	+ 209	27	39,093	+ 5,518
Blackpool and Fleetwood	,, 8	459	+ 80	14	18,588	+ 180
Blackp'l, St. Anne's & Lytham	,, 6	318	...	49	19,735	+ 7,220
Bolton Corporation	,, 9	1,823	+ 55	28	53,048	+ 305
Bournemouth Corporation	,, 5	1,060	+ 57	‡27	32,819	+ 1,891
Bradford Corporation	,, 8	4,548	+ 349	27	130,421	+ 22,436
Brighton Corporation	,, 9	968	+ 111	27	30,616	+ 3,121
Brisbane Tramways	Aug. 24	2,301	+ 24	8	19,500	+ 76
Bristol Trams & Carriage	Oct. 7	5,180	+ 167	9	107,654	+ 1,104
Buenos Ayres & Belgrano	Sept. 4	3,119	- 32	‡21	67,526	+ 3,196
	,, 11	3,828	+ 298			
Burnley Corporation	Oct. 8	1,140	+ 314	2	2,264	+ 549
Burton Corporation	,, 9	368	- 47	¶27	10,146	+ 1,792
Calcutta Tramways Co.	,, 8	a40,521	+ a11,599	15	a515,829	+ a58,820
Camborne-Redruth	,, 10	119	+ 18	23	2,718	- 105
Cardiff Corporation	,, 8	1,924	- 90	27	58,118	+ 1,771
Carlisle Tramways Co.	,, 8	196	- 15	40	8,108	+ 260
Central London Railway	,, 8	6,751	+ 247	14	88,771	- 581
Chatham & Dist. Lt. Rys.	,, 6	633	+ 4	40	23,944	+ 2,148
City & South London Rly.	,, 9	2,768	+ 19	15	36,210	- 1,112
Colchester Corporation	,, 6	234	...	10	3,402	...
Cork Electric Trams Co.	,, 6	505	- 51	40	19,027	- 2,463
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	Sept. 30	525	- 7	39	21,190	+ 3,816
Dover Corporation	Oct. 8	207	- 17	28	6,865	- 207
Dublin & Lucan Railway	,, 7	180	- 15	14	2,018	- 80
Dublin Southern District	,, 7	980	- 3	‡14	76,985	- 3,440
Dublin United	,, 7	3,980	- 63			
Dudley—Stourbridge	Sept. 30	952	+ 47	39	34,628	+ 1,891
Dundee Corporation	Oct. 5	874	- 48	...	...	...
East Ham Council	,, 8	665	- 2	27	20,984	+ 1,414
Gateshead & Dist. Trams	Sept. 30	1,010	+ 49	39	35,623	+ 1,516
Glasgow Corporation	Oct. 8	14,737	+ 646	†19	271,911	+ 15,561
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	Sept. 30	239	- 56	39	10,245	+ 638
Gt. Northern & City Rly.	Oct. 8	1,177	...	34	32,940	...
Greenock & Port Glasgow	Sept. 30	662	- 26	39	22,941	+ 1,192
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 30	293	- 7	39	11,792	+ 1,082
Huddersfield	Oct. 8	1,249	- 3	27	38,934	+ 2,691
Hull Corporation	,, 8	2,091	- 126	27	59,448	+ 7,609
Ilford District Council	,, 8	388	- 23	¶26	13,691	+ 561
Ilkeston Corporation	,, 5	135	- 87	...	...	...
Ipswich Corporation	,, 8	443	...	27	14,747	...
Isle of Thanet Co.	,, 8	481	- 2	1	481	- 2
Kidderminster & District	Sept. 30	127	- 4	39	5,253	+ 35
Kirkcaldy Corporation	Oct. 5	244	- 38	40	9,278	...
Lanarkshire Trams Co.	,, 6	683	+ 75	40	25,983	...
Leeds Corporation	,, 8	5,741	+ 818	26	167,400	+ 10,065
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	,, 1	10,669	- 115	40	415,478	+ 12,099
Liverpool Overhead Rly.	,, 9	1,504	- 58	†15	24,616	- 928
*London County Council	,, 1	13,642	+ 2,725	§26	389,299	+ 70,489
Lowestoft	,, 8	174	- 32	...	...	...
Maidstone Corporation	,, 6	148	...	12	2,175	...
Manchester Corporation	,, 8	12,864	+ 649	27	339,926	+ 13,984
Mersey Railway	,, 8	1,548	+ 202	14	20,318	+ 1,553
Merthyr	Sept. 30	205	- 7	39	7,941	+ 110
Metropolitan Elec. Trams	Oct. 7	1,803	+ 489	14	27,455	+ 6,747
Middleton	Sept. 30	306	- 7	39	13,117	+ 181
Nelson Corporation	Oct. 8	120	+ 22	28	3,428	+ 1,108
Newcastle-on-Tyne Corp.	,, 8	3,594	+ 853	14	51,744	+ 3,678
Newport (Mon.)	,, 8	498	+ 42	1	498	+ 42
Oldham, Ashton & Hyde	Sept. 30	554	- 41	39	21,669	- 933
Oldham Corporation	,, 25	1,156	...	...	...	...
	Oct. 2	1,208				
Perth (W. A.) Elec. Trams	,, 7	1,279	+ 52	40	52,099	+ 6,080
Peterborough	Sept. 30	144	- 32	39	6,068	- 153
Poole and District	,, 30	321	- 7	39	12,283	- 30
Portsmouth Corporation	Oct. 8	1,753	+ 49	§27	59,668	+ 4,848
Potteries	Sept. 30	1,774	+ 87	39	63,803	+ 5,276
Reading Corporation	Oct. 5	638	+ 19	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	Sept. 30	253	+ 67	39	6 479	+ 15
Salford Corporation	Oct. 10	4,040	+ 199	27	115,033	+ 7,491
Sheerness	Sept. 28	68	- 3	39	2,566	- 481
Sheffield Corporation	Oct. 9	4,622	+ 230	§28	134,68	+ 2,939
Southampton Corp'ation	,, 6	982	- 79	27	28,272	- 1,918
Southend Corporation	,, 5	315	+ 19	27	11,618	+ 1,210
Southport Tramways	Sept. 30	841	- 41	39	13,277	+ 559
S. Staffordshire Trams.	,, 30	729	- 337	39	30,117	- 5,371
Stockport Corporation	...	...	...	...	...	...
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	,, 30	545	+ 11	39	21,645	+ 1,010
Taunton Trams	,, 30	54	- 32	39	2,229	- 284
Tynemouth and District	,, 30	631	+ 313	39	12,300	- 665
Tyneside Trams Co.	Oct. 5	336	+ 29	40	15,841	+ 2,614
Wallasey District Council	,, 8	726	+ 50	§27	21,922	+ 1,824
Walsall	...	...	...	...	...	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 6	1,088	...	32	29,477	...
Weston-super-Mare	Sept. 28	135	+ 23	39	5,748	+ 451
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 30	340	- 22	39	15,463	- 39
Worcester	,, 30	318	+ 166	34	11,130	+ 5,953
Wrexham	,, 30	109	- 39	39	4,426	- 691
Yorkshire Woollen District	,, 30	493	- 8	39	23,475	+ 8,721

(a) These comparisons are with the corresponding period last year.

* Partly electrical † Minus 8 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Oct. 12	Rate per Cent. Yielded.	Dividend Due.	Business Week to Oct. 12. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	3/0	Anglo-Argentine Ordinary Shares	6⅝—6¾	4 7 3	April, Oct	6¾	6⅛
5	2/6	Do. 5% Cum. Pref.	5⅜—5⅝	4 8 10	..	5⅝	5⅜
St.	6%	Do. Permanent 6% Deb. Stock	139 —142	4 4 10	..	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	102 —104	4 17 6	..	104	103¼
10	6%	Barcelona Tramways Ord.	9 —10	3 0 0	..	9⅛	9¼
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 0	..	..	..
100	5%	Do. 5 per Cent. Debs.	98 —101	4 19 6	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	⅛—¼	..	..	..	..
1	..	Do. 5% Cum. Pref.	3/32—⅛	..	..	1	..
5	..	Brisbane Electric Trams. Invest. Ord.	1¾—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	..	4⅜	4½
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96 —101	4 9 8	..	..	..
10	8½	Bristol Tramways and Carriage Ord.	19 —20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	99 —102	5 17 8	..	..	..
St.	5%	Do. Pref. Ord. Stock	100 —103	4 18 0	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	104⅝—106⅞	4 6 7	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 —100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	9⅜—10	5 17 8	..	10⅛	9⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅝—11⅛	5 6 7	Feb, Aug	11⅛	10⅝
St.	5/0	Do. 5 per Cent. Perpetual Debs	115 —118	4 4 7	..	117⅛	117⅛
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	94 —97	..	..	96½	95⅛
5	1/6	Buenos Ayres and Belgrano Ord.	3⅞—4⅛	5 9 3	..	4⅜	3⅞
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5⅛—5⅜	5 4 4	..	5⅛	..
5	3/0	Do. "B"	5¼—5⅜	5 11 6	..	5⅜	..
St.	5%	Do. 5 per Cent. Debs.	105 —108	4 12 8	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102 —105	4 16 3	..	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. 5% Deb. Stk.	96 —99	5 2 6	..	97	96⅛
5	3 0	Calcutta Tramways	7½—7⅞	4 2 9	..	..	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 4 0	..	107⅜	..
1	1/0	Cape Electric Tram Shares	1⅝—1⅞	5 6 8	..	1 13/16	1⅝
St.	4%	Central London Ordinary Stock	87 —90	4 9 0	June, Dec	89⅜	85⅜
St.	4%	Do. 4 per Cent. Pref. Stock	100 —102	3 18 3	..	102	..
St.	4%	Do. Deferred Stock	79 —81	4 18 9	..	..	..
100	4%	Do. 4 per Cent. Debs.	107 —110	3 13 4	..	109	107½
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4⅜—5⅛	4 15 3	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	4 0 0	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	47 —49	4 10 10	Feb, Aug	49	47⅛
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 3	Feb, Aug	..	..
St.	5%	Do. (1896)	117 —120	4 3 6	..	..	..
St.	5%	Do. (1901)	113 —117	4 6 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	105 —108	3 14 9	May, Nov	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	101 —104	4 18 0	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13 —14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	3 0½	Gt. Northern & City Rly. Prf. Ord. (4%)	5⅛—5⅜	..	..	5⅛	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 —20	4 10 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—14⅞	4 1 4½	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109 —111	4 1 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 —91	4 7 11	..	..	..
10	12½	Liverpool Overhead Railway Ord	8⅜—8⅝	3 15 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10⅛—11	4 10 11	..	10⅜	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —105	3 16 4	..	..	..
St.	..	Madras Elec. Trams 5% Deb. Stk.	102 —105	..	Jan, July	103⅜	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅞—1⅛	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1	5 0 0	..	..	..
St.	13/7	Do. 4½% Deb. Stock	100 —102	..	..	10 ⅛	99⅜
100	5%	Montreal St. Ry. St'g 5% Mrt. Dbs. (1908)	100 —103	4 17 8	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 —105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1½	..	May	..	..
St.	5%	Perth, W.A.) Elec. Trams. 1st Mt. Db. Stk.	102 —105	4 16 6	..	104½	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	86 —89	3 7 5	June, Dec	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance E'ec. Co. 5% Cum. Pref.	⅜—½	5 14 2	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	⅛—¼	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5½—6	6 13 4	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¼—6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 7	..	..	..
St.	4½%	British Thomson-Houston 4½% 1st Mt. Db.	100 —102	4 8 6	..	..	..
5	3/0	British Westinghouse 6% Pref.	2⅜—3⅛	9 4 6	..	2⅞	2⅛
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	87 —90	4 10 2	..	87½	..
2	..	Brush Electrical Engineering	½—¾	..	March	..	..
2	2/4⅓	Do. 6 per Cent. Pref. Non-Cum.	1 —1⅛	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	94 —97	4 12 10	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	70 —75	6 0 9	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½—10½	5 14 3	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	102 —105	4 5 8	Nov, May	104	102½
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	½—⅝	5 6 8	..	2⅛	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 16 10	..	100	4½
1	1/2½	Chadburn's (Ship) Telegraph Ord.	¾—1⅛	8 0 0	..	10	..
5	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—2	3 15 0	Jan, July	1⅞	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	90 —95	5 6 5	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	7 —7½	6 13 4	Sept	7⅝	..
5	3/0	Do. 6% Cum. Pref.	5¼—5½	5 4 4	Sept	5½	5⅛
St.	4½%	Do. 4½% Deb. Stock	103—106	4 5 9	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 —82	4 18 1	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	78 —82	6 2 0	..	..	..
5	4/8	Edmundson's Elec. Corp. Ord.	6⅛—6⅜	5 9 9	H'lf-yearly	6⅛	6⅜
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6¼	4 16 0	..	6⅛	6⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105 —108	4 3 10	..	..	..
2	1/7½	Electric Construction Co.	1 —1½	6 8 0	July	1⅛	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2 —2½	5 12 0	July	2⅛	..
St.	4%	Do 4 per Cent. 1st Mort. Deb. (red.)	96 —99	4 0 9	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 —9½	5 5 3	..	9⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91 —96	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½—11½	6 1 9	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 —111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	19 —20	5 0 0	Feb, Aug	..	..
10	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11½	4 8 10	Mar, Sept	..	..
15	12/0	Telegraph Construction & Maintenance	36 —39	6 3 1	Mar, July	37½	36
10	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 6	Jan, July	..	..
5	..	Willans and Robinson Ord.	1 —2	..	Apr, Oct	7⅝	7⅝
5	..	Do. 6 per Cent. Cum. Pref.	2 —3	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	75 —80	5 1 0	May, Nov	..	..

Share.	Last Dividend	Name.	Price Wed., Oct. 12.	Rate per Cent. Yielded.	Dividend Due.	Business Week to Oct. 12. Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d.			
..	..	Blackheath & Greenwich Dist. El. Lt. See South Metropolitan Elec. Lt. & Power Co. below	.. —..	..	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	12½	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 —106	4 5 9	..	..	..
5	..	Bromley (Kent) El. Lt. & Power Shares	5½—5¾	..	..	..	..
St.	4½%	Do. 1st Debs	102 —105	4 7 9	..	103½	103
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	10⅝	10⅜
5	3/6	Do. 7 per Cent. Pref.	10½—10⅝	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7⅛ — 8	4 7 6	..	7⅛	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	107 —110	3 13 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8½ — 9	4 8 9	Feb, Aug	8⅝	..
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 1 10	Feb, Aug	5⅝	5⅜
5	2/3	Do. City Undertaking 4½% Cm. Pref.	5⅛—5	4 10 0	..	..	..
5	2/3	Do. Do. (1903)	4⅝—5	..	..	4⅝	..
St.	4%	Do. 4% Deb. Stock (red.)	103 —106	3 17 8	..	104	..
5	2/3	Chelsea Electric Supply Ord.	6½—7	4 2 2	March	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108 —111	4 1 9	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	10½—11⅜	4 18 0	Feb, Aug	10⅛	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅜	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	120 —125	4 0 0	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103 —106	4 5 9	..	103½	105
10	4/0	County of London Elec. Supply Ord.	8¼—9¼	4 4 3	..	8⅜	8⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—12	5 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	105 —108	4 3 6	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	102 —105	4 7 5	..	..	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 —93	5 7 6	..	..	..
..	..	Folkestone Electricity Supply Co. Ord.	5¼—6	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 —104	4 7 6	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
5	5/0	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St (red.)	101 —103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm. Prf.	⅛—¼	..	..	..	..
5	5/0	Kensingtn & Knghtsbdge Ord.	12 —13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6¾—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —104	3 17 3	..	..	..
3	..	London Electric Supply Ord.	1⅞—2⅛	..	..	..	..
5	3/0	Do. 6 per Cent. Pref.	5 —5⅛	5 9 1	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	97 —100	4 1 0	Mr, Jn, S, D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	15⅜—16⅛	5 10 8	April, Oct	16⅛	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅛—5⅜	4 0 0	Jan. July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	112 —117	3 18 0	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 — 99	3 10 6	..	98½	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	93 —96	4 13 9	..	..	..
10	6.0	Notting Hill Electric Ord.	14½—15½	3 17 6	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	99 —102	3 18 6	..	..	..
5	2/6	Oxford Electric Ord.	5⅜—6½	5 4 0	March	6	5⅛
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 0	..	..	..
1	..	Rand Electric	1⅛—1⅜	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mt. Deb	98 —101	4 9 0	April, Oct	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	14½—15½	4 18 7	Feb, Aug	15⅜	..
5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 —101	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2⅜—3½	6 8 1	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 — 87	4 12 6	..	..	..
5	3/0	South London Electric Supply Ord.	4⅛—4⅜	3 3 1	..	4⅛	4⅛
1	..	South Metrop'n Elec. Lt. & Power Ord.	¾—1	..	..	1⅛	..
1	0/8½	Do. 7% Cum. Pref.	1⅛—1⅜	4 13 4	..	1⅛	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	104 —108	4 3 8	..	..	..
5	2/6	Urban Electric Supply Ord.	4⅜ 5	5 0 0	..	5	4⅛
5	2/6	Do. 5% Cum. Pref.	4⅜—5	5 0 0	..	4⅛	..
St.	..	Do. 4½ 1st Mort. Deb.	100 —102	..	..	..	..
5	6/6	Westminster Electric Supply Ord.	12½—13⅛	5 0 0	Mar, Sept	13⅛	13⅛
5	2/6	Do. 5 per Cent. Cum. Pref.	6½—6¾	3 14 0	..	..	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 19 0	Jan, July	..	..
10	..	Amazon Telegraph	2¼—3¼	..	Jn, Dec	..	..
St.	12/6	Anglo-American	50 —55	5 5 9	F, My, Ag, N	50½	..
St.	25/0	Do. Preferred	93 —98	5 12 8	F, My, Ag, N	98½	97
St.	2/0	Do. Deferred	8 —8¼	1 3 2	F, My Ag, N	8⅜	8
100	82	Commercial Cable Capital Stock	170 —190	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93 —96	4 3 6	Jn Ap, Jy, O	94½	93⅜
10	5/0	Cuba Submarine Ord.	7 —8	7 10 0	Feb, Aug	7⅜	..
10	10/0	Do. Preference 10 per Cent.	15 —16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅝—101⅞	4 9 2	Jan, July	..	..
20	3/0	Direct United States Cable	10½—10¾	5 11 3	Ja, Ap, Jy, O	..	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —102	4 9 6	Jn, Dec	..	..
St.	66/0	Eastern Ordinary	132 —137	5 2 1	Ja, Ap, Jy, O	136	132
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —90	3 18 6	Ja Ap, Jy, O	89½	88
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106 —109	3 14 3	May, Nov	108	106½
10	2/6	Eastern Extension	12½—13	5 7 9	Ja, Ap, Jy, O	18	12⅞
St.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 14 3	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	100 —103	3 18 6	Feb, Aug	101½	100
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101⅞—104⅞	3 18 3	May, Nov	..	..
10	5/0	Gt. Nrthn. (of Copenhagen)	22½—23½	5 1 9	Jan, July	..	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100 —102	4 9 6	June, Dec	..	..
25	37/6	Indo-European	44 —47	5 6 4	May, Nov	45	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..
10	6/0	West African Telegraph Shares	6 —7	5 14 3	..	..	..
2½	..	West Coast of America	⅛—¼	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 6	Jan, July	..	..
10	..	West India and Panama	⅝—¾	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½—7	8 11 5	May, Nov	7	6½
..	..	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 17 10	Jan, July	..	..
10	8/0	Western Telegraph	12½—13	5 7 9	Mr, Jn, O, D	12⅛	11⅞
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —104	4 16 3	June, Dec	..	..
St.	..	Do. 4% Deb. Stock (red.)	101 —104	3 17 6	..	102½	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5 —5½	6 7 3	August	5⅜	..
1	0/7½	Monte Video Telephone Ord.	⅛—¼	..	..	..	..
St.	6%	National Co. Pref. Stock	104 —106	5 13 9	..	105⅜	104½
St.	5%	Do. Def. Stock	92 —94	5 6 5	..	93⅞	93½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 8	Feb, Aug	13⅛	13⅛
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11 —13	4 12 4	Feb, Aug	11⅞	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5¾	4 13 0	Feb, Aug	5⅞	5½
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 —99	3 10 8	June, Dec	98⅜	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104 —106	3 15 9	..	106½	..
..	5/9	Do. Do. Prov. Certs. 35% to be pd.	67 —69	..	..	67½	..
1	0/8½	Oriental	⅝—1⅛	6 6 8	April, Oct	1⅜	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	¼—1¼	4 16 0	..	..	..
5	5/0	United River Plate	6 —6½	6 3 3	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5¾	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103 —106	4 14 4	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½—5½	5 14 4	..	..	..
10	2/0	Globe Telegraph and Trust	9¼—9⅝	5 12 8	Ja Ap, Jy, O	9⅝	9⅜
10	3/0	Do. 6 per Cent. Pref.	12¾—14¼	4 4 3	Ja Ap, Jy, O	13½	13½
100	6%	Submarine Cables Trust (Cert.)	119 —124	4 19 3	April, Oct	98½	98⅜
..	86/7	Underground Elec. Rys. Co. of London 5% Profit Sharing Secured Notes	98½—99	..	..	..	..

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